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HUSKY CHANNEL AREA; FIELD SUMMARY OF SOILS AND PERMAFROST DATA WITH A PRELIMINARY SITE APPRAISAL

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HUSKY CHANNEL AREA; FIELD SUMMARY OF SOILS AND PERMAFROST DATA WITH A PRELIMINARY SITE APPRAISAL

by J. A. Pihlainen

This note attempts to summarize pertinent field information on the Husky Channel area collected by our personnel (J.A. Pihlainen, R.J.E. Brown and G.H. Johnston) on the Aklavik Survey Party. The aim of this note is to report the most significant field findings at this time with the understanding that a more complete report will be made when all of the soil testing data are complete and all field notes have been reviewed.

Our first responsibility to the Aklavik Survey Party is the collection of soils and permafrost data at the various potential sites. In this field report, the potential townsite and airstrip locations in the Husky Channel area have been subdivived into regions of similar soil conditions (Fig. 1). Three major landforms are evident; the Richardson Mountains, alluvial fans of the Richardson Mountains, and the delta of the Mackenzie River. The boundaries of these landforms were located in the field and sampling was carried out at selected or representative portions of each landform. For explanatory purposes, soil conditions similar to those at sampled points are assumed for unsampled portions of the landforms. It will be noted that the delta landform was not sampled. The Permafrost Research Station carried out extensive sampling during 1953 on this landform. In any case, this landform is the site of the present town of Aklavik and has been judged unsatisfactory.

Part 1 of this note is a statement of field findings at the Husky Channel area; Part 2, an appraisal of the region as a site.

PART 1:- SUMMARY OF SOILS AND PERMAFROST FIELD DATA

The Husky Channel sitearea is approximately 12 miles southwest of Aklavik and two miles west from the junction of the Husky and Peel Channels. Airphoto investigation previous to ground reconnaissance had established that the series of coalescing alluvial fans from the Richardson Mountains were the most promising potential sites. Access to the region is afforded by the Husky Channel which is approximately 300 ft. wide. Navigation of the Husky Channel for river barge traffic may prove to be difficult so the fans selected for investigation were those closest to the junction of the Peel and Husky Channels. Thus the area covered was about 8 miles long by 1 1/2 miles wide. Field reconnaissance confirmed that the investigated fans were similar to those farther south so that reliable predictions of any fan could be made on the findings of the investigated fans.

Richardson Mountains

Although the Richardson Mountains have not been considered as a potential townsite, the landform is of interest because it is the origin of the alluvial fans and might also provide suitable engineering materials. This north-south range of mountains is two to three miles from the Husky Channel whose course is generally parallel to the mountains. The mountains rise approximately 2,000 feet above the delta although Black Mountain, 10 miles south of the camp site rises over 2,800 feet.

The mountains are comprised chiefly of sandstone, shale and conglomerate in either a weakly or strongly cemented state. Frost action appears to play a large part in the erosional process as most of the exposed bedrock shows many frost cracks and foliation.

Fossil imprints were observed on a flat at the toe of the ridged saddle west of the camp and at an elevation of 1,000 feet. They were abundant in the weathered shaley conglomerate.

Since the only observations to date have been made in winter, only one reference to soil conditions can be made. Soil slumps were observed at an elevation of 800 feet on a north-facing ridge west of the camp. The almost vertical slip faces were spaced about 10 feet apart and ranged in height from 2 to 6 feet. The soil was a light brown silt with friable "mudstones" in the top two feet with streaks and flakes of organic material throughout the face of the exposure.

Low Lying Richardson Mountain Area

Approximately 2 miles north of the campsite fan begins an area of material which appears similar superficially to the Richardson Mountains but is lower in elevation (see Fig. 2). Moreover it is distinctly different from the alluvial fan and the deltaic deposits. Although the general area appears to be unsuitable as a townsite from the point of view of accessibility, the area was investigated since it resembles some potential sites to the north and on the east side of the delta.

Drill hole AB20 was advanced to a depth of 22 feet, between the two lakes shown on Fig. 2. Vegetation in the general vicinity of the borehole consisted of sphagnum and reindeer moss, Labrador Tea, wintergreen and scrub. The area was covered with frost mounds (similar to those described on page 6) averaging 2 feet in diameter and 8 inches high. Topographically the site was an almost flat bench or "plateau-like" projection of the upland which stood   feet above the lakes.

Soil testing results are not available at present but the first 7 feet appear to be a silt with organic material and ice segregation from hairline thickness to 3/16-inch, averaging 1/16-inch. From 7 to 12 feet the soil is a silty clay with large individual ice lens up to 3/4 inch thick. The moisture content (weight of water to weight of soil expressed as a percentage) here is estimated to be 90 per cent. From 12 to 17 feet, the material is a silty gravel, with subrounded and angular pebbles up to 1 inch in diameter. At the 17-foot depth, a greyish brown silty clay (resembling a glacial till) with unsorted angular and rounded pebbles was encountered. The material was described as "unfrozen" since there was no apparent ice although the temperature of the material may have been below 32°F. The core could be easily broken by hand although the material was compacted and dense. Penetration through the material was very slow and hard on equipment so the hole was abandoned at the 22-foot depth.

<u>Alluvial Fans</u>

The alluvial fans in the Husky Channel area form a north-south band, one to three miles wide, at the base of the Richardson Mountains (see Fig. 1). The deposition of fan material is confined mainly to the spring of the year when meltwater from the Richardson Mountains reaches the lesser grade of the fan. The changing course of the creeks is reflected by fan vegetation and topography. Heavy willow thickets stand side by side with open "grass meadows" depending on the past history of the creeks. In general, the first impression of the alluvial fans is that of a gently tilted plain with random streaks and blotches of low vegetation and scrubby brush.

<u>Vegetation</u>.- Vegetation is the most pronounced feature which makes possible subdivision of the alluvial fans into two distinct types. For convenience these two types of fans will be referred to as:

(a) Scrub-covered fans;
(b) Forested fans.

The initially investigated campsite fan is an example of the scrub-covered fan while the series of coalescing fans approximately 5 miles south of the camp (referred to as the "Spruce Fan") are examples of forested fans.

<u>Scrub-covered Fans</u>.- Vegetation on a scrub-covered fan consists of willow and alder thickets (maximum 15 feet high) open grass meadows, open areas of bare soil, grass tussocks (or "niggerheads"), sphagnum moss with patches of reindeer moss frequently covering 1-foot high frost mounds and 30 foot diameter polygonal cracks. Plants include juniper, blueberry, wintergreen, Labrador Tea, and stunted birch, alder and willow. As mentioned before, the vegetation appears to trace the past movements of the supporting creeks and this gives the fan a "braided" appearance when viewed from the air or on air photographs.

<u>Forested Fans</u>.- Vegetation on the forested fans is essentially similar to that of the previously described "scrub-covered" fans with the addition of spruce trees which reach a maximum height of approximately 25 feet. The "concentration" and overall heights of the vegetation appear to average higher and hence the braided effect is more pronounced.

Topography

Topographically, the alluvial fans occupy a position between the Richardson Mountains and the low lying deltaic deposits. Areally the topography is that of a slightly tilted plain. The merging of the fan into the deltaic deposits is usually imperceptible and generally only discerned by vegetation changes.

Two distinct grades were observed on the investigated fans (see Fig. 3). The first is an initial relatively steep grade which extends to the one-third or one-half point of fan length. At the campsite fan this grade amounted to 1.9 per cent and on the spruce fan was 6.1 per cent. The second and final grade to the deltaic deposits is usually longer and lower. At the campsite fan it amounted to 1.3 per cent and was 2.3 per cent at the spruce fan.

Locally, the ground surface is characterized by the following random phenomena; polygons in local depressions surrounded by peripheral mounds up to 5 feet high, traces or complete polygonal cracks 30 feet in diameter with depths measured in inches, creek levels up to 5 feet high, and frost mounds up to 5 feet in diameter and one foot high.

Soils

As would be expected, the soils which compose the fans show characteristics of the weathered portion of the Richardson Mountains from which they have been derived. Thus the campsite fan with adjacent mountain material of friable shale and sandstone, is composed of a light brown silt-sized soil with varying amounts of organic material and thin layers (inches to one foot thick) of crumbly "siltsones" or "mudstones" and some relatively more resistant sandstone pebbles. This point is even more strikingly shown by the spruce fan soils. A near surface layer of soil is bright red and the parent gullies expose thick beds of a red conglomerate.

Campsite Fan:- Soil sampling at the campsite fan was carried out at three locations, the base, approximate third point, and the edge of the fan, as shown in Fig. 2.

Drill hole AB17, at the edge of the fan was advanced to a 32-foot depth with a core recovery of over 90 per cent. The hole was then bailed of wash water, filled with diesel fuel, and temperatures were recorded at various depths (maximum 25 feet) with a slow reading mercury thermometer.

From field examination, the soil at Drill hole AB17 appears to be predominantly silt sized with varying amounts of organic matter. The organic material ranges from black flake-like traces to random strata of undecomposed twigs, roots and are measured in inches. The presence of friable "mudstones" averaging 1/8-inch in diameter was also noted in the cores. In general, the soil was more plastic in the "mudstone" regions.

Moisture, or more correctly, ice content samples were taken at least every two feet of penetration. The ice content (expressed as a percentage of the weight of dry soil in the sample) in 30 samples from depths of 2 to 31 feet, averaged 85 per cent and ranged from 27 to 154 per cent. The form of the ice segregation was in horizontal layers or lens and ranged in thickness from hairline (less than 1/32-inch) to 3/4-inch, averaging 1/16-inch.

Temperature measurements at various depths in the diesel fuel filled hole gave a minimum temperature of 18°F. at a 5-foot depth which gradually increased to 22.5°F. at 25 feet. Two sets of temperature readings were taken late in April with approximately 1 week between specific readings. The second set showed a warming up of approximately 1°F. for almost every depth. Because of the many possible sources of error, it is recommended that the soil temperature data collected are used as a first approximation of probable soil temperatures rather than as actual design data.

A summary of data* collected at Drill hole AB17 is shown on page and includes a graphical presentation of moisture content and soil temperatures with depth.

Drilling difficulties were experienced at Drill hole AB18 located at approximately the two third point from the beginning of the fan (Fig. 2). Two core barrels "froze-in" at 5- and 12-foot depths. Samples were obtained only to five feet and the location had to be abandoned to recover the core barrels. The samples that were obtained did not appear to differ significantly from those of the previous drill hole, AB17.

Drill hole AB19 at approximately the top of the fan (Fig. 2) was drilled to a depth of 38 feet with core recovery averaging 50 per cent. Soil testing results are not now available from this hole. Significant differences were, however, observed during sampling. The presence of gravelly layers from one to ten inches thick were noted at random depths starting at approximately the 4-foot depth. The predominant soil again appeared to be silt-sized and the presence of more organic material was also evident. Ice segregation was similar to Drill hole AB17.

Caving in of the drilled hole at the 25-foot depth restricted temperature observations. Further caving occurred after the slow reading thermometer was placed in the hole and the thermometer was lost at approximately the 20-foot level.

There are numerous signs of intensive frost action throughout the campsite fan. Large areas contain frost mounds and polygonal cracks are distributed throughout much of the fan. A typical large frost mound was excavated beside Drill hole AB18.

* not received from WAP

The frost mound investigated was elliptical in plan view with axes of approximately 4 and 3 feet. The mound rose 10 inches and had four 2-inch deep cracks radiating from the centre. Reindeer moss covered the south half while the northern portion was bare with odd tufts of short grass. The top layer of soil, 4 inches thick at the top to 9 inches at the sides, was a reddish brown silt with organic material. There was no discernible ice segregation although ice did cement the soil making it well bonded. Underlying this "topsoil" was a 7-inch layer of light brown silt with clay. Ice segregation was irregular with horizontal layers and dikes at various angles. The lens thickness ranged from hairline to 3/4-inch thick but averaged 1/8-inch. The moisture content of this material is estimated to be 150 per cent. The third and final distinctive frozen soil type observed in the excavation was also a light brown silt with clay but with only parallel ice lens averaging 1/16-inch thick (estimated water content of 100 per cent). The presence of irregularly shaped hollows between the "topsoil" and the silt-clay with irregular ice segregation was noted at the perimeter of the mound. The hollows of one mound apparently connect with others as drilling wash water circulation to the top of the drill hole was lost on Drill hole AB-18. Three hundred gallons of water were used in this hole and all was lost in subsurface seepage. The frost mound investigated is typical of a large type and others as small as 1 foot in diameter were noted.

Polygonal cracks on the campsite fan averaged 25 feet in diameter. Since extensive investigation by trenching could be carried out with less effort during the summer, investigation of polygons and polygonal cracks was left for some future (and warmer) date.

<u>Spruce Fan</u>:- Soil sampling at the spruce fan was carried out at one location (Fig. 4). A preliminary test pit (AX-5) revealed the presence of a gravelly soil 2 to 4 feet below the ground surface. Since the extent of this gravelly soil was unknown, Drill hole AB-21 was drilled in the near vicinity.

Drill hole AB-21, on the midpoint of the Spruce Fan was advanced to a depth of 29 feet. Although soil testing results are not available at present, the soils appear to be predominantly silt sized with strata of silty gravel, clay, and organic material. Silty gravel was noted at the 4-, 9-, 14-, 18-, and 23-foot depths in strata which ranged from 6 to 36 inches and averaged 15 inches. Reddish silt-clay strata were noted at the 7-, 15-, 17-, and 20-foot depths in strata which ranged from 4 to 22 inches thick and averaged 15 inches. Moisture contents or the amount of ice segregation appeared to be similar to Drill hole AB-19 as did the amount of organic material. No soil temperature observations were possible because of the loss of the thermometer in Drill hole AB-19.

Snow Cover at Husky Channel Sites

Snow cover observations were made in the spring. At this time the cover had attained its maximum depth from the accumulated fall over the entire winter. Some snow would be lost from the surface by sublimation but it is thought that the snow cover was at its maximum when observations were made. The snow cover observations were divided into two categories:

(a) sheltered locations;
(b) exposed locations.

Sheltered locations include all areas where tree growth is dense enough to provide shelter from wind and so prevent drifting. The forested fans and deltaic deposits are the two such areas in the Husky Channel area. The snow cover reached a depth of 36 to 40 inches. The top few inches to one foot formed a crust of powdery snow below which the profile consisted of small ice crystals (granular or "sugar" snow). Generally the crust would just support a man's weight on snowshoes although it often failed.

Exposed locations include all areas devoid of trees or where tree growth is insufficient to provide shelter from wind and so prevent drifting. The Richardson Mountains, low lying Richardson Mountain area, and scrub-covered fans are the exposed locations in the Husky Channel area. Generally the maximum snow cover was about 15 inches deep. The top few inches formed a hard crust of powdery snow which was packed and glazed by the wind. Below this crust, the profile consisted of small ice crystals as in the sheltered regions. On the scrub-covered fans, snow drifts 5 feet deep and many yards long formed in the east-west lines of dense willow thicket. Generally the wind-packed crust was sufficiently strong to support a man's weight on snowshoes.

PART II - FIELD APPRAISAL

The potentialities as a townsite of the various landforms reported in the first part of this note will now be briefly discussed under various considerations. It is difficult to confine comments solely to soil and permafrost considerations since many other factors are of equal, if not of more, importance. Accordingly the landforms, and the problems they will present to location, buildings, roads, airstrips, and materials will be discussed primarily from the soils point of view and the complementary factors (to be reported in detail by others) will be brought in generally to clarify certain opinions.

Richardson Mountains

Although the greater part of the Richardson Mountains landform has not been considered as a potential site, it does offer some limited engineering materials to nearby construction.

Engineering Materials: Relatively strongly cemented sandstone exposures are found in some of the creeks close to the campsite fan.

Most of the exposures visited appear to require some preliminary stripping and clearing. The quality of the rock as a concrete aggregate is questioned from both the chemical and physical points of view. Some rocks observed were "stained" with salts (?) and weathered chert pebbles from a shaley conglomerate fractured under hand pressure.

There is a possibility that the gravel from creek beds could be utilized but the difficulties of obtaining and hauling it should be considered before a decision to utilise it is made. The grading of creek gravel is generally poor being mostly over 3 inches or then with many friable "mudstones" and sandstones.

OPINION:- It is felt that the Richardson Mountains can supply only a small limited amount of engineering material to nearby sites. Concrete aggregate is not available and the creek gravel found is best suited for fill or ballast.

Low Lying Richardson Mountain Area

Location:- Since this location is 3 miles from the Husky Channel, the nearest navigable stream, wharf facilities would be distinct and removed from the town. This would cause no relative burden (apart from hauling) to permanent residents of the town but might create a shack and "tent-city" of transients at the Husky Channel. This is to be avoided from both sanitation and aesthetic considerations.

Drainage:- Since the most probable water supply for the site is below the town area, difficulties in drainage may be experienced. Most probably one lake would have to be allotted for surface drainage and hence ruled unsuitable for domestic uses. The problem of erosion could become a reality after the area has been occupied for a number of years. Even though the soils at the site are permeable when unfrozen, the presence of permafrost creates an artificial water table close to the surface. After the living organic cover has been worn away by occupation, this permafrost level would go to a lower depth. Thus the surface soils with water contents five to ten times normal, would soon resemble slurry which can flow and drain away like water.

Buildings:- The soils to a depth of 17 feet can be classed as poor for building foundations. Building foundations resting on the ground surface with heat losses from the buildings, could experience settlements measurable in feet. Frost action on surface or shallow foundations could be expected. Recommended foundations for permanent buildings in the area would proably be the relatively costly bearing piles to the glacial till at the 17-foot depth. Poor frozen soil conditions would probably necessitate utility lines above ground surface with "expensive" foundations to combat settlements and intensive frost action. The location is quite exposed and heating design should take into consideration some "wind-chill" factor.

Roads:- The access road from the wharf at the Husky Channel to the townsite could prove to be quite costly because its entire length is over low lying "poor" soils. This three-mile road, being the route for goods from river traffic to the town must be well constructed since its peak traffic load will be during the summer when the supporting power of the underlying soil is near its minimum. In this area, this is best accomplished by a good fill section on logs and brush. Drainage and a high roadbed to allow for normal channel flooding are two other important considerations.

Roads in the townsite should be fill sections with an ample layer of brush and logs to preserve frozen conditions of the base course. Fill sections are also recommended since a minimum of snow removal is required. The prevailing wind is north-south and so the main townsite roads could be oriented in this direction, again to facilitate snow removal.

Airstrip:- There are no suitable large areas for an airstrip in this landform.

Engineering Materials:- No suitable engineering materials were observed at this site although the limited materials of the adjacent landforms could be utilised.

Opinion:- It is thought that this site offers no outstanding advantages to a townsite and from the point of view of soils and permafrost is not recommended.

Alluvial Fans

For practical purposes, no significant differences in soils were noted between the forested and scrub-covered fans reported in Part I of this note. Accordingly, the following comments will apply to both types of fans.

Location:- Since it seems advisable to keep river traffic travel on the Husky Channel to a minimum, the most favoured location would be on one of the fans north of the spruce fan (Fig. 1). There is no suitable water supply on the alluvial fans so that either a lake in the delta east of the chosen fan or the small lakes north of the fans must be utilised. Deltaic lakes fringing the fans are not favoured since the natural drainage from the fan and inhabited area would be into the water supply. In any case, these lakes are either flooded annually by the Husky Channel or lie stagnant. If the small lakes north of the campsite fan are a suitable water supply, the closest fan to them is preferred.

Access to almost all of the fans is afforded by a maximum of 1,000 feet of travel over low-lying deltaic material. Construction of this road would be under conditions similar to those already mentioned on this page.

Drainage:- With a natural grade varying from one to six per cent, drainage of the fans should present no real difficulties. However, many of the fans and portions of all are very wet during the spring. Design of drainage systems should be based on this maximum spring condition and should, in the case of the parent creek, by-pass the town. Erosion of the surface after some length of occupation would have to be considered as mentioned on page 8.

Buildings:- The silty soils with high ice contents found at the site offer the same type of problem for building foundations that are now being experienced at Aklavik. Buildings with surface foundations could be expected to settle as much as 5 feet if precautions to prevent building heat losses to the ground are not taken. For permanent buildings, the use of pile foundations would be hindered by the thin strata of silty gravel found at certain depths. Excavation would be difficult and expensive. The location is also quite exposed and heating design should take into consideration some "wind-chill" factor.

Roads:- Again, because of the high ice contents in the silt-sized soils, roads should be fill sections which depend for supporting power on the frozen base course. Drifting snow is common at the sites and to minimize snow removal, main roads could be north-south the direction of the prevailing wind.

Airstrip:- Almost any one of the fans could supply a suitably flat area for an airstrip. The silt-sized soils and high ice contents dictate a fill section for the airstrip. However, suitable and large amounts of fill are not available in the area. Since the prevailing winds are north-south, the airstrip would be at right angles to natural drainage. Thus a well designed and ample drainage system is necessary to cope with the spring runoff.

Engineering materials:- Engineering materials such as gravel can be found on the surface of the fans but to a limited extent. Most of the gravelly creek outwashes inspected consisted of a silty gravel. The gravel was in many cases predominantly friable sandstone and shale. The quality of the gravel is questioned. For small demands, the alluvial gravel could be used as a base course fill or ballast.

Opinion:- Apart from its location close to the present town of Aklavik and topography favourable for a townsite and airstrip, the Husky Channel sites offer no outstanding advantages. The soil and permafrost findings do not recommend the site.

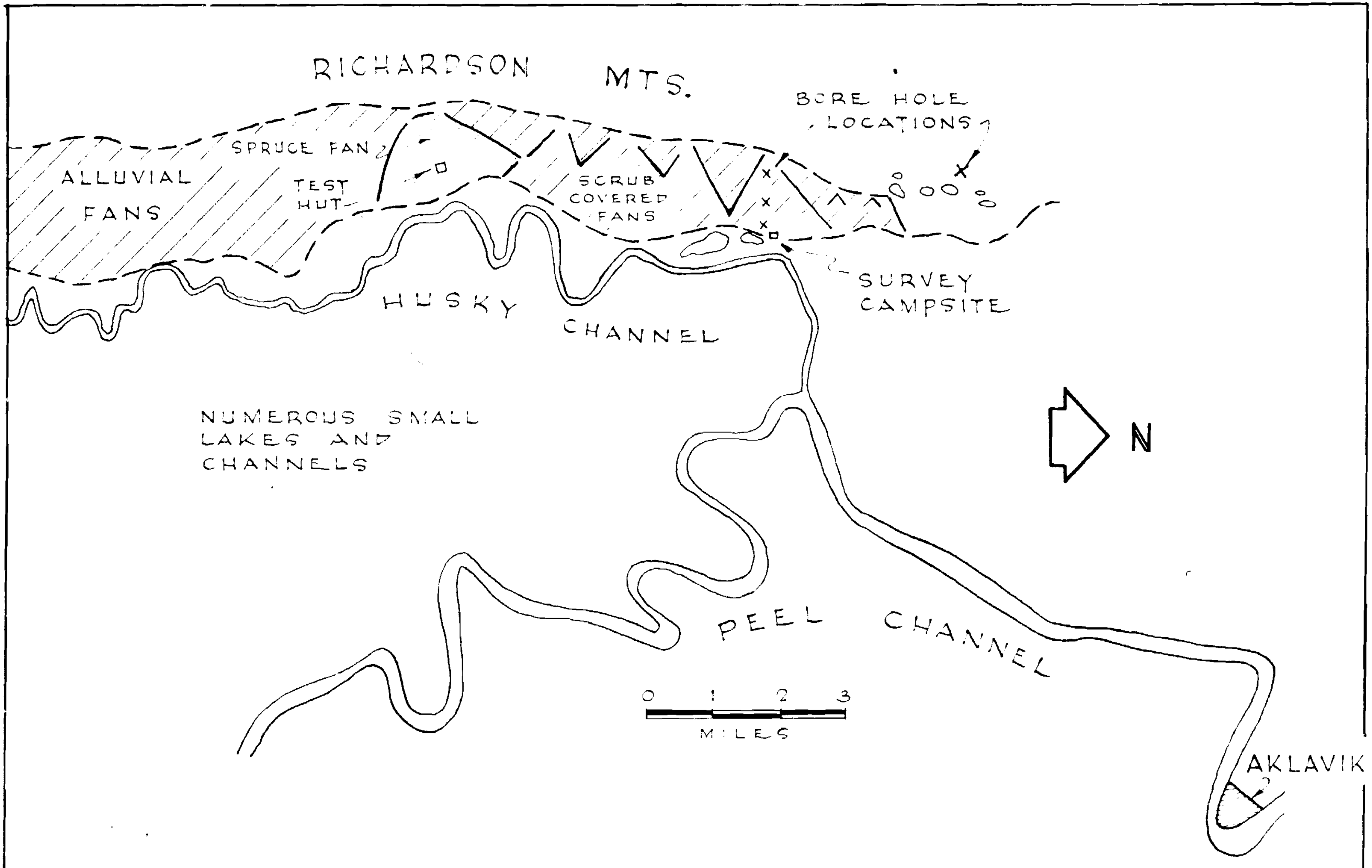

FIG. 1 HUSKY SITE AREA

(FROM RCAF AIRPHOTOS)

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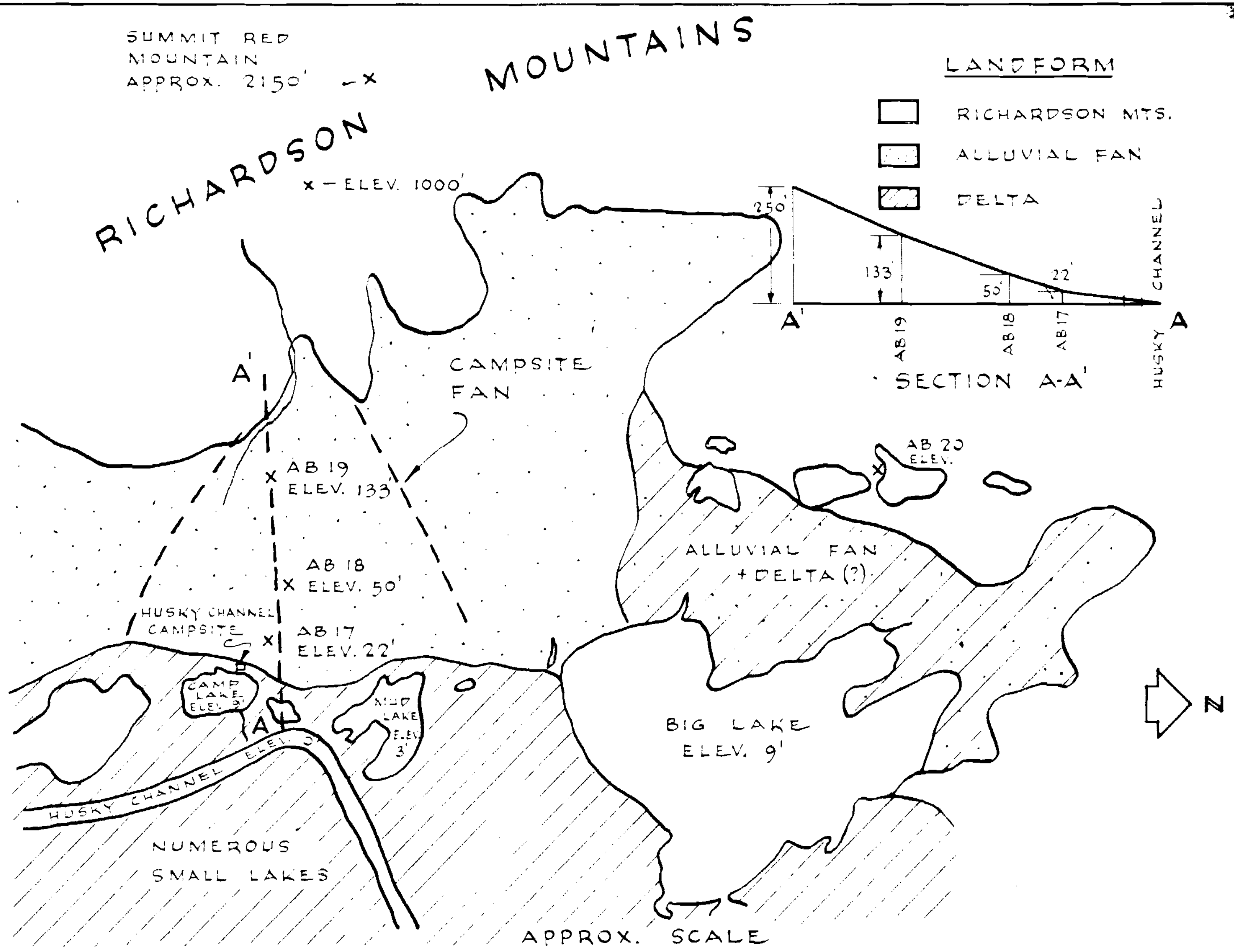

FIG. 2 CAMPSITE FAN AREA

FROM RCAF PHOTO A 2861-182

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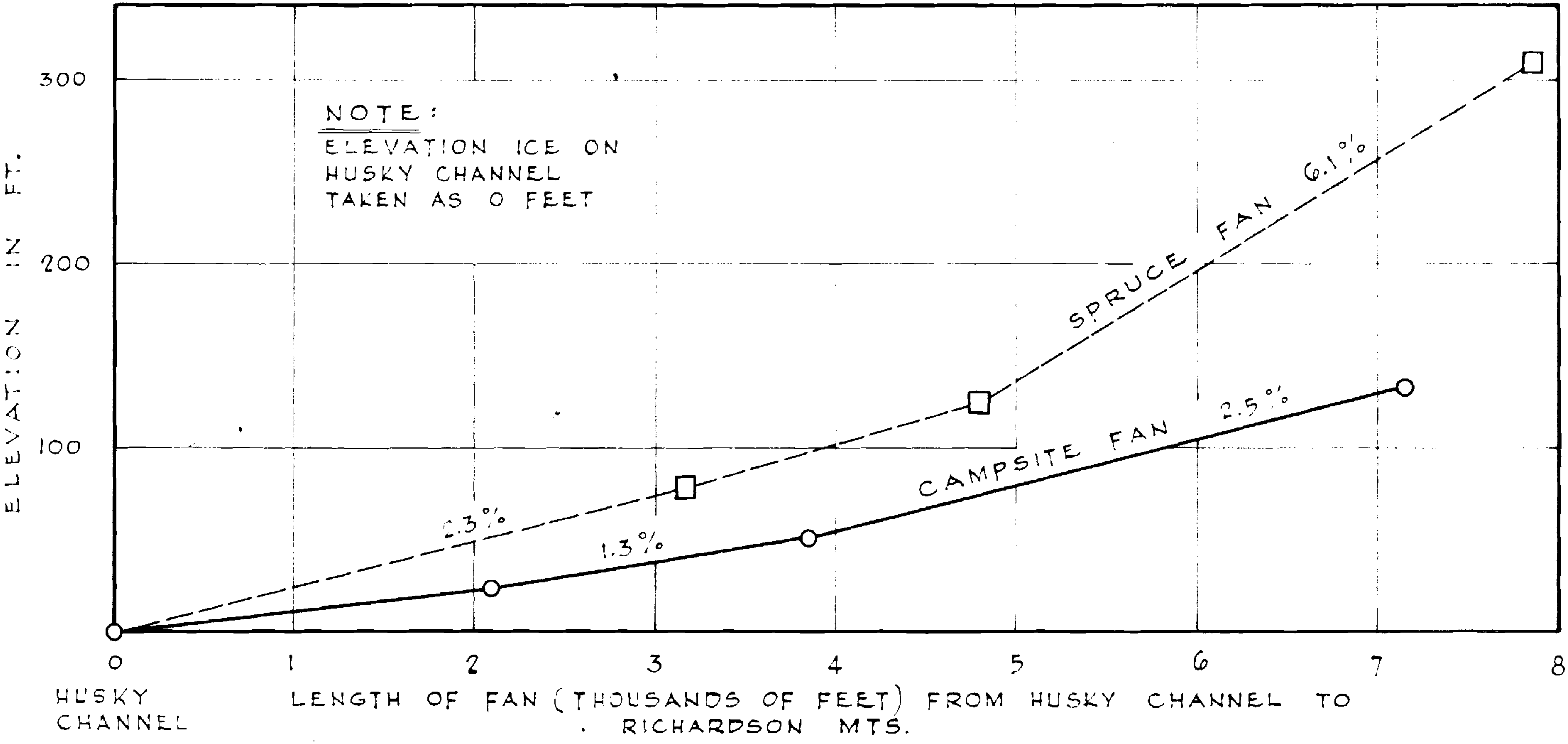

FIG. 3 TYPICAL ALLUVIAL FAN GRADIENTS

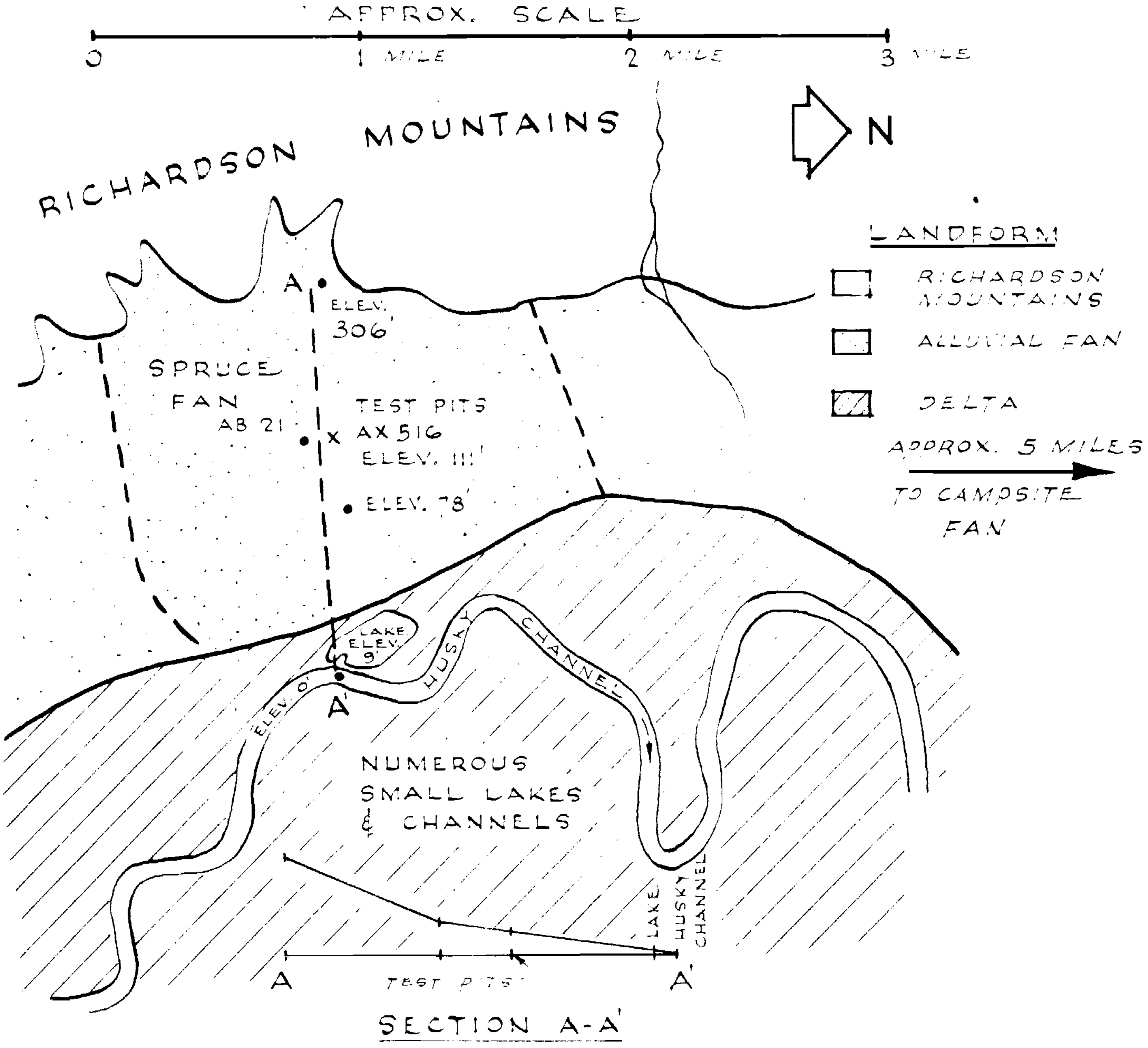

FIG. 4 SPRUCE FAN AREA

FROM R C A F PHOTO A12861-185

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