

ANAKTUVUK PASS ALL-TERRAIN VEHICLE
VEGETATION MONITORING EXPERIMENTAL SITE
SUMMARY REPORT, 1994

Introduction

An experimental vegetation and soil monitoring site was established during the field season of 1994. The site was established to test the methodology for monitoring ATV impact outlined in the draft All-Terrain Vehicle Vegetation Monitoring Plan for Gates of the Arctic National Park and Preserve, 1994. Methodology from the draft Monitoring Plan was used with slight modification of surface profile work.

Preliminary selection of twenty-three additional monitoring sites was made on color infrared aerial photos. These selected sites will serve as the vegetation monitoring sites when implementation of the All-Terrain Vehicle Vegetation Monitoring Plan takes place. Ground truthing for aerial photo interpretation work was conducted by Argo in the Anaktuvuk Pass area.

Site

The experimental vegetation and soil monitoring site was established at the western end of Kollutarak Creek, near Chandler Lake on the north slope of the Brooks Range, Gates of the Arctic National Park and Preserve (See Figure 1). The location of this site can be found on Chandler Lake (A-5) Quadrangle, Alaska - North Slope Borough in the NW1/4, Section 19, T14S, R3W, Umiat Meridian at an altitude of 900m (2953 ft.). The site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Frame 071 (9975) from August 1987 (GAAR 07 AKP AUG87 071, photo is located with study materials).

Methodology

A 30m X 10m treatment (ATV trail) plot and a 30m X 10m control (undisturbed) plot were established at a randomly selected site along the ATV trail. The site was mapped on a 1987 color infrared aerial photo [GAAR (Roll) 07 AKP AUG87 (Frame) 071] and Chandler Lake (A-5) Quadrangle, Alaska - North Slope Borough, 1:63,360 Series (Topographic) (Figure 1). Stakes with orange flagging were posted at the four corners of each plot for future detection.

A Vegetation Point Sampling Frame was used to sample vegetation to estimate percent coverage by plant species. Every 3m, paralleling the 30m transect, the 1m Vegetation Point Sampling Frame was positioned along the trail inside the treatment plot or randomly within the control plot. Points (10 points, welding rods) were placed through evenly spaced (every 10cm) holes (10 holes) in the frame. Vegetation or ground that was touched by each point was recorded. The 1m frame was pivoted 180 degrees after the first 10

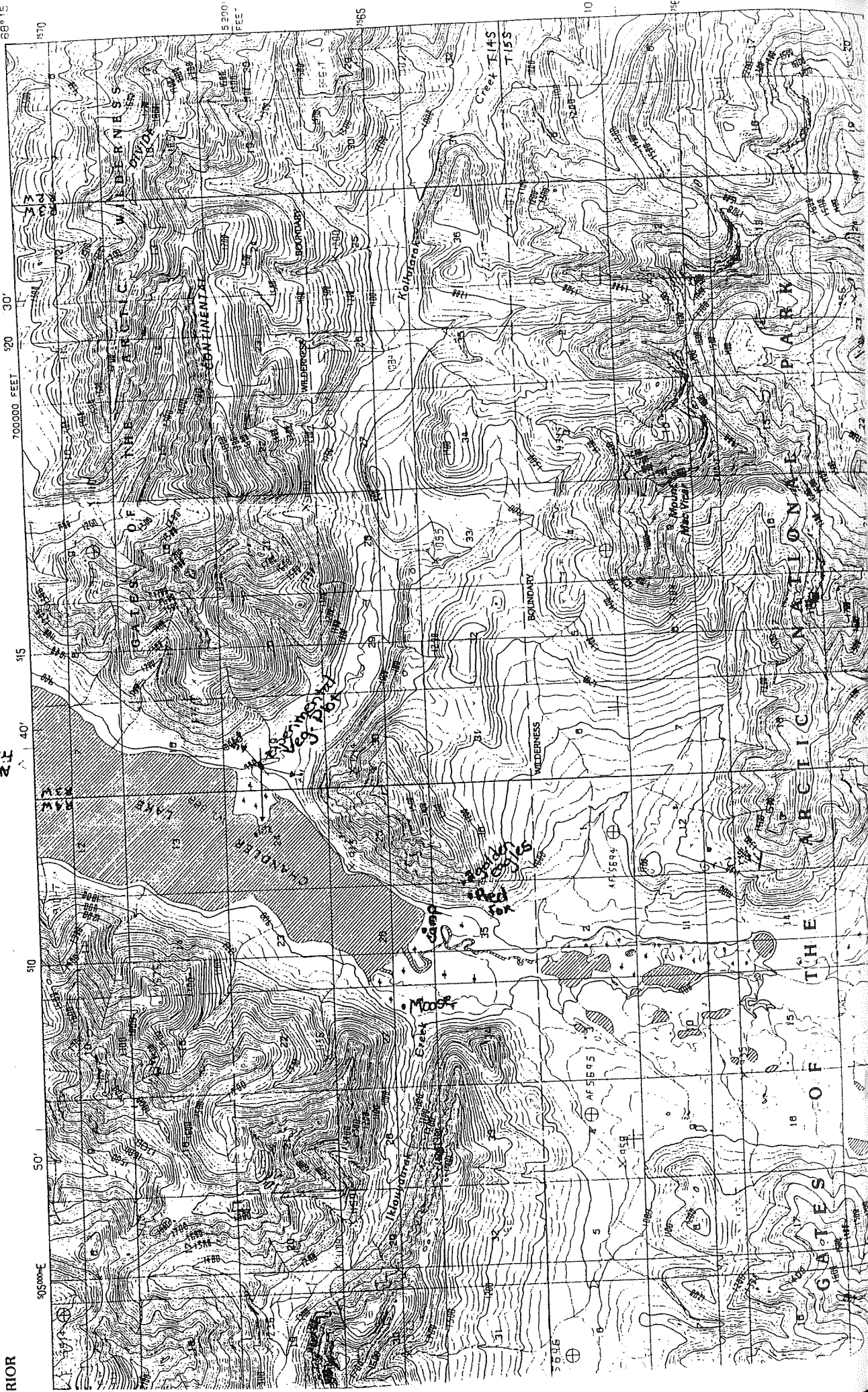
FIGURE 1: Experimental Vegetation
Sampling Site Location
(The Map is 78% of
Original Size).

AL MEASURED
FROM TRUE NORTH

CHANDLER LAKE (A-5) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)

152° 24' 15"

R10R



oints were sampled so that the frame worked as if it were a 2m frame. 20 points were sampled at each placement with a total of 200 points sampled at each plot. A vegetation list was recorded listing plant species by family (See Appendix A). Nomenclature for vascular plants followed Hulten (1968). Nomenclature for non-vascular plants followed Vitt, Marsh and Bovey (1988). Data sheets for vegetation survey can be found in Appendix A. The vegetation community was classified according to Viereck (1992).

Soil surface profiles were taken in both the treatment and control plots. Surface profile measurements were taken by stretching an elastic cord over a 5m span. A measuring tape was laid along the ground the length of the cord. Within the treatment plot the 5m span of elastic cord was laid perpendicular to the 30m transect covering a cross section of the ATV trail. Within the control plot the 5m span was placed perpendicular to the 30m transect randomly across the plot. A ruler was then used to measure from the elastic cord to the ground. Measurements are recorded every 5cm along the 5m span (100 points). The length of the surface profile at each plot was changed from the original specifications established in the Monitoring Plan of 10m to 5m. The surface profile work took more time than originally expected and had to be shortened to complete the study as time permitted. The surface profile from this experimental plot completely covered a cross section of the ATV trail which should give sufficient information for comparison.

Depth to permafrost measurements were taken in both the treatment and control plots. A measuring tape was laid along the ground for a length of 10m. The soil was probed with a 1m calibrated rod every 10cm (100 points). Rocks that were encountered were easily distinguishable by sound and the point was resampled. Within the treatment plot, the tape was placed perpendicular to the 30m transect covering a cross section of the ATV trail. Within the control plot the tape was placed perpendicular to the 30m transect randomly across the plot.

Soil information was recorded for both control and treatment site. Organic mat measurements for fibric, hemic and sapric layers were taken. Mineral soil descriptions and color classifications were made. Disturbance level classifications were made for this site showing site impact.

Ground Truth Information for Photo Interpretation
Color infrared aerial photos taken by Aeromap Inc. will be interpreted the winter of 1994-95. Information to be obtained from photos included a classification of vegetation along ATV trails, lengths and widths of ATV trails and a classification of ATV trail impact. Photo interpretation requires ground information for accuracy assessment. A ground truthing survey was conducted by Argo during the field season of 1994 for winter of 1994-95 photo interpretation.

The ground truth survey consisted of 100 ground points along the ATV trails on Park non-wilderness land which were mapped on the 1984-88 color infrared aerial photos, photographed, and classified according to vegetation community type and trail impact (See Appendix B for classification keys). All varieties of vegetation community types and trail impact encountered were surveyed. Throughout the photo interpretation process the 100 ground points will serve as examples with which other areas on the photos will be compared.

Future Monitoring Site Location

Future monitoring site locations were selected from the 1984-88 color infrared 9in X 9in aerial photography previously obtained by the Park. Twenty-three additional sites were selected for a total of 24 sites which will include the experimental plot. Six sites were selected in the Anaktuvuk River area, 6 sites were selected in the Inukpasugruk (Giant) Creek area, 5 sites were selected in the Kollutarak Creek area, and 6 sites were selected in the Ekopuk Creek area. The sites were selected from randomly selected ground truthing sites previously surveyed for photo interpretation (See above). Selection criterium included vegetation community classification and level of impact. At least one monitoring site was selected for each vegetation community classification. If a vegetation community classification showed varying levels of impact, sites were chosen representing that community at each impact level. Location of selected monitoring sites can be seen in Appendix C. A description and location of selected monitoring sites are described below.

Site 1 (Anaktuvuk River) is located on Chandler Lake (A-3) Quadrangle, Alaska, North Slope Borough in the W1/2, SW1/4, Section 21, T15S, R4E, Umiat Meridian at an altitude of 808m (2650 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 3A, 09/05/85, frame 6382 (09/05/85 FL3A 6382, photo is located with study materials). This site was classified vegetatively as Willow-Sedge Shrub Tundra and has a low disturbance level.

Site 2 (Anaktuvuk River) is located on Chandler Lake (A-3) Quadrangle, Alaska, North Slope Borough in the E1/2, SW1/4, Section 21, T15S, R4E, Umiat Meridian at an altitude of 808m (2650 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 3A, 09/05/85, frame 6383 (09/05/85 FL3A 6383, photo is located with study materials). This site was classified vegetatively as Dryas Tundra (Dryas Dwarf Scrub) and has a low disturbance level.

Site 3 (Anaktuvuk River) is located on Chandler Lake (A-2) Quadrangle, Alaska in the E1/2, SE1/4, Section 21, T15S, R4E, Umiat Meridian at an altitude of 840m (2750 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial

photograph Flight Line 3A, 09/05/85, frame 6384 (09/05/85 FL3A 6384, photo is located with study materials). This site was classified vegetatively as Dryas-Sedge Tundra (Dryas Dwarf Scrub) and has a low disturbance level.

Site 4 (Anaktuvuk River) is located on Chandler Lake (A-2) Quadrangle, Alaska in the SW1/4, SE1/4, Section 22, T15S, R4E, Umiat Meridian at an altitude of 840m (2750 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 3A, 09/05/85, frame 6386 (09/05/85 FL3A 6386, photo is located with study materials). This site was classified vegetatively as Sedge-Dryas Tundra (Mesic Graminoid Herbaceous) and has a moderate disturbance level.

Site 5 (Anaktuvuk River) is located on Chandler Lake (A-2) Quadrangle, Alaska in the SE1/4, SE1/4, Section 22, T15S, R4E, Umiat Meridian at an altitude of 840m (2750 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 3A, 09/05/85, frame 6387 (09/05/85 FL3A 6387, photo is located with study materials). This site was classified vegetatively as Closed Low Willow Scrub and has a moderate disturbance level.

Site 6 (Anaktuvuk River) is located on Chandler Lake (A-2) Quadrangle, Alaska in the NW1/4, NE1/4, Section 26, T15S, R4E, Umiat Meridian at an altitude of 870m (2850 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 3A, 09/05/85, frame 6389 (09/05/85 FL3A 6389, photo is located with study materials). This site was classified vegetatively as Willow Tundra (Willow Dwarf Scrub) and has a low disturbance level.

Site 7 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the NW1/4, NW1/4, Section 4, T16S, R2E, Umiat Meridian at an altitude of 750m (2450 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 113 (GAAR 06 AKP AUG87 113, photo is located with study materials). This site was classified vegetatively as Sedge-Willow-Birch Tundra (Mesic Graminoid Herbaceous) and has a moderate disturbance level.

Site 8 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the NW1/4, NW1/4, Section 4, T16S, R2E, Umiat Meridian at an altitude of 750m (2450 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 114 (GAAR 06 AKP AUG87 114, photo is located with study materials). This site was classified vegetatively as Mixed Shrub-Sedge Tussock Tundra (Open Low Scrub) and has a moderate disturbance level.

Site 9 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the NW1/4, NW1/4, Section 4, T16S, R2E, Umiat

Meridian at an altitude of 750m (2450 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 114 (GAAR 06 AKP AUG87 114, photo is located with study materials). This site was classified vegetatively as Closed Low Birch-Willow Scrub and has a moderate disturbance level.

Site 10 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the SW1/4, NW1/4, Section 4, T16S, R2E, Umiat Meridian at an altitude of 760m (2500 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 115 (GAAR 06 AKP AUG87 115, photo is located with study materials). This site was classified vegetatively as Wet Sedge Meadow Tundra (Wet Graminoid Herbaceous) and has a moderate disturbance level.

Site 11 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the SW1/4, NW1/4, Section 4, T16S, R2E, Umiat Meridian at an altitude of 760m (2500 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 115 (GAAR 06 AKP AUG87 115, photo is located with study materials). This site was classified vegetatively as Open Low Willow Scrub and has a moderate disturbance level.

Site 12 (Inukpasugruk Creek) is located on Chandler Lake (A-3) Quadrangle, Alaska in the NE1/4, SE1/4, Section 5, T16S, R2E, Umiat Meridian at an altitude of 760m (2500 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 6, Aug. 1987, Frame 116 (GAAR 06 AKP AUG87 116, photo is located with study materials). This site was classified vegetatively as Open Tall Willow Scrub and has a moderate disturbance level.

Site 13 (Kollutarak Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NW1/4, NW1/4, Section 36, T15S, R1W Umiat Meridian at an altitude of 700m (2300 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Aug. 1987, Frame 020 (GAAR 07 AKP AUG87 020, photo is located with study materials). This site was classified vegetatively as Open Low Birch Willow Scrub and has a moderate disturbance level.

Site 14 (Kollutarak Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NW1/4, NW1/4, Section 25, T15S, R1W Umiat Meridian at an altitude of 680m (2230 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Aug. 1987, Frame 022 (GAAR 07 AKP AUG87 022, photo is located with study materials). This site was classified vegetatively as Open Low Birch-Willow Scrub and has a moderate disturbance level.

Site 15 (Kollutarak Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NW1/4, NW1/4, Section 25, T15S, R1W Umiat Meridian at an altitude of 680m (2230 ft.) (See appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Aug. 1987, Frame 022 (GAAR 07 AKP AUG87 022, photo is located with study materials). This site was classified vegetatively as Mesic Shrub Birch-Ericaceous (Open Low Scrub) and has a moderate disturbance level.

Site 16 (Kollutarak Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NE1/4, NE1/4, Section 26, T15S, R1W Umiat Meridian at an altitude of 680m (2230 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Aug. 1987, Frame 023 (GAAR 07 AKP AUG87 023, photo is located with study materials). This site was classified vegetatively as Closed Tall Willow Scrub and has a moderate disturbance level.

Site 17 (Kollutarak Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NE1/4, NE1/4, Section 26, T15S, R1W Umiat Meridian at an altitude of 680m (2230 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Roll 7, Aug. 1987, Frame 023 (GAAR 07 AKP AUG87 023, photo is located with study materials). This site was classified vegetatively as Closed Low Birch-Willow Scrub and has a moderate disturbance level.

Site 18 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NW1/4, SE1/4, Section 19, T16S, R1W Umiat Meridian at an altitude of 620m (2035 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6146 (09/05/85 FL2A 6146, photo is located with study materials). This site was classified vegetatively as Mesic Shrub Birch-Ericaceous (Open Low Scrub) and has a moderate disturbance level.

Site 19 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the W1/2, SW1/4, Section 19, T16S, R1W Umiat Meridian at an altitude of 640m (2100 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6146 (09/05/85 FL2A 6146, photo is located with study materials). This site was classified vegetatively as Shrub Birch-Ericaceous Shrub Bog (Open Low Scrub) and has a moderate disturbance level.

Site 20 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the 680m (2230 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6147 (09/05/85 FL2A 6147, photo is located with study materials). This site was classified vegetatively as Open Low Birch-Willow Scrub and has a moderate disturbance level.

Site 21 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the SE1/4, SW1/4, Section 24, T16S R1W Umiat Meridian at an altitude of 660m (2165 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6148 (09/05/85 FL2A 6148, photo is located with study materials). This site was classified vegetatively as Closed Low Birch-Willow Scrub and has a low disturbance level.

Site 22 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the SE1/4, SW1/4, Section 24, T16S, R1W Umiat Meridian at an altitude of 660m (2165 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6148 (09/05/85 FL2A 6148, photo is located with study materials). This site was classified vegetatively as Mixed Shrub-Sedge Tussock Tundra (Open Low Scrub) and has a low disturbance level.

Site 23 (Ekokpuk Creek) is located on Chandler Lake (A-4) Quadrangle, Alaska-North Slope Borough in the NW1/4, NW1/4, Section 25, T16S, R1W Umiat Meridian at an altitude of 660m (2165 ft.) (See Appendix C). This site has also been marked on the color infrared 9in X 9in aerial photograph Flight Line 2A, 09/05/85, Frame 6148 (09/05/85 FL2A 6148, photo is located with study materials). This site was classified vegetatively as Wet Sedge Meadow Tundra (Wet Graminoid Herbaceous) and Closed Low Willow Scrub and has a low disturbance level.

Results

The experimental vegetation monitoring site at Chandler Lake was vegetatively classified as Mixed Shrub-Sedge Tussock Tundra and was visually estimated as moderately impacted (See Appendix A, Disturbance Rating Scale). The soil information recorded showed that the control plot had a greater organic mat depth than the treatment plot (See Appendix A, Soil Information). Control plot depth to permafrost was very shallow (0.5cm) after hitting mineral soil while the treatment plot mineral soil thaw depth was 27cm. There was only slight ponding along the ATV trail (See Appendix A, Vegetation Study).

Two-way analyses of variance ($P > 0.050$) were conducted for vascular, nonvascular and total plant cover by treatment (Appendix D). Year was not a factor because only one year's data has been collected. The 10 placements of the sampling frame at each plot were considered replicates for the analysis. The species variable served as the interaction error term. Two sample t-tests ($P > 0.050$) and one-way analyses of variance ($P > 0.050$) were conducted on all life forms with sample size equal to or greater than 2 and over 1% cover (Appendix D). The mean percent cover of vegetation by lifeform was calculated and graphed (Figure 3). Statistix statistical package was used for all statistical calculations and

Lotus 1-2-3 was used to graph the mean percent cover of life form.

Surface profile, depth to permafrost and permafrost profile data were graph (Figure 2). Two sample t-tests were conducted for surface profile and depth to permafrost raw data. Lotus 1-2-3 was used to graph profile and depth data. Statistix computer statistical package was used to conduct t-tests.

Discussion and Conclusion

Results of plant cover analysis by treatment showed no statistically significant difference between control and treatment plots for total plant cover and vascular plant cover (Appendix D). Non-vascular plant cover showed statistically significant difference between control and treatment plots for the replicate factor and treatment and replicate interaction. This signifies a significant loss of non-vascular plants from impacted areas. The use of ATV's in this area has greatly reduced the cover of Lichen, Moss and Liverwort species. Total and vascular plant cover analysis demonstrates that the impact is not significant overall confirming that an overall rating of moderate impact is accurate for this site.

Results of surface profile and depth to permafrost data analysis showed a statistically significant difference between control and treatment plots for both surface profile and depth to permafrost measurements. This indicated serious rut depth in ATV trail and thawing of permafrost under ATV trail and surrounding area.

Differences in Organic mat depth and mineral soil thaw depth measurements demonstrate a decrease in organic mat within the ATV trail track with a subsequent thawing of the permafrost layer beneath. This reconfirms the results from the surface profile and depth to permafrost data analysis mentioned above.

Significant impact was found in several areas of this impact site including non-vascular plant cover, trail rut depth and permafrost depth. Other areas such as vascular plant cover and total plant cover did not show serious differences between treatment and control plot. This site is considered moderately impacted. This experimental study compares a disturbed plot with a similar undisturbed plot. The statistical analysis preformed on the data from these two plots analyzed the differences and significance of differences between the plots. Comparison by treatment can show areas of significant difference which can be interpreted as a deviation from the control or an impact. The data collected in 1994 will serve as base line data with which future data can be compared. This years analysis will serve as a documentation of the present impact from ATV use. In the future, year to year comparison of treatment plot data will demonstrate site recovery or deterioration and whether the deterioration is significant.

FIGURE 2

AKP ATV VEGETATION MONITORING STUDY

EXPERIMENTAL SITE, CHANDLER LAKE

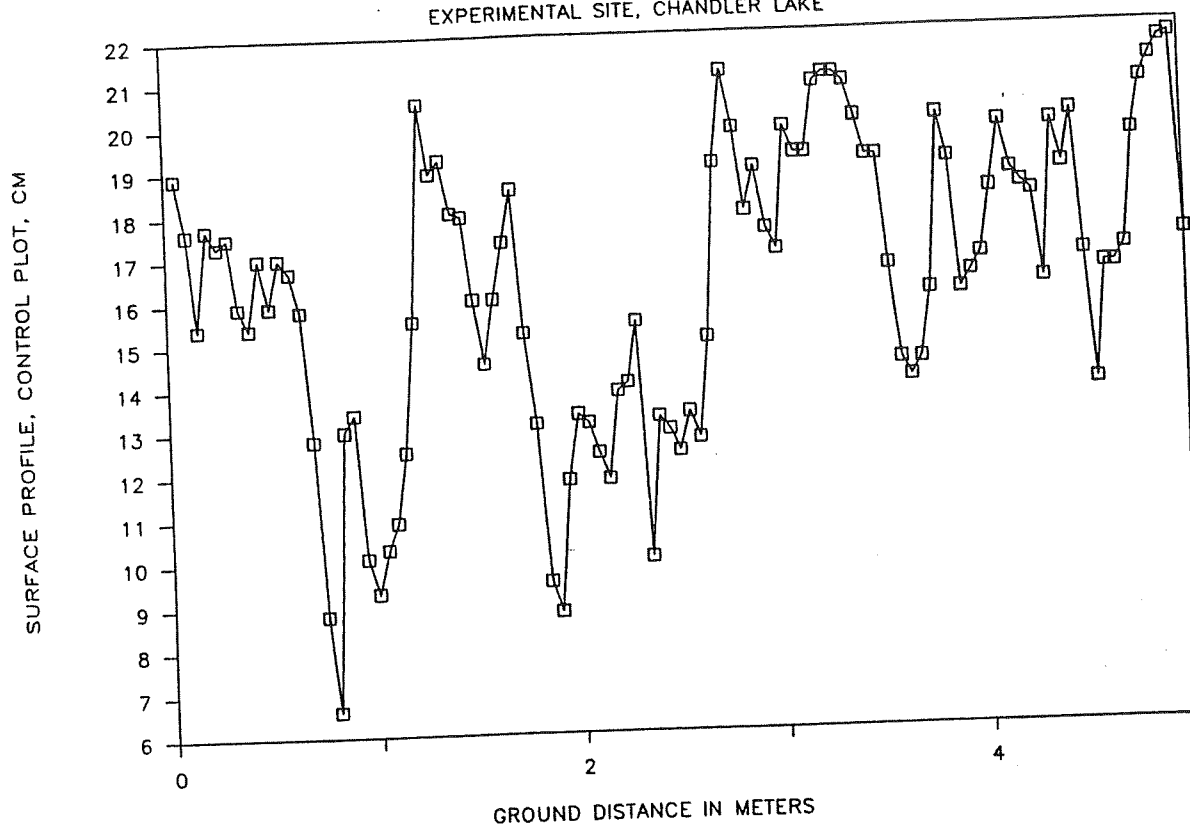


FIGURE 2

AKP ATV VEGETATION MONITORING STUDY

EXPERIMENTAL SITE, CHANDLER LAKE

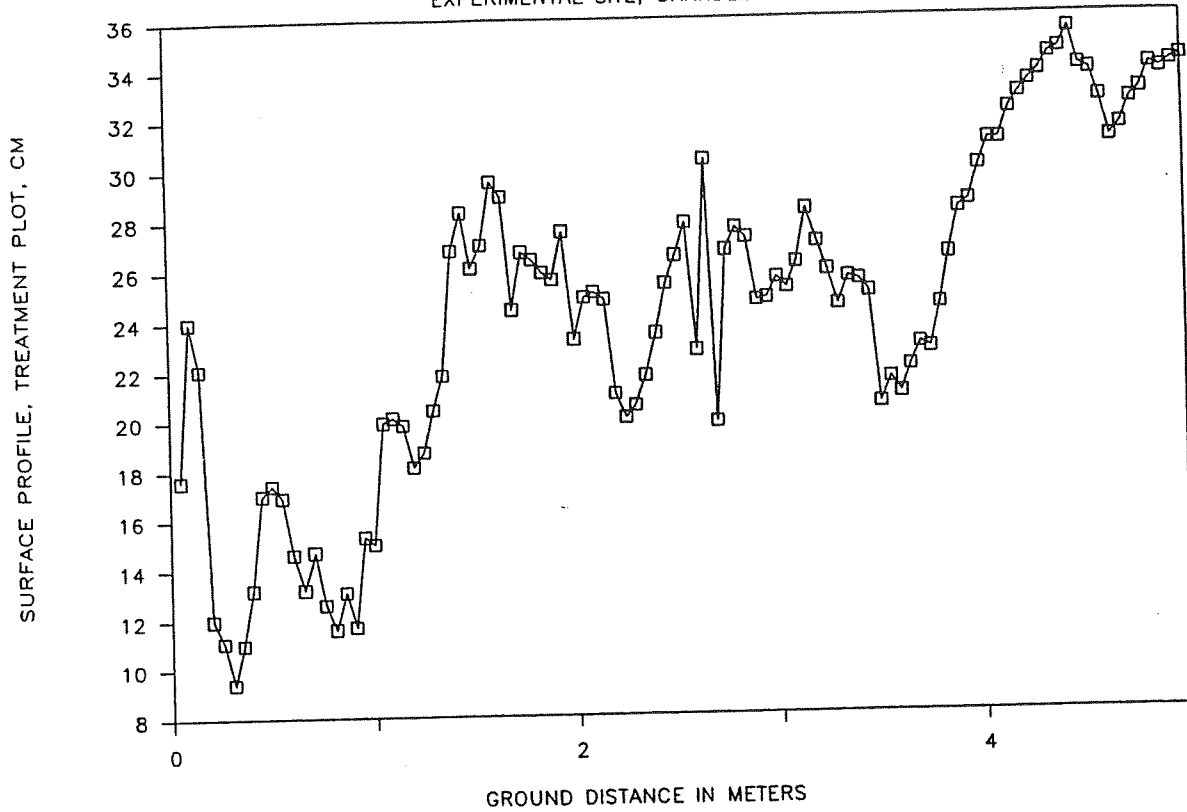


FIGURE 2

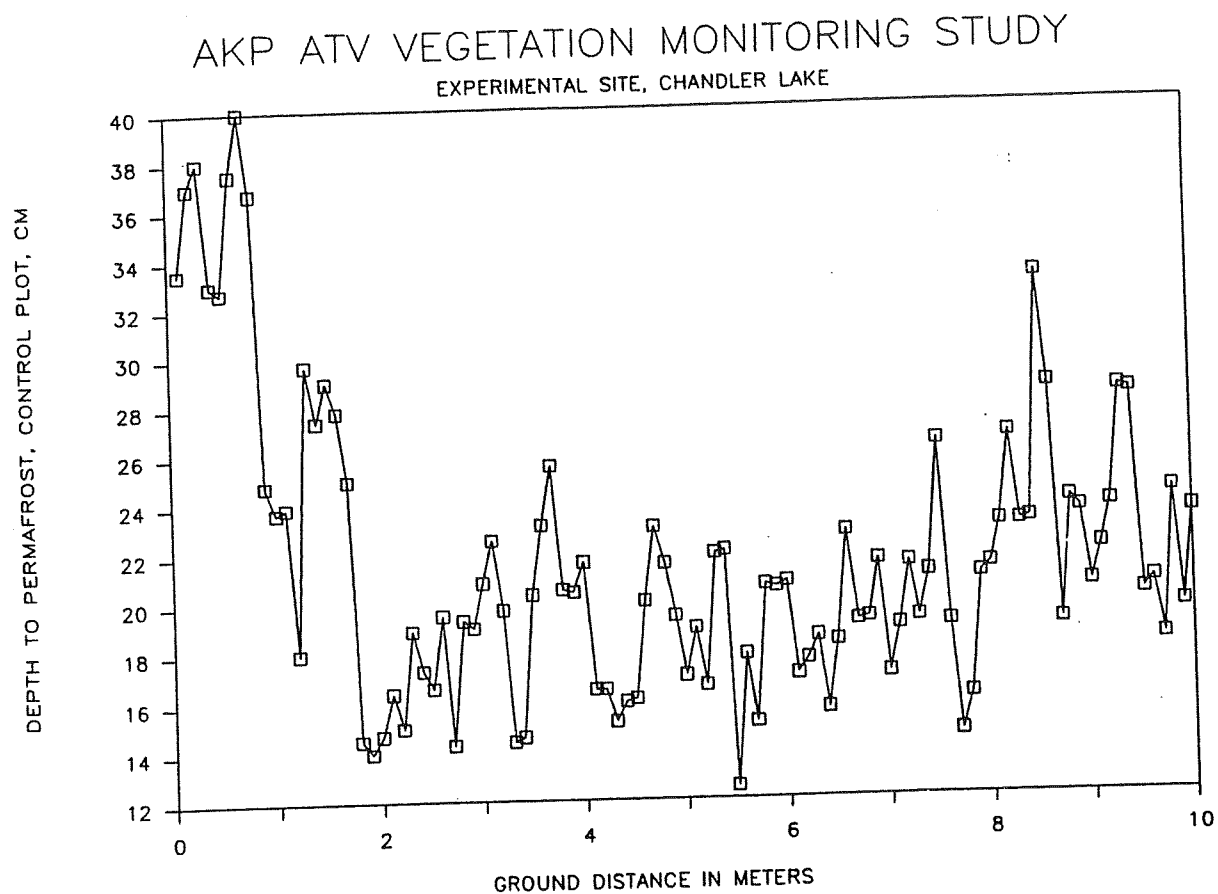


FIGURE 2

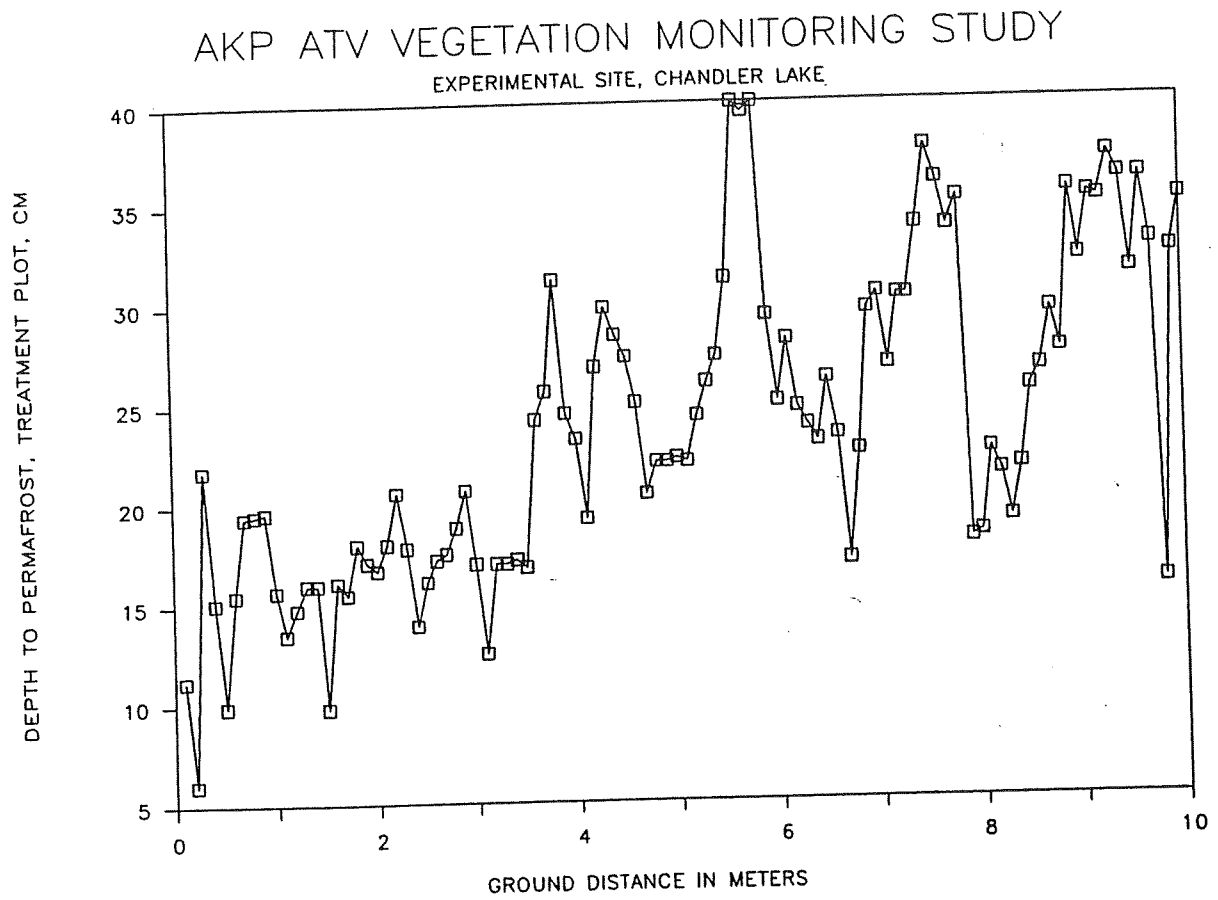


FIGURE 2
AKP ATV VEGETATION MONITORING STUDY
EXPERIMENTAL SITE, CHANDLER LAKE

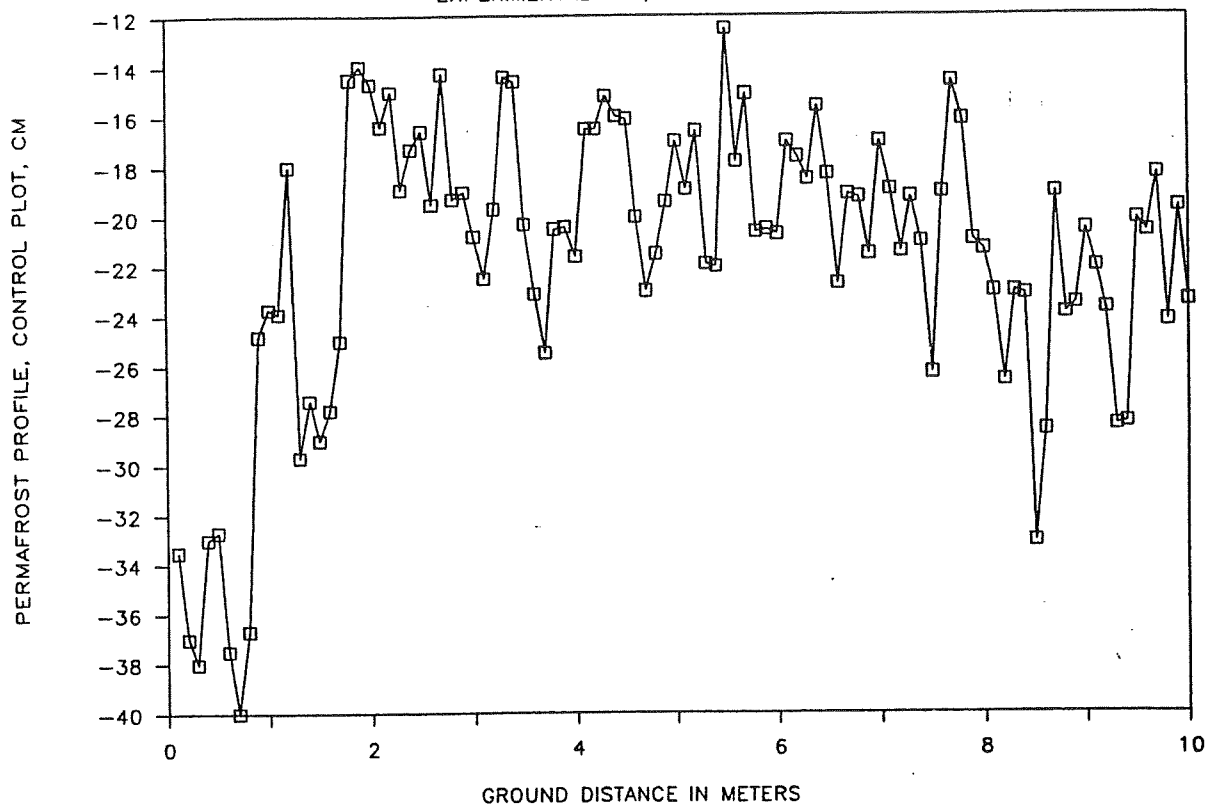


FIGURE 2

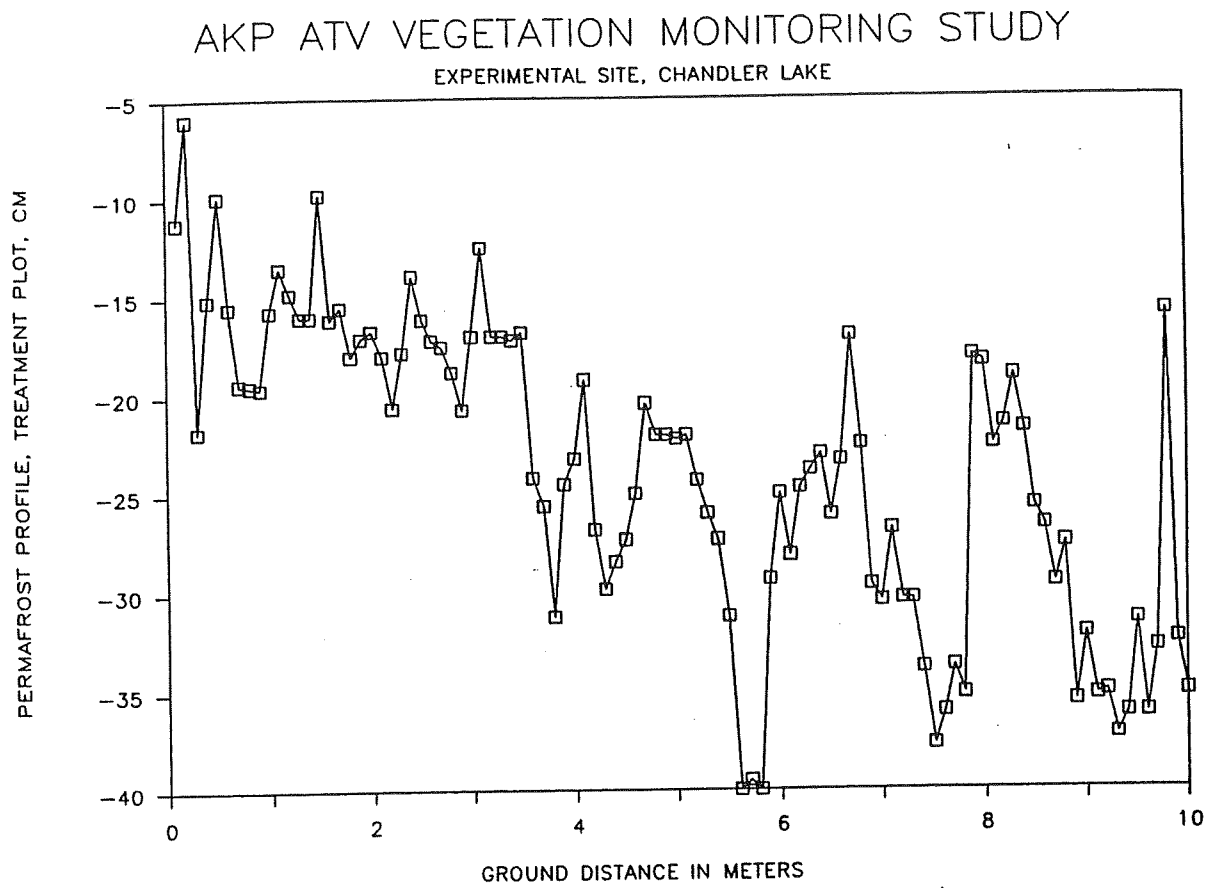
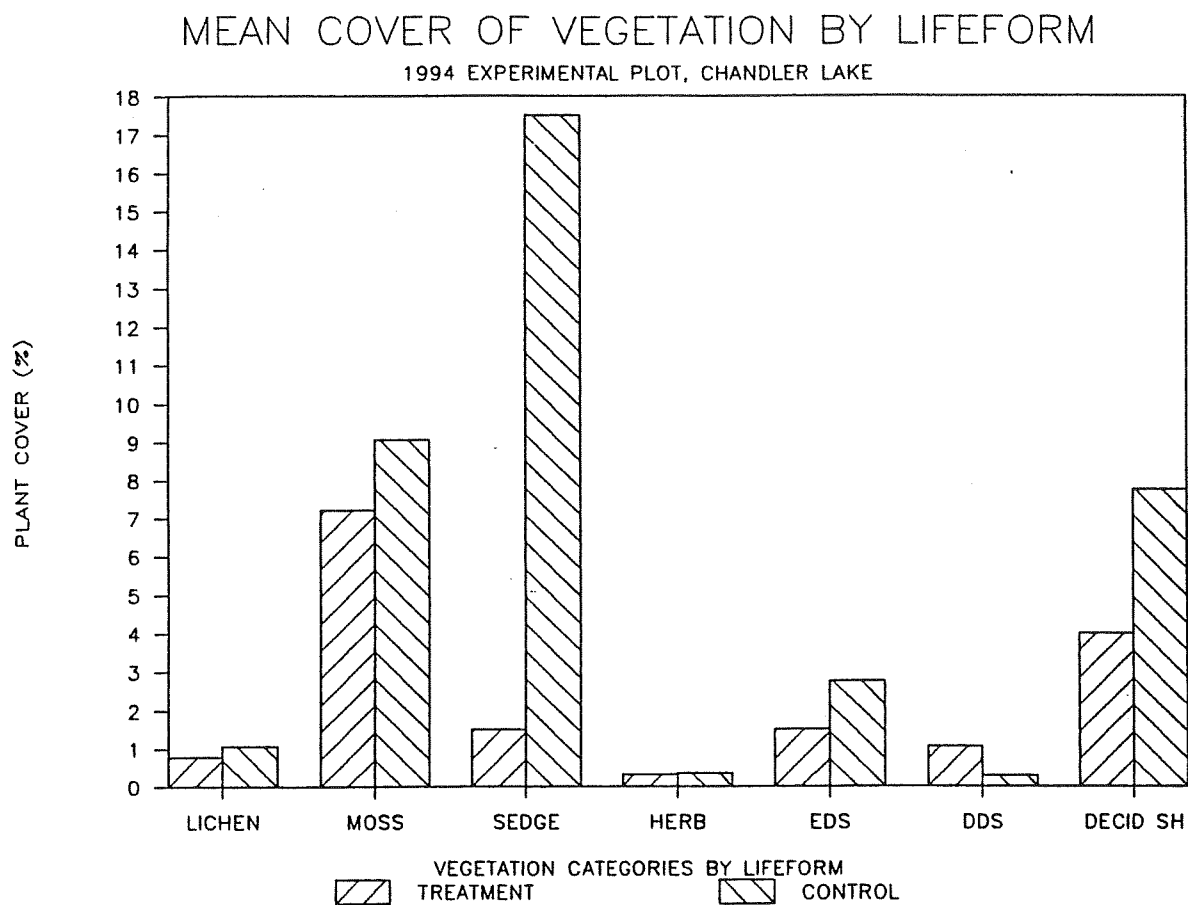


FIGURE 3



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APPENDIX A
VEGETATION STUDY
Point Frame Cover Data Sheet

Site: _____
 Plot: _____ Date: _____ Observers: _____
 Veg. Type: _____ Photo Roll: _____ Frame: _____
 Slope: _____ Aspect: _____
 (20 points in each column. Each column is a new location.)

[illegible]

APPENDIX A (CONTINUED)
VEGETATION STUDY
Point Frame Cover Data Sheet

Plot: Treatment Date: 07/10/94 Observers: Shea/Kraska/David
Veg. Type: Mixed Shrub-Sedge Tussock Tundra Photo Roll: Roll 1
Frames: 1-4, 6-17 Slope: 3% Aspect: 290° (magnetic)

(20 points in each column. Each column is a new location.)

SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL
FORBS											
Herb sp.				1							
<u>Stellaria</u> sp.					1				2		
SEDGES											
<u>Carex aquatilis</u> subsp. <u>stans</u>	10	3	2	7	6	10	8	8	11	5	
<u>Eriophorum</u> <u>vaginatum</u> subsp. <u>vaginatum</u>	6	5	9	8	7	6	12	13	6	4	
GRASS											
Grass sp.					1						
DWARF DECIDUOUS SHRUBS											
<u>Betula nana</u> subsp. <u>exilis</u>	1	4				1					
<u>Dryas octopetala</u> subsp. <u>octopetala</u> var. <u>octopetala</u>						1					
<u>Ledum palustre</u> subsp. <u>decumbens</u>		2			1				2		
<u>Salix reticulata</u> subsp. <u>reticulata</u>	2	1	1	1		1	1	1			
DWARF EVERGREEN SHRUB											
<u>Cassiope</u> <u>tetragona</u> subsp. <u>tetragona</u>	2			2	1		1			1	
<u>Vaccinium vitis-</u> <u>idaea</u> subsp. <u>minus</u>	1	2	1	1			5	1		2	
DECIDUOUS SHRUB											
<u>Salix glauca</u>				1	2	5	3	1	2	2	

VEGETATION STUDY (CONTINUED)
Point Frame Cover Data Sheet

S 1, Chandler Lake, Kollutarak Creek
P. Treatment

SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL
LICHEN											
<u>Cetraria</u> <u>cucullata</u>		6			1		1	2	2		
<u>Cetraria</u> sp.	1	2				2		2			
<u>Cladonia</u> sp.	1	2	2				2	2	1		
<u>Dactylina</u> <u>arctica</u>		1				1	1				
<u>Peltigera</u> <u>venosa</u>								1			
<u>Stereocaulon</u> sp.	1										
MOSS											
Acrocarpous Moss	6	10	2	12	14	7	8	12	11	13	
<u>Pleurozium</u> <u>schreberi</u>	4	2	3	1	3	2	2	7	9	4	
<u>Polytrichum</u> sp.	1										
<u>nagnum</u> sp.	1	1		1	3	6	4		2	3	
LIVERWORT											
Liverwort sp.	1		1	2	1	2	1	3	1	1	
MISCELLANEOUS											
Organic Material (churned up peat)	10	13	11	12	11	11	11	10	10	12	
Ponding	2		2	2							

(Organic Material is churned peat not ground litter)

VEGETATION STUDY
Point Frame Cover Data Sheet

S : 1, Chandler Lake, Kollutarak Creek
Plot: Control Date: 07/11/94 Observers: Shea/Kraska/David
Veg. Type: Mixed Shrub-Sedge Tussock Tundra Photo Roll: Roll 1
Frames: 3-17 Slope: 3% Aspect: 290°(magnetic)

(20 points in each column. Each column is a new location.)

SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL
FORBS											
Herb sp.											
<u>Polygonum bistorta</u>			1						2		
<u>Stellaria</u> sp.		1									
SEDGES											
<u>Carex aquatilis</u> subsp. <u>stans</u>	4	7	7	1	6			5	4	6	
<u>Eriophorum vaginatum</u> subsp. <u>vaginatum</u>	9	13	10	8	7	18	11	13	11	9	
GRASS											
Grass sp.										1	
DWARF DECIDUOUS SHRUBS											
<u>Betula nana</u> subsp. <u>exilis</u>	1		1				2			1	
<u>Dryas octopetala</u> subsp. <u>octopetala</u> var. <u>octopetala</u>			2	1	1			2			
<u>Ledum palustre</u> subsp. <u>decumbens</u>	4				1	1					
<u>Salix reticulata</u> subsp. <u>reticulata</u>	1	1	1					1			
DWARF EVERGREEN SHRUB											
<u>Cassiope tetragona</u> subsp. <u>tetragona</u>					2			3	2		
<u>Vaccinium vitis-idaea</u> subsp. <u>minus</u>	1	4	3	3	2	1	2			2	

VEGETATION STUDY (CONTINUED)
Point Frame Cover Data Sheet

S 1, Chandler Lake, Kollutarak Creek
P. Control

SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL
DECIDUOUS SHRUB											
<u>Vaccinium uliginosum</u> subsp. <u>microphyllum</u>				3							
<u>Salix glauca</u>	1	4	4	2	2		5	3	10	3	
LICHEN											
<u>Cetraria cucullata</u>	2	4		3	3	1				1	
<u>Cetraria</u> sp.		1				1	1				
<u>Cladina rangiferina</u>	2		2	4	5	1	2			3	
<u>Cladonia</u> sp.	1	3		1		1					
<u>Dactylina arctica</u>	1	3		2			1			3	
<u>Phoma pallidum</u>			1				1				
<u>Peltigera aphthosa</u>						1	1				
<u>Peltigera venosa</u>	1	2		1							
<u>Stereocaulon</u> sp.											
MOSS											
Acrocarpous Moss	11	14	13	16	9	7	14	8	11	10	
Pleurocarpous Moss	3	3	2	1	2				1		
<u>Pleurozium schreberi</u>	12	6	5	7	13	3	8	10	10	9	
<u>Polytrichum</u> sp.											
<u>Sphagnum</u> sp.	2	2	3		3		5		6		
LIVERWORT											
Liverwort sp.		2	3	1	3	1	1	8	6	6	
MISCELLANEOUS											
ineral Soil						2					
Organic Material (churned up peat)	4								1	2	

APPENDIX A (CONTINUED)
ANAKTUVUK PASS ALL-TERRAIN VEHICLE TRAIL
VEGETATION MONITORING STUDY
EXPERIMENTAL VEGETATION PLOT
CHANDLER LAKE FLORA LIST

BETULACEAE

Betula nana L. subsp. exilis (Sukatsch.) Hult.

CARYOPHYLLACEAE

Stellaria L. sp.

CLADONIACEAE

Cladina rangiferina

Cladonia sp.

CYPERACEAE

Carex aquatilis Wahlenb subsp. stans (Drej.) Hult.

Eriophorum vaginatum L. subsp. vaginatum

ENTODONTACEAE

Pleurozium schreberi

ERICACEAE

Cassiope tetragona (L.) D. Don subsp. tetragona

Ledum palustre L. subsp. decumbens (Ait.) Hult.

Vaccinium uliginosum L. subsp. microphyllum Lange

Vaccinium vitis-idaea L. subsp. minus

MINEAE

Grass sp.

LIVERWORT

Liverwort

NEPHROMATACEAE

Nephroma expallidum

PARMELIACEAE

Cetraria cucullata

Cetraria sp.

PELTIGERACEAE

Peltigera aphthosa

Peltigera venosa

POLYGONACEAE

Polygonum bistorta L. subsp. plumosum (Small) Hult.

POLYTRICHACEAE

Polytrichum sp.

ROSACEAE

Dryas octopetala L. subsp. octopetala var. octopetala

SALICACEAE

Salix glauca L.

Salix reticulata L. subsp. reticulata

SCROPHULARIACEAE
Pedicularis sp.

S FNACEAE
 magnum sp.

STEREOCAULACEAE
Stereocaulon sp.

USNEACEAE
Dactylina arctica

Miscellaneous
 Acrocarpous Moss
 Herb sp.
 Mineral Soil
 Organic Material (churned up moss and vegetation)
 Pleurocarpous Moss
 Ponding

APPENDIX A (CONTINUED)
Notes

tation Form Code for data entry
= Lichen
M = Moss and Liverworts
F = Ferns, Horsetails, Club Moss
G = Grasses
S = Sedges
H = Forb/Herb
EDS = Dwarf Evergreen Shrubs
DDS = Dwarf Deciduous Shrubs
ES = Evergreen Shrubs
DS = Deciduous Shrubs
ET = Evergreen Trees
DT = Deciduous Shrubs
B = Bare Ground
O = Organic Materials
MIN = Mineral Soil
P = Ponding

Definitions

- Organic Material - churned up organic material not litter

APPENDIX A (CONTINUED)
 ANAKTUVUK PASS ALL-TERRAIN VEHICLE TRAIL
 VEGETATION MONITORING STUDY
 SOIL SURFACE PROFILE AND DEPTH TO PERMAFROST DATA
 CHANDLER LAKE

SOIL SURFACE PROFILE (EVERY 5CM, FOR 5M), CONTROL PLOT		SOIL SURFACE PROFILE (EVERY 5CM, FOR 5M), TREATMENT PLOT		DEPTH TO PERMAFROST (EVERY 10CM FOR 10M), CONTROL PLOT		DEPTH TO PERMAFROST (EVERY 10CM FOR 10M), TREATMENT PLOT	
18.9	13.3	17.6	27.8	33.5	18.9	11.2	22.0
17.6	12.7	24.0	22.7	37.0	16.6	6.0	24.3
15.4	15.0	22.1	30.3	38.0	21.9	21.8	26.0
17.7	19.0	12.0	19.8	33.0	22.0	15.1	27.3
17.3	21.1	11.1	26.7	32.7	12.5	9.9	31.2
17.5	19.8	9.4	27.6	37.5	17.8	15.5	40.0
15.9	17.9	11.0	27.2	40.0	15.1	19.4	39.5
15.4	18.9	13.2	24.7	36.7	20.6	19.5	40.0
17.0	17.5	17.0	24.8	24.8	20.5	19.6	29.3
15.9	17.0	17.4	25.6	23.7	20.7	15.7	25.0
17.0	19.8	16.9	25.2	23.9	17.0	13.5	28.1
16.7	19.2	14.6	26.2	18.0	17.6	14.8	24.7
15.8	19.2	13.2	28.3	29.7	18.5	16.0	23.8
12.8	20.8	14.7	27.0	27.4	15.6	16.0	23.0
8.8	21.0	12.6	25.9	29.0	18.3	9.8	26.1
6.6	21.0	11.6	24.5	27.8	22.7	16.1	23.3
13.0	20.8	13.1	25.6	25.0	19.1	15.5	17.0
3.4	20.0	11.7	25.5	14.5	19.2	18.0	22.5
0.1	19.1	15.3	25.0	14.0	21.5	17.1	29.6
9.3	19.1	15.0	20.5	14.7	17.0	16.7	30.4
10.3	16.6	19.9	21.5	16.4	18.9	18.0	26.8
10.9	14.4	20.1	20.9	15.0	21.4	20.6	30.3
12.5	14.0	19.8	22.0	18.9	19.2	17.8	30.3
15.5	14.4	18.1	22.9	17.3	21.0	13.9	33.8
20.5	16.0	18.7	22.7	16.6	26.3	16.1	37.7
18.9	20.0	20.4	24.5	19.5	19.0	17.2	36.0
19.2	19.0	21.8	26.5	14.3	14.6	17.5	33.7
18.0	16.0	26.8	28.3	19.3	16.1	18.8	35.1
17.9	16.4	28.3	28.6	19.0	20.9	20.7	18.0
16.0	16.8	26.1	30.0	20.8	21.3	17.0	18.3
14.5	18.3	27.0	31.0	22.5	23.0	12.5	22.5
16.0	19.8	29.5	31.0	19.7	26.6	17.0	21.4
17.3	18.7	28.9	32.2	14.4	23.0	17.0	19.0
18.5	18.4	24.4	32.8	14.6	23.1	17.2	21.7
15.2	18.2	26.7	33.3	20.3	33.1	16.8	25.6
23.1	16.2	26.4	33.7	23.1	28.6	24.2	26.6
9.5	19.8	25.9	34.4	25.5	19.0	25.6	29.5
8.8	18.8	25.6	34.6	20.5	23.9	31.2	27.5
11.8	20.0	27.5	35.4	20.4	23.5	24.5	35.5
13.3	16.8	23.2	33.9	21.6	20.5	23.2	32.1
13.1	13.8	24.9	33.7	16.5	22.0	19.2	35.2
12.4	16.5	25.1	32.6	16.5	23.7	26.8	35.0
11.8	16.5	24.8	31.0	15.2	28.4	29.8	37.2
3.8	16.9	21.0	31.5	16.0	28.3	28.4	36.1
14.0	19.5	20.0	32.5	16.1	20.1	27.3	31.4
15.4	20.7	20.5	32.9	20.0	20.6	25.0	36.1
10.0	21.2	21.7	33.9	23.0	18.3	20.4	32.8
13.2	21.6	23.4	33.7	21.5	24.2	22.0	15.8
12.9	21.7	25.4	34.0	19.4	19.6	22.0	32.4
12.4	17.2	26.5	34.2	17.0	23.4	22.2	35.0

APPENDIX A (CONTINUED)
SOIL INFORMATION

S: Drainage and Number: Chandler Lake, Kollutarak Creek, Site 1,
Experimental Plot.

Site Vegetation Community: Mixed Shrub-Sedge Tussock Tundra

Date: 07/11/94

Surveyors: Shea, Kraska, David

Treatment Site

Organic Mat

Description:

Classification:

Thickness: 1. F = 5.5cm, H = 1.0cm, S = 0.0cm.

Mineral Soil

Description: Wet, 50% clay, 20% sand, 30% silty loam.

Color Classification: 2.5Y 4/2 (value/chroma) Dark Greyish Brown.

Depth of Soil to Permafrost: 27 cm.

Control Site

Organic Mat

Description: Wet

Classification:

Thickness: 1. F = 7cm, H = 5cm, S = 1cm.

Mineral Soil

Description: Wet, Sandy Loam

Color Classification: 10YR 5/3 (value/chroma)

Depth of Soil to Permafrost: 5cm

F = Fibric organic layers which consist of slightly decomposed well preserved and identifiable fibers. Fibric layers have a low bulk density.

H = Hemic organic layers which have an intermediate degree of decomposition and intermediate bulk density.

S = Sapric organic layers which are greatly decomposed with low amounts of fiber and a high bulk density.

APPENDIX A (CONTINUED)

DISTURBANCE RATING AND LEVEL

Site Drainage and Number: Chandler Lake, Kollutarak Creek, Site 1,
Experimental Plot.

Site Vegetation Community: Mixed Shrub-Sedge Tussock Tundra

Date: 07/11/94 Surveyors: Shea, Kraska, David

Disturbance Rating Scale

Vegetation = 5

Soil = 3

Microtopography = 5

Total = 13 Moderate Impact

Disturbance Level and Description

Moist Sedge-Shrub Tundra

2 Trail appears wetter than surrounding area. Common compression of microsites and mosses. 25-50% decrease in shrubs or mosses. May have visible increase in sedge cover or flowering of sedges.

(See Keys for Disturbance Rating Scale and Disturbance Level and Description on following pages)

APPENDIX A (CONTINUED)

DISTURBANCE RATING SCALE

FACTOR	RATING	DISTURBANCE
Vegetation	1	No discernable change.
	2	Slight compression, leaves of stems temporarily bent or rearranged (can barely perceive ATV passage).
	3	Compression - mosses, graminoids, herbaceous species mostly flattened, shrubs becoming compressed.
	4	Tearing and removal of leaves or tearing and displacement of mosses or lichens; or flattening, breakage, or abrasion of woody stems or branches.
	5	Greater 10%-25% of the original composition is not recognizable.
	6	Greater 25%-50% of the original composition is not recognizable.
	7	Greater 50%-70% of the original composition is not recognizable.
	8	Greater 75%-100% of the original composition is not recognizable.
Soil (peat, organic or mineral)	1	No discernable change.
	2	Greater than 0%-5% exposed.
	3	Greater than 5%-10% exposed.
	4	Greater than 10%-25% exposed.
	5	Greater than 25%-50% exposed.
	6	Greater than 50%-75% exposed.
	7	Greater than 75%-90% exposed.
	8	Greater than 90%-100% exposed.
Micro-topography	1	No discernable change.
	2	Track depression < 2.5cm for < 50% of the track length, or slight compression evident on individual tussocks or hummocks.*

DISTURBANCE RATING SCALE (CONTINUED)

3	Track depression < 2.5cm for > 50% of the track length, or slight to moderate tussock or hummock compression.*
4	Track depression > 2.5cm - 5cm for > 50% of the track length, or moderate tussock or hummock compression.*
5	Track depression > 5cm - 10cm for > 50% of the track length, or moderate to severe tussock or hummock compression.*
6	Track depression > 10cm - 15cm for > 50% of the track length, or severe tussock or hummock compression.*
7	Track depression > 15cm - 20cm for > 50% of the track length, or severe tussock or hummock compression to destruction.*
8	Track depression > 20cm for > 50% of the track length, or tussocks or hummocks destroyed.

* Tussock/Hummock Compression

Slight: Sedge stems flattened or missing on tops of individual tussocks; hummocks compressed less than 25% of their original height.

Moderate: Compression so that trail is evident, but tussocks or hummocks are compressed less than 50% of their original height.

Severe: Compression is evident for the entire length of the trail and tussocks or hummocks are compressed greater than 50% of their original height.

Destruction: Tussocks or hummocks are flattened.

(Taken from Ahlstrand, Cantor and Racine (1988))

APPENDIX A (CONTINUED)
DISTURBANCE LEVEL AND DESCRIPTION

Aquatic graminoid tundra

- 0 No impact
- 1 Decrease in emergent vegetation

Wet graminoid tundra

- 0 No impact or may have a few widely scattered scuffed microsites.
- 1 May be slightly greener or darker than surrounding area with more flowering sedges and less moss cover. Some compression or scuffing of higher microsites.
- 2 Trail appears wetter than surrounding area. Common compression of microsites and mosses.
- 3 Obvious track depression. Standing water apparent on trail that is not present in surrounding area during wet years.

Moist sedge-shrub tundra

- 0 No impact or may have a few widely scattered scuffed microsites.
- 1 Decrease in shrubs or mosses, but less than 25%. May be slightly greener or darker than surrounding area and with more flowering sedges and standing dead sedge leaves. Some compression or scuffing of higher microsites.
- 2 Trail appears wetter than surrounding area. Common compression of microsites and mosses. 25-50% decrease in shrubs or mosses. May have visible increase in sedge cover or flowering of sedges.
- 3 Obvious track depression. Standing water apparent on trail that is not present in adjacent area during wet years. Vegetation type changing to wet graminoid, with increased sedge cover and a marked decreased shrub and moss cover. Where track depression has not occurred, over 50% decrease in vegetation or shrubs.

Moist sedge tussock tundra

- 0 No impact or slight scuffing of tussocks. 0-4% decrease in vegetation cover.
- 1 5-25% decrease in vegetation cover in tracks or whole plot. Scuffed or crushed tussocks still visible, but with common recolonization. Exposed soil <3%.
- 2 25-50% decrease in vegetation cover in tracks or whole plot. Over 30% of tussocks still are compressed although regrowth of tussocks may be occurring. Exposed organics or mineral soil 3-15%. Portions of trail may be wetter and may show some change in vegetative composition.
- 3 Vegetation decrease over 50% in tracks or whole plot. Destruction of tussocks or mound tops nearly continuous. General depression of trail still evident. Exposed soil over 15% and change in vegetative composition.

APPENDIX A (CONTINUED)
DISTURBANCE LEVEL AND DESCRIPTION (CONTINUED)

Moist shrub tundra

- 0 No impact or slight scuffing of microsites.
- 1 5-25% decrease in vegetation or shrub cover. Damaged tussocks or hummocks have common recolonization.
- 2 25-50% decrease in vegetation or shrub cover.
- 3 Over 50% decrease in vegetation or shrub cover.

Riparian shrubland

- 0 No impact or slight decrease in shrub cover.
- 1 Less than 25% decrease in vegetation or shrub cover. Little change in ground cover.
- 2 Vegetation or shrub cover decrease 25-50%. Some disturbance to ground cover.
- 3 Over 50% decrease in vegetation or shrub cover. Substantial damage to ground cover.

Dryas terrace

- 0 No impact or may have a few widely scattered scuffed microsites. Entire trail is no longer visible, but individual tracks show discontinuous impact. Less than 30% decrease in vegetation cover and less than 5% soil exposed within the tracks.
- 2 Visible impact with 30-60% vegetation decrease and 5-15% soil exposed but little disruption of vegetative mat. Impact within the tracks may be more severe, approaching level 3 disturbance.
- 3 Over 60% vegetation decrease and vegetative mat mostly disrupted. Over 15% soil exposed or over 50% increase in bare ground.

(Table taken from Emers et al. 1992, 3-4)

APPENDIX A
PHOTO LOG

Site Drainage and Number: Chandler Lake, Kollutarak Creek, Site 1,
Experimental Plot.

Site Vegetation Community: Mixed Shrub-Sedge Tussock Tundra

Date: 07/11/94

Surveyors: Shea, Kraska, David

<u>Roll</u>	<u>Frame</u>	<u>Description</u>
1	1	Treatment Plot, 30m transect
1	2	ATV Trail
1	3	Treatment and Control Plot, 30m transect
1	4	Treatment and Control Plot, 30m transect
1	5	Control Plot, 30m transect
1	6	Site 1, East to West
1	7	Site 1, East to West
1	8	Site 1, East to West
1	9	Site 1, South to North
1	10	Site 1, South to North
1	11	Site 1, South to North
1	12	Site 1, West to East
1	13	Site 1, West to East
1	14	Site 1, West to East
	15	Site 1, North to South
	16	Site 1, North to South
1	17	Site 1, North to South

APPENDIX B
GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
ANAKTUVUK RIVER

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTOS
A1	3	2	3	8 LOW	2	IIC2H	ROLL 1 FR35&36
A2	3	2	4	9 LOW	2	IIC2H	ROLL 2 FR 1
A3	2	2	2	6 LOW	1	IID1A	FR 2
A4	5	3	4	12 MODERATE	2	IIB2A	FR 6&7
A5	1	1	1	3 LOW	0	GRAVEL	FR 8
A6	2	2	2	6 LOW	1	IID1B	FR 9&10
A7	2	2	2	6 LOW	2	IID1A	FR 11&12
A8	3	3	4	10 MODERATE	2	IID1A	FR 13&14
A9	4	2 PONDING	5	11 MODERATE	2	IIIA2J	FR 15&16
A10	5	3 PONDING	5	13 MODERATE	2	IIC1B	FR 17&18
A11	2	2	2	6 LOW	1	IID1C	FR 19&20
A12	4	3	3	10 MODERATE	2	IIB2A STREAM	FR 21&22
A13	3	2	3	8 LOW	1	IIC2G	FR 23&24
A14	5	3 PONDING	5	13 MODERATE	2	IIIA2H	FR 25&26
A15	2	2	2	6 LOW	1	IID1A	FR 27&28
A16	4	2	2	8 LOW	1	IIC2G GRAVEL	FR 30&31
A17	2	1	2	5 LOW	1	IID1A	FR 32
A18	3	2	3	8 LOW	2	IID3A	FR 29
A19	1	1	1	3 LOW	0	IID1C	FR 33
A20	1	1	1	3 LOW	0	IIC2G	FR 34
A21	1	1	1	3 LOW	0	IIC2G GRAVEL	FR 35

See below for Keys to Classification; sites correspond to areas marked on 1984-88 color infrared aerial photos; Veg Impact Class, Soil Impact Class and Microtopo Impact Class are added to equal Total Impact Class)

APPENDIX B (CONTINUED)
GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
INUKPASUGRUK (GIANT) CREEK

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTOS
G1	4	3	4	11 MODERATE	1	IIC2H	ROLL 3 FR 1&2
G2	5	3	4	12 MODERATE	2	IIB2A	FR 3&4
G3	4	2	5	11 MODERATE	2	IIC2G	FR 5
G4	5	2	4	11 MODERATE	2	IIC2A	FR 6&7
G5	4	3	5	12 MODERATE	2	IIIA2H/ I	FR 8
G6	5	2	5	12 MODERATE	2	IIC2A	FR 9
G7	6	5	5	16 MODERATE	3	IIC1C	FR 10&11
G8	4	3	4	11 MODERATE	1	IID1C TALLER SHRUBS	FR 12&13
G9	6	2	4	12 MODERATE	2	IIB2A	FR 14&15
G10	5	3	5	13 MODERATE	3	IIB2A	FR 16
G11	4	3 PONDING	5	12 MODERATE	2	IIIA3A	FR 17
G12	3	1	4	8 LOW	1	IIC2 LICHEN	FR 18&19
G13	5	4 PONDING	5	14 MODERATE	3	IIC2B	FR 20
G14	3	2	4	9 LOW	1	IIC2A	FR 21
G15	5	3	5	13 MODERATE	3	IIC2G	FR 22
G16	4	2	4	10 MODERATE	2	IIC2G	FR 23
G17	4	3	5	12 MODERATE	2	IIC2A	FR 24

GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
 INUKPASUGRUK (GIANT) CREEK (CONTINUED)

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP -TION	VIERECK VEG CLASS	PHOTOS
G18	4	2	4	10 MODERATE	1	IIC2G	FR 25&26 ROLL 4 FR 1
G19	2	1	2	5 LOW	1	IIC2G LICHEN	FR 2
G20	2	1	2	5 LOW	1	IIC2H	FR 3
G21	3	1	2	6 LOW	1	IID1B	FR 4
G22	4	2	4	10 MODERATE	1	IIB2A	FR 5
G23	2	1	1	4 LOW	1	IIC2A	FR 6
G24	3	2	3	8 LOW	1	IIC2G	FR 7&8
G25	2	1	1	4 LOW	1	IIC2A/B	FR 9&10

See below for Keys to Classification; sites correspond to areas marked on 84-88 color infrared aerial photos; Veg Impact Class, Soil Impact Class and Microtopo Impact Class are added to equal Total Impact Class)

APPENDIX B (CONTINUED)
GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
KOLLUTARAK CREEK

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTO
K1	5	3	4	12 MODERATE	2	IIC2F	ROLL 4 FR 19
K2	5	2	4	11 MODERATE	2	IIC2F GRAVEL	FR 20
K3	6	4	5	15 MODERATE	3	IIC2G	FR 21
K4	5	3	4	12 MODERATE	2	IIC2G ERIC.	FR 22
K5	6	4	5	15 MODERATE	3	IIC2G	FR 23
K6	6	4	5	15 MODERATE	3	IIC2G ERIC.	FR 24&25
K7	7	4	5	16 MODERATE	3	IIC2G ERIC./ ERIOPH.	FR 26 ROLL 5 FR 1&2
K8	6	3	5	14 MODERATE	2	IIC2G ERIC./ ERIOPH	FR 3
K9	4	2 PONDING	6	12 MODERATE	3	IIIA3A	FR 4&5
K10	3	1	3	7 LOW	1	IIC2H	FR 6
K11	5	2	5	12 MODERATE	2	IIIA3A	FR 7&8
K12	2	1	3	6 LOW	1	IIB2A GRAVEL BAR	FR 9
K13	5	3	4	12 MODERATE	2	IIC2G	FR 10
K14	6	4	4	14 MODERATE	2	IIC2G	FR 11&12
K15	5	3	4	12 MODERATE	2	IIC2F	FR 13
K16	5	3	4	12 MODERATE	2	IIC2F GRAVEL- LY	FR 14
K17	5	3	4	12 MODERATE	2	IIC2F	FR 15&16

GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
KOLLUTARAK CREEK (CONTINUED)

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTO
K18	5	3	5	13 MODERATE	3	IIC2F	FR 17&18
K19	6	4	5	15 MODERATE	3	IIC2C	FR 19
K20	6	4	5	15 MODERATE	3	IIC2C	FR 20
K21	7	4	5	16 MODERATE	3	IIC1A	FR 21&22
K22	6	4	4	14 MODERATE	3	IIC2F LICHEN	FR 23&24
K23	6	4	6	16 MODERATE	3	IIB2A	ROLL 6 FR 1
K24	6	4	5	15 MODERATE	3	IIB2A	FR 2&3
K25	6	4	5	15 MODERATE	2	IIB1A	FR 4
K26	5	1	5	11 MODERATE	2	IIC1C	FR 5&6
K27	6	5	5	16 MODERATE	3	IIB2A	FR 7&8
K28	6	3	5	14 MODERATE	2	IIC1C	FR 9
K29	7	5	4	16 MODERATE	3	IIC2C	FR 10&11
K30	6	4	5	15 MODERATE	2	IIC1A	FR 12&13

(See below for Keys to Classification; sites correspond to areas marked on 1984-88 color infrared aerial photos; Veg Impact Class, Soil Impact Class and Microtopo Impact Class are added to equal Total Impact Class)

APPENDIX B (CONTINUED)
GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
EKOKPUK CREEK

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTO
E1	3	2	2	7 LOW	1	IID2/ LICHEN	ROLL 6 FR 24 ROLL 7 FR 1
E2	5	2	3	10 MODERATE	1	IIC2C/ LESS LICHEN	FR 2
E3	5	2	4	11 MODERATE	2	IIC2C	FR 3
E4	5	2	4	11 MODERATE	2	IIC2C	FR 4
E5	5	2	4	11 MODERATE	2	IIC2A	FR 5&6
E6	4	2	4	10 MODERATE	1	IIC2A	FR 7&8 (8 WAS BURN AREA)
E7	5	2	4	11 MODERATE	2	IIC2A	FR 9
E8	5	4	5	14 MODERATE	2	IIC2D	FR 10&11
E9	5	3	5	13 MODERATE	2	IIC2F	FR 12&13
E10	5	3	2	10 MODERATE	1	IID2/ LICHEN	FR 14
E11	5	4 PONDING	5	14 MODERATE	2	IIIA3A	FR 15&16
E12	5	2	5	12 MODERATE	2	IIC2A	FR 17
E13	2	2	2	6 LOW	1	IID2/ LICHEN/ LOW BIRCH	FR 18

GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
EKOKPUK CREEK (CONTINUED)

SITE	VEG IMPACT CLASS	SOIL IMPACT CLASS	MICRO- TOPO IMPACT CLASS	TOTAL IMPACT CLASS	VISUAL DESCRIP- TION	VIERECK VEG CLASS	PHOTO
E14	5	2	5	12 MODERATE	2	IIC2F	FR 19&20
E15	3	2	2	7 LOW	1	IIC2C/ LICHEN	FR 21&22
E16	2	1	2	5 LOW	1	IID2/ LOW BIRCH/ LICHEN	FR 23
E17	2	1	2	5 LOW	1	IID2/ MORE BIRCH/ LESS LICHEN	FR 24&25
E18	4	2	4	10 MODERATE	2	IIC2A	ROLL 8 FR 1&2
E19	2	1	2	5 LOW	1	IID2/ LOW BIRCH/ WILLOW/ LICHEN	FR 3
E20	4	2	4	10 MODERATE	1	IIC2A	FR 4&5
E21	2	1	1	4 LOW	1	IID2/ LOW BIRCH/ WILLOW/ LICHEN	FR 6&7
E22	3	2	2	7 LOW	1	IIC1C	FR 8&9 (9 SHOWS TALL WILLOW)
E23	3	1	2	6 LOW	1	IIC2A	FR 10
E24	3	2 PONDING	4	9 LOW	2	IIIA3A/ IIC1B	FR 11&12 TWO TRAILS
E25	2	2	2	6 LOW	1	IID2/ LICHEN/ WILLOW/ BIRCH	FR 13

APPENDIX B (CONTINUED)
DISTURBANCE RATING SCALE

Disturbance
Level

Description

Vegetation:

- | | |
|---|---|
| 1 | Undamaged; no discernible change. |
| 2 | Slight compression; leaves or stems temporarily bent or rearranged; vehicle passage barely perceptible. |
| 3 | Mosses, graminoids and other herbaceous species compressed and leaves flattened; shrub stems becoming compressed. |
| 4 | Leaves or mosses and lichens torn or removed; woody shrub stems flattened, with some breakage and abrasion. |
| 5 | 11-25% of original vegetation composition not discernable. |
| 6 | 26-50% not discernable |
| 7 | 51-75% not discernable |
| 8 | 76-100% not discernable |

Soil:

- | | | | |
|---|----------------|---|-----------------|
| 1 | None exposed | 5 | 26-50% exposed |
| 2 | 1-5% exposed | 6 | 51-75% exposed |
| 3 | 6-10% exposed | 7 | 76-90% exposed |
| 4 | 11-25% exposed | 8 | 91-100% exposed |

Microrelief:

- | | |
|---|--|
| 1 | No discernible change or depression of the surface |
| 2 | Tracks evident but with less than half of track depressed 1 inch; slight compression of tussocks or hummocks |
| 3 | Surface depression less than 1 inch over majority of track; slight to moderate compression of tussocks or hummocks |
| 4 | Track depressed 1-2 inches; moderate tussock or hummock compression |
| 5 | Track depressed 2-4 inches; moderate to severe tussock or hummock compression |
| 6 | Track depressed 4-6 inches; severe tussock or hummock compression |
| 7 | Track depressed 6-8 inches; severe compression or destruction of tussocks or hummocks |
| 8 | Depressions or ruts greater than 8 inches deep; tussocks or hummocks completely flattened or destroyed |

By adding up the ranking of the 3 categories of impacts, Racine and Johnson (1988) characterized overall disturbance to tundra as high (20-24), moderate (10-19), and low (0-9).
(Table taken from Sinnott, 1990)

APPENDIX B (CONTINUED)
VISUAL DESCRIPTION CLASSIFICATION

Rating	Description
0	Not visible - trail could not be discerned
1	Barely perceptible - trail could be discerned from disjunct disturbance or from a particular viewpoint
2	Visible - continuous trail could be discerned from most angles
3	Easily visible - noticeable color change on trail, obvious contrast with undisturbed area

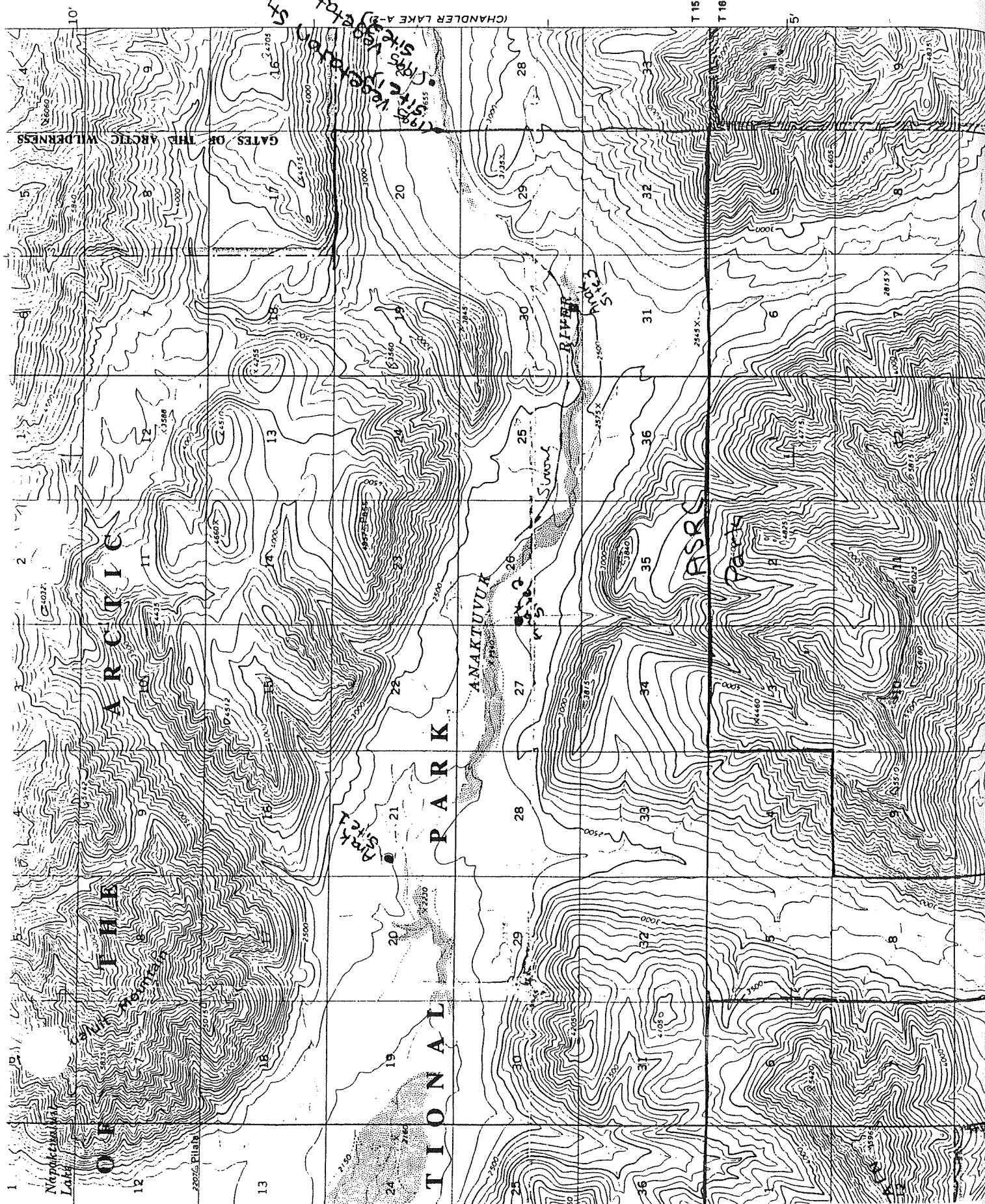
(Taken from Felix et al, 1986)

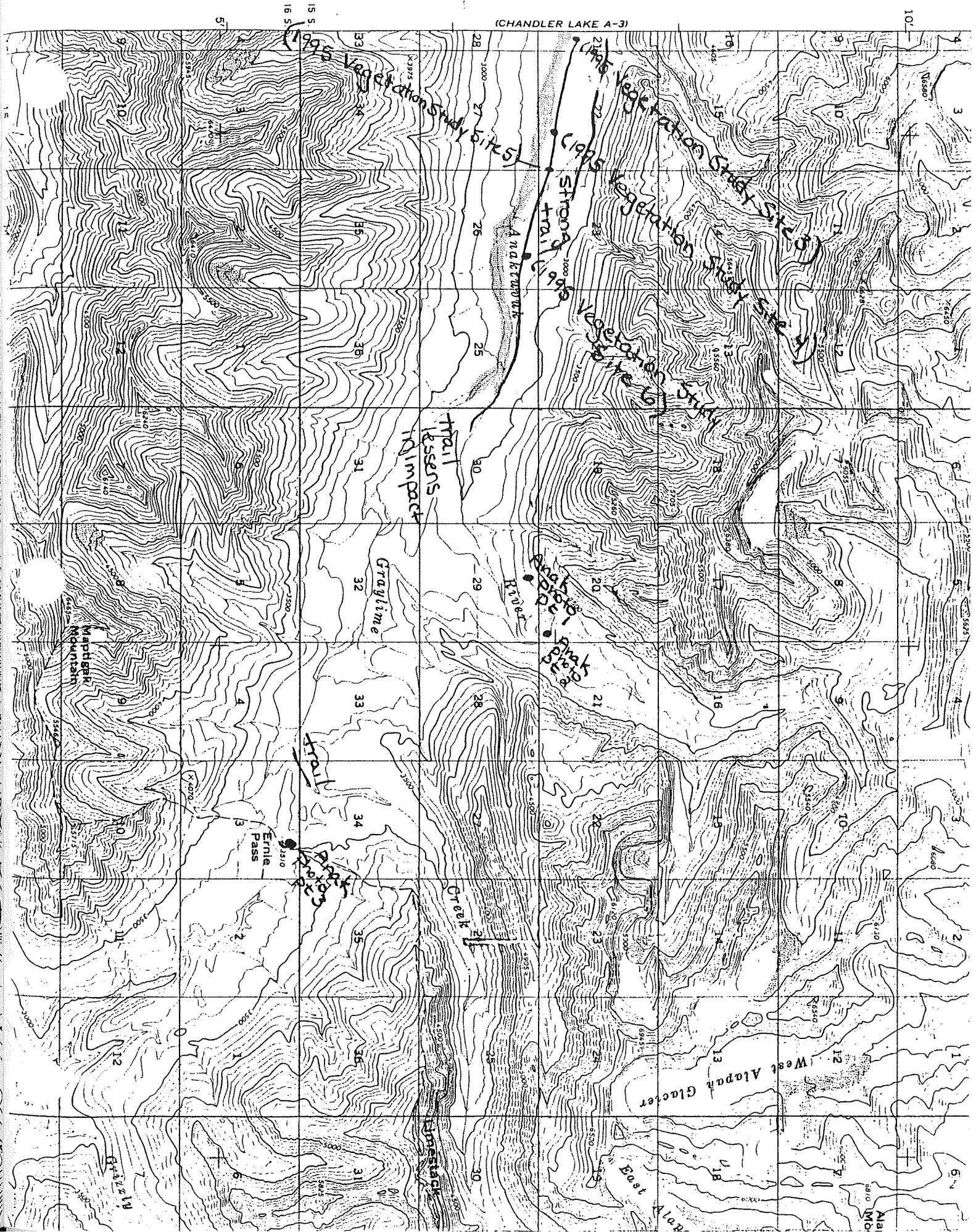
VIERECK'S VEGETATION CLASSIFICATION

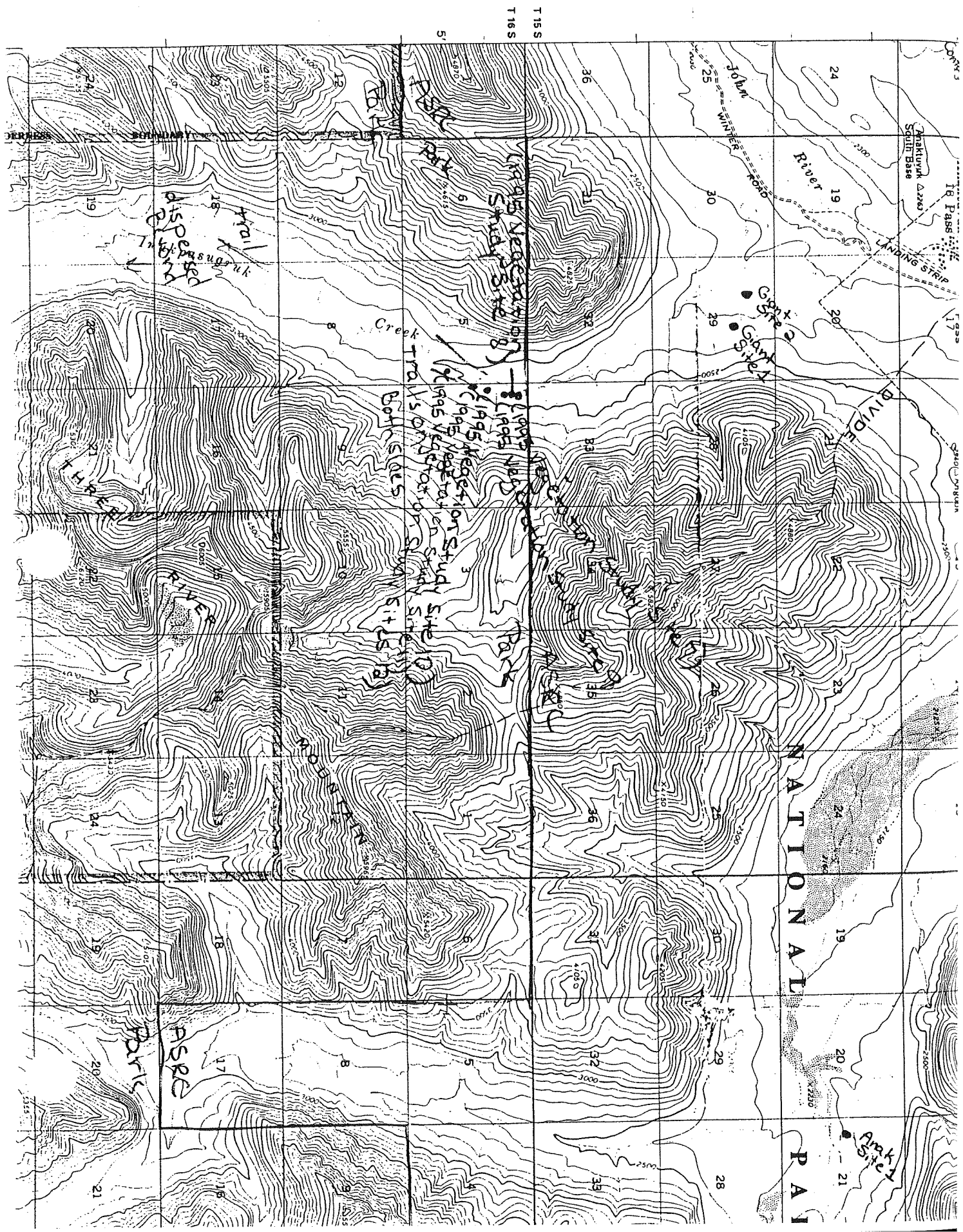
Class	Description
IIB1A	Closed Tall Willow Scrub
IIB2	Open Tall Scrub
IIB2A	Open Tall Willow Scrub
IIC1A	Closed Low Birch Scrub
IIC1B	Closed Low Willow Scrub
IIC1C	Closed Low Birch-Willow Scrub
IIC2A	Mixed Shrub-Sedge Tussock Tundra (Open Low Scrub)
IIC2C	Mesic Shrub Birch-Ericaceous (Open Low Scrub)
IIC2D	Shrub Birch-Ericaceous Shrub Bog (Open Low Scrub)
IIC2F	Open Low Birch-Willow Scrub
IIC2G	Open Low Willow Scrub
IIC2H	Willow-Sedge Shrub Tundra (Open Low Scrub)
IID1A	Dryas Tundra (Dryas Dwarf Scrub)
IID1B	Dryas-Sedge Tundra (Dryas Dwarf Scrub)
IID1C	Dryas-Lichen Tundra (Dryas Dwarf Scrub)
IID2	Ericaceous Dwarf Scrub
IID3A	Willow Tundra (Willow Dwarf Scrub)
IIIA2H	Sedge-Willow Tundra (Mesic Graminoid Herbaceous)
IIIA2I	Sedge-Birch Tundra (Mesic Graminoid Herbaceous)
IIIA2J	Sedge-Dryas Tundra (Mesic Graminoid Herbaceous)
IIIA3A	Wet Sedge Meadow Tundra (Wet Graminoid Herbaceous)

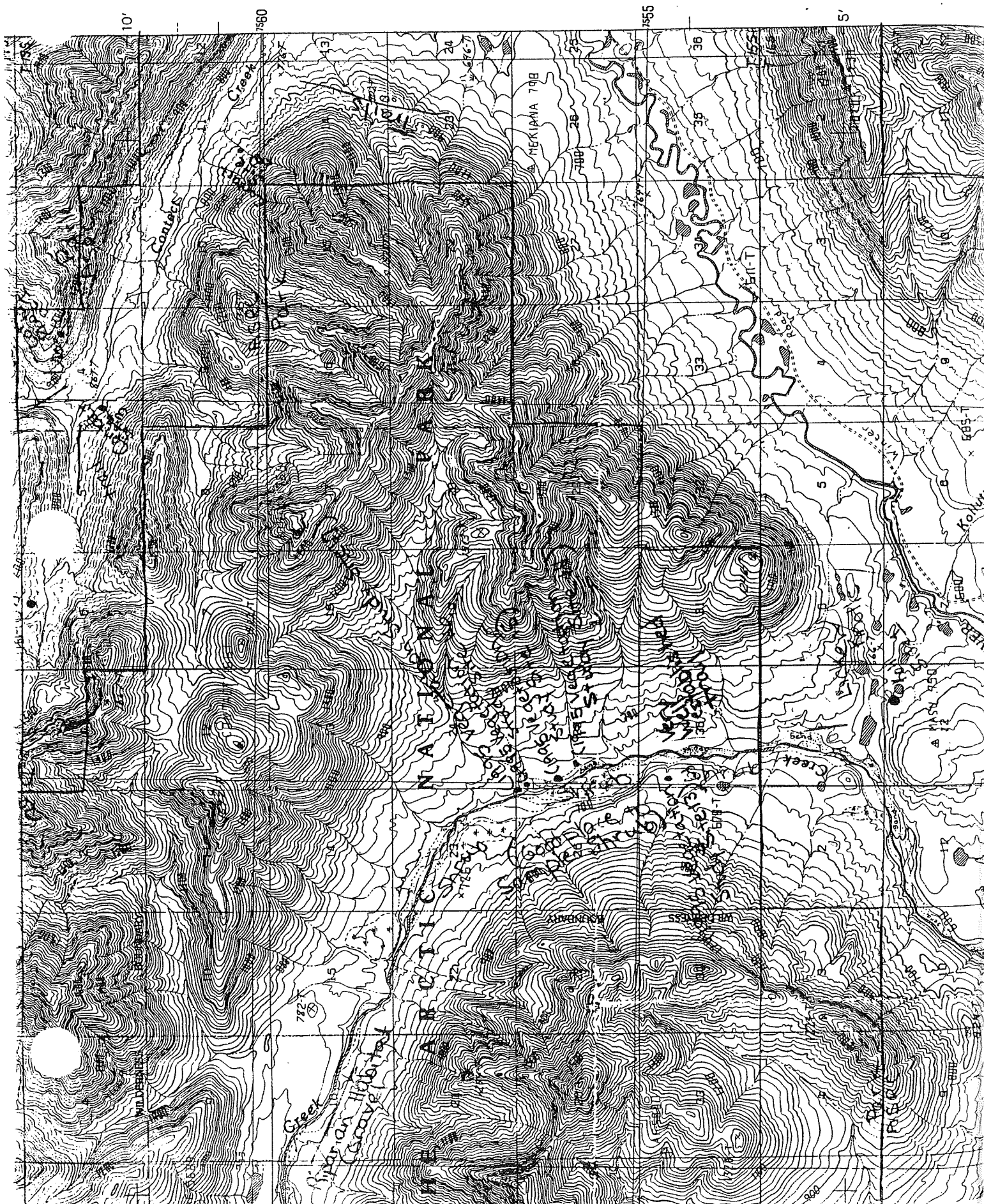
(Taken from Viereck et al, 1992)

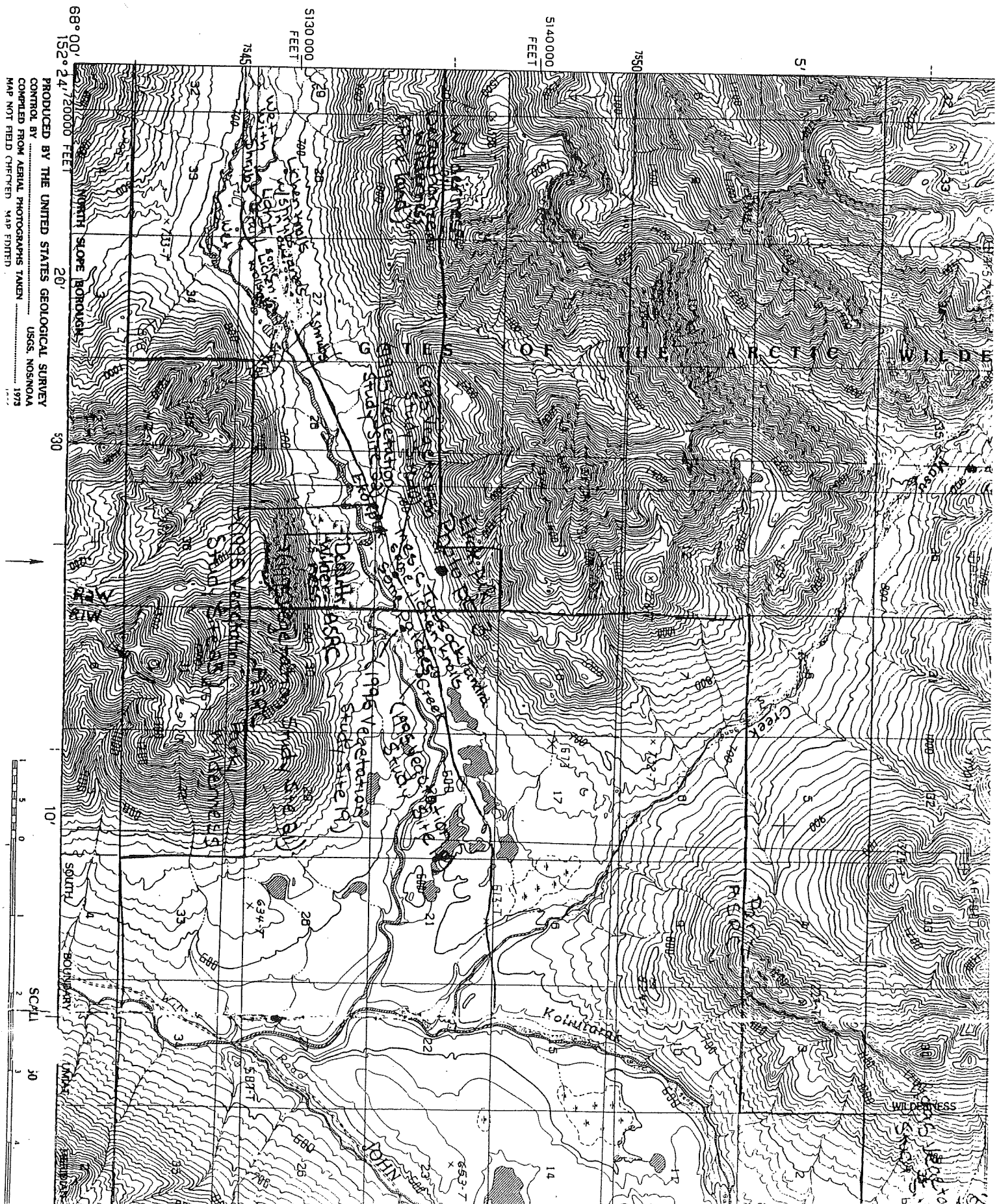
T 15 S	T 16 S
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GROUND TRUTH FOR AERIAL PHOTO INTERPRETATION 1994
EKOKPUK CREEK (CONTINUED)

APPENDIX D
STATISTICAL ANALYSIS

<u>Variable</u>	<u>N</u>	<u>1994</u> <u>Dx</u>	<u>Cx</u>	<u>Test</u>	<u>D>C</u>
Surface Profile	100	24	16	T-Test	*
Depth to Permafrost	100	24	22	T-Test	*
Deciduous Shrubs	2	4	9	T-Test	
Evergreen Dwarf Shrub	2	5	6	T-Test	
Dwarf Deciduous Shrub	3	3	3	T-Test	
Lichen	9	2	3	T-Test	
Moss	6	14	22	T-Test	
Herb	4	1	1	T-Test	

<u>Variable</u>	<u>1994</u> <u>DF</u>	<u>SS</u>	<u>Test</u>	<u>D>C</u>
Total Plant Cover	9	5.02311	Two-Way AOV & Bon	
Vascular Plant Cover	9	4.82000	Two-Way AOV & Bon	
Non-Vascular Plant Cover	9	3.31111	Two-Way AOV & Bon	*
Deciduous Shrubs	3	0.01797	One-Way AOV & Bon	
Evergreen Dwarf Shrub	3	0.00212	One-Way AOV & Bon	
Lichen	17	0.01348	One-Way AOV & Bon	
Moss	11	0.42237	One-Way AOV & Bon	
Herb	7	2.719E-04	One-Way AOV & Bon	

AOV - Analysis of Variance

Bon - Bonferroni

D - Disturbed Plots

C - Control Plots

DF - Degrees of Freedom

SS - Sum of Squares

- Indicates a significant difference ($P > 0.05$) between treatments.