YUKON GOLD ICE PAD TUNDRA VEGETATION ASSESSMENT: 1993 Through 1995

Final Report

LGL ALASKA RESEARCH ASSOCIATES, INC.
4175 Tudor Centre Drive, Suite 101
Anchorage, Alaska 99508

For

BP EXPLORATION (ALASKA) INC.
P.O. Box 196612
Anchorage, Alaska 99519-6612

In Compliance to Department of the Army Permit Number 4-930426 (Staines River 1)

29 March 1996

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Prepared By

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EXECUTIVE SUMMARY

This report describes results from the second growing season after melt of the 1992–1994 Yukon Gold ice pad, located approximately 5 km west of the Staines River at T8N, R23E, Sect. 13, Umiat Merdian, Alaska. In 1993, a baseline vegetation study was conducted to characterize the tundra vegetation in the area surrounding the multi-season ice pad. In 1994, the first growing season after the ice pad was allowed to melt, live vegetation cover within the pad footprint was compared with control sites outside of the pad footprint. All classes of vegetation for paired control and impact plots were reduced in 1994; live vegetation ($t = 4.703$, $p<0.0001$), graminoid ($t = 4.998$, $p<0.0001$), forb ($t = 2.716$, $p=0.0123$), shrub ($t = 4.733$, $p<0.0001$), and combined vascular plant cover ($t = 7.564$, $p<0.0001$). The threshold of ≥70% of control live vegetation was not met, requiring continuation of monitoring in 1995.

In 1995, significant differences in live vegetation ($t = 6.801$, $p<0.0001$), graminoid ($t = 6.062$, $p<0.0001$), shrub ($t = 4.709$, $p<0.0001$), and combined vascular plant cover ($t = 8.234$, $p<0.0001$) were measured between paired control and impact plots. In association with these differences in live cover was a significant increase in barren cover ($t = -6.927$, $p<0.0001$) within the pad footprint. Non-vascular plant cover, primarily mosses, and forb cover were not different between control and impact plots.

The live vegetation cover within the pad footprint was 67% of the control area in 1994 and 66% in 1995. With the addition of 50% of the control taxa standard deviation, percent of control live vegetation cover within the pad footprint was 53% of the control area in 1994 and 58% in 1995. Because the impact to live cover was greater within the 2 m edge zone, the overall recovery within the pad footprint may be more accurately described by omitting the edge plots. When the edge zone is excluded, the percent of live vegetation within the pad footprint increased to 75% of the control area.

There was no evidence of thermokarsting or subsidence of the tundra surface except in the area of the well head and the short trench on the south edge of the pad footprint. The most obvious ice pad impacts were compaction and decreased live cover on strangmoor ridges, and decreased live cover at the pad edges. New graminoid seedling growth was observed. Forbs have apparently already returned to normal levels within the impact area. Strangmoor ridges may be visibly impacted for a much longer period. The effects of the multi-year Yukon Gold ice pad appear to be similar to effects of ice roads, seismic trails and snow pads, except for the lack of decrease in non-vascular plant cover and lack of increased thaw depth for the pad area. Recovery should continue in a similar fashion for several additional years.

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INTRODUCTION

In the winter of 1992–1993, BP Exploration (Alaska) Inc. (BPXA) constructed the Yukon Gold ice pad approximately 16 km south of Point Thomson and 5 km west of the Staines River at T8N, R23E, Sect. 13, Umiat Merdian, Alaska. The pad was insulated over the 1993 summer and was subsequently used to support equipment for drilling an exploratory well during the 1993–1994 winter. During summer 1993, BPXA and LGL Alaska Research Associates, Inc. (LGL) initiated a study to evaluate the potential effects of this ice pad on tundra vegetation. Using ice pads which are maintained over the summer is a new approach to oil exploration in the arctic, and therefore the effects on tundra vegetation are unknown. There are studies which document the effects of compaction on tundra vegetation from winter ice roads (Brown and Grave 1979; Walker and Webber 1980; Walker et al. 1987), but with an ice pad which is maintained over the summer, the vegetation also loses a growing season. This study evaluates the joint effects of compaction and loss of a growing season on tundra vegetation, and documents tundra damage resulting from sources other than the ice pad.

In summer 1993, the vegetation and plant cover in the area surrounding the ice pad was characterized (Kertell 1993), with the goal of evaluating the effects of the multi-year ice pad on plant cover during subsequent monitoring. Impact live vegetation cover measured during summer 1994 was 53% of control live cover, when calculated with the addition of 50% of the cumulative control cover standard deviation. This was less than the threshold 70% of control live cover required by permit to suspend further monitoring. These results necessitated a continuation of live cover monitoring during summer 1995 (Schick and Noel 1995).

All three years of monitoring data (1993 to 1995) are summarized within this report (Appendix A through D). Live vegetation cover and species composition in the area surrounding the pad and within the footprint of the pad for 1994 and 1995 monitoring data (Appendix C and D) are compared to evaluate the impact of the ice pad on pre-existing tundra vegetation. Results of 1995 monitoring are compared to 1993 and 1994 monitoring data. Moss species identifications previously unavailable for 1994 data are presented. The Yukon Gold Monitoring Plan: Vegetation 1993–1996 which provides the basis for this study is presented in Appendix E.

METHODS

Study Design and Sampling

The study design involves sampling the vegetation surrounding the ice pad (control plots), and sampling the vegetation in the "footprint" of the pad (impact plots) after it melted in summer 1994 (as per the Yukon Gold Monitoring Plan, Appendix C). The study is modeled after a general impact assessment study design presented by Stewart–Oaten et al. (1986), and is designed so that possible differences in plant phenology or sampling dates among years are controlled for experimentally by sampling paired control and impact sites in each year. Plant phenology or live plant cover may vary among years, for example, due to a substantially late or early snow melt relative to the other years or disparate sampling dates. This experimental design detects impacts independent of these potentially confounding effects. The detection of an impact depends on the assumption that the vegetation and plant cover around the perimeter of the pad (where control plots were sampled in 1993) did not differ, before development, from the vegetation and plant cover under the pad (where impact plots were sampled in 1994 and 1995). That is, any differences found in vegetation and plant cover between control and impact sites must be assumed to be due solely to the effect of the ice pad.

We evaluated this assumption in 1994 by scrutinizing large scale (1955, 1:53,000 black and white, and 1979, 1:60,000 color infra-red) pre-development aerial photographs and determined the vegetation under and around the pad appeared homogeneous. This area was fairly uniform in vegetative cover, with little variation in color or texture. Because vegetation under the pad looked similar to the surrounding area in pre-development photographs, the assumption that the two areas did not differ was considered valid (Schick and Noel 1995). The area where the Yukon Gold ice pad was placed is within a large expanse of wet strangmoor vegetation which stretches for several kilometer in all directions.

In 1993, 25 paired plots (50 total plots) were sampled outside the ice pad boundaries from 13–16 July (Kertell 1993). These data indicated that the undisturbed vegetation surrounding the pad was statistically homogeneous on a large scale, and that this intensity of sampling was sufficient to overcome micro-geographic differences in vegetation and plant cover. In 1994, we sampled at the same intensity, although later in the season, 2–4 August, to gather data on taxa missing from the 1993 data. In particular, grasses and some forbs are not conspicuous on the Arctic Coastal Plain until August, and many of these taxa were absent from the 1993 data (Kertell 1993). This change did not result in early flowering taxa being underrepresented, because early flowering taxa were not yet senescing, and were still identifiable by fruit and

vegetative structures in early August. In 1995, sampling was conducted on 27–29 July, grasses and forbs were in flower.

Vegetation sampling was conducted using the point method. This method is the preferred technique for measuring cover in low growing vegetation (Mueller–Dombois and Ellenberg 1974; Hays et al. 1981). Vegetation sampling was conducted using a $1m^2$ frame constructed of 1" aluminum bars fitted with adjustable legs at each corner (Kertell 1993) (Fig. 1). This frame is subdivided into 100 square decimeters by monofilament line wrapped at two levels to create a "crosshair" sighting device (Fig. 1). Five randomly selected locations were used in each of the ten rows for a total of 50 sample points. Within the frame, sample points for each plot were determined by sighting through the frame's "crosshairs" and recording two specific points of intersection, one in the canopy and one on the ground. These intersections are termed "hits." After recording sightings at both the canopy and ground layers for a sample of 50 points in a plot, a new plot location was selected and the process was repeated.

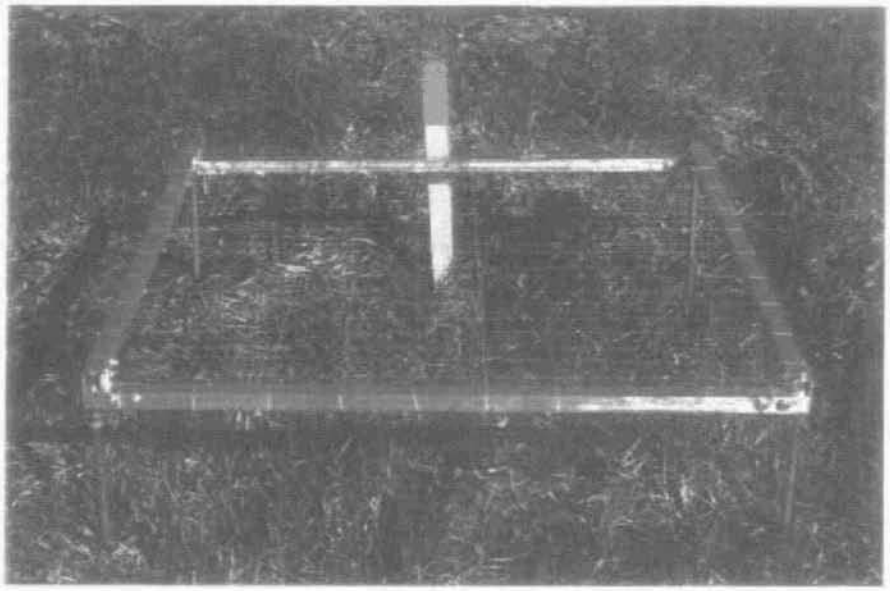
These data permit calculations of percent cover as follows:

$$\%\ Cover = \frac{number\ of\ hits\ for\ species\ A}{total\ number\ of\ sample\ points = 50} \times 100$$

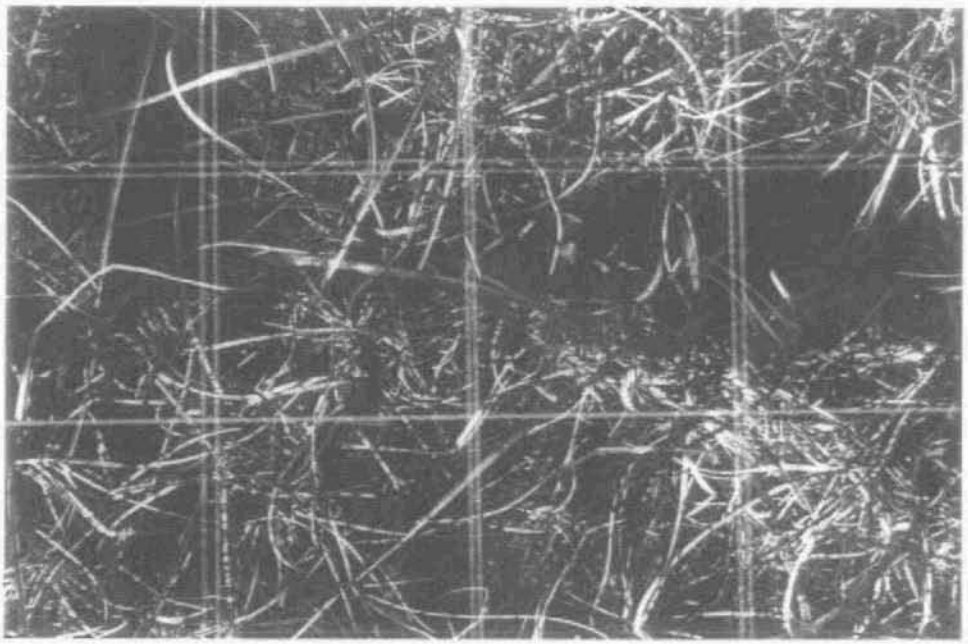
This results in a total possible ground cover of 200%, 100% for the canopy layer and 100% for the ground layer.

In 1993, estimates of percent cover were obtained by recording only the first hit from each "crosshair" sighting; i.e. either canopy or ground hits, not both, were recorded. This approach resulted in a maximum of 50 hits per m^2 plot and a maximum cover value of 100% for all categories combined. This methodology results in an accurate estimate of plant cover at the canopy level, but underestimates the ground cover of mosses and lichens (Kertell 1993). To more adequately describe this two layered plant community, in 1994 and 1995 we recorded both the first canopy hit and the ground layer hit for each "crosshair" sighting as explained above. This allowed us to more accurately determine the impact of the Yukon Gold ice pad upon both the vascular plant community and the non–vascular plant community. Where 1993, 1994 and 1995 data are compared, a total possible ground cover of 100% is used by combining canopy and ground cover for 1994 and 1995 and dividing by the total 100 hits per 50 sample points.

In 1994 and 1995, we sampled 25 control plots outside the boundary of the ice pad, and 25 impact plots within the boundary of the melted ice pad (Fig. 2 and 3). Prior to sampling, we located the reinforced steel rods ("rebar") placed at the pad boundary corners and marked the



A.



B.

Figure 1. Sampling frame used for point–method vegetation sampling at the Yukon Gold site, Alaska, for monitoring studies during 1993 to 1995, photo 29 July 1995. A.—view of frame within ice pad footprint. B.—close–up view of cross–hairs at location outside the pad footprint.

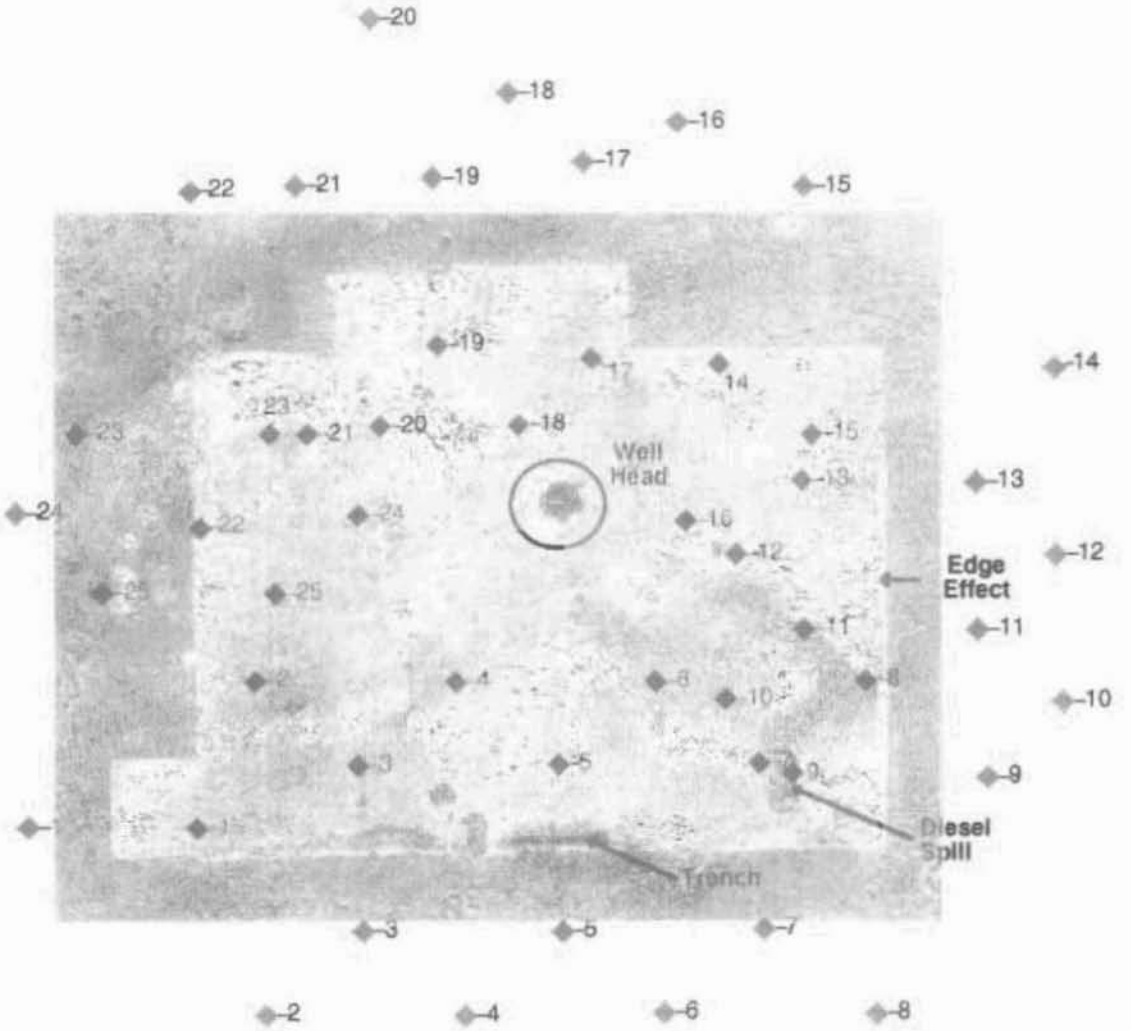


Figure 2. Sample locations for paired vegetation plots at the Yukon Gold site, Alaska, for data collected 2-4 August 1994, with references to visual impacts (1994 color infrared photo). Plot numbers refer to data in Appendix C.

Yukon Gold Ice Pad - 1995 (2nd Summer Post Melt)

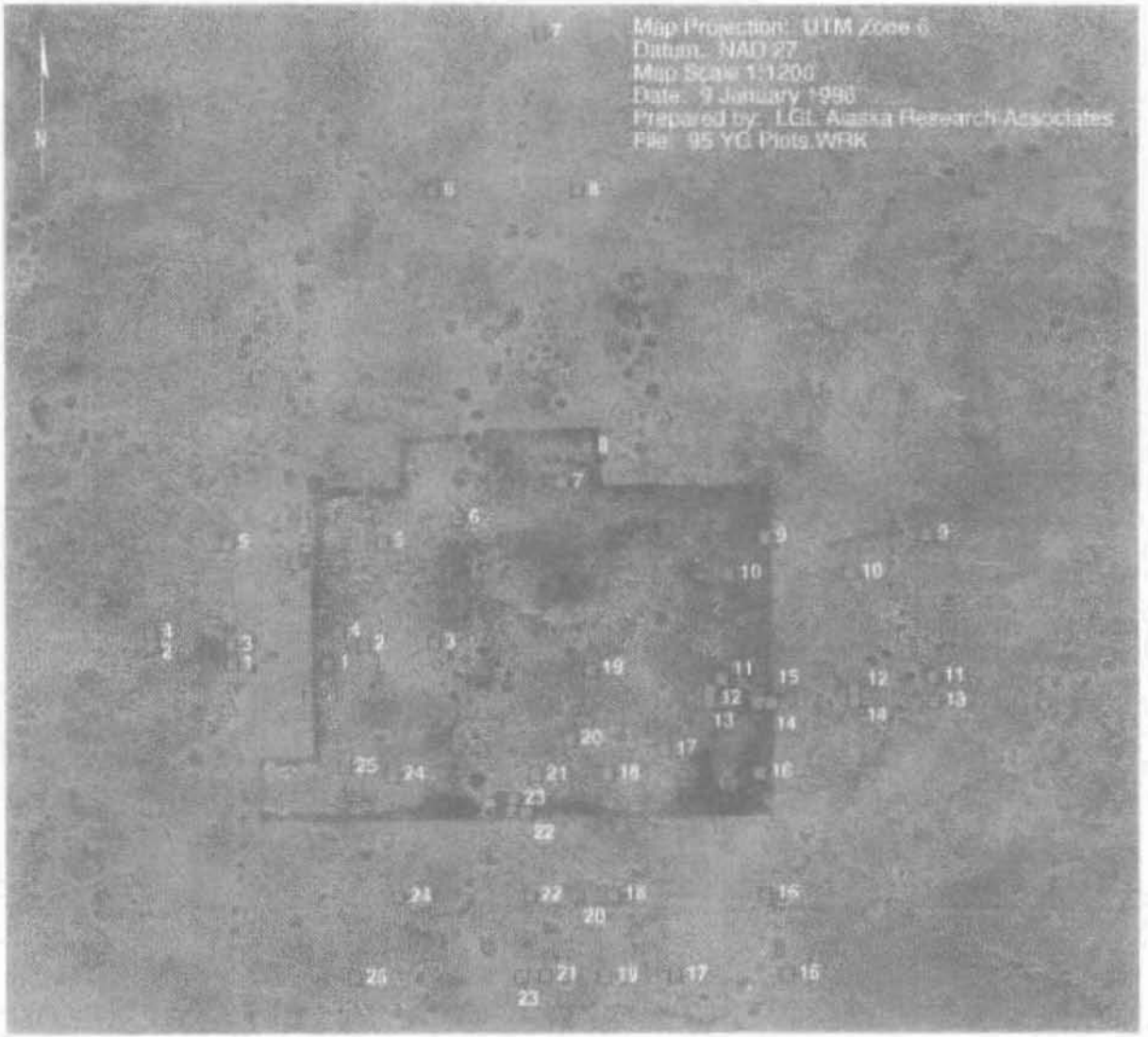


Figure 3. Sample locations for paired vegetation plots at the Yukon Gold site, Alaska, for data collected 27-29 July 1995 (10 August 1995 color infrared photo). Plot numbers refer to data in Appendix D.

boundary of the ice pad with laths to delineate control and impact areas. The boundary of the ice pad remained obvious from compaction of vegetation and increased plant mortality at the edge of the pad footprint. Impact plots were randomly sampled within a numbered grid overlaying the ice pad map. Areas impacted by the well head, trench, and diesel spill were removed from sampling. Impact sites were located by measuring from the nearest pad corner and then perpendicular and within the pad boundary. The corresponding control plots were then located using either 20, 40, 60, or 100 m distances perpendicular and away from the pad boundary. Both control and impact plots in each pair were sampled on the same day. An area to the north of the pad site was used to pile snow, removed while the ice pad was in use. This resulted in some minor, patchy disturbances such as trash accumulation and scrapes on the tundra surface. In this area, control sites were located by moving 60 and 100 m away from the pad boundary.

Data Analysis

The null hypothesis tested in this study was:

Ho: There is no difference in plant cover between the area previously covered by the Yukon Gold ice pad and the surrounding control area.

Test: Paired *t* tests were used to compare plant cover values in impact versus control plots.

Plot data were analyzed in two ways. First, vegetation plot data were pooled and mean percent cover for impact and control plots were calculated to illustrate the relative contribution of the different cover types (complete data for 1994 in Appendix C, Table C–1 and C–2; for 1995 in Appendix D, Table D-1 and D-2). Second, two-tailed paired-sample *t* tests were used to test for differences in cover values between paired impact and control plots. We conducted paired tests for each taxon separately and for natural groupings (graminoids, forbs, shrubs, vascular plants, and non-vascular plants) to evaluate responses of specific taxa and the vegetation as a whole to compaction and the loss of a growing season. Finally, percent cover was calculated to determine the "Percent of Control" vegetation for compliance with the Yukon Gold Monitoring Plan (Appendix E).

RESULTS

Description of the Area

The site of the now-melted Yukon Gold ice pad lies within a large area of continuous wet graminoid, dwarf shrub tundra (Walker and Webber 1980), which extends nearly unbroken for

several kilometers in all directions and slopes very gradually and almost imperceptibly down to the Staines River some 5 km to the east. A small, beaded stream occurs approximately 1.5 km to the west. Prominent micro-sites in the area are the abundant strangmoor ridges and the somewhat less common frost boils. The area is apparently completely flooded with melt water in early spring (Declan Troy, pers. comm.). By mid-July, the area was fully drained, but heavy rains prior to sampling on 27–29 July left flooded tundra and saturated soils across most of the sampling area. The peat soils in the area contain a large component of gravel not far below the tundra surface and this may contribute to the relatively good drainage in the area.

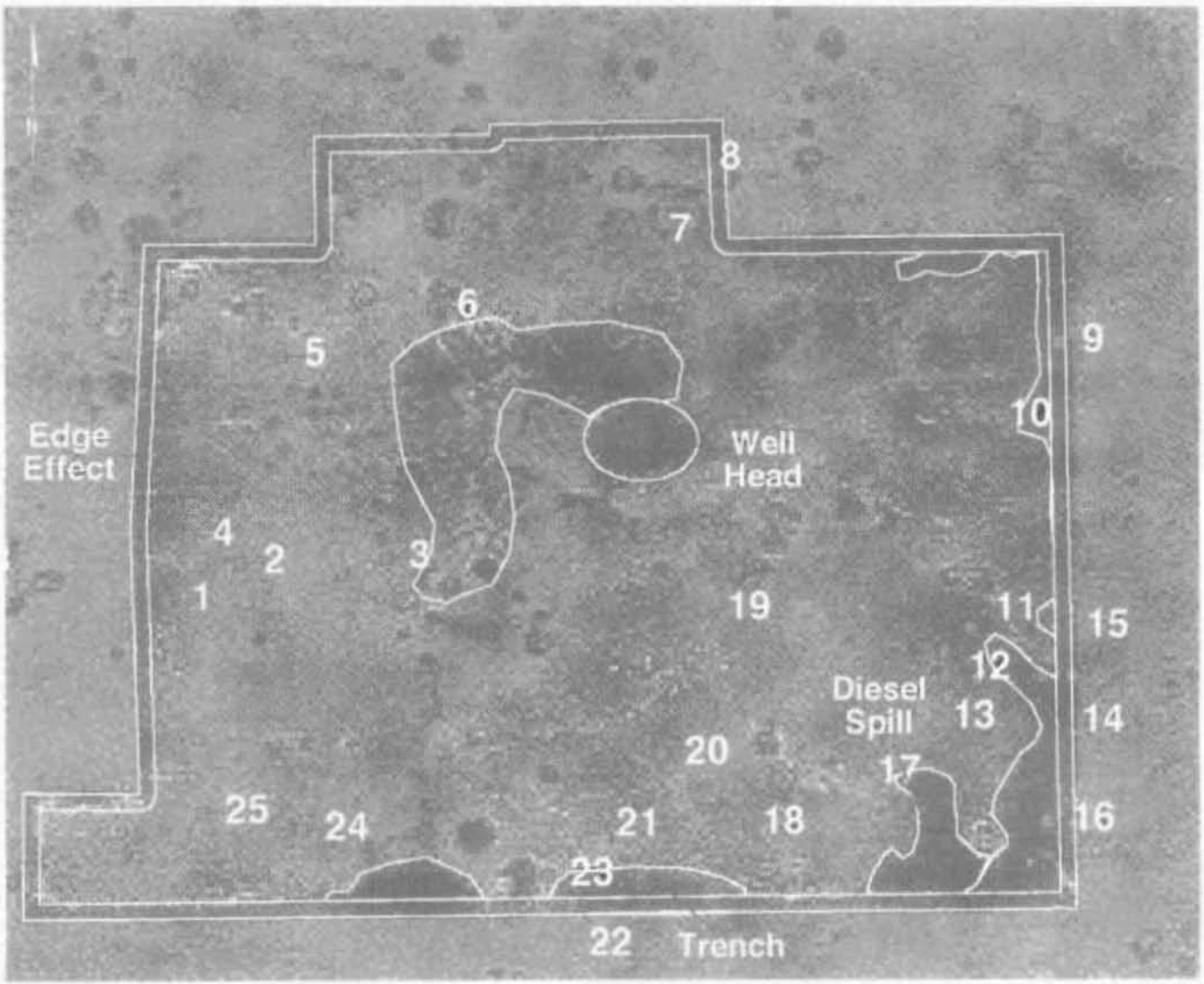
There were several impacts from the ice pad visible in 1995 (Fig. 4).

1. The prominent "edge effect" described in 1994 was still clearly discernible because of the increase in dead vegetation (Fig. 5) and visible standing water (water appears black on color infrared, Figs. 3 and 4). The edge varied in width, but was roughly 1 m covering approximately 0.22 acres, or 8% of the pad area. Edge plots 9, 15, and 22 averaged 10% live cover in 1995 (Fig. 4, Appendix D).

2. Several additional irregularly shaped areas of plant mortality extended from the edge into the pad's footprint, especially along the east pad edge and at one location on the south pad edge. These areas were less conspicuous and generally showed greater vegetative recovery than the edges. Plots 14 and 16 within these areas averaged 25% live cover (Fig. 4, Appendix D). However, some of the mortality along the east edge of the pad footprint may be a result of surface water spread of a nearby diesel spill.

3. The strangmoor ridges within the pad area continued to show damage due to compression and, in a few cases, scraping. These areas appear as light worm-like tracks on the color infrared image (Fig. 4). In contrast, the intervening, low-lying wet areas sometimes appeared scarcely different from similar areas outside of the pad. Figure 6 illustrates the lack of vascular plant cover on ridges and the damaged moss mat, especially as compared to a nearby normal ridge.

Yukon Gold Ice Pad - 1995 (2nd Summer Post Melt)



Disturbed Areas Within the Pad Perimeter

Description	Acres
Pad Footprint	2.65
Edge Effect	0.22
Well Head	0.03
Trench	0.02
Diesel Spill	0.03
Unknown Cause	0.23

Color Infrared photo taken 10 August 1995, by Aeromap U.S., Inc. Photo has been modified to enhanse contrast.

Map Projection: UTM Zone 6
Datum: NAD 27
Map Scale 1:600
Date: 4 October 1996
Prepared by: LGL Alaska Research Associates
File: 96 YG Pad Impacts.WRK

Figure 4. Color infrared photo of the Yukon Gold site, 10 August 1995, showing disturbances and vegetation sampling plots for 27-29 July 1995. Plot numbers refer to data in Appendix D.

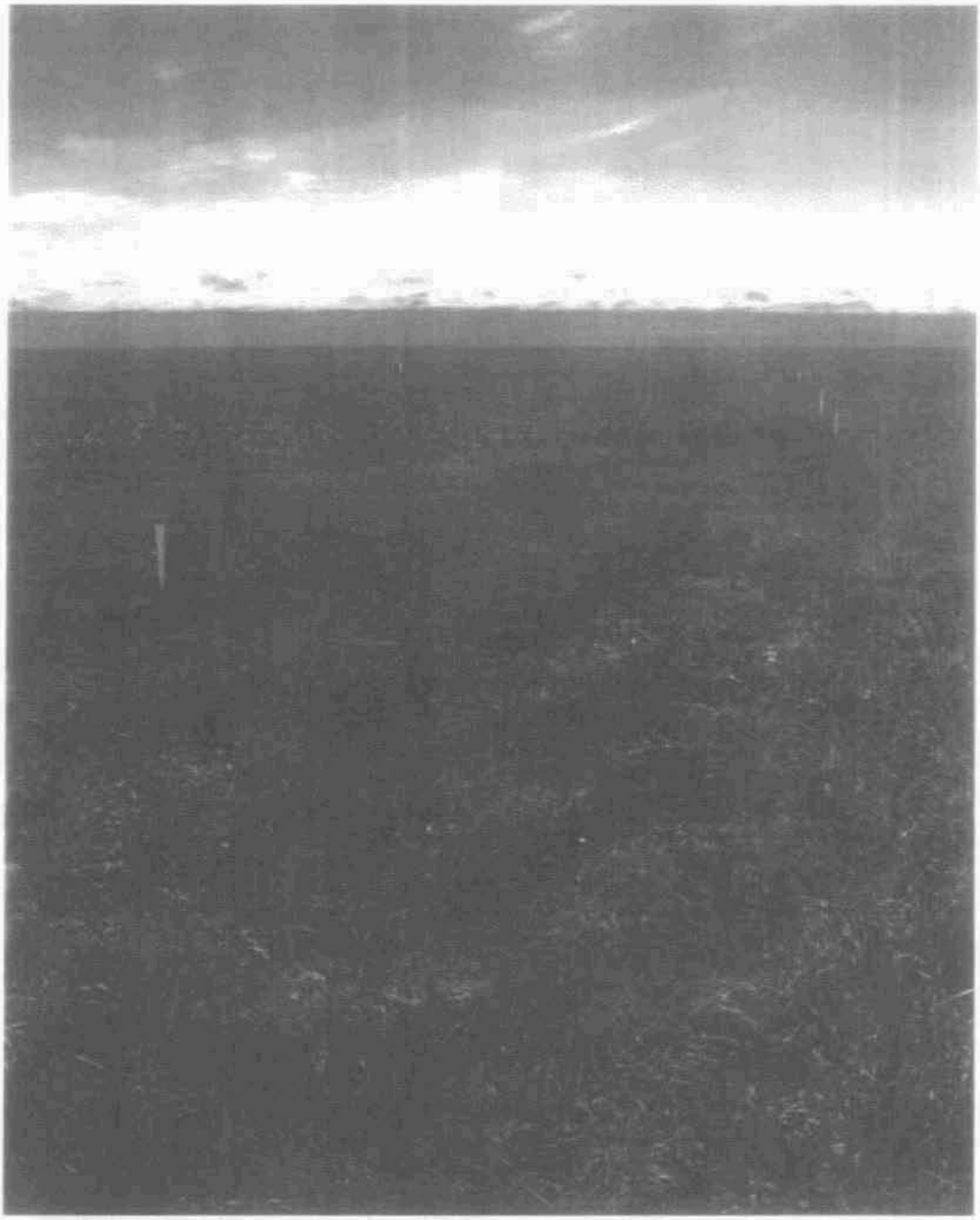


Figure 5. East edge of the Yukon Gold site footprint, Alaska, illustrating vegetation recovery within the "edge effect" after two growing seasons. Edge effect is distinguishable because of reduced live cover and reduced standing dead vegetation, photo 29 July 1995.

A.

B.

Figure 6. Strangmoor ridges within and outside the Yukon Gold site footprint, Alaska, illustrating the effect of compaction and the extent of recovery after two growing seasons, photos 29 July 1995. A.—strangmoor ridge within pad footprint. B.—strangmoor ridge outside of pad footprint.

In addition there were several impacts not directly attributable to the ice pad, but which resulted from drilling activities. These areas cover between 0.24 and 0.28 acres or about 9 to 10% of the ice pad footprint area in 1994 (Fig. 4).

1. The area surrounding the well head had subsided to ≥ 1.3 m depth (Fig. 7). This depression was filled with water during sampling and covered approximately 0.03 acres, or 1%, of the pad area. The area of decreased live cover near the well head, which may be due to the temporary storage of drilling cuttings on the ice pad, covers approximately 0.15 acres, or 5%, of the pad area (Figs. 4 and 7).

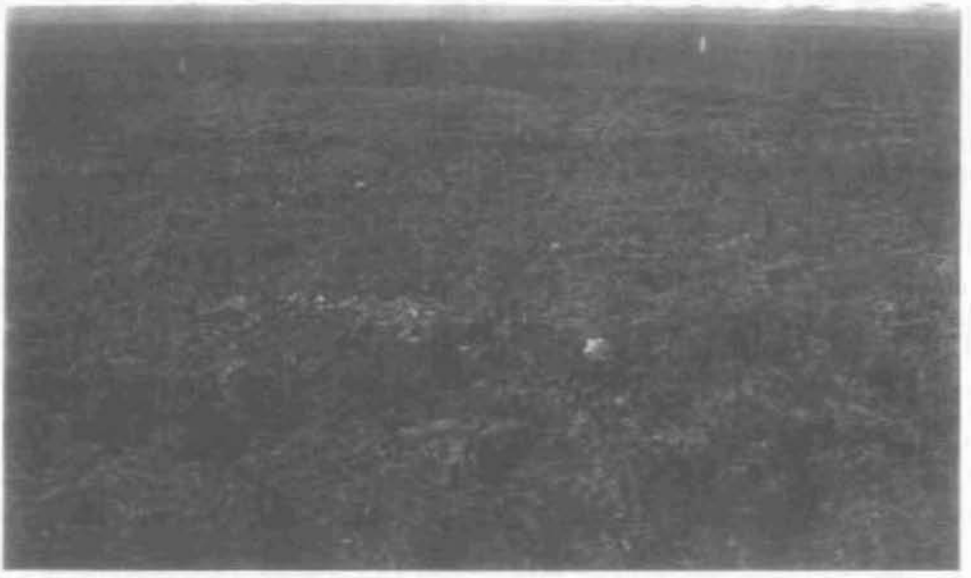
2. An area of tundra vegetation approximately 0.03 acres or 1% of the pad area, located in the southeast corner was impacted by a diesel fuel spill (Figs. 4 and 8). It may be likely that a portion of the area in the pad corner was impacted by spreading of the diesel spill by surface water, possibly increasing the impact area to 0.08 acres, or 3%, of the pad area. Some live vegetation was beginning to grow within the diesel spill area.

3. A small trench up to 0.6 m deep and 1 m wide was dug to provide space for camp utility lines. This area covers about 0.02 acres or 0.8% of the ice pad area (Figs. 4 and 9).

Pooled Plot Analyses

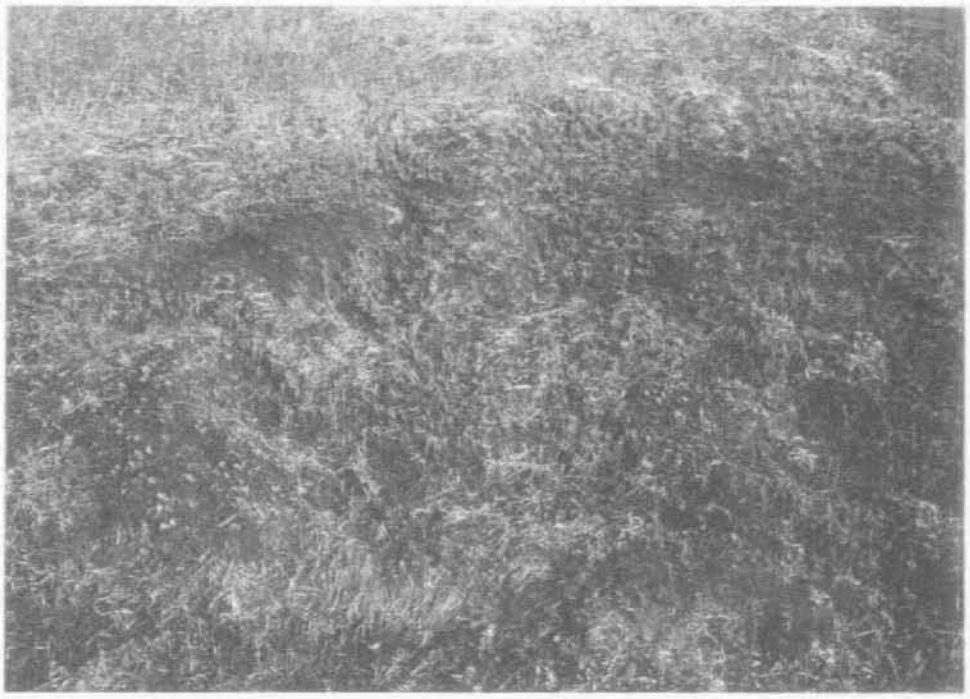
Vegetation plot data were pooled to calculate means for the number of hits and percent cover of both natural vegetation groupings (Table 1) and individual plant taxa (Table 2 and Table 3) for control and impact plots during 1994 and 1995. Variability around each mean is described as plus and minus (±) one standard deviation (SD). Mean percent cover for total live vegetation averaged lower within the "footprint" of the pad compared to surrounding tundra in both 1994 and 1995 (Table 1), but variation and ranges for individual plots were large (Fig. 10). Mean cover of dead plant material was roughly similar between the control and impact areas, but the No Canopy and Bare Ground categories were higher at impact sites than control sites for both 1994 and 1995. Generally, canopy cover was lower at impact sites due to lower vascular plant cover than at control sites. The ground cover of non-vascular plants, however, was similar at impact and control plots. Vascular plants, primarily graminoid vegetation, dominated the live vegetation category at both impact and control plots, but made up a larger proportion of the total live vegetation at control sites (86%) than at impact sites (77%) in 1995.

A.



B.

Figure 7. Area of subsidence and an area of decreased live vegetation near the well head within the Yukon Gold site footprint, photos 29 July 1995. A.—well head. B.—area of decrease live vegetation near well head.



A.

B.

Figure 8. Diesel spill area within the footprint of the Yukon Gold site, Alaska, photos 29 July 1995. A.—close view of spill area. B.—southeast corner of ice pad footprint and spill area. (Note *Eriophorum* inflorescence in foreground and background.)

Figure 9. Trench on the south edge of the Yukon Gold site, Alaska, facing east, photo 29 July 1995.

Table 1. Mean number of hits and percent cover by vegetation category for impact and control plots at the Yukon Gold site, Alaska, for data collected 2-4 August 1994 and 27–29 July 1995. Data for canopy level and ground level are combined, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
	1994 Data			
	Impact (n=24)		Control (n=24)	
Living Vegetation	30.58 ±10.10	61.16% ±20.20%	45.38 ±14.40	90.76% ±28.80%
Dead Plant Material	36.08 ±12.65	72.16% ±25.30%	33.38 ±18.01	66.76% ±36.02%
Barren Ground	33.33 ±8.52	66.66% ±17.04%	21.25 ±7.77	42.50% ±15.54%
Graminoids	9.08 ±6.35	18.16% ±12.70%	16.96 ±6.49	33.92% ±12.98%
Forbs	0.21 ±0.41	0.42% ±0.83%	0.75 ±0.90	1.50% ±1.79%
Shrubs	0.04 ±0.20	0.08% ±0.41%	2.54 ±2.54	5.08% ±5.07%
All Vascular	9.33 ±6.36	18.66% ±12.72%	20.25 ±5.53	40.50% ±11.06%
All Non-Vascular	21.25 ±12.21	42.50% ±24.42%	25.13 ±15.68	50.26% ±31.36%
	1995 Data			
	Impact (n=25)		Control (n=25)	
Live Vegetation	36.76 ±12.26	73.52% ±24.52%	55.72 ±5.61	111.44% ±11.22%
Dead Plant Material	40.48 ±7.65	80.96% ±15.30%	40.00 ±6.64	80.00% ±13.28%
Barren	22.76 ±13.64	45.52% ±27.28%	4.28 ±2.72	8.56% ±5.44%
Graminoids	26.44 ±13.11	52.88% ±26.22%	42.36 ±3.05	84.72% ±6.10%
Forbs	1.08 ±1.22	2.16% ±2.44%	1.32 ±1.14	2.64% ±2.28%
Shrubs	0.88 ±1.17	1.76% ±2.34%	4.16 ±3.74	8.32% ±7.48%
All Vascular	28.40 ±12.68	56.80% ±25.36%	47.84 ±3.44	95.68% ±6.88%
All Non-Vascular	8.36 ±7.47	16.72% ±14.94%	7.88 ±6.44	15.76% ±12.88%

Table 2. Mean number of hits and percent cover by plant taxa for impact and control plots at the Yukon Gold site, Alaska, for data collected 2–4 August 1994. Data are organized with two hits recorded, one at canopy level and one at ground level, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=24)		Control (n=24)	
	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
Barren				
Bare Canopy or Ground	32.38 ±8.95	64.76% ±17.90%	21.25 ±7.77	42.50% ±15.54%
Gravel	0.96 ±2.44	1.92% ±4.88%	0.00 ±0.00	0.00% ±0.00%
Dead Plant Material				
Litter	24.83 ±11.37	49.66% ±22.74%	21.67 ±13.94	43.34% ±27.88%
Standing Dead	11.25 ±7.62	22.50% ±15.24%	11.71 ±5.52	23.42% ±11.04%
Graminoids				
Carex aquatilis	1.33 ±1.40	2.66% ±2.80%	3.75 ±2.27	7.50% ±4.54%
Carex atrofusca	0.08 ±0.41	0.16% ±0.82%	0.21 ±0.59	0.42% ±1.18%
Carex bigelowii	0.00 ±0.00	0.00% ±0.00%	0.42 ±1.84	0.84% ±3.68%
Carex saxatilis	1.00 ±1.44	2.00% ±2.88%	1.96 ±2.44	3.92% ±4.88%
Eriophorum angustifolium	6.58 ±5.12	13.16% ±10.24%	10.46 ±5.26	20.92% ±10.52%
Juncus biglumis	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Forbs				
Equisetum variegatum	0.13 ±0.34	0.26% ±0.68%	0.25 ±0.68	0.50% ±1.36%
Pedicularis sudetica	0.08 ±0.28	0.16% ±0.56%	0.46 ±0.66	0.92% ±1.32%
Polygonum viviparum	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Shrubs				
Dryas integrifolia	0.00 ±0.00	0.00% ±0.00%	1.13 ±2.23	2.26% ±4.46%
Salix arctica	0.00 ±0.00	0.00% ±0.00%	0.58 ±0.72	1.16% ±1.44%
Salix lanata	0.00 ±0.00	0.00% ±0.00%	0.33 ±0.92	0.66% ±1.84%
Salix reticulata	0.04 ±0.20	0.08% ±0.40%	0.50 ±0.66	1.00% ±1.32%
Non-Vascular Plants				
Lichens	0.04 ±0.20	0.08% ±0.40%	0.13 ±0.61	0.26% ±1.22%
Liverworts	0.04 ±0.20	0.08% ±0.40%	0.08 ±0.28	0.16% ±0.56%
Mosses	21.27 ±12.11	42.54% ±24.22%	24.92 ±15.58	49.84% ±31.16%
Bryum pseudotriquetrum	0.63 ±1.13	1.26% ±2.26%	0.88 ±1.23	1.76% ±2.46%
Hypnum bambergeri	1.38 ±2.22	2.76% ±4.44%	2.04 ±4.29	4.08% ±8.58%
Oncophorus wahlenbergii	0.13 ±0.45	0.26% ±0.90%	0.29 ±0.75	0.58% ±1.50%
Scorpidium scorpioides	13.88 ±9.67	27.76% ±19.34%	13.88 ±11.54	27.76% ±23.08%
Tomenthypnum nitens	5.17 ±8.25	10.34% ±16.50%	7.79 ±11.59	15.58% ±23.18%

Table 3. Mean number of hits and percent cover by plant taxa for impact and control plots at the Yukon Gold site, Alaska, for data collected 27–29 July 1995. Data for canopy level and ground level are combined, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=25)		Control (n=25)	
	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
Barren				
Bare Canopy or Ground	22.76 ±13.64	45.52% ±27.28%	4.28 ±2.72	8.56% ±5.44%
Dead Plant Material				
Litter	39.88 ±7.74	79.76% ±15.48%	39.48 ±6.50	78.96% ±13.00%
Standing Dead	0.60 ±1.00	1.20% ±2.00%	0.52 ±0.65	1.04% ±1.30%
Graminoids				
Carex aquatilis	6.04 ±3.86	12.08% ±7.72%	6.28 ±3.40	12.56% ±6.80%
Carex atrofusca	0.00 ±0.00	0.00% ±0.00%	0.36 ±1.60	0.72% ±3.20%
Carex bigelowii	0.08 ±0.40	0.16% ±0.80%	0.68 ±2.43	1.36% ±4.86%
Carex misandra	0.00 ±0.00	0.00% ±0.00%	0.44 ±0.87	0.88% ±1.74%
Carex saxatilis	1.44 ±2.22	2.88% ±4.44%	4.28 ±4.71	8.56% ±9.42%
Eriophorum angustifolium	18.72 ±11.87	37.44% ±23.74%	29.08 ±5.28	58.16% ±10.56%
Juncus biglumis	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Forbs				
Caltha palustris arctica	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Equisetum variegatum	0.84 ±1.14	1.68% ±2.28%	0.40 ±0.71	0.80% ±1.42%
Pedicularis sudetica	0.04 ±0.20	0.08% ±0.40%	0.48 ±0.65	0.96% ±1.30%
Polygonum viviparum	0.16 ±0.47	0.32% ±0.94%	0.32 ±0.63	0.64% ±1.26%
Saxifraga hirculus	0.04 ±0.20	0.08% ±0.40%	0.08 ±0.28	0.16% ±0.56%
Shrubs				
Dryas integrifolia	0.00 ±0.00	0.00% ±0.00%	1.44 ±1.61	2.88% ±3.22%
Salix arctica	0.68 ±1.03	1.36% ±2.06%	1.52 ±1.64	3.04% ±3.28%
Salix lanata	0.00 ±0.00	0.00% ±0.00%	0.32 ±0.90	0.64% ±1.80%
Salix reticulata	0.16 ±0.37	0.32% ±0.74%	0.76 ±1.51	1.52% ±3.02%
Salix rotundifolia	0.04 ±0.20	0.08% ±0.40%	0.12 ±0.44	0.24% ±0.88%
Non-Vascular Plants				
Liverworts	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Mosses				
Bryum pseudotriquetrum	0.48 ±0.92	0.96% ±1.84%	0.60 ±0.87	1.20% ±1.74%
Distichium sp.	0.00 ±0.00	0.00% ±0.00%	0.36 ±0.76	0.72% ±1.52%
Funaria hygrometrica	0.04 ±0.20	0.08% ±0.40%	0.04 ±0.20	0.08% ±0.40%
Hypnum bambergeri	1.32 ±5.19	2.64% ±10.38%	0.96 ±2.82	1.92% ±5.64%
Oncophorus wahlenbergii	0.00 ±0.00	0.00% ±0.00%	0.20 ±1.00	0.40% ±2.00%
Scorpidium scorpioides	3.16 ±4.20	6.32% ±8.40%	3.52 ±3.56	7.04% ±7.12%
Tomenthypnum nitens	3.20 ±4.99	6.40% ±9.98%	1.68 ±1.99	3.36% ±3.98%

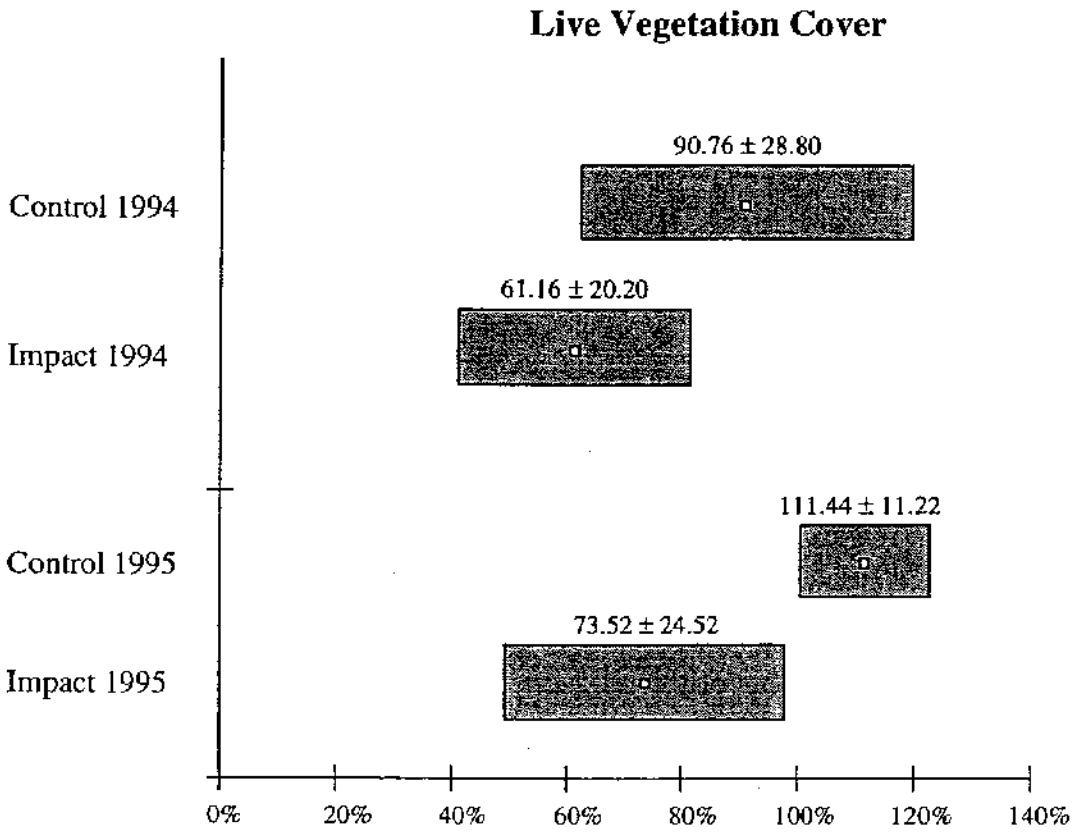


Figure 10. Comaprison of means and standard deviations for 1994 and 1995 percent live vegetation cover at the Yukon Gold site, Alaska.

Eriophorum angustifolium and *Carex aquatilis* dominated the graminoid vegetation at both control and impact plots in 1994 and 1995 (Table 2, and Table 3), although *E. angustifolium* was reduced on impact plots In contrast, forbs and shrubs were not numerous, contributing 10% of live cover at control sites and 4% live cover on impact sites in 1995 (Table 1). Mosses dominated the non-vascular plant cover, specifically *Scorpidium scorpioides* and *Tomenthypnum nitens* (Table 2 and Table 3). Mean cover values from 1993 through 1995 are presented in Table 4. Data for 1994 and 1995 are normalized to a total 100% maximum cover for comparison with 1993 data. The extent of live vegetation recovery within the pad footprint on 29 July 1995 is illustrated in Figure 11.

Paired Plot Analyses

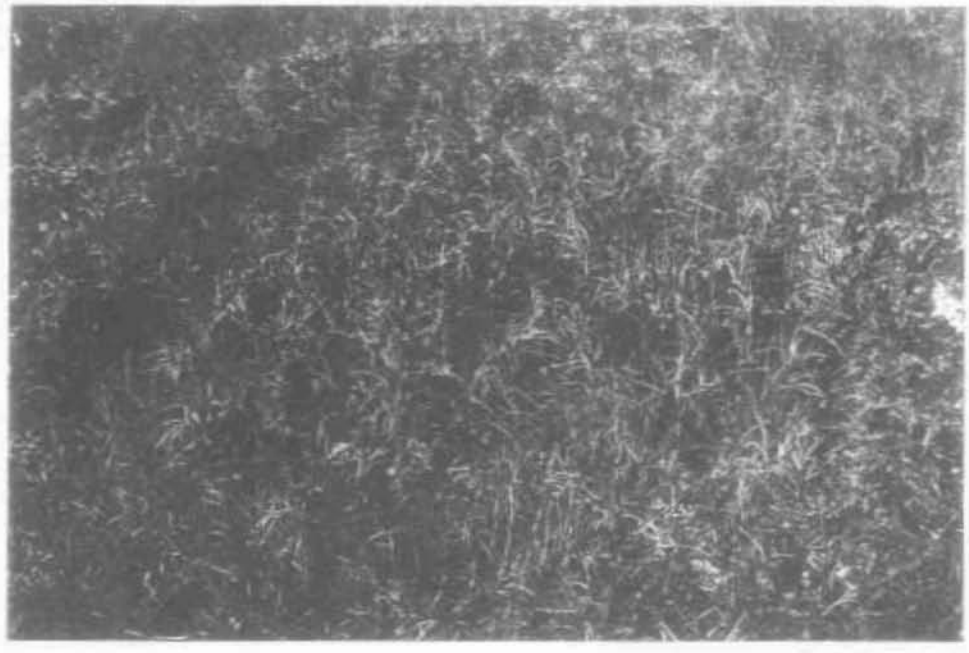
Paired sample *t* tests were conducted on both natural vegetation groupings in 1994 and 1995 (Table 5) and individual plant taxa (Table 6 and Table 7). Total live vegetation, graminoids and shrubs were significantly lower at impact plots ($P < 0.0001$), while barren ground was significantly higher at impact plots ($P < 0.0001$) for both 1994 and 1995. The cover of dead plant material, and non-vascular plants did not differ between control and impact plots ($P > 0.18$) for 1994 and 1995. The null hypothesis is rejected for all live cover categories except forbs in 1995 and non-vascular plants in both 1994 and 1995 (Table 5).

E. angustifolium, C. aquatilis and *Carex saxatilis* dominated graminoid cover. *E. angustifolium,* and *C. saxatilis* were significantly more abundant at control plots in both 1994 and 1995 ($P<0.05$, Table 6 and Table 7). The forb *Pedicularis sudetica,* and the shrubs *Salix arctica, Salix reticulata,* and *Dryas integrifolia* were significantly more abundant on control plots in both 1994 and 1995 ($P<0.05$, Table 6 and Table 7). Non-vascular plants were not significantly different between control and impact plots in either 1994 or 1995 ($P>0.05$). The null hypothesis is rejected for *E. angustifolium, P. sudetica, D. integrifolia, S. arctica,* and *S. reticulata* for 1994 and 1995 (Table 5 and Table 6).

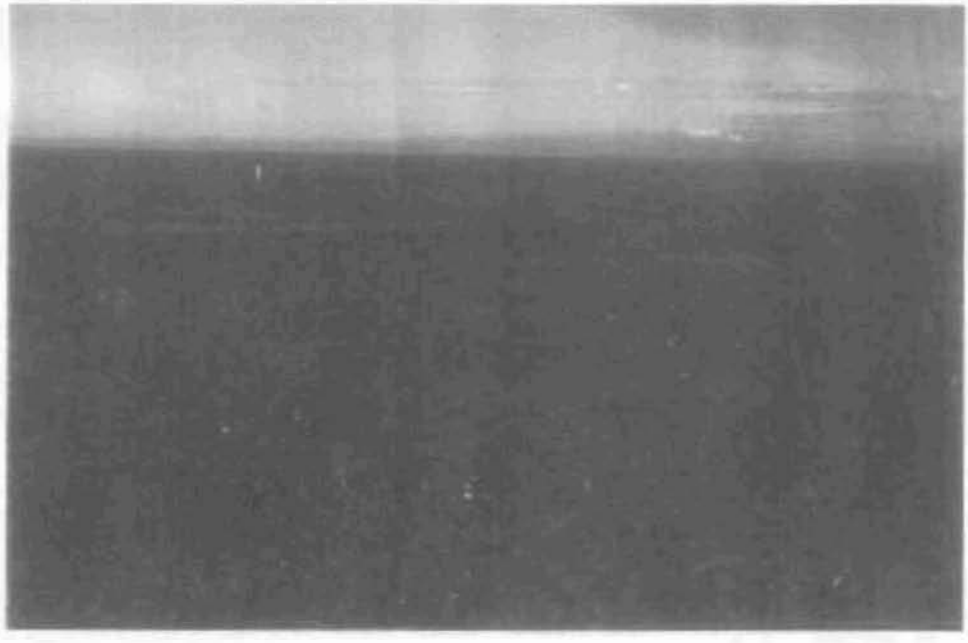
Paired plot comparisons for 1993 through 1995 data are presented for live vegetation and graminoid cover in Figure 12, Tables 8 and 9. The mean difference between paired control plots for 1993 data was near zero. Post-impact 1994 and 1995 data illustrate the decrease in live vegetation and graminoid cover at impact plots as a negative mean difference between paired impact and control plots. There was a slight decrease in the mean difference (greater difference between impact and control plots) from 1994 to 1995 for both live cover and graminoid vegetation; however 95% confidence intervals overlap, so this decrease was not significant (Fig. 12, Tables 8 and 9).

Table 4. Mean number of hits and percent cover by vegetation category for impact and control plots at the Yukon Gold site, Alaska, for data collected 13–16 July 1993, 2–4 August 1994, and 27–29 July 1995. Data for 1993 include only one hit at each data point, while data for 1994 and 1995 include two hits per data point, one at canopy level and one at ground level. Canopy and ground level cover are combined for 1994 and 1995 and are divided by the total 100 points for comparison with 1993 data, yielding a theoretical maximum of 100 percent cover. Standard deviation is abbreviated SD.

	1993 Data		1994 Data				1995 Data			
	Control (n=50)		Impact (n=24)		Control (n=24)		Impact (n=25)		Control (n=25)	
	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
Live Vegetation	17.0 ±5.7	34.0% ±11.4%	30.6 ±12.3	30.6% ±12.3%	45.4 ±5.6	45.4% ±5.6%	36.8 ±12.3	36.8% ±12.3%	55.7 ±5.6	55.7% ±5.6%
Dead Plant Material	29.3 ±4.9	58.6% ±9.8%	36.1 ±7.7	36.1% ±7.7%	33.4 ±6.6	33.4% ±6.6%	40.5 ±7.7	40.5% ±7.7%	40.0 ±6.6	40.0% ±6.6%
Barren	3.7 ±4.0	7.4% ±8.0%	33.3 ±13.6	33.3% ±13.6%	21.3 ±2.7	21.3% ±2.7%	22.8 ±13.6	22.8% ±13.6%	4.3 ±2.7	4.3% ±2.7%
Graminoids	9.7 ±3.7	19.4% ±7.4%	9.1 ±13.1	9.1% ±13.1%	17.0 ±3.1	17.0% ±3.1%	26.4 ±13.1	26.4% ±13.1%	42.4 ±3.1	42.4% ±3.1%
Forbs	0.2 ±0.5	0.4% ±0.9%	0.2 ±1.2	0.2% ±1.2%	0.8 ±1.1	0.8% ±1.1%	1.1 ±1.2	1.1% ±1.2%	1.3 ±1.1	1.3% ±1.1%
Shrubs	2.2 ±2.6	4.3% ±5.1%	0.0 ±1.2	0.0% ±1.2%	2.5 ±3.7	2.5% ±3.7%	0.9 ±1.2	0.9% ±1.2%	4.2 ±3.7	4.2% ±3.7%
All Vascular	12.1 ±3.6	24.2% ±7.2%	9.3 ±12.7	9.3% ±12.7%	20.3 ±3.4	20.3% ±3.4%	28.4 ±12.7	28.4% ±12.7%	47.8 ±3.4	47.8% ±3.4%
All Non-Vascular	4.9 ±5.2	9.9% ±10.3%	21.3 ±7.5	21.3% ±7.5%	25.1 ±6.4	25.1% ±6.4%	8.4 ±7.5	8.4% ±7.5%	7.9 ±6.4	7.9% ±6.4%



A.



B.

Figure 11. Vegetation cover within the Yukon Gold site, Alaska, showing vegetation recovery after two growing seasons, photo 29 July 1995. A.—close view of vegetation cover within ice pad footprint. B.—view to west from within ice pad footprint, right stake is within footprint, left stake is outside footprint.

Table 5. Results of paired-sample t tests comparing impact and control plots by category for data collected 2-4 August 1994 and 27–29 July 1995 at the Yukon Gold site, Alaska. Data for canopy level and ground level are combined, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=25)	Control (n=25)			Accept Null Hypothesis
	Mean No. Hits (±SD)	Mean No. Hits (±SD)	t Value	P Value (two tailed)	(α=0.05)
	1994 Data				
	Impact (n=24)	Control (n=24)			
Live Vegetation	30.58 ±10.10	45.38 ±14.40	4.703	<0.0001	No
Dead Plant Material	36.08 ±12.65	33.38 ±18.01	-0.735	0.4695	Yes
Barren	33.33 ±8.52	21.25 ±7.77	-5.464	<0.0001	No
Graminoids	9.08 ±6.35	16.96 ±6.49	4.998	<0.0001	No
Forbs	0.21 ±0.41	0.75 ±0.90	2.716	0.0123	No
Shrubs	0.04 ±0.20	2.54 ±2.54	4.733	<0.0001	No
All Vascular	9.33 ±6.36	20.25 ±5.53	7.564	<0.0001	No
All Non-Vascular	21.25 ±12.21	25.13 ±15.68	1.377	0.1817	Yes
	1995 Data				
	Impact (n=25)	Control (n=25)			
Live Vegetation	36.76 ±12.26	55.72 ±5.61	6.801	<0.0001	No
Dead Plant Material	40.48 ±7.65	40.00 ±6.64	-0.213	0.8333	Yes
Barren	22.76 ±13.64	4.28 ±2.72	-6.927	<0.0001	No
Graminoids	26.44 ±13.11	42.36 ±3.05	6.062	<0.0001	No
Forbs	1.08 ±1.22	1.32 ±1.14	0.796	0.4339	Yes
Shrubs	0.88 ±1.17	4.16 ±3.74	4.709	<0.0001	No
All Vascular	28.40 ±12.68	47.84 ±3.44	8.234	<0.0001	No
All Non-Vascular	8.36 ±7.47	7.88 ±6.44	-0.223	0.8256	Yes

Table 6. Results of paired-sample t tests comparing impact and control plots by plant taxa for data collected 2–4 August 1994, at the Yukon Gold site, Alaska. Data are organized with two hits recorded, one at canopy level and one at ground level, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=24)	Control (n=24)			Accept Null Hypothesis (α=0.05)
	Mean No. Hits (±SD)	Mean No Hits (±SD)	t Value	P Value (two tailed)	
Barren					
No Canopy or Bare Ground	32.38 ±8.95	21.25 ±7.77	-5.188	<0.0001	No
Gravel	0.96 ±2.44	0.00 ±0.00	-1.924	0.0668	Yes
Graminoids					
Carex aquatilis	1.33 ±1.40	3.75 ±2.27	4.306	0.0003	No
Carex atrofusca	0.08 ±0.41	0.21 ±0.59	0.827	0.4170	Yes
Carex bigelowii	0.00 ±0.00	0.42 ±1.84	1.110	0.2786	Yes
Carex saxatilis	1.00 ±1.44	1.96 ±2.44	1.638	0.1150	Yes
Eriophorum angustifolium	6.58 ±5.12	10.46 ±5.26	2.896	0.0082	No
Juncus biglumis	0.00 ±0.00	0.04 ±0.20	1.000	0.3277	Yes
Forbs					
Equisetum variegatum	0.13 ±0.34	0.25 ±0.68	0.768	0.4503	Yes
Pedicularis sudetica	0.08 ±0.28	0.46 ±0.66	2.584	0.0166	No
Polygonum viviparum	0.00 ±0.00	0.04 ±0.20	1.000	0.3277	Yes
Shrubs					
Dryas integrifolia	0.00 ±0.00	1.13 ±2.23	2.469	0.0214	No
Salix arctica	0.00 ±0.00	0.58 ±0.72	3.984	0.0006	No
Salix lanata	0.00 ±0.00	0.33 ±0.92	1.781	0.0881	Yes
Salis reticulata	0.04 ±0.20	0.50 ±0.66	3.114	0.0049	No
Non Vascular Plants					
Lichens	0.04 ±0.20	0.13 ±0.61	0.624	0.5385	Yes
Liverworts	0.04 ±0.20	0.08 ±0.28	0.569	0.5747	Yes
Mosses	21.17 ±12.11	24.92 ±15.58	1.344	0.1921	Yes
Bryum pseudotriquetrum	0.63 ±1.13	0.88 ±1.23	0.710	0.4850	Yes
Hypnum bambergeri	1.38 ±2.22	2.04 ±4.29	0.725	0.4760	Yes
Oncophorus wahlenbergii	0.13 ±0.45	0.29 ±0.75	0.941	0.3567	Yes
Scorpidium scorpioides	13.88 ±9.67	13.88 ±11.54	0.000	2.0686	Yes
Tomenthypnum nitens	5.17 ±8.25	7.79 ±11.59	1.124	0.2727	Yes

Table 7. Results of paired-sample t tests comparing impact and control plots by plant taxa for data collected 27–29 July 1995 at the Yukon Gold site, Alaska. Standard deviation is abbreviated SD.

	Impact (n=25)	Control (n=25)			Accept Null Hypothesis
	Mean No. Hits (±SD)	Mean No. Hits (±SD)	t Value	P Value (two tailed)	(α=0.05)
Barren					
Bare Canopy or Ground	22.76 ±13.64	4.28 ±2.72	-6.927	<0.0001	No
Dead Plant Material					
Litter	39.88 ±7.74	39.48 ±6.50	-0.178	2.0639	Yes
Standing Dead	0.60 ±1.00	0.52 ±0.65	-0.371	0.7136	Yes
Graminoids					
Carex aquatilis	6.04 ±3.86	6.28 ±3.40	0.248	0.8063	Yes
Carex atrofusca	0.00 ±0.00	0.36 ±1.60	1.122	0.2729	Yes
Carex bigelowii	0.08 ±0.40	0.68 ±2.43	1.208	0.2388	Yes
Carex misandra	0.00 ±0.00	0.44 ±0.87	2.529	0.0184	No
Carex saxatilis	1.44 ±2.22	4.28 ±4.71	2.528	0.0185	No
Eriophorum angustifolium	18.72 ±11.87	29.08 ±5.28	3.809	0.0008	No
Juncus biglumis	0.00 ±0.00	0.04 ±0.20	1.000	0.3273	Yes
Forbs					
Caltha palustris arctica	0.00 ±0.00	0.04 ±0.20	1.000	0.3273	Yes
Equisetum variegatum	0.84 ±1.14	0.40 ±0.71	-1.701	0.1019	Yes
Pedicularis sudetica	0.04 ±0.20	0.48 ±0.65	3.381	0.0025	No
Polygonum viviparum	0.16 ±0.47	0.32 ±0.63	0.941	0.3563	Yes
Saxifraga hirculus	0.04 ±0.20	0.08 ±0.28	1.000	0.3273	Yes
Shrubs					
Dryas integrifolia	0.00 ±0.00	1.44 ±1.61	4.474	0.0001	No
Salix arctica	0.68 ±1.03	1.52 ±1.64	2.201	0.0376	No
Salix lanata	0.00 ±0.00	0.32 ±0.90	1.778	0.0881	Yes
Salix reticulata	0.16 ±0.37	0.76 ±1.51	2.268	0.0326	No
Salix rotundifolia	0.04 ±0.20	0.12 ±0.44	0.811	0.4254	Yes
Non-Vascular Plants					
Liverworts	0.00 ±0.00	0.04 ±0.20	1.000	0.3273	Yes
Mosses					
Bryum pseudotriquetrum	0.48 ±0.92	0.60 ±0.87	0.499	0.6220	Yes
Distichium sp.	0.00 ±0.00	0.36 ±0.76	2.377	0.0258	No
Funaria hygrometrica	0.04 ±0.20	0.04 ±0.20	0.000	1.0000	Yes
Hypnum bambergeri	1.32 ±5.19	0.96 ±2.82	-0.308	0.7607	Yes
Oncophorus wahlenbergii	0.00 ±0.00	0.20 ±1.00	1.000	0.3273	Yes
Scorpidium scorpioides	3.16 ±4.20	3.52 ±3.56	0.327	0.7463	Yes
Tomenthypnum nitens	3.20 ±4.99	1.68 ±1.99	-1.415	0.1699	Yes

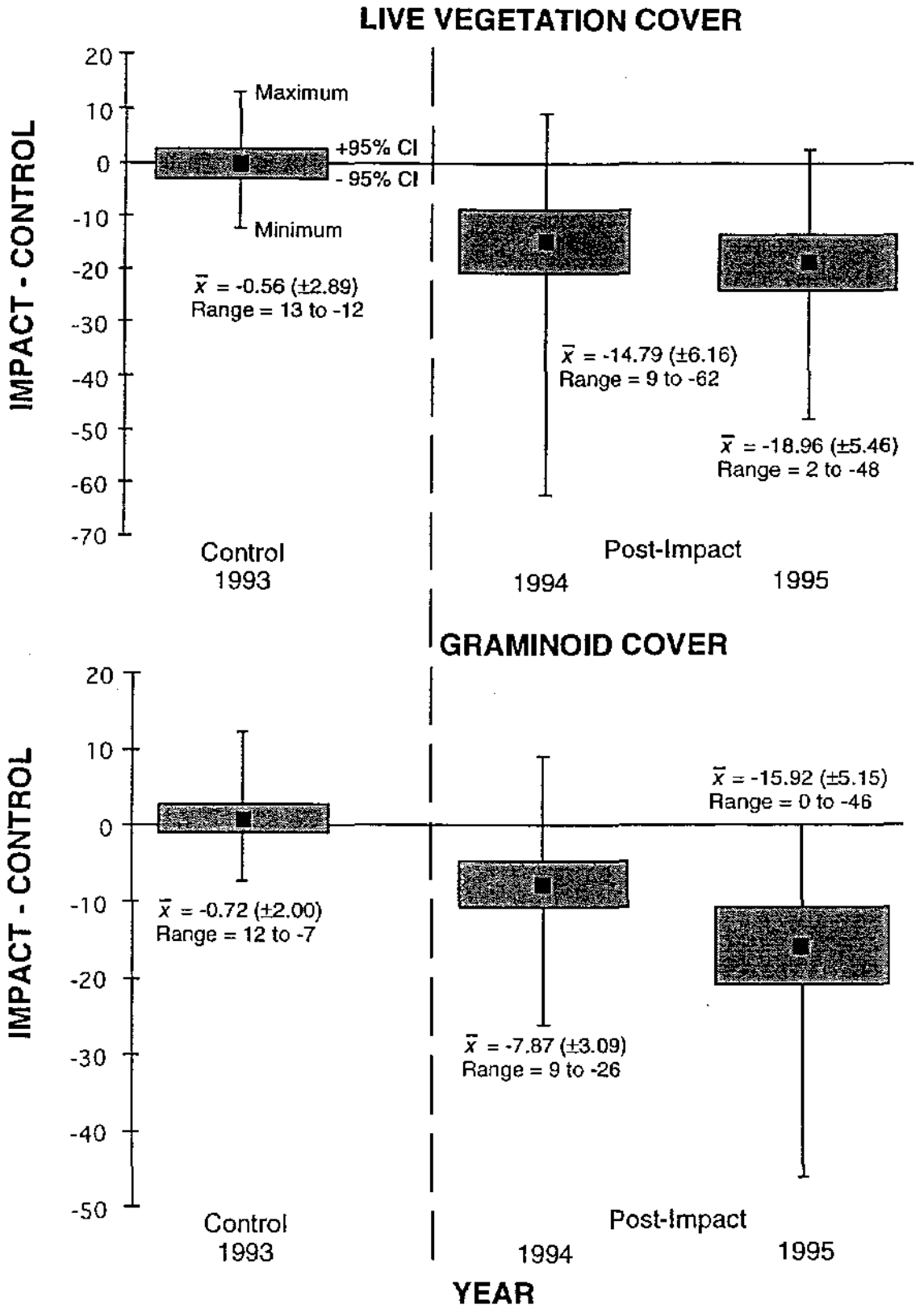


Figure 12. Mean differences (±95 % Confidence Interval) between members of individual plot pairs for control (1993, n=25) and post-impact (1994, n=24; 1995, n=25) live vegetation and graminoid cover at the Yukon Gold site, Alaska. Data for live vegetation and graminoid cover at paired plots are presented in Tables 8 and 9.

Table 8. Number of hits for live vegetation cover data from 1993, 1994, and 1995 Yukon Gold site, Alaska, monitoring data used in Before-After-Control-Impact (BACI) analysis in Figure 12.

	Live Vegetation 1993			Live Vegetation 1994			Live Vegetation 1995		
Plot Pair	Control (a)	Control (b)	Difference	Impact	Control	Difference	Impact	Control	Difference
1	24	11	13	38	64	-26	44	62	-18
2	9	13	-4	23	31	-8	54	52	2
3	34	23	11	38	51	-13	41	61	-20
4	24	23	1	12	74	-62	47	53	-6
5	12	19	-7	26	50	-24	41	48	-7
6	14	22	-8	19	35	-16	44	54	-10
7	13	25	-12	25	37	-12	43	56	-13
8	8	16	-8	39	65	-26	20	56	-36
9	22	10	12				22	70	-48
10	18	11	7	27	37	-10	46	49	-3
11	31	21	10	27	18	9	39	59	-20
12	13	21	-8	19	46	-27	32	53	-21
13	19	19	0	26	30	-4	34	49	-15
14	12	18	-6	11	41	-30	39	57	-18
15	10	14	-4	41	35	6	16	48	-32
16	12	16	-4	41	56	-15	11	55	-44
17	8	13	-5	41	51	-10	44	57	-13
18	20	15	5	34	31	3	31	52	-21
19	16	25	-9	19	44	-25	49	50	-1
20	13	11	2	37	55	-18	34	60	-26
21	14	18	-4	31	26	5	50	67	-17
22	24	19	5	50	62	-12	17	56	-39
23	12	19	-7	37	33	4	23	61	-38
24	21	15	6	34	58	-24	47	55	-8
25	16	16	0	39	59	-20	51	53	-2
Mean			-0.56			-14.79			-18.96
SD			7.38			15.41			13.94
95% CI			2.89			6.16			5.46
Max			13			9			2
Min			-12			-62			-48

Table 9. Number of hits for graminoid vegetation cover data from 1993, 1994, and 1995 Yukon Gold site, Alaska, monitoring data used in Before-After-Control-Impact (BACI) analysis in Figure 12.

	Graminoids 1993			Graminoids 1994			Graminoids 1995		
Plot Pair	Control (a)	Control (b)	Difference	Impact	Control	Difference	Impact	Control	Difference
1	23	11	12	18	24	-6	42	45	-3
2	8	12	-4	11	17	-6	42	44	-2
3	9	11	-2	6	16	-10	39	39	0
4	10	9	1	9	21	-12	40	42	-2
5	9	3	6	12	27	-15	38	41	-3
6	13	12	1	11	23	-12	35	40	-5
7	11	8	3	16	16	0	38	42	-4
8	8	13	-5	2	14	-12	13	35	-22
9	15	6	9				13	38	-25
10	16	10	6	12	17	-5	11	45	-34
11	2	6	-4	14	14	0	35	41	-6
12	6	13	-7	9	22	-13	13	46	-33
13	10	14	-4	8	17	-9	26	44	-18
14	12	9	3	1	14	-13	33	45	-12
15	6	13	-7	4	23	-19	1	47	-46
16	12	10	2	0	11	-11	2	39	-37
17	6	7	-1	12	20	-8	17	44	-27
18	7	11	-4	16	21	-5	22	42	-20
19	13	11	2	2	28	-26	35	48	-13
20	8	3	5	5	15	-10	31	43	-12
21	9	7	2	13	19	-6	32	39	-7
22	10	10	0	1	5	-4	8	41	-33
23	11	4	7	24	15	9	23	41	-18
24	6	12	-6	0	5	-5	31	43	-12
25	12	9	3	12	3	9	41	45	-4
Mean			0.72			-7.88			-15.92
SD			5.11			7.72			13.13
95% CI			2.00			3.09			5.15
Max			12			9			0
Min			-7			-26			-46

Vegetation Monitoring Requirements

Table 10 includes live cover data and calculations for determining the percent of control live cover value for compliance with the vegetation monitoring program (Appendix E). Table 10 includes 1994 and 1995 impact and control plot pooled mean live cover data derived from vegetation plots. Percent of control live vegetation cover within the pad footprint was 67% in 1994 and 66% in 1995. This represents a net decrease in live vegetation cover from 1994 to 1995 of 1%. If the base condition is calculated, with the addition of 50% of the control group standard deviation, the percent of control live vegetation cover within the pad footprint was 53% in 1994 and 58% in 1995. This represents a net increase in live vegetation cover from 1994 to 1995 of 5%. Because the impact to live cover was greater within the edge zone, the overall recovery within the pad footprint may be more accurately described by omitting the edge plots within the affected areas at 1 m and 2 m intervals. For plots within the footprint excluding the 1 m edge zone (n=22), which represents 92% of the pad area, percent of control live cover was 70% in 1995. For plots within the footprint excluding the 2 m edge zone (n=19), which represents 84% of the pad area, percent of control live cover was 75% in 1995.

DISCUSSION

The paired *t* tests indicate that measurable and significant reductions in live vegetation and graminoid cover in the pad area remain (Table 5). This is consistent with visual evaluation of the ice pad site. Live cover at control sites has apparently increased during sampling: 1993, 34%; 1994, 45%; and 1995, 56% (Table 3). This may be due in part to the later sampling periods in 1994 (early August) and 1995 (late July) compared to mid-July in 1993. Other factors potentially influencing live cover measures are variation in precipitation and snow-melt timing, or differences in observer techniques. Variability in observer techniques may be responsible for the apparent increase in graminoid cover and decrease in barren and non-vascular cover from 1994 to 1995. Because the impact of the ice pad was not uniform within the pad footprint, higher variability in the impact plots was expected. The similarity in variance between impact and control plots in 1994 suggests there was either some inconsistency in recording point contacts, or that due to random selection more patchy control areas were sampled. In contrast, the variance for control plots was less than that for impact plots in 1995. Environmental conditions that also may have contributed to differences in cover measures between years were standing water, saturated soils and breezy conditions during 1995. Differences in annual phenology and observers are controlled for by using paired plot comparisons within years and by using the percent of control value to normalize the live vegetation cover measure.

Table 10. Percent of control live vegetation cover at impact and control plots for 1994 and 1995 at the Yukon gold site, Alaska. Data were collected 2-4 August 1994 and 26–29 July 1995, at the Yukon Gold ice pad, Alaska. Standard deviation is abbreviated SD.

	1994 Mean % Cover (±SD)		1995 Mean % Cover (±SD)	
	Impact (n=24)	Control (n=24)	Impact (n=25)	Control (n=25)
Live Vegetation	61.16 ±20.20	90.76 ±28.80	73.52 ±24.52	111.44 ±11.22
Graminoids		33.92 ±12.98		84.72 ±6.10
Forbs		1.50 ±1.79		2.64 ±2.28
Shrubs		5.08 ±5.07		8.32 ±7.48
All Non-Vascular		50.26 ±31.36		15.76 ±12.88
Cumulative SD		±51.20		±28.74
50% of Cumulative SD		±25.60		±14.37
Percent of Control Live Vegetation Cover	61.16% + 90.76% = 67.39%		73.52% ÷ 111.44% = 65.97%	
Recovery Rate (% of Control) (Percent of Control Live Cover 1995 - Percent of Control Live Cover 1994)			66% - 67% = -1%	
Base Cover Condition (Mean Control Cover + 50% Cumulative SD)	90.76% + 25.60% = 116.39%		111.44% + 14.37% = 125.81%	
Percent of Base Condition	61.16% ÷ 116.39% = 52.55%		73.52% ÷ 125.81% = 58.43%	
Recovery Rate (% of Base Condition) (Percent of Base Condition 1995 - Percent of Base Condition 1994)			58% - 53% = 5%	

Live vascular plant cover, primarily graminoids, was significantly reduced (34% decrease) on impact plots in 1995, as in 1994 results (33% decrease). Non-vascular plants appeared to be largely unaffected by the ice pad. The large standard deviation for impact plots compared to control plots (roughly four times larger for impact vascular plant cover) indicated patchiness in the recovery which is consistent with visual observations. While some areas appear to be near normal, other areas show decreased live cover. Even though some areas remain visibly damaged, especially strangmoor ridges, 76% of the impact plots were within 75% of the mean control plot live cover.

No thaw depths have been recorded during monitoring, and the only areas of obvious thermokarst were near the well head and the trench. The southeast corner of the pad appears to be low, but this low area extends beyond the footprint edge heading northeast and appears to be a normal depression. Rains prior to monitoring on 27–29 July caused extensive areas of standing water and saturated soils within and around the pad footprint. This flooding also appeared normal. There was no obvious increase in ponding or subsidence of the tundra surface within the pad footprint, which would indicate an increased thaw depth. Standing water was more visible within the impact area because of the decreased live vegetation cover and increased barren cover.

The percent of the control live vegetation cover base condition for impact plots (Table 10) meets the 30% to 69% of control live vegetation cover criterion, as stipulated in the Yukon Gold Monitoring Plan (Appendix E). Specifically, impact live cover was 58% of control live cover. Changes in the degree of variability for control plot taxa from 1994 to 1995, complicate use of the base condition. Without the addition of variance to the percent of control, live vegetation cover was 66% in 1995. When the edge zone impact is excluded, percent of control live vegetation increases to 75%.

Reported effects of winter ice roads, winter seismic trails, and snow pads are summarized in Table 11. The most long-lasting effect of these disturbances appears to be increased thaw depth and the flattening of local micro-topography due to compaction. Although thaw depths have not been monitored at the Yukon Gold site, there was no noticeable visual indication that thaw depths have increased. However, the effect of compression on strangmoor ridges remains. These physical changes can result in changes in plant composition due to increased wetness (Walker and Webber 1980). The effects of such changes are apparently more severe in areas with pronounced micro-topography (Brown and Berg 1980).

A second effect of ice road, winter seismic trail, and snow pad construction is direct damage to individual plants, which vary in susceptibility to disturbance (Walker et al. 1987;

Table 11. Reported effects of winter ice roads, winter seismic trails, and snow pads on tundra vegetation at sites in arctic Alaska and Canada.*

Type of Disturbance	Microtopography	Depth of Thaw	Microenvironment	Vegetation Cover	Upright Shrubs (e.g., willows)	Lichens/ Mosses	*C. aquatilis/ E. angustifolium*
Winter Ice Roads	Decrease due to compaction (4)	Increase (5)	Increase in wetness due to compression of microtopography (4); Tussocks compressed and sheared, 4 years recovery, some still dead and damaged (1)	Decrease (5)	Decrease due to broken or abraded terminal stems and wetter microenvironment (1)	Decrease due to compression and wetter microenvironment in tussock tundra, impact expressed 2nd summer post-impact (1)	Little effect or increase due to wetter microenvironment (4)
		Return to preimpact after several years (1)					
Winter Seismic Trails	Trampling and Compaction (1)	Increase (5)	Increase in wetness due to compression of microtopography (3)	With little snow up to 85% cover destroyed (1)	Decrease due to broken terminal stems (3,6)	Decrease due to crushing (3,6)	Little effect or increase due to wetter microenvironment (3)
				Decrease (5)	Moist graminoid sedge/barren complex: Decrease, significant--1 site, Decrease, non-significant--1 site. Regrowth 2 summers after disturbance (3)	Moist graminoid sedge/barren complex: Decrease significant--2 sites (3)	
				Moist Sedge, Control 73-110%, Impact 78-68% (3)			
Snow Pads	Decrease due to abrasion (2)	Increase (1,2)		1st Summer decreased, recover after 3 years (1)	Decrease due to broken terminal stems (1,2)	Decrease due to compression (1)	
				Moist sedge/shrub tundra, 10-20 cm snow depth, 22.7% cover decrease (6)	Moist sedge/shrub tundra, 10-20 cm snow depth, 55.5% shrub cover decrease (6)		

*Sources of information are coded by number: 1. Walker et al. 1987; 2. Brown and Berg 1980; 3. Felix and Raynolds 1989a; 4. Walker and Webber 1980; 5. Brown and Grave 1979; 6. Felix and Raynolds 1989b

Felix and Raynolds 1989a, b). The plants most susceptible to damage are willows and other upright shrubs (Brown and Berg 1980; Walker et al. 1987; Felix and Raynolds 1989a, b), and lichens and mosses (Walker et al. 1987; Felix and Raynolds 1989a, b). Lichens and mosses are apparently very susceptible to compression when frozen (Walker et al. 1987). Vascular plants, such a *C. aquatilis* and *E. angustifolium*, are least affected by compression (Walker et al. 1987; Felix and Raynolds 1989a). Walker et al. (1987) reported that vascular plant cover was reduced during the first growing season following snow pad construction, but had largely recovered after three years. Cover by mosses and lichens was still reduced after three years compared to control plots (Walker et al. 1987).

In contrast to Walker et al.'s (1987) findings for snow pads, the multi-season Yukon Gold ice pad has primarily affected vascular plant cover. Although reduction in vascular plant cover was still apparent at this site two years after the ice pad had melted, new *Eriophorum* and *Carex* seedling growth was evident at impact sites. However, it may take several more years for these seedlings to contribute significantly to live vegetation cover. Forb species had returned to normal levels since 1994, when there were significantly less forbs on impact plots. Shrub vegetation was still significantly reduced on impact plots, especially *D. integrifolia*, which was most often located on strangmoor ridges. We suspect that by the third year, recovery of vascular plants on the Yukon Gold site may not be as complete as observed by Walker et al. (1987) for snow pads, probably due to the impact of the loss of a growing season. Even though no measurable decrease in non-vascular plant cover has been measured at the Yukon Gold site, the visible damage to strangmoor ridges (especially to the mosses) will probably require more than three years for recovery. In contrast to the visible damage to mosses on strangmoor ridges, *S. scorpioides* within the trough areas appeared normal.

CONCLUSIONS

Live vegetation cover, composed primarily of graminoid vegetation, at the Yukon Gold site remained visibly and measurably decreased compared to the surrounding tundra in 1995. The most obvious ice pad impacts were to strangmoor ridges, and at the pad edges. Other impacts from drilling operations effected approximately 9 to 10% of the footprint area. The only obvious increases in thaw depths were associated with the well head and trench. Changes in the degree of variability for control plot taxa from 1994 to 1995, complicate use of the base condition. Without the addition of variance to the percent of control, live vegetation cover was 66% in 1995. When the edge zone impact is excluded, percent of control live vegetation increased to 75%.

New seedling graminoid growth was observed, but these small plants may require a fourth or fifth year to reach a crown size that will contribute to cover density. Forbs have apparently already returned to normal levels within the impact area. Strangmoor ridges may be visibly impacted for a much longer period. In summary, besides the lack of decrease in non-vascular plant cover and lack of evidence for an increased thaw depth found in studies of ice roads, seismic trails and snow pads, the effects of the multi-year Yukon Gold ice pad appear to be similar. In addition, we expect recovery will also be similar, although perhaps requiring several additional years for a comparable recovery, to compensate for the loss of a growing season.

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APPENDIX A. SPECIES LIST FOR YUKON GOLD SITE MONITORING

Table A-1. Plant taxa identified at the Yukon Gold ice pad, Alaska, during vegetation studies conducted summer 1994 and summer 1995. Codes appear in Appendix A and Appendix B tables and were also used during field data collection.

Species or Category	Code
Barren	
Bare Canopy of Ground	BARE
Gravel	GRAV
Dead Plant Material	
Litter	LITT
Standing Dead	STDE
Graminoids	
Carex aquatilis	CAAQ
Carex atrofusca	CAAT
Carex bigelowii	CABI
Carex misandra	CAMI
Carex saxatilis	CASA
Carex sp.	CASP
Eriophorum angustifolium	ERAN
Juncus biglumis	JUBI
Forbs	
Caltha palustris arctica	CAPA
Equisetum variegatum	EQVA
Pedicularis sudetica	PESU
Polygonum viviparum	POVI
Saxifraga hirculus	SAHI
Shrubs	
Dryas integrifolia	DRIN
Salix arctica	SAAR
Salix lanata	SALA
Salix reticulata	SARE
Salix rotundifolia	SARO
Non-Vascular Plants	
Lichens	LICH
Liverworts	LIVE
Mosses	
Bryum pseudotriquetrum	BRPS
Distichium sp.	DISP
Funaria hygrometrica	FUHY
Hypnum bambergeri	HYBA
Oncophorus wahlenbergii	ONWA
Scorpidium scorpioides	SCSC
Tomenthypnum nitens	TONI
Mixture of species	MOMX

APPENDIX B. 1993 YUKON GOLD VEGETATION DATA

Table B-1. Numbers of hits by category for pooled plot comparison (based on a total of 50 hits/plot) for 1993 Yukon Gold site, Alaska.

Plot No.	Carex spp./ Eriophorum angustifolium	Moss spp.	Salix spp.*	Dryas integrifolia	Lichen spp.	Pedicularis sudetica	Potentilla spp.	Polygonum viviparum	Total Living Vegetation	Dead Plant Material	Barren Ground
1a	23	1	0	0	0	0	0	0	24	26	0
2a	8	1	0	0	0	0	0	0	9	32	9
3a	9	9	0	3	13	0	0	0	34	16	0
4a	10	9	0	5	0	0	0	0	24	24	2
5a	9	0	1	0	0	2	0	0	12	29	9
6a	13	0	0	0	0	1	0	0	14	27	9
7a	11	0	2	0	0	0	0	0	13	29	8
8a	8	0	0	0	0	0	0	0	8	35	7
9a	15	2	5	0	0	0	0	0	22	26	2
10a	16	1	0	1	0	0	0	0	18	32	0
11a	2	17	1	8	0	0	2	0	31	14	5
12a	6	4	3	0	0	0	0	0	13	37	0
13a	10	6	3	0	0	0	0	0	19	29	2
14a	12	0	0	0	0	0	0	0	12	26	12
15a	6	4	0	0	0	0	0	0	10	33	7
16a	12	0	0	0	0	0	0	0	12	34	4
17a	6	2	0	0	0	0	0	0	8	28	14
18a	7	7	4	2	0	0	0	0	20	30	0
19a	13	3	0	0	0	0	0	0	16	32	2
20a	8	3	2	0	0	0	0	0	13	37	0
21a	9	3	1	1	0	0	0	0	14	35	1
22a	10	12	1	1	0	0	0	0	24	26	0
23a	11	0	1	0	0	0	0	0	12	36	2
24a	6	15	0	0	0	0	0	0	21	27	2
25a	12	0	3	0	1	0	0	0	16	32	2

*Salix reticulata, S. arctica, S. planifolia pulchra, S. lanata richardsoni

Table B-1. Continued.

Plot No.	Carex spp./ Eriophorum angustifolium	Moss spp.	Salix spp.*	Dryas integrifolia	Lichen spp.	Pedicularis sudetica	Potentilla spp.	Polygonum viviparum	Total Living Vegetation	Dead Plant Material	Barren Ground
1b	11	0	0	0	0	0	0	0	11	38	1
2b	12	0	0	0	0	1	0	0	13	29	8
3b	11	6	3	3	0	0	0	0	23	26	1
4b	9	10	2	2	0	0	0	0	23	27	0
5b	3	13	3	0	0	0	0	0	19	31	0
6b	12	9	0	0	0	1	0	0	22	28	0
7b	8	7	9	1	0	0	0	0	25	25	0
8b	13	0	1	2	0	0	0	0	16	29	5
9b	6	1	1	1	0	1	0	0	10	31	9
10b	10	0	0	0	0	1	0	0	11	33	6
11b	6	9	5	1	0	0	0	0	21	28	1
12b	13	8	0	0	0	0	0	0	21	24	5
13b	14	4	1	0	0	0	0	0	19	31	0
14b	9	6	3	0	0	0	0	0	18	32	0
15b	13	0	0	0	0	1	0	0	14	33	3
16b	10	3	1	2	0	0	0	0	16	27	7
17b	7	5	1	0	0	0	0	0	13	21	16
18b	11	3	0	0	1	0	0	0	15	31	4
19b	11	12	0	0	2	0	0	0	25	20	5
20b	3	6	1	0	0	1	0	0	11	35	4
21b	7	7	0	3	0	0	0	1	18	29	3
22b	10	3	2	4	0	0	0	0	19	29	2
23b	4	12	3	0	0	0	0	0	19	31	0
24b	12	2	1	0	0	0	0	0	15	34	1
25b	9	5	1	1	0	0	0	0	16	30	4

*Salix reticulata, S. arctica, S. planifolia pulchra, S. lanata richardsoni

Table B-2. Numbers of hits by category for paired plot comparison (based on a total of 50 hits/plot) for 1993 Yukon Gold site, Alaska.

Plot No.	Carex spp./ Eriophorum angustifolium	Salix spp.*	Forbs**	Moss spp./ Lichen spp.	Total Living Vegetaton	Dead Plant Material	Barren Ground
1a	23	0	0	1	24	26	0
2a	8	0	0	1	9	32	9
3a	9	0	3	22	34	16	0
4a	10	0	5	9	24	24	2
5a	9	1	2	0	12	29	9
6a	13	0	1	0	14	27	9
7a	11	2	0	0	13	29	8
8a	8	0	0	0	8	35	7
9a	15	5	0	2	22	26	2
10a	16	0	1	1	18	32	0
11a	2	1	11	17	31	14	5
12a	6	3	0	4	13	37	0
13a	10	3	0	6	19	29	2
14a	12	0	0	0	12	26	12
15a	6	0	0	4	10	33	7
16a	12	0	0	0	12	34	4
17a	6	0	0	2	8	28	14
18a	7	4	2	7	20	30	0
19a	13	0	0	3	16	32	2
20a	8	2	0	3	13	37	0
21a	9	1	1	3	14	35	1
22a	10	1	1	12	24	26	0
23a	11	1	0	0	12	36	2
24a	6	0	0	15	21	27	2
25a	12	3	0	1	16	32	2

*Salix reticulata, S. arctica, S. planifolia pulchra, S. lanata richardsoni

**Pedicularis sudetica, Dryas integrifolia, Potentilla spp., Polygonum viviparum

Table B-2. Continued.

Plot No.	Carex spp./ Eriophorum angustifolium	Salix spp.**	Forbs**	Moss spp./ Lichen spp.	Total Living Vegetation	Dead Plant Material	Barren Ground
1b	11	0	0	0	11	38	1
2b	12	0	1	0	13	29	8
3b	11	3	3	6	23	26	1
4b	9	2	2	10	23	27	0
5b	3	3	0	13	19	31	0
6b	12	0	1	9	22	28	0
7b	8	9	1	7	25	25	0
8b	13	1	2	0	16	29	5
9b	6	1	2	1	10	31	9
10b	10	0	1	0	11	33	6
11b	6	5	1	9	21	28	1
12b	13	0	0	8	21	24	5
13b	14	1	0	4	19	31	0
14b	9	3	0	6	18	32	0
15b	13	0	1	0	14	33	3
16b	10	1	2	3	16	27	7
17b	7	1	0	5	13	21	16
18b	11	0	0	4	15	31	4
19b	11	0	0	14	25	20	5
20b	3	1	1	6	11	35	4
21b	7	0	4	7	18	29	3
22b	10	2	4	3	19	29	2
23b	4	3	0	12	19	31	0
24b	12	1	0	2	15	34	1
25b	9	1	1	5	16	30	4

*Salix reticulata, S. arctica, S. planifolia pulchra, S. lanata richardsoni

**Pedicularis sudetica, Dryas integrifolia, Potentilla spp., Polygonum viviparum, Saxifraga hirculus

APPENDIX C. 1994 YUKON GOLD VEGETATION DATA

Table C-1. Number of hits by plant taxa for paired plot t tests and pooled plot means, based on two hits per sampling point for a total of 100 hits per plot for 1994 Yukon Gold site, Alaska. Data were collected 2–4 August 1994.

	Graminoids								Forbs			Shrubs			
Plot	CAAQ	CAAT	CABI	CASA	CASP	All Carex	ERAN	JUBI	EQVA	PESU	POVI	DRIN	SAAR	SALA	SARE
C1	7	0	9	0	0	16	8	0	0	0	0	4	0	1	0
C2	6	0	0	3	0	9	8	0	0	0	0	1	0	0	1
C3	3	0	0	4	0	7	9	0	0	0	0	0	0	0	0
C4	5	0	0	5	0	10	11	0	0	1	0	1	0	0	2
C5	5	0	0	2	0	7	20	0	0	1	0	0	2	0	1
C6	1	0	0	0	0	1	22	0	2	0	0	0	0	0	0
C7	1	0	0	0	0	1	15	0	0	0	0	1	0	4	1
C8	3	0	0	0	0	3	11	0	2	0	0	2	0	0	0
C10	3	2	0	0	1	6	11	0	0	1	0	0	0	0	1
C11	1	0	0	3	0	4	10	0	0	0	0	0	0	0	0
C12	4	0	0	6	0	10	12	0	0	1	0	0	0	0	0
C13	0	0	0	6	0	6	11	0	2	1	0	0	0	0	0
C14	3	0	0	0	0	3	11	0	0	0	0	0	2	0	1
C15	4	0	0	8	0	12	11	0	0	2	0	0	1	0	1
C16	4	0	0	2	0	6	5	0	0	0	0	0	0	0	2
C17	9	0	0	0	1	10	10	0	0	1	0	0	1	0	0
C18	3	0	0	4	0	7	14	0	0	1	0	0	1	0	0
C19	6	0	0	3	0	9	19	0	0	0	0	0	1	0	0
C20	7	1	0	0	0	8	7	0	0	0	0	1	1	0	1
C21	6	0	0	0	0	6	13	0	0	0	0	0	1	0	0
C22	3	0	0	0	0	3	2	0	0	0	0	6	2	0	0
C23	3	2	0	1	0	6	8	1	0	2	0	0	1	1	0
C24	2	0	0	0	1	3	2	0	0	0	1	2	1	2	1
C25	1	0	1	0	0	2	1	0	0	0	0	9	0	0	0
Sum	90	5	10	47	3	155	251	1	6	11	1	27	14	8	12
Average	3.75	0.21	0.42	1.96	0.13	6.46	10.46	0.04	0.25	0.46	0.04	1.13	0.58	0.33	0.50
SD	2.27	0.59	1.84	2.44	0.34	3.67	5.26	0.20	0.68	0.66	0.20	2.23	0.72	0.92	0.66

Table C-1. Continued.

	Non-Vascular								Barren	
Plot	LICH	LIVE	BRPS	HYBA	ONWA	SCSC	TONI	MOSS	BARE	GRAV
C1	0	0	0	17	2	13	2	35	11	0
C2	0	0	0	0	0	12	0	12	16	0
C3	0	0	0	0	0	19	16	35	33	0
C4	0	0	0	7	0	42	0	49	22	0
C5	0	1	1	11	0	2	4	18	11	0
C6	0	0	2	0	0	8	0	10	22	0
C7	0	0	0	3	0	3	9	15	24	0
C8	0	0	0	0	0	47	0	47	26	0
C10	0	0	1	0	0	4	13	18	31	0
C11	0	0	0	0	0	4	0	4	27	0
C12	0	0	5	0	0	18	0	23	16	0
C13	0	0	2	0	0	8	0	10	20	0
C14	0	0	3	0	0	18	3	24	25	0
C15	0	0	1	0	0	6	1	8	8	0
C16	0	0	0	0	0	27	16	43	29	0
C17	0	0	1	0	1	20	7	29	15	0
C18	0	1	0	0	0	7	0	7	20	0
C19	0	0	1	0	0	14	0	15	12	0
C20	0	0	1	1	0	18	17	37	22	0
C21	0	0	1	1	0	4	0	6	14	0
C22	0	0	0	2	0	9	38	49	30	0
C23	0	0	2	0	1	11	0	14	12	0
C24	0	0	0	7	0	16	23	46	33	0
C25	3	0	0	0	3	3	38	44	31	0
Sum	3	2	21	49	7	333	187	598	510	0
Average	0.13	0.08	0.88	2.04	0.29	13.88	7.79	24.92	21.25	0.00
SD	0.61	0.28	1.23	4.29	0.75	11.54	11.59	15.58	7.77	0.00

Table C-1. Continued.

	Graminoids								Forbs			Shrubs			
Plot	CAAQ	CAAT	CABI	CASA	CASP	All Carex	ERAN	JUBI	EQVA	PESU	POVI	DRIN	SAAR	SALA	SARE
I1	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0
I2	2	0	0	1	0	3	8	0	0	0	0	0	0	0	0
I3	1	2	0	0	0	3	3	0	1	0	0	0	0	0	0
I4	1	0	0	0	0	1	8	0	0	0	0	0	0	0	0
I5	2	0	0	0	0	2	10	0	1	0	0	0	0	0	0
I6	4	0	0	1	0	5	6	0	0	1	0	0	0	0	0
I7	2	0	0	1	0	3	13	0	0	0	0	0	0	0	0
I8	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0
I10	0	0	0	3	0	3	9	0	0	0	0	0	0	0	0
I11	1	0	0	2	2	5	9	0	0	0	0	0	0	0	1
II12	2	0	0	3	0	5	4	0	0	1	0	0	0	0	0
I13	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0
I14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
I15	1	0	0	1	0	2	2	0	0	0	0	0	0	0	0
I16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I17	0	0	0	1	0	1	11	0	0	0	0	0	0	0	0
I18	1	0	0	1	0	2	14	0	0	0	0	0	0	0	0
I19	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
I20	2	0	0	0	0	2	3	0	0	0	0	0	0	0	0
I21	4	0	0	2	0	6	7	0	0	0	0	0	0	0	0
I22	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0
I23	5	0	0	6	0	11	13	0	0	0	0	0	0	0	0
I24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I25	1	0	0	2	0	3	9	0	0	0	0	0	0	0	0
Sum	32	2	0	24	2	60	158	0	3	2	0	0	0	0	1
Average	1.33	0.08	0.00	1.00	0.08	2.50	6.58	0.00	0.13	0.08	0.00	0.00	0.00	0.00	0.04
SD	1.40	0.41	0.00	1.44	0.41	2.55	5.12	0.00	0.34	0.28	0.00	0.00	0.00	0.00	0.20

Table C-1. Continued.

	Non-Vascular								Barren	
Plot	LICH	LIVE	BRPS	HYBA	ONWA	SCSC	TONI	MOSS	BARE	GRAV
I1	0	0	0	1	0	19	0	20	29	0
I2	0	0	0	7	0	5	0	12	33	0
I3	0	0	0	2	0	17	12	31	45	0
I4	0	0	1	0	0	2	0	3	30	0
I5	0	0	0	6	0	5	2	13	34	0
I6	0	0	4	0	0	3	0	7	40	0
I7	0	0	0	1	0	8	0	9	32	0
I8	0	0	1	1	0	31	4	37	49	0
I10	0	0	0	0	0	12	3	15	33	0
I11	0	0	1	2	0	0	9	12	26	0
II12	0	0	0	0	0	9	0	9	26	0
I13	0	0	0	1	2	3	12	18	35	0
I14	0	0	0	0	0	10	0	10	41	0
I15	0	0	1	3	0	33	0	37	35	0
I16	1	0	0	0	0	4	36	40	41	0
I17	0	1	0	0	1	25	2	28	37	3
I18	0	0	0	0	0	18	0	18	20	2
I19	0	0	1	0	0	8	8	17	46	4
I20	0	0	0	2	0	17	13	32	25	0
I21	0	0	1	0	0	17	0	18	20	11
I22	0	0	4	7	0	23	14	48	35	0
I23	0	0	0	0	0	13	0	13	12	3
I24	0	0	1	0	0	24	9	34	30	0
I25	0	0	0	0	0	27	0	27	23	0
Sum	1	1	15	33	3	333	124	508	777	23
Average	0.04	0.04	0.63	1.38	0.13	13.88	5.17	21.17	32.38	0.96
SD	0.20	0.20	1.13	2.22	0.45	9.67	8.25	12.11	8.95	2.44

Table C-2. Number of hits by category for paired plot t tests and pooled plot means, based on two hits per sampling point for a total of 100 hits per plot for 1994 Yukon Gold site, Alaska. Data were collected 2–4 August 1994.

Plot	Graminoids	Forbs	Shrubs	Combined Vascular Plants	Combined Non-Vascular Plants	Live Vegetation	Barren	Dead Plant Material
C1	24	0	5	29	35	64	11	25
C2	17	0	2	19	12	31	16	53
C3	16	0	0	16	35	51	33	16
C4	21	1	3	25	49	74	22	4
C5	27	1	3	31	19	50	11	39
C6	23	2	0	25	10	35	22	43
C7	16	0	6	22	15	37	24	39
C8	14	2	2	18	47	65	26	9
C10	17	1	1	19	18	37	31	32
C11	14	0	0	14	4	18	27	55
C12	22	1	0	23	23	46	16	38
C13	17	3	0	20	10	30	20	50
C14	14	0	3	17	24	41	25	34
C15	23	2	2	27	8	35	8	57
C16	11	0	2	13	43	56	29	15
C17	20	1	1	22	29	51	15	34
C18	21	1	1	23	8	31	20	49
C19	28	0	1	29	15	44	12	44
C20	15	0	3	18	37	55	22	23
C21	19	0	1	20	6	26	14	60
C22	5	0	8	13	49	62	30	8
C23	15	2	2	19	14	33	12	55
C24	5	1	6	12	46	58	33	9
C25	3	0	9	12	47	59	31	10
Sum	407	18	61	486	603	1089	510	801
Average	16.96	0.75	2.54	20.25	25.13	45.38	21.25	33.38
SD	6.49	0.90	2.54	5.53	15.68	14.40	7.77	18.01

Table C-2. Continued.

Plot	Graminoids	Forbs	Shrubs	Combined Vascular Plants	Combined Non-Vascular Plants	Live Vegetation	Barren	Dead Plant Material
I1	18	0	0	18	20	38	29	33
I2	11	0	0	11	12	23	33	44
I3	6	1	0	7	31	38	45	17
I4	9	0	0	9	3	12	30	58
I5	12	1	0	13	13	26	34	40
I6	11	1	0	12	7	19	40	41
I7	16	0	0	16	9	25	32	43
I8	2	0	0	2	37	39	49	12
I10	12	0	0	12	15	27	33	40
I11	14	0	1	15	12	27	26	47
I12	9	1	0	10	9	19	26	55
I13	8	0	0	8	18	26	35	39
I14	1	0	0	1	10	11	41	48
I15	4	0	0	4	37	41	35	24
I16	0	0	0	0	41	41	41	18
I17	12	0	0	12	29	41	40	19
I18	16	0	0	16	18	34	22	44
I19	2	0	0	2	17	19	50	31
I20	5	0	0	5	32	37	25	38
I21	13	0	0	13	18	31	31	38
I22	1	1	0	2	48	50	35	15
I23	24	0	0	24	13	37	15	48
I24	0	0	0	0	34	34	30	36
I25	12	0	0	12	27	39	23	38
Sum	218	5	1	224	510	734	800	866
Average	9.08	0.21	0.04	9.33	21.25	30.58	33.33	36.08
SD	6.35	0.41	0.20	6.36	12.21	10.10	8.52	12.65
Total	625	23	62	710	1113	1823	1310	1667

APPENDIX D. 1995 YUKON GOLD VEGETATION DATA

Table D-1. Number of hits by plant taxa for paired plot t tests and pooled plot means, based on two hits per sampling point for a total of 100 hits per plot for 1995 Yukon Gold site, Alaska. Data were collected 27–29 July 1995.

	Graminoids									Forbs					Shrubs	
Plot	CAAQ	CAAT	CABI	CAMI	CASA	CASP	All Carex	ERAN	JUBI	CAPA	EQVA	PESU	POVI	SAHI	DRIN	SAAR
C1	13	0	0	0	3	0	16	29	0	0	1	0	2	0	0	4
C2	7	0	0	3	11	0	21	23	0	0	0	0	0	0	1	3
C3	12	0	0	0	0	0	12	27	0	0	0	0	1	0	6	6
C4	5	0	0	2	8	0	15	27	0	0	0	2	1	0	0	3
C5	6	0	0	1	1	0	8	33	0	0	0	1	0	0	0	2
C6	8	0	0	2	0	2	12	28	0	1	0	1	0	0	3	4
C7	5	0	12	1	0	1	19	23	0	0	0	1	0	0	2	1
C8	6	0	0	0	0	1	7	28	0	0	0	1	0	0	3	1
C9	10	1	0	0	0	4	15	23	0	0	1	0	0	1	2	0
C10	5	0	0	0	3	1	9	36	0	0	0	0	0	0	0	0
C11	2	0	2	0	2	2	8	33	0	0	2	0	0	0	1	3
C12	4	0	0	0	14	1	19	27	0	0	0	1	0	0	0	0
C13	4	0	2	0	16	1	23	21	0	0	0	0	0	0	0	0
C14	1	0	0	0	7	1	9	36	0	0	0	1	0	0	0	1
C15	2	0	0	0	5	0	7	40	0	0	0	0	0	0	0	0
C16	7	0	0	0	1	1	9	30	0	0	2	0	0	0	2	0
C17	7	0	0	0	0	0	7	37	0	0	0	0	0	0	3	1
C18	13	0	0	0	6	0	19	22	1	0	0	0	0	0	4	1
C19	4	0	0	0	7	0	11	37	0	0	0	1	0	0	0	0
C20	8	0	1	0	2	7	18	25	0	0	2	0	0	0	1	1
C21	7	0	0	0	2	0	9	30	0	0	0	2	1	0	1	2
C22	1	0	0	0	9	2	12	29	0	0	1	1	2	0	3	0
C23	6	8	0	0	0	3	17	24	0	0	0	0	1	1	3	2
C24	10	0	0	2	1	3	16	27	0	0	1	0	0	0	1	0
C25	4	0	0	0	9	0	13	32	0	0	0	0	0	0	0	3
Sum	157	9	17	11	107	30	331	727	1	1	10	12	8	2	36	38
Average	6.28	0.36	0.68	0.44	4.28	1.20	13.24	29.08	0.04	0.04	0.40	0.48	0.32	0.08	1.44	1.52
SD	3.40	1.60	2.43	0.87	4.71	1.66	4.86	5.28	0.20	0.20	0.71	0.65	0.63	0.28	1.61	1.64

Table D-1. Continued.

	Graminoids									Forbs					Shrubs	
Plot	CAAQ	CAAT	CABI	CAMI	CASA	CASP	All Carex	ERAN	JUBI	CAPA	EQVA	PESU	POVI	SAHI	DRIN	SAAR
I1	9	0	2	2	0	2	15	31	0	0	0	0	0	0	0	0
I2	7	0	0	0	3	3	13	32	0	0	1	0	1	1	1	1
I3	3	0	0	0	6	6	15	30	0	0	1	0	1	1	1	1
I4	7	0	0	0	0	0	7	33	0	0	0	0	0	0	0	0
I5	9	0	0	0	9	9	27	20	0	0	0	0	0	0	0	0
I6	7	0	0	0	1	1	9	27	0	0	1	1	2	3	3	3
I7	4	0	0	0	2	2	8	32	0	0	1	0	1	1	1	1
I8	11	0	0	0	0	0	11	2	0	0	3	0	3	3	3	3
I9	13	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0
I10	4	0	0	0	0	0	4	7	0	0	3	0	3	3	3	3
I11	8	0	0	0	0	0	8	27	0	0	0	0	0	0	0	0
I12	7	0	0	0	0	0	7	6	0	0	0	0	0	0	0	0
I13	6	0	0	0	0	0	6	18	0	0	0	0	0	0	0	0
I14	7	0	0	0	2	2	11	23	0	0	0	0	0	0	0	0
I15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
I16	0	0	0	0	0	0	0	2	0	0	2	0	2	2	2	2
I17	2	0	0	0	0	0	2	14	0	0	1	0	1	1	1	1
I18	5	0	0	0	1	1	7	16	0	0	1	0	1	1	1	1
I19	9	0	0	0	0	0	9	26	0	0	0	0	0	0	0	0
I20	15	0	0	0	4	4	23	12	0	0	1	0	1	1	1	1
I21	7	0	0	0	1	1	9	24	0	0	2	0	2	2	2	2
I22	6	0	0	0	0	0	6	2	0	0	4	0	4	4	4	4
I23	0	0	0	0	2	2	4	21	0	0	0	0	0	0	0	0
I24	3	0	0	0	2	2	7	26	0	0	0	0	0	0	0	0
I25	1	0	0	0	3	3	7	37	0	0	0	0	0	0	0	0
Sum	151	0	2	2	36	38	229	468	0	0	21	1	22	23	23	23
Average	6.04	0	0.08	0.08	1.44	1.52	9.16	18.72	0	0	0.84	0.04	0.88	0.92	0.92	0.92
SD	3.8566	0	0.4	0.4	2.2189	2.2008	6.175759	11.866	0	0	1.1431	0.2	1.1662	1.222	1.222	1.222

Table D-1. Continued.

	Shrubs			Non-Vascular										Barren	
Plot	SALA	SARE	SARO	LIVE	BRPS	DISP	FUHY	HYBA	MOMX	ONWA	SCSC	TONI	Moss	Canopy	Ground
C1	0	0	0	0	2	0	0	0	0	0	8	0	10	2	0
C2	0	0	0	0	2	0	0	0	0	0	1	1	4	4	0
C3	4	1	0	0	3	0	0	0	0	0	1	0	4	1	0
C4	0	0	2	0	1	0	0	1	0	0	1	0	3	4	0
C5	0	0	0	0	1	0	0	0	0	0	2	1	4	6	5
C6	0	3	0	0	0	0	0	0	0	0	0	2	2	5	0
C7	0	3	0	0	0	0	1	0	0	0	2	4	7	6	0
C8	1	0	0	0	0	0	0	3	0	5	2	5	15	9	0
C9	0	0	0	0	0	3	0	14	2	0	7	2	28	9	1
C10	1	0	0	0	1	1	0	1	0	0	0	0	3	3	2
C11	0	0	0	0	0	1	0	1	0	0	7	3	12	4	0
C12	0	0	0	0	0	0	0	0	0	0	6	0	6	3	0
C13	0	0	0	0	0	0	0	0	0	0	5	0	5	4	0
C14	0	0	0	0	0	1	0	0	1	0	8	0	10	3	1
C15	0	0	0	0	1	0	0	0	0	0	0	0	1	3	0
C16	0	4	0	0	2	1	0	0	0	0	3	2	8	4	0
C17	0	5	0	0	0	0	0	0	0	0	0	4	4	1	0
C18	0	0	0	0	0	0	0	0	2	0	3	0	5	4	1
C19	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
C20	0	0	1	0	0	0	0	2	0	0	3	7	12	4	0
C21	0	0	0	0	1	0	0	1	3	0	15	2	22	4	3
C22	2	0	0	0	0	0	0	0	1	0	3	2	6	2	2
C23	0	0	0	1	1	0	0	1	3	0	5	2	12	4	0
C24	0	3	0	0	0	2	0	0	0	0	0	5	7	1	1
C25	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0
Sum	8	19	3	1	15	9	1	24	12	5	88	42	196	90	17
Average	0.32	0.76	0.12	0.04	0.60	0.36	0.04	0.96	0.48	0.20	3.52	1.68	7.84	3.60	0.68
SD	0.90	1.51	0.44	0.20	0.87	0.76	0.20	2.82	0.96	1.00	3.56	1.99	6.41	2.29	1.22

Table D-1. Continued.

	Shrubs			Non-Vascular									Barren	
Plot	SALA	SARE	SARO	LIVE	BRPS	DISP	FUHY	HYBA	MOMX	ONWA	SCSC	TONI	Moss	Canopy	Ground
I1	0	0	0	0	1	0	0	0	0	0	0	0	1	7	2
I2	0	1	0	0	3	0	0	0	0	0	5	2	10	5	0
I3	0	1	1	0	0	0	0	0	0	0	0	0	0	8	0
I4	0	0	0	0	0	0	0	0	0	0	7	0	7	8	0
I5	0	0	0	0	0	0	0	0	0	0	3	0	3	11	3
I6	0	3	0	0	0	0	1	3	0	0	0	0	4	12	3
I7	0	1	0	0	0	0	0	1	0	0	0	2	3	11	0
I8	0	3	0	0	1	0	0	0	0	0	1	2	4	34	2
I9	0	0	0	0	0	0	0	1	0	0	1	6	8	36	5
I10	0	3	0	0	0	0	0	26	0	0	0	5	31	34	4
I11	0	0	0	0	3	0	0	0	0	0	0	1	4	15	0
I12	0	0	0	0	0	0	0	0	0	0	3	14	17	35	2
I13	0	0	0	0	0	0	0	0	1	0	0	6	7	23	2
I14	0	0	0	0	2	0	0	0	0	0	0	2	4	15	0
I15	0	0	0	0	0	0	0	0	0	0	7	8	15	49	2
I16	0	2	0	0	0	0	0	0	0	0	7	0	7	46	2
I17	0	1	0	0	0	0	0	1	0	0	0	21	22	28	1
I18	0	1	0	0	0	0	0	0	0	0	2	3	5	24	0
I19	0	0	0	0	0	0	0	1	0	0	6	5	12	14	1
I20	0	1	0	0	0	0	0	0	0	0	0	2	2	18	5
I21	0	2	0	0	1	0	0	0	2	0	10	1	14	13	1
I22	0	4	0	0	1	0	0	0	0	0	2	0	3	36	2
I23	0	0	0	0	0	0	0	0	0	0	0	0	0	27	1
I24	0	0	0	0	0	0	0	0	0	0	16	0	16	15	0
I25	0	0	0	0	0	0	0	0	1	0	9	0	10	7	0
Sum	0	23	1	0	12	0	1	33	4	0	79	80	209	531	38
Average	0	0.92	0.04	0	0.48	0	0.04	1.32	0.16	0	3.16	3.2	8.36	21.24	1.52
SD	0	1.222	0.2	0	0.9183	0	0.2	5.1859	0.4726	0	4.2	4.9917	7.4715	12.888	1.5578

Table D-2. Number of hits by category for paired plot t tests and pooled plot means, based on two hits per sampling point for a total of 100 hits per plot for 1995 Yukon Gold site, Alaska. Data were collected 27–29 July 1995.

Plot	Graminoids	Forbs	Shrubs	Combined Vascular Plants	Combined Non-Vascular Plants	Live Vegetation	Barren	Dead Plant Material	Percent Standing Water	Percent Strangmoor Ridge
C1	45	3	4	52	10	62	2	36		7
C2	44	0	4	48	4	52	4	44	0	75
C3	39	1	17	57	4	61	1	38		
C4	42	3	5	50	3	53	4	43		
C5	41	1	2	44	4	48	11	41	95	2
C6	40	2	10	52	2	54	5	41	70	33
C7	42	1	6	49	7	56	6	38		
C8	35	1	5	41	15	56	9	35	0	27
C9	38	2	2	42	28	70	10	20	50	50
C10	45	0	1	46	3	49	5	46	30	0
C11	41	2	4	47	12	59	4	37	0	
C12	46	1	0	47	6	53	3	44	30	
C13	44	0	0	44	5	49	4	47		
C14	45	1	1	47	10	57	4	39		2
C15	47	0	0	47	1	48	3	49	0	0
C16	39	2	6	47	8	55	4	41		40
C17	44	0	9	53	4	57	1	42		30
C18	42	0	5	47	5	52	5	43	40	20
C19	48	1	0	49	1	50	1	49	5	0
C20	43	2	3	48	12	60	4	36	25	40
C21	39	3	3	45	22	67	7	26	0	35
C22	41	4	5	50	6	56	4	40	10	30
C23	41	2	5	48	13	61	4	35	0	60
C24	43	1	4	48	7	55	2	43	15	30
C25	45	0	3	48	5	53	0	47	5	0
Sum	1059	33	104	1196	197	1393	107	1000	375	481
Average	42.36	1.32	4.16	47.84	7.88	55.72	4.28	40.00	22.06	25.32
SD	3.05	1.14	3.74	3.44	6.44	5.61	2.72	6.64	28.01	22.30

Table D-2. Continued.

Plot	Graminoids	Forbs	Shrubs	Combined Vascular Plants	Combined Non-Vascular Plants	Live Vegetation	Barren	Dead Plant Material	Percent Standing Water	Percent Strangmoor Ridge
I1	42	0	1	43	1	44	9	47		5
I2	42	1	1	44	10	54	5	41		
I3	39	1	1	41	0	41	8	51		
I4	40	0	0	40	7	47	8	45		5
I5	38	0	0	38	3	41	14	45	0	0
I6	35	2	3	40	4	44	15	41		45
I7	38	1	1	40	3	43	11	46	90	8
I8	13	3	0	16	4	20	36	44	40	60
I9	13	1	0	14	8	22	41	37	0	0
I10	11	4	0	15	31	46	38	16		10
I11	35	0	0	35	4	39	15	46	80	20
I12	13	1	1	15	17	32	37	31		70
I13	26	0	1	27	7	34	25	41		40
I14	33	0	2	35	4	39	15	46	30	6
I15	1	0	0	1	15	16	51	33	60	40
I16	2	2	0	4	7	11	48	41	30	
I17	17	1	4	22	22	44	29	27	0	100
I18	22	1	3	26	5	31	24	45	0	22
I19	35	2	0	37	12	49	15	36	0	25
I20	31	1	0	32	2	34	23	43	0	20
I21	32	2	2	36	14	50	14	36		
I22	8	4	2	14	3	17	38	45		0
I23	23	0	0	23	0	23	28	49	75	
I24	31	0	0	31	16	47	15	38	30	
I25	41	0	0	41	10	51	7	42	2	0
Sum	661	27	22	710	209	919	569	1012	437	476
Average	26.44	1.08	0.88	28.40	8.36	36.76	22.76	40.48	29.13	25.05
SD	13.11	1.22	1.17	12.68	7.47	12.26	13.64	7.65	33.06	27.85

APPENDIX E. YUKON GOLD ICE PAD PERMIT

DEPARTMENT OF THE ARMY PERMIT

Permittee BP Exploration (Alaska) Inc.

Permit No. 4-930426 (Staines River 1)

Issuing Office U. S. Army Engineer District, Alaska

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To retain a 2.6 acre insulated ice pad. Approximately 584,000 gallons of water was required for the 6- to 24-inch thick ice pad with largest dimensions of 384' X 272' and covered with about 600 insulated 8' X 24' panels. Each panel consists of 4-inch thick expanded polystyrene foam beadboard sandwiched between Oriented Strand Board. The insulation will be removed in the fall/winter of 1993 prior to drilling operation. The remaining ice pad will be left to melt during the spring breakup of 1994.

All work will be performed in accordance with the attached plan, 5 sheets dated June 28, 1993, and one sheet dated September 3, 1993.

Project Location:

Section 13, T. 8 N., R. 23 E., Umiat Meridian.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on July 30, 1994. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. A revised monitoring plan addressing vegetation, surface tundra disturbance/soil compaction, and bird use shall be submitted within 30 days from the date of permit issuance for Corps of Engineers approval. The vegetation component shall comprise the crux of the monitoring effort. Specific criteria for the monitoring plan duration and thresholds for active rehabilitation efforts are cited in the attached table and shall be incorporated within the revised monitoring plan.

(Continued on Page 2-A)

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

Special Conditions cont:

2. Annual monitoring reports shall be submitted by January 15 of the year following the annual monitoring effort. The final report shall be due by March 15, following the end of the final field monitoring period.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

_____ September 17, 1993

(PERMITTEE) AND TITLE *(DATE)*

Supervisor, Permitting

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

_____ 9/17/93

(DISTRICT ENGINEER) Colonel John W. Pierce *(DATE)*

Jeffrey K. Towner, Chief, Enforcement Section

Regulatory Branch

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

_____ _____

(TRANSFEREE) *(DATE)*

Yukon Gold Monitoring Plan: Vegetation, 1993-1996

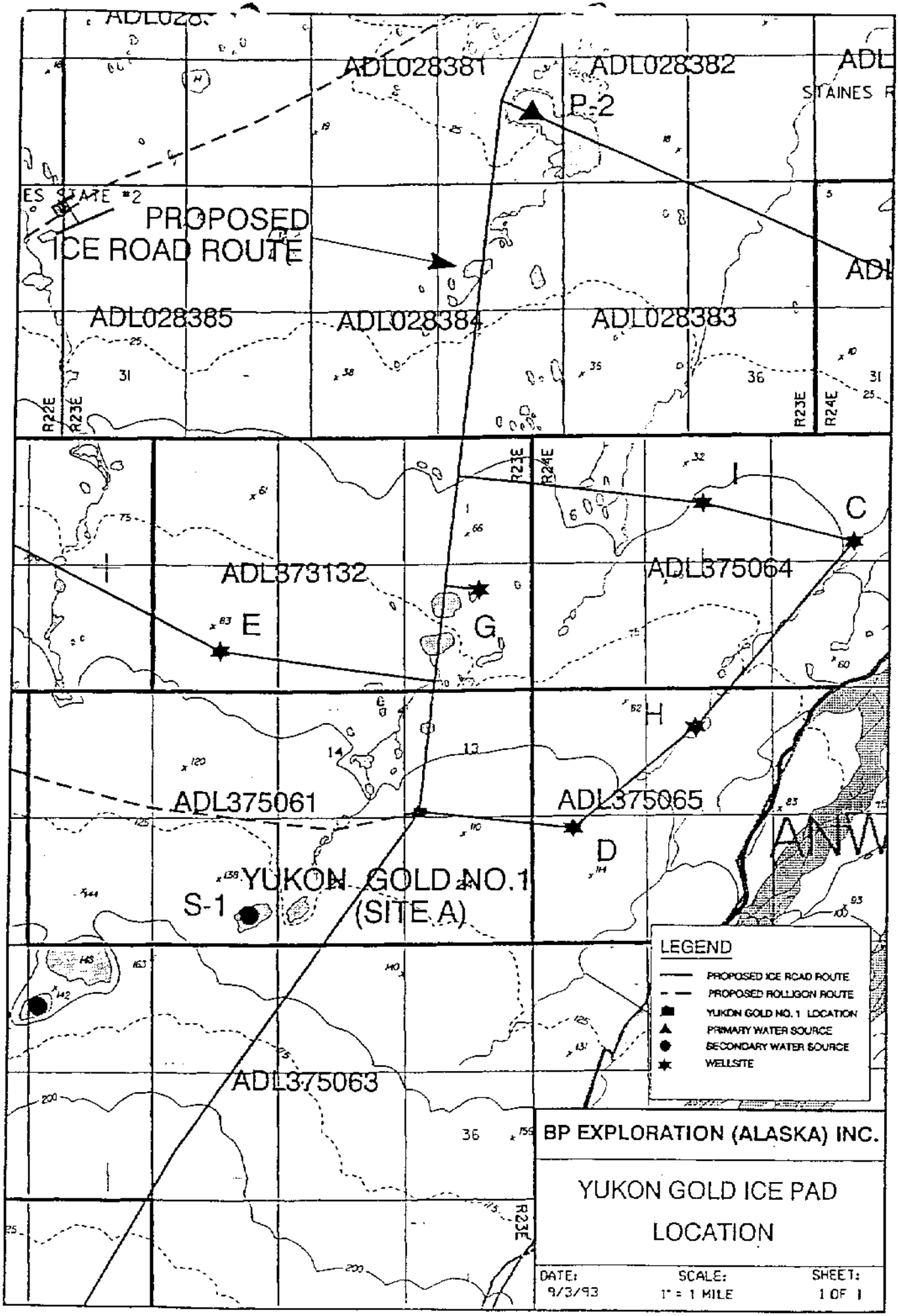
Criterion	1993	1994	1995	1996
Pad construction; oversummer 1993	Photograph; vegetation control plot sampling; breeding bird study			
≥70 % total live vegetation coverage*		Photograph; vegetation control and impact plot comparison; final report; project complete		
30-69 % total live vegetation coverage		Photograph; vegetation control and impact plot comparison; interim report	Photograph; vegetation control and impact plot comparison; positive rate of natural site recovery (≥10 % recovery from 1994 sampling) and with a ≥50% total live vegetation cover; final report; project complete If total live vegetation cover <50% or if recovery rate <10%, continue sampling in 1996	Photograph; vegetation control and impact plot comparison; positive rate of natural site recovery (≥10% recovery from 1995 sampling) and with a ≥50% total live vegetation cover; final report; project complete If total live vegetation cover <50% or if annual recovery rate <10%, reassess mitigation approach in consultation with USACE
≤29 % total live vegetation coverage		Photograph; vegetation control and impact plot comparison; consultation with USACE; fertilizer application; interim report	Photograph; vegetation control and impact plot comparison; interim report	Reassess mitigation approach in consultation with USACE

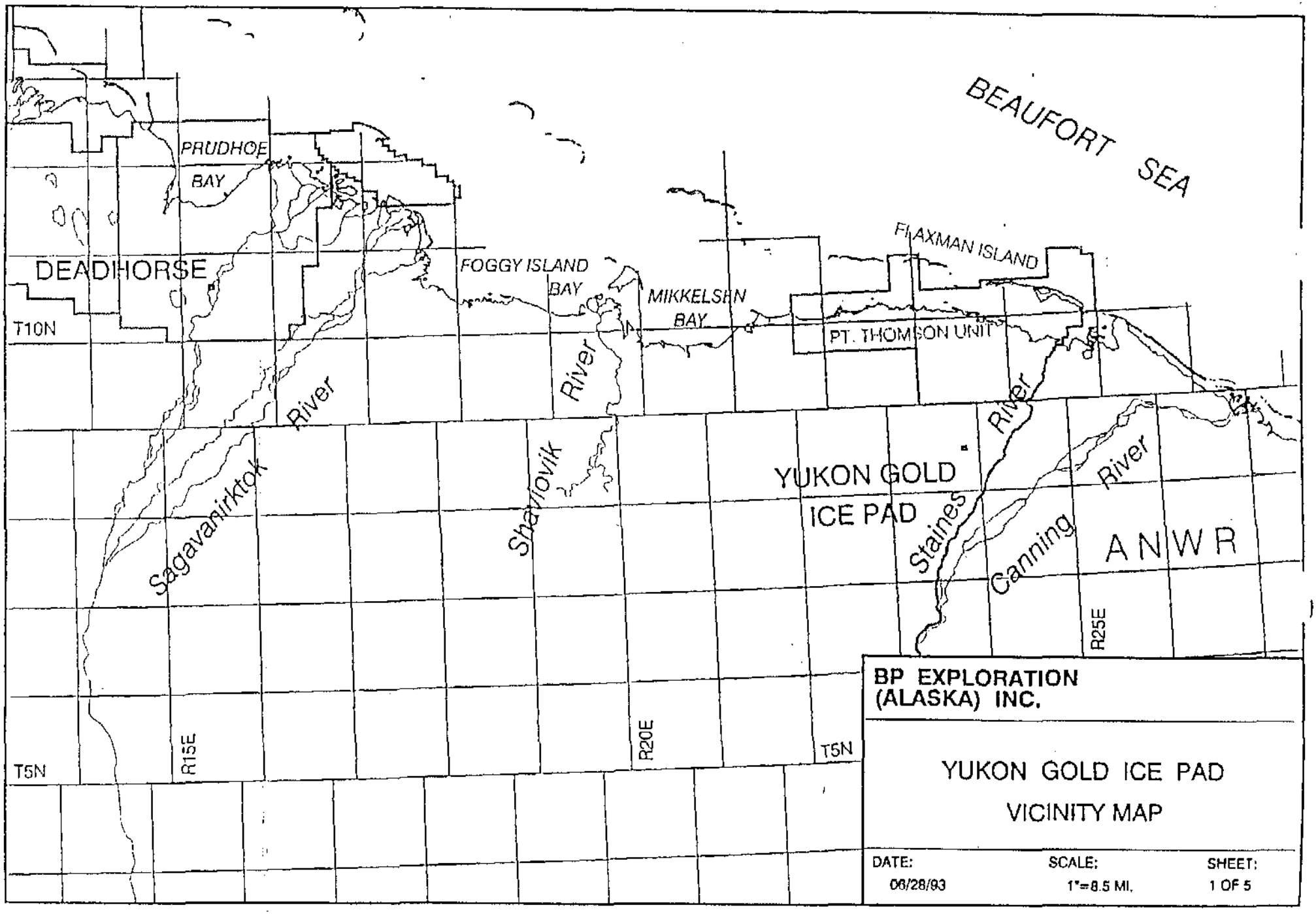
* Relative to mean vegetation cover of adjacent undisturbed control plots plus 0.5 standard deviation (SD) (e.g., 1993 mean control plot vegetation cover was 34.0% and cumulative SD of eight dominant species classes was 14.3%; 0.5xSD=7.2%, thus base condition percent cover equals 34.0%+7.2% or 41.2%). The criterion of 70% of vegetation cover would equal 28.8% (41.2%x0.7) total live vegetation cover.

The value for total live vegetation cover will be calculated annually based on the current year sampling results for mean cover and SD.

Yukon Gold Monitoring Plan: Tundra Surface Disturbance/Soil Compaction

1994—Photograph, including aerial oblique and on-ground, a minimum of three times: during early season site visit to assess cleanup requirements; at the time of vegetation monitoring in mid-late summer; and during final site inspection in mid-late fall. Visually monitor ice pad site to qualitatively assess amount, if any, of significant ponding at the ice pad location relative to the surrounding undisturbed tundra. If persistent ponding or other indications of surface impacts are identified including vegetation recovery <50%, annual photography will be continued in conjunction with the vegetation monitoring program. Photographs and a description of surface disturbances, including subsidence and the depth of ponding relative to surrounding undisturbed tundra, will be submitted as part of the vegetation monitoring report.


ADL028381
ADL028382
P-2
PROPOSED
ICE ROAD ROUTE
ADL028385
ADL028384
ADL028383
ADL373132
ADL375064
E
G
C
H
ADL375061
ADL375065
D
YUKON GOLD NO.1
(SITE A)
S-1
ADL375063
R22E
R23E
R24E
LEGEND
PROPOSED ICE ROAD ROUTE
PROPOSED ROLLIGON ROUTE
YUKON GOLD NO. 1 LOCATION
PRIMARY WATER SOURCE
SECONDARY WATER SOURCE
WELLSITE
BP EXPLORATION (ALASKA) INC.
YUKON GOLD ICE PAD
LOCATION
DATE: 9/3/93
SCALE: 1" = 1 MILE
SHEET: 1 OF 1

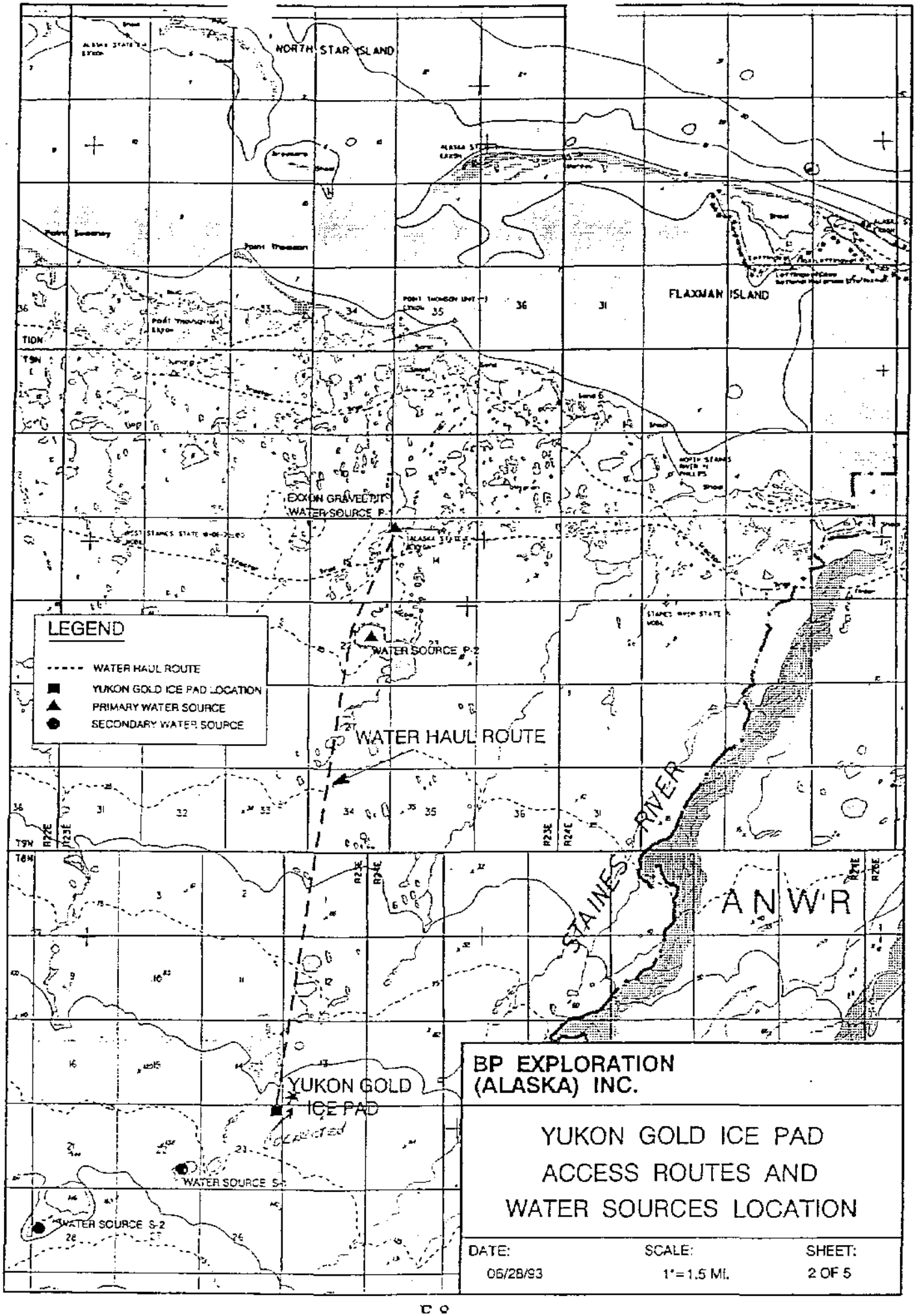


BP EXPLORATION (ALASKA) INC.

YUKON GOLD ICE PAD

VICINITY MAP

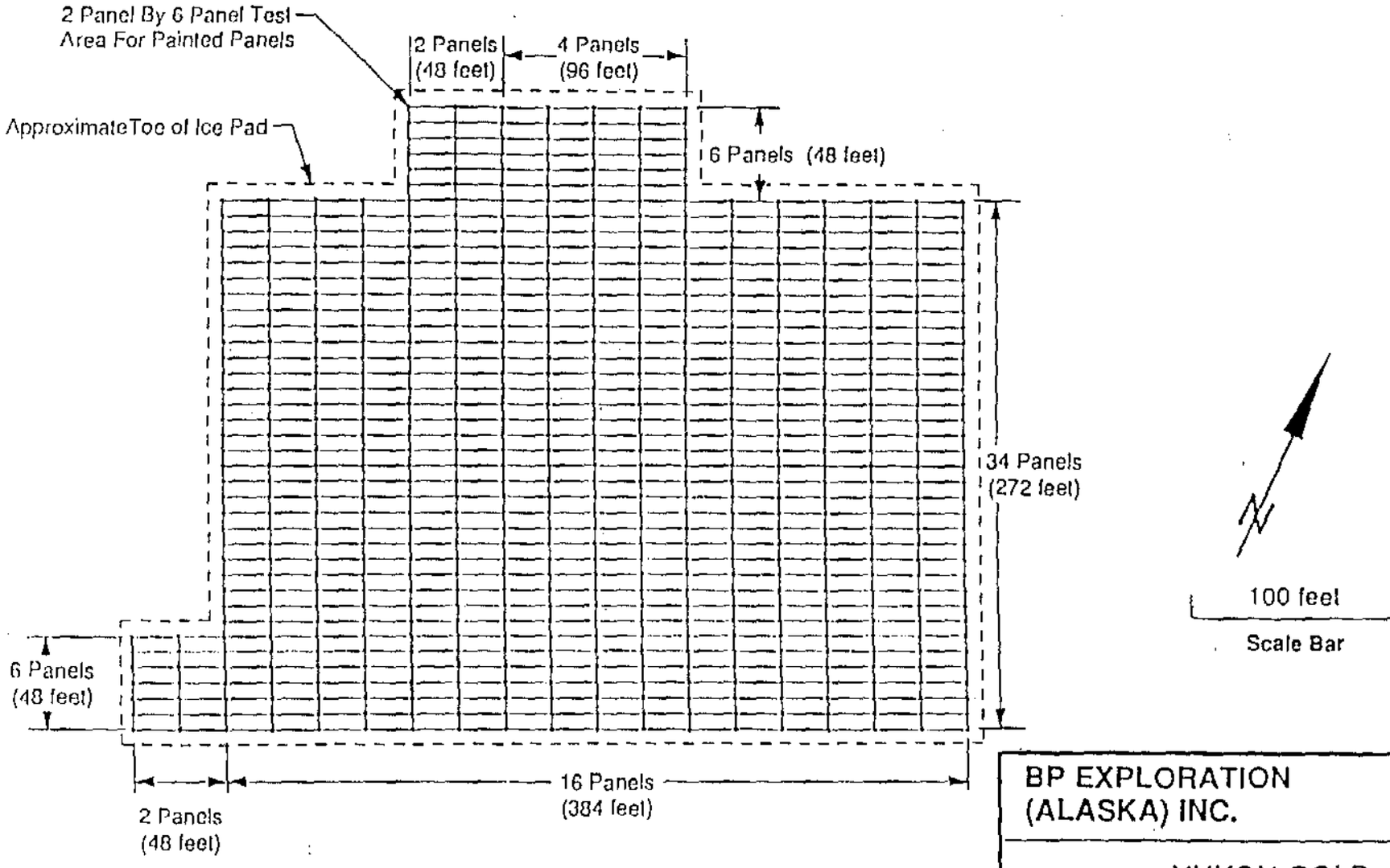
DATE:	SCALE:	SHEET:
06/28/93	1"=8.5 MI.	1 OF 5



BP EXPLORATION (ALASKA) INC.

YUKON GOLD ICE PAD ACCESS ROUTES AND WATER SOURCES LOCATION

DATE:	SCALE:	SHEET:
06/28/93	1"=1.5 MI.	2 OF 5



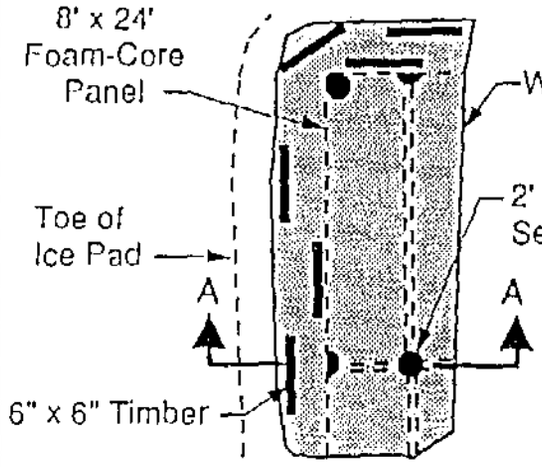
LAYOUT OF 8" X 24' INSULATED PANELS

Area of Paneled Pad = 2.6 Acres

BP EXPLORATION
(ALASKA) INC.

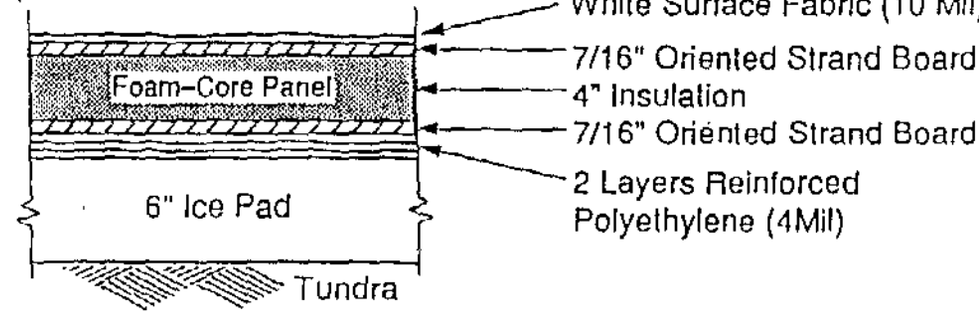
YUKON GOLD
INSULATED PAD PROJECT
ICE PAD PLOT PLAN

DATE:	SCALE:	SHEET:
6/28/93	NOT TO SCALE	3 of 5



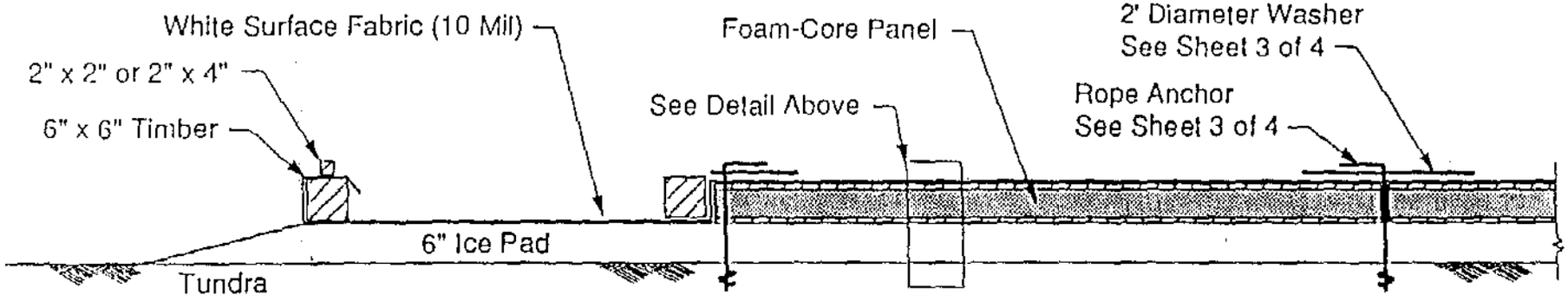
PLAN VIEW OF PAD CORNER

NOT TO SCALE



DETAIL OF FINISHED CROSS-SECTION

NOT TO SCALE



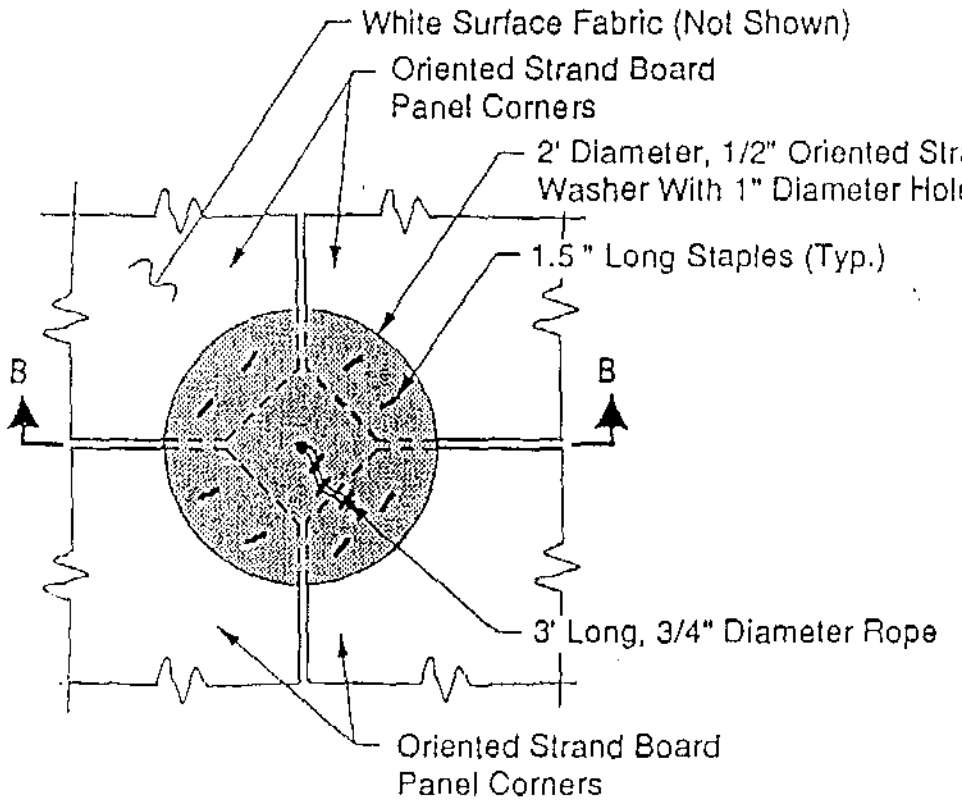
SECTION A- A

NOT TO SCALE

BP EXPLORATION (ALASKA) INC.

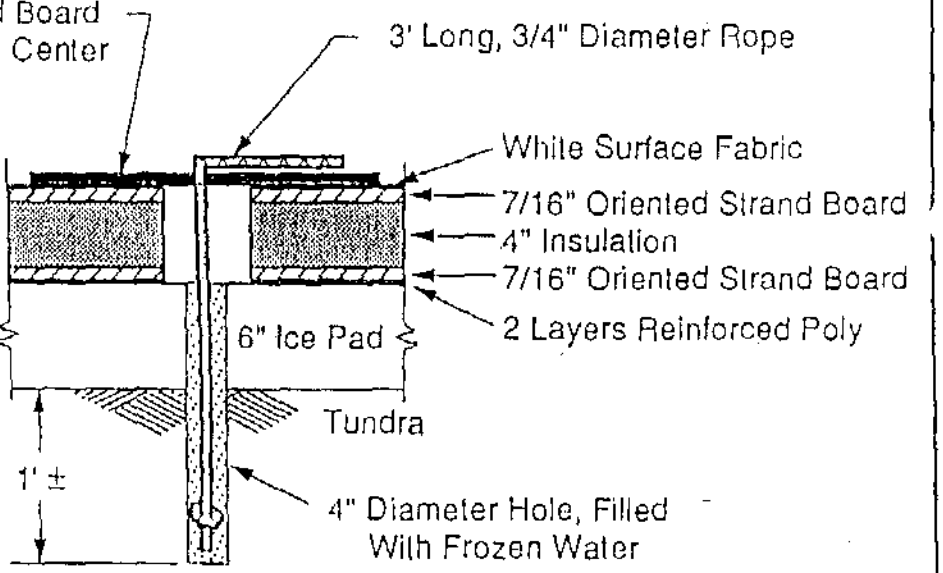
YUKON GOLD
INSULATED PAD PROJECT
PAD CROSS SECTIONS

DATE:	SCALE:	SHEET:
6/28/93	NOT TO SCALE	4 of 5



PLAN VIEW : TIE-DOWN SYSTEM

NOT TO SCALE



SECTION B–B : CROSS-SECTION OF ROPE ANCHOR

NOT TO SCALE

BP EXPLORATION
(ALASKA) INC.

YUKON GOLD
INSULATED PAD PROJECT
ANCHOR PLAN VIEW
AND CROSS SECTION

DATE:	SCALE:	SHEET:
6/28/93	NOT TO SCALE	5 of 5