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PRELIMINARY GEOLOGIC EVALUATION OF THE CHENA AREA, ALASKA*

by

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* This report is preliminary and has not been edited or revised for conformity with U. S. Geological Survey standards and nomenclature.

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It seems fitting at this session of the Alaska Science Conference, the first to be held in the Fairbanks area, to give a preliminary summary of the practical results of a geologic investigation of the Chena area east of Fairbanks. The work was done by the Geological Survey in 1950. One important objective of the study was to consider some of the geologic problems affecting development of the land for commercial and agricultural use — especially to outline the parts of the area that are subject to possible ground subsidence and differential settling because of melting of ground ice masses in permafrost following clearing of the land for agriculture and for construction.

The Chena area includes 127 square miles in a two-mile-wide strip on either side of the Chena and Little Chena Rivers, from a point 11 miles east of Fairbanks up the Little Chena River to latitude 64° 55' N. and eastward up the Chena River to longitude 146° 40' W., or 31 miles upstream from Fairbanks. This area is outlined on the accompanying map, and the percentages quoted below apply to the land within the outline.

The area includes the valley bottoms along the Chena and Little Chena Rivers and parts of the adjoining Yukon-Tanana upland that rise 300 to 1,000 feet above the valleys. Small creeks flow through narrow to broad gaps in the bordering hills into the river valleys, across alluvial fans. The valleys are dotted with numerous oxbow lakes and abandoned river channels near the present stream courses. Only a few lakes occur away from the rivers. Drainage of the area is via the Chena and Little Chena Rivers to the Tanana River.

In the time available for presentation of this report, it seems more important to summarize the practical results of the investigation than to dwell at length on the complex geologic history of the Chena Valley. The geologic units are subdivided into those generally unsuited for agriculture and construction, and those that are relatively favorable:

<u>Generally unsuitable for agriculture and construction</u>

1. Alluvial fan and creek valley silt deposits

2. Bedrock bluffs

Relatively favorable for agriculture and construction

1. Floodplain deposits

2. Low terrace deposits

3. Chena River sand terrace deposits

4. Upland silt

All of these units, with the exception of the Chena River sand terrace, can be traced westward into the Fairbanks area. Because of the relative abundance of subsurface data in the Fairbanks area, some of the predictions of ground water and permafrost conditions in the Chena area are based, in part, on data from the Fairbanks area. For example, even though no exposures of ground ice masses in permafrost were observed in the Chena area, one can trace the geologic units in which they are known to occur near Fairbanks eastward into the Chena area. Furthermore, some of the same microrelief features (such as polygonal cracks and vegetation patterns and thaw lakes) are found in parts of the Chena area as are found in areas known to be underlain by ground ice masses in the Fairbanks area. By this type of analogy, therefore, one can be reasonably safe in predicting that ground ice masses occur in the Chena area. In fact, the entire area underlain by alluvial fan and creek valley deposits — 42 percent of the Chena area — is believed to be subject to the danger of differential settling due to melting of ground ice masses once the ground temperature regimen is disturbed by clearing of the insulating vegetation.

Generally unsuitable for agriculture and construction

1. Alluvial fan and creek valley deposits.— Alluvial fan and creek valley deposits, occupying 42 percent of the Chena area, are the only geologic unit in which ground ice masses are a common feature of the perennially frozen sediments. A generalized composite geologic section would consist of 10 to over 120 feet of complexly interbedded silt, peat, organic silt, and minor lenses of sand and gravel, underlain by 10 to nearly 200 feet of gravel. Recorded depth of bedrock beneath these deposits ranges from 10 to 317 feet. Although some ground ice masses are known to occur in frozen gravel, it is the upper beds of frozen silt, organic silt, and peat that contain the large polygonal and tabular ground ice masses. These are the deposits usually referred to as "muck" in the Fairbanks mining district where spectacular exposures of ground ice occur in the placer cuts. In many parts of the creek valleys and alluvial fans in the Chena area, the ground ice masses are reflected by surface polygonal cracks, polygonal vegetation patterns, thaw lakes, and pits. In many other places, however, ice masses probably lie beneath ground in which there is no surface indication. Ground ice masses

appear to lie at varying depths beneath the surface. Pits resulting from melting ground ice may not necessarily form immediately following stripping of the vegetation mat for construction or agricultural purposes, but may appear only after soil temperatures are altered at depth over a period of several years. The complex history of formation and thawing of permafrost, and its relationship to deposition of the alluvial fan and creek valley silts, seems to be related to the climatic history during the Pleistocene and Recent epochs. However, neither the climatic history nor the subsurface geology are well enough understood to permit precise location of areas of high concentration of ice masses in the creek valleys and alluvial fans. Therefore, the entire area covered by creek valley and alluvial fan deposits, or 42 percent of the Chena area, must be regarded as subject to possible differential settlement of the ground because of melting of ground ice masses in permafrost if the thermal regimen of the ground is disturbed by agricultural or constructional activity.

Alluvial fans and creek valleys have poor soil drainage, small local areas of winter icings, and boggy ground conditions. They lack easily-worked deposits of sand and gravel for road construction and timber for cabins and bridge construction. Ground water is probably available from thawed gravel beneath the frozen organic silt and silt deposits at depths of 10 to 150 feet in the upland and as deep as 175 feet on the lower parts of alluvial fans in the lowland.

2. Bedrock bluffs.— An additional one-half percent of the Chena area consists of steep, river-cut bedrock bluffs that are too steep for agricultural use. The bluffs are the principal source of rock for construction. Mica schist and quartzite are the dominant bedrock types.

Relatively favorable for agriculture and construction

The 57 1/2 percent of the Chena area that is free of ground ice masses consists of (1) floodplain deposits, (2) low terrace deposits, (3) Chena River sand terrace deposits, and (4) upland silt. Even in these geologic units, the geologic problems are important and must be considered in developing the land. For example, periodic flooding of the floodplains, poor soil drainage on the low terraces, and uncertain prospects for ground water in the upland are some of the more important problems.

1. Floodplain deposits.— The floodplains of the Chena and Little Chena Rivers occupy 33 percent of the Chena area. One to twenty feet of surficial alluvial silt covers thick deposits of complexly interbedded and lenticular gravel, sand, and minor amounts of silt and peat. The surficial silt is generally well drained except during periodic river floods that last for a few days following heavy summer rains and spring snow melt. Low-lying bars and

abandoned channels are flooded nearly every year, and the higher parts of the floodplain are flooded at infrequent intervals, perhaps of the order of once every 5 or 10 years. Beneath the river beds and abandoned channels permafrost is absent or thin, but elsewhere it occurs from depths of 2 to 10 feet downward to perhaps deeper than the 122 feet recorded in the only well within this unit. Thawed layers and lenses appear to be common in permafrost in the floodplain at Fairbanks, and conditions are probably much the same in the Chena area. Large ground-ice masses are rare in the permafrost of the floodplain deposits. Water is available from gravelly alluvium beneath permafrost. It is most easily obtained at shallow depths from thawed gravel beneath or adjacent to the present river beds. The floodplain white spruce-birch-balsam-poplar forest presents some difficulty in clearing, except in local brush-covered, burned areas, but offers a source of saw-grade lumber for construction purposes. Shallow, easily-worked gravel and sand are abundant in the channels of Chena and Little Chena Rivers.

2. Low terrace deposits.— The low alluvial terraces border the floodplains and occupy 10 percent of the Chena area. The poorly-drained, muskeg-covered alluvial silt mantle ranges from 5 to about 25 feet thick. Like the floodplain, it overlies complexly interbedded and lenticular deposits of gravel and sand. Though no subsurface data are available, permafrost probably is more continuous laterally and with depth than in the floodplain. Supplies of ground water are probably obtainable from thawed gravel beneath permafrost at a depth ranging from 50 to 150 feet. Permafrost may be comparatively thin beneath old channel scars that are expressed as gentle arcuate swales filled with muskeg vegetation. Large ground ice masses probably are not common. The open, scrubby black spruce-tamarack forest interspersed with sedge marsh and bog is easily cleared. Locally, the ground may be too soft for the summer operation of heavy equipment. Parts of the low terraces may be subject to river flooding at widely spaced intervals, as, for example, floods of the order of magnitude of the 1937 spring flood at Fairbanks.

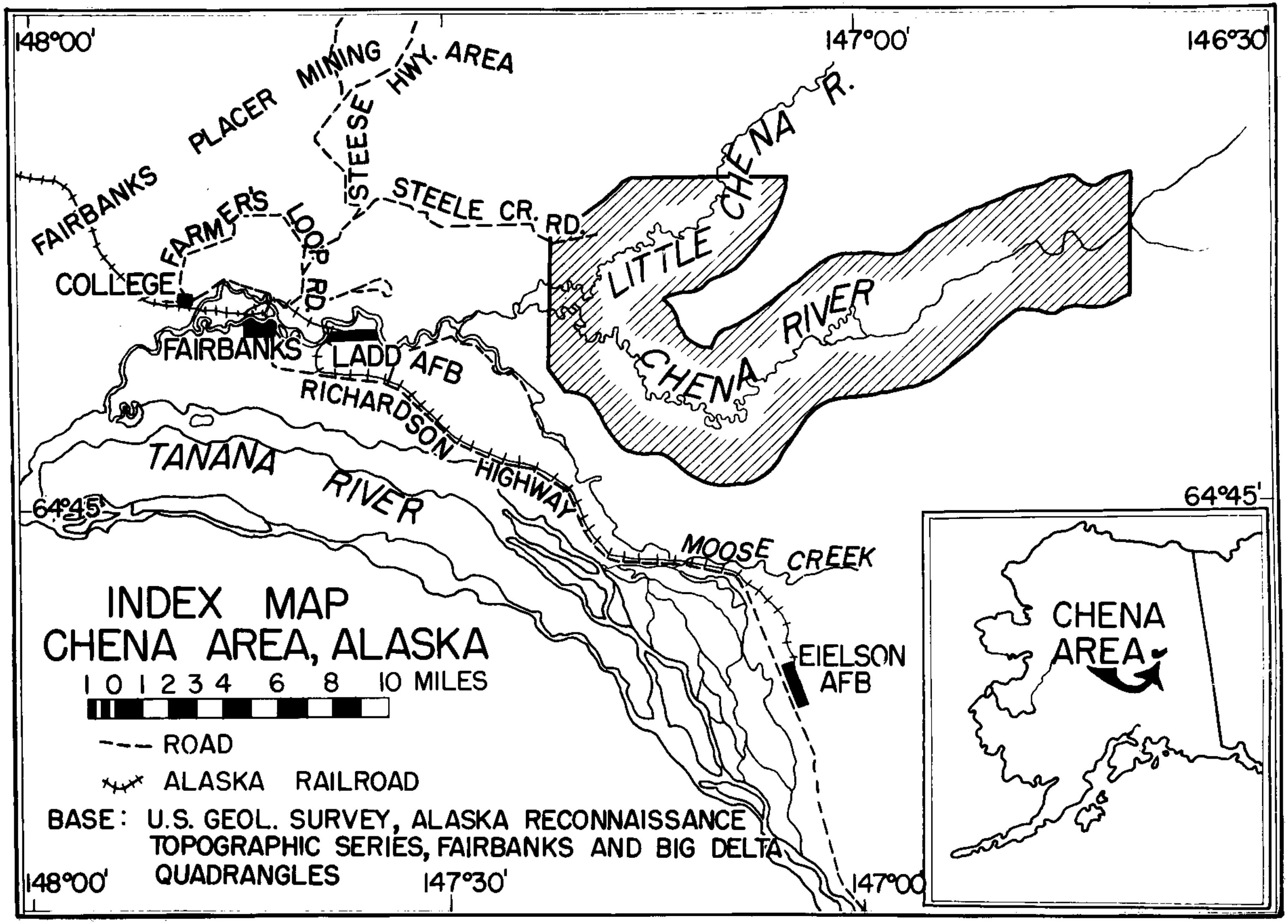
3. Chena River sand terrace deposits.— The sand terrace along the north side of the Chena River occupies 4 1/2 percent of the Chena area. It lies 20 to 50 feet above the river and is not subject to river floods. It has a flat surface grown over with dense, easily-cleared aspen and willow brush. The soil consists of sandy silt that grades downward into sand. The thickness of the sand is not known, but it is probably underlain by gravel at a depth greater than 6 feet. Permafrost is not present within 6 feet of the surface and may be absent. Soil drainage is excellent. Ground water possibilities would seem favorable provided that thawed gravel lay beneath the terrace sand deposits. However, no subsurface data are available.

4. Upland silt. — The summits and upper slopes of the upland are mantled with well-drained tan silt of eolian origin and occupy 10 percent of the Chena area. The unit is an eastward extension of similar uplands near Fairbanks that are free of permafrost. The silt ranges from a few inches thick on sharp-crested hills where schist bedrock lies close to the surface, to more than 14 feet thick elsewhere. Soil erosion on the steeper upper slopes may become an important problem in areas where the water can become channelized in gullies. Many of the now-stabilized gullies testify to the past effectiveness of erosion by running water. Clearing problems range from difficult in dense stands of spruce-birch to relatively easy on brush-covered, burned-over ground. Upland spruce and birch forests of the western Chena area are one source of timber and fuel for use in Fairbanks. Gravel and sand are not available in the upland, and rock is available only from the sharp-crested hills where the silt cover is thin, and from bedrock bluffs separating the upland from river valleys. Ground water is usually obtainable only from bedrock, and past experience has shown that ground water supplies are uncertain even at a depth of 100 feet.

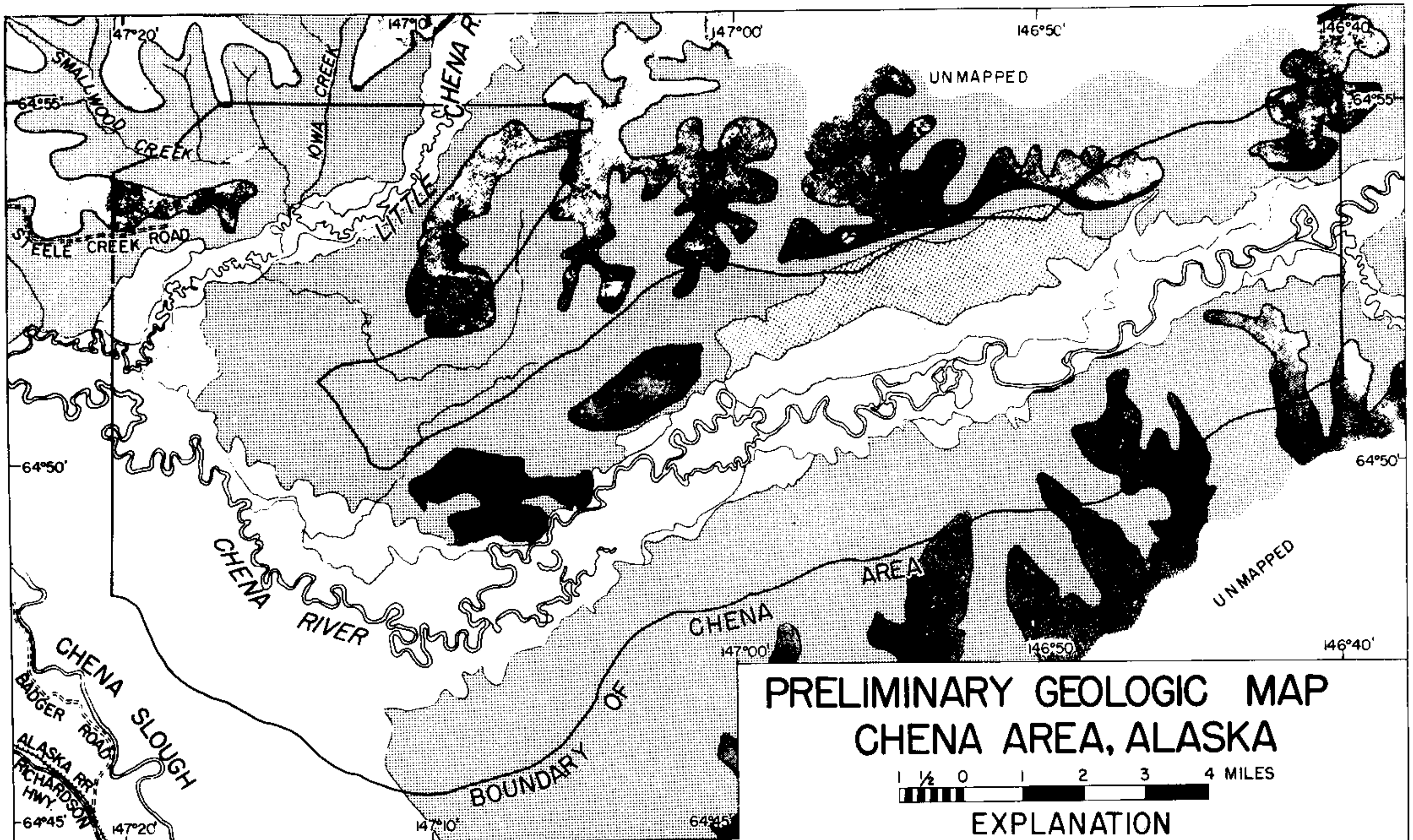
GEOLOGIC EVALUATION OF THE CHENA AREA

SUMMARY

	GEOLOGIC UNIT	PERCENT OF CHENA AREA	EVALUATION AND LIMITATIONS DUE TO GEOLOGIC FACTORS
Unsuitable for agriculture & construction 4 1/2 %	1. Alluvial fan and creek valley deposits	42	Unsuitable because of poor soil drainage, lack of sand and gravel for construction, and possibility of ground subsidence owing to melting of ground ice masses in permafrost.
	2. Bedrock bluffs	1/2	Unsuitable for agriculture because of steep slope. Principal source of rock for construction.
Relatively favorable for agriculture and construction — 57 1/2 %	1. Floodplain deposits	33	Suitable for agriculture but subject to periodic river floods. No ground ice masses. Good possibility for abundant shallow ground water. Sand and gravel abundant; timber plentiful.
	2. Low terrace deposits	10	Less suitable than floodplain because of poor soil drainage, poorer possibilities for shallow ground water, high permafrost level, and boggy ground. Few to no ice masses. Little sand and gravel available.
	3. Chena River sand terrace deposits	4 1/2	Suitable for agriculture and construction. No river floods; no ice masses. Excellent soil drainage. Ground water possibilities generally good; no subsurface data. Gravel not available within 6 feet of surface. No timber resources.
	4. Upland silt	10	Suitable for agriculture. Probably no permafrost nor ice masses. Good soil drainage. Possible soil erosion on steeper slopes. Ground water prospects uncertain even at depth of 100 feet. No sand or gravel for construction.


148°00'
147°00'
146°30'
FAIRBANKS PLACER MINING AREA
STEESE HWY.
FARMER'S LOOP RD.
STEELE CR. RD.
COLLEGE
FAIRBANKS
LADD AFB
RICHARDSON HIGHWAY
TANANA RIVER
LITTLE CHENA R.
CHENA RIVER
64°45'
MOOSE CREEK
EIELSON AFB
INDEX MAP
CHENA AREA, ALASKA
1 0 1 2 3 4 6 8 10 MILES
ROAD
ALASKA RAILROAD
BASE: U.S. GEOL. SURVEY, ALASKA RECONNAISSANCE TOPOGRAPHIC SERIES, FAIRBANKS AND BIG DELTA QUADRANGLES
148°00'
147°30'
147°00'
CHENA AREA

1595



PRELIMINARY GEOLOGIC MAP
CHENA AREA, ALASKA

1 ½ 0 1 2 3 4 MILES

EXPLANATION

- FLOODPLAIN DEPOSITS: gravel, sand and silt, generally well drained
- LOW TERRACE DEPOSITS: silt-mantled sand and gravel; poorly drained
- SAND TERRACE DEPOSITS: well-drained Chena River alluvial sand
- ALLUVIAL FAN AND CREEK VALLEY SILT: organic silt, peat, silt and ground ice
- UPLAND SILT: well-drained loessial silt
- BEDROCK: dominantly schist and quartzite

Compiled by John R. Williams, 1954, from 1950 field surveys and 1949 aerial photography.

Base: U.S. Geological Survey, 1:63,360 Fairbanks D-1 and Big Delta D-6 quadrangles.

SYMBOLS

- Paved highway
- Gravel or dirt road
- Alaska Railroad

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