Geology and Ground Water for Land-Use Planning in the Eagle River-Chugiak Area, Alaska
1974

(Basic data and interpretations)

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Prepared by the U.S.Department of the Interior, Geological Survey
in cooperation with the Greater Anchorage Area Borough

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NOTE: In the following tables, well numbers designate well location by township north, range west (from Seward base and meridian), section number, and map number within section. Locations are plotted and map numbers indicated on plate 1.

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SUMMARY

The Eagle River – Chugiak area is a rapidly growing residential part of the Greater Anchorage Area Borough, south-central Alaska. High-density, urban development in some parts of the area may be restricted because of the nature of the surficial geologic materials and their hydrologic characteristics. This report assembles all information collected by the U.S. Geological Survey on the geology and ground-water resources of the Eagle River – Chugiak area.

The study area lies mostly within the Cook Inlet – Susitna Lowland and consists of low hills and intervening channels, hummocky ridges, sloping alluvial fans, and low-lying tidal flats that border Knik Arm. The eastern part of the area lies on the steep slopes of the Chugach Mountains. Drainage is generally to the west and northwest, except that locally the slopes drain southwesterly to the Eagle River, the major stream of the area.

Both bedrock and unconsolidated deposits are found at the surface in the Eagle River – Chugiak area. Bedrock is of two principal kinds--hard metamorphic and related igneous rocks exposed in the Chugach Mountains, and relatively soft sedimentary rocks beneath much of the lowland. The sedimentary rocks are largely covered by surficial deposits of glacial and alluvial origin. Both bedrock and the surficial deposits have varying degrees of usefulness as construction materials--sand and gravel, aggregate--for engineering works. However, characteristics of those same geologic materials such as drainage, foundation and excavation conditions, and the slope and slope stability of the several landforms they compose place restrictions on the manner and degree to which the area may be developed.

Limited amounts of ground water can be recovered from the bedrock in the Eagle River – Chugiak area, particularly where the rock is fractured and weathered. Greater success in locating larger amounts of ground water can be expected in the more permeable and more porous unconsolidated surficial deposits. Available evidence indicates that the types of geologic materials from which ground water can be recovered in adequate quantities for even single-family use are limited in number and areal extent. However, two alluvial-fan areas-- at Meadow Creek and at Peters Creek--are potential sources for larger, communitywide water supplies. A yield of 326 gpm (gallons per minute) or 20.6 l/s (liters per second) has been reported for one well on the Meadow Creek fan.

The existing inorganic chemical quality of ground water in the Eagle River – Chugiak area is acceptable for domestic use. A potential for bacteriological pollution of the water exists, however, in the relatively high-density residential area of Eagle River, where individual shallow wells and septic tanks are used. Part of the community is now served by a sewage-collection system and treatment facility. Pollution potential will decrease as this service is extended throughout the more densely populated sections of the area.

INTRODUCTION

Location

The Eagle River – Chugiak area is a rapidly growing residential part of the Greater Anchorage Area Borough near the head of Knik Arm, an estuary of Cook Inlet in south-central Alaska (fig. 1). Most of the area lies between the Eagle River to the south and Peters Creek to the north. The largest community, Eagle River, is about 12 miles northeast of Anchorage. Chugiak is about 6 miles farther northeast along the old Glenn Highway.

Urban Growth and Need for Study

In 1970, the approximately 45-square-mile or 117 km (square kilometers) Eagle River – Chugiak area had a population of 5,832 (Greater Anchorage Area Borough Planning Dept., 1972). Comparisons of 1960 and 1970 census data (U.S. Dept. Commerce, 1971) show that in those 10 years the area's population increased by nearly 700 percent, indicating a more rapid growth rate than the rest of the borough. The Eagle River – Chugiak area population was 2.7 percent of the total borough population in 1960 and 4.6 percent in 1970 (Greater Anchorage Area Borough Planning Dept., 1972).

The increasing population has placed and will continue to place ever-increasing stresses on the area's environment. Some parts of the area are not well suited to urban development because of poor drainage and foundation conditions and limited ground-water supplies. Elsewhere, steep slopes and potentially unstable slopes place restrictions on the degree of development that is feasible without creating conditions for severe local erosion of slopes or mass downslope movement via creep and landslides. Construction materials (such as sand and gravel) are in reasonably good supply but are not evenly distributed throughout the area. Identifying the best potential sites for development of this resource and planning their utilization would prevent the resources from being irretrievably lost by being covered by housing or other facilities.

The water supply for the area is obtained primarily from numerous privately-owned small-yield wells that produce less than 10 gpm (0.6 l/s). There is no municipally owned water-distribution system. Local systems supply several trailer courts and housing subdivisions. Most commercial establishments and private homes are supplied by individual-use wells.

A consequence of the area's rapid population growth, particularly the community of Eagle River, is an increase in the number and extent of relatively high-density residential centers. Until central water and sewer systems are provided those centers, the dual requirements of a safe, adequate water supply and proper sewage disposal will necessitate an increasingly better understanding of both the ground-water system and the surficial geologic materials. Part of the community of Eagle River is now served by a sewage-collection system and treatment facility that began operation in late 1971.

This report assembles all information collected by the U.S. Geological Survey on the geology and ground-water resources of the Eagle River – Chugiak area. It is intended to provide basic data and analyses of the physical environment of the area that might be of use to developers, public officials, and land-use planners, as well as to individual home builders and well-drilling and septic-tank contractors. The report is divided into three major topics: (1) physiography; (2) geology, including interpretations of engineering properties; and (3) ground water. Maps and text material are used to present the data and analyses.

ACKNOWLEDGEMENTS

This report is part of continuing engineering-geology and water-resources investigations of the Greater Anchorage Area Borough by the U.S. Geological Survey. The report and related study was completed in cooperation with several departments of the borough and all work was done within the cooperative agreement between the Greater Anchorage Area Borough and the U.S. Geological Survey.

The authors wish to thank their colleagues in the U.S. Geological Survey for their help in collecting and compiling the data used here and for their helpful comments in the preparation of this report. Local well drillers and area residents provided much valuable information. The findings and conclusions discussed in the ground-water section corroborate and extend the conclusions of an earlier U.S. Geological Survey study of the area by Waller (1960).

PHYSIOGRAPHY

Topography and Drainage

The Eagle River – Chugiak area lies at the boundary between two major physiographic provinces of Alaska, and includes parts of the Kenai – Chugach Mountains of the Pacific Border Ranges province and the Cook Inlet – Susitna Lowland of the Coastal Trough province (Wahrhaftig, 1965). The developed part of the area lies at the eastern edge of the Cook Inlet Lowland; altitudes range from sea level (tidewater of Knik Arm) to about 600 feet or 182 m (meters). Development extends up the broad Eagle River valley and onto the lower slopes of the Chugach Mountains. These slopes rise abruptly in altitude along a sharply defined mountain front to peaks of 3,000 to 4,500 feet (914.4 to 1,371.6 m) within 5 miles or 8.0 km (kilometers) of the community of Eagle River. Both mountains and lowland have been moderately dissected by postglacial erosion processes.

Drainage is generally to the west and northwest. The Eagle River is a major stream having an average flow of 359 mgd (million gallons per day) or 15.7 m^3/s (cubic meters per second). The river heads within the Chugach Mountains at Eagle Glacier, about 25 miles (40.2 km) southeast of the community of Eagle River, and flows northwesterly to Knik Arm. Meadow Creek drains a small mountain-front basin, flows through the community of Eagle River, and joins the Eagle River (stream) at the Glenn Highway. Several other streams, the largest of which is Peters Creek (estimated average flow of 125 mgd or 5.5 m^3/s), drain the western slopes of the Chugach Mountains and the lowland northwest of the Glenn Highway (fig. 1).

Landforms

The Eagle River – Chugiak area has been divided into 9 classes of landforms. These classes are based on both the shape and altitude of the land surface and the underlying geology. The distribution of landforms is shown in figure 2, which also includes a summary of other physical characteristics described elsewhere in this report.

Much of the lowland consists of low hills and intervening channels related to glacial deposits; superimposed on this basic pattern are hummocky ridges also of glacial origin, stream-deposited alluvial fans, valleys cut below the general land surface, escarpments along sea and river bluffs, and tidal flats bordering Knik Arm. The Chugach Mountains include three principal landforms: (1) the individual mountains, (2) the valleys, and (3) the relatively flat to rolling or hummocky upland areas which are also largely the result of glaciation.

Slope

Slope is the gradient of the land surface and may be expressed by the angle between the inclined land surface and the horizontal plane. Consideration of the slope of the ground surface is important in any land-use classification, particularly if the proposed use would create or increase slope instability. With increasing slope of the ground surface, restrictions on development generally become more stringent, and grading problems and prevention of slope instability become more difficult.

A map of the slopes in the Eagle River – Chugiak area, slightly modified from one previously published by the U.S. Geological Survey (Schmoll and Dobrovolny, 1971), is shown in figure 3. The slope map summarizes the slope information provided by the contours on the topographic map by grouping local areas having similar slopes into a single map unit. The map was constructed basically from the topographic map by measuring the spacing between contours. Greater accuracy was added by using aerial photographs to locate details of the topography not apparent from the contours. Some slope measurements were made in the field, but the map has not been checked extensively on the ground.

Six categories of slope were mapped. Their boundaries were placed at convenient percentage figures appropriate to land-use development. They are not intended to provide precise boundaries above or below which a particular land use should be prohibited. Rather, the categories classify the land according to its slope and serve as a guide to the limitations that slope poses on land-use development. For this purpose, slope is commonly expressed in percent; the amount of vertical rise of the land surface is given as a percentage of the horizontal distance over which the rise occurs. Corresponding ranges of values for slope angles in degrees, used commonly in scientific studies, and slope ratios, widely used in engineering practice, also are provided in the description of each map unit. The relation among these three methods for measuring slope is shown in a diagram in figure 3. Another diagram illustrates the slope categories depicted on the map.

GEOLOGY

Geologic Map

A geologic map portrays the distribution of earth materials that are exposed at the ground surface. The geologic map contains basic data from which are derived other interpretive maps, such as those concerning engineering properties of the earth materials.

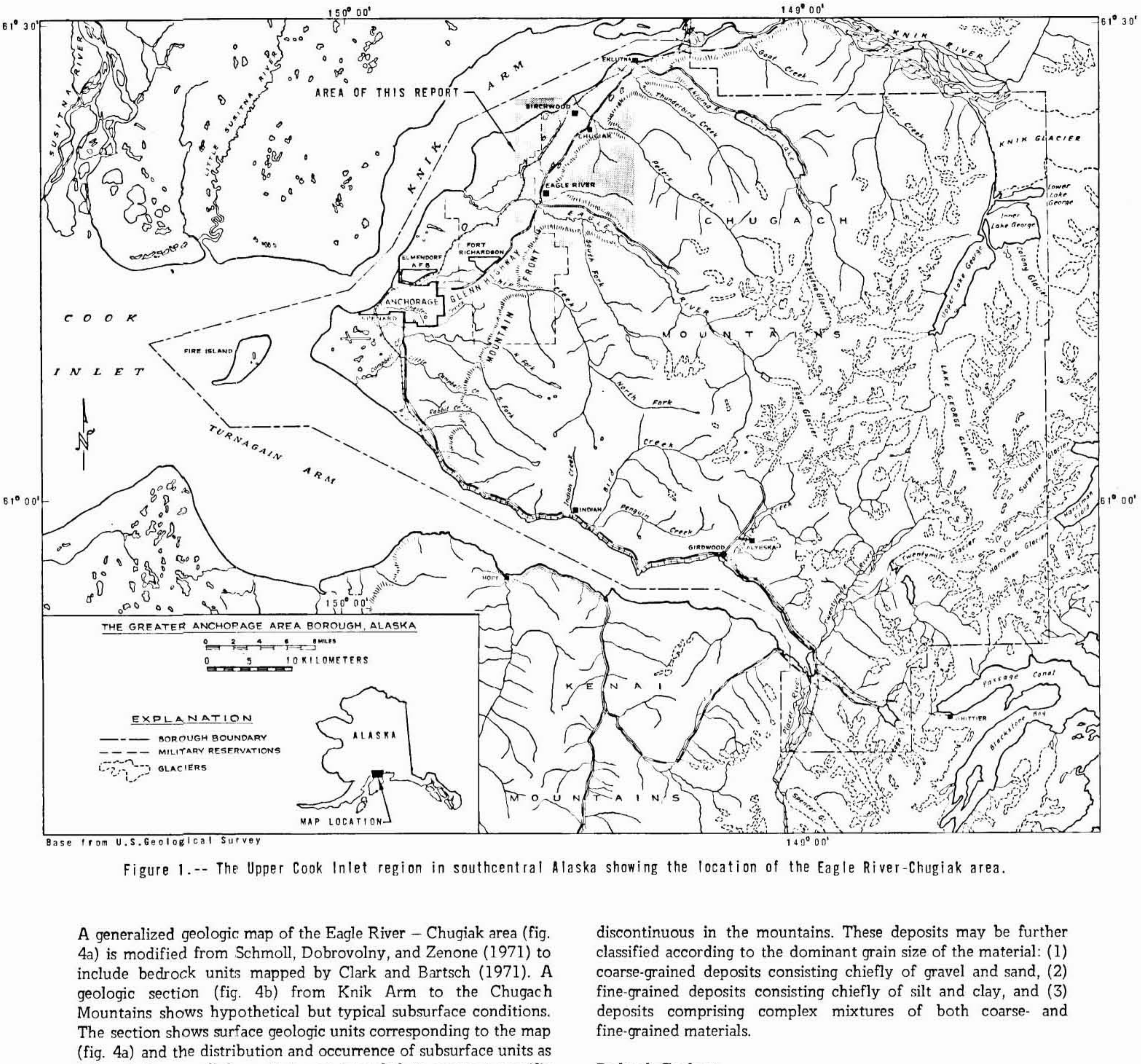


Figure 1.-- The Upper Cook Inlet region in southcentral Alaska showing the location of the Eagle River-Chugiak area.

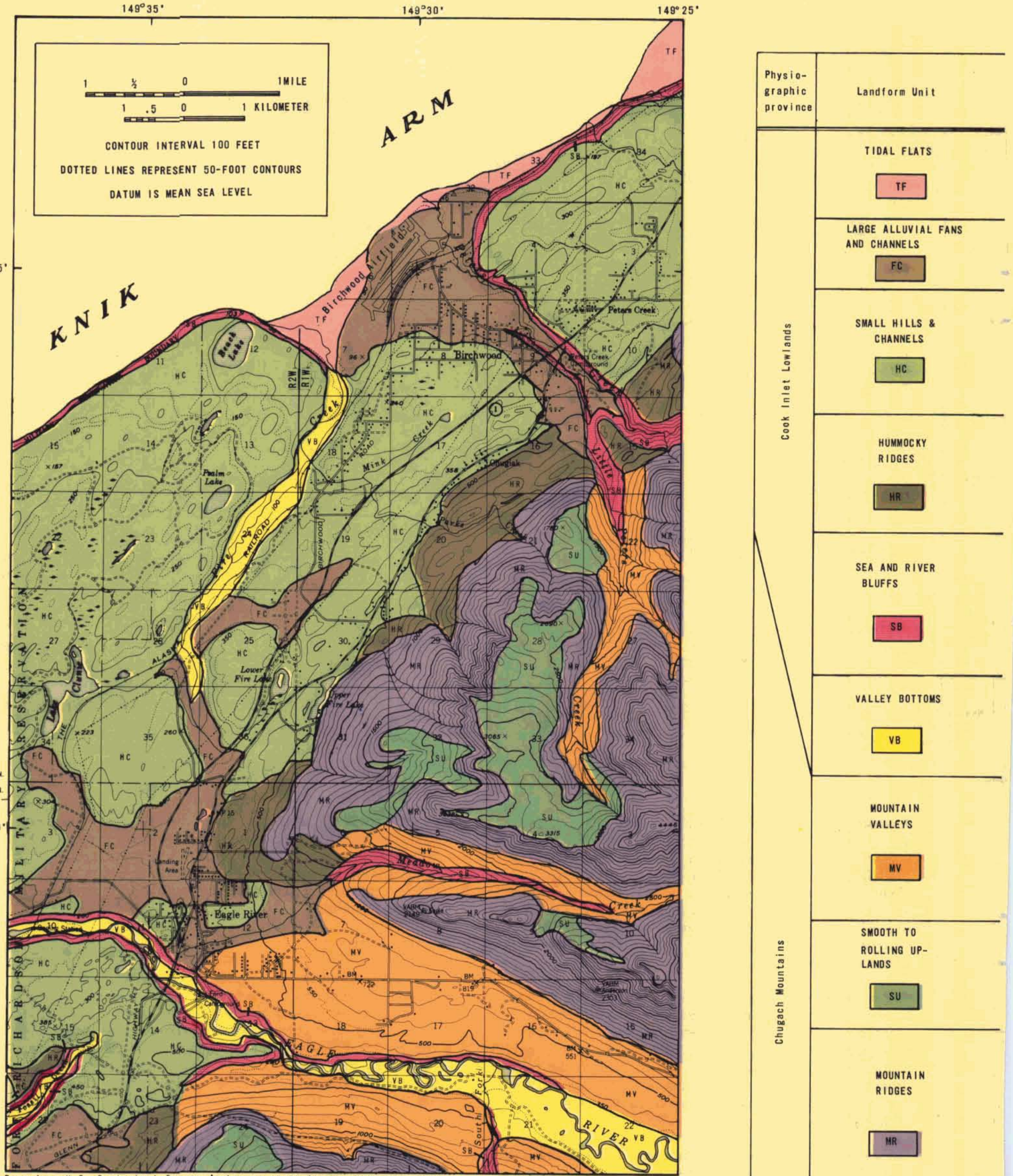
A generalized geologic map of the Eagle River – Chugiak area (fig. 4a) is modified from Schmoll, Dobrovolny, and Zenone (1971) to include bedrock units mapped by Clark and Bartsch (1971). A geologic section (fig. 4b) from Knik Arm to the Chugach Mountains shows hypothetical but typical subsurface conditions. The section shows surface geologic units corresponding to the map (fig. 4a) and the distribution and occurrence of subsurface units as inferred from well logs; it is not intended to portray specific subsurface conditions.

The two major categories of geologic materials that are exposed in the area are bedrock and unconsolidated surficial deposits. The bedrock consists of: (1) hard metamorphic and related igneous rocks that are widely exposed in the Chugach Mountains, and (2) relatively soft sedimentary rocks that lie beneath the surficial deposits in the lowland. The sedimentary rocks are exposed in only a few places, mostly in cut banks of the Eagle River downstream from the Glenn Highway.

The unconsolidated surficial deposits, chiefly of glacial and alluvial origin, form a layer of varying thickness over the lowland but are discontinuous in the mountains. These deposits may be further classified according to the dominant grain size of the material: (1) coarse-grained deposits consisting chiefly of gravel and sand, (2) fine-grained deposits consisting chiefly of silt and clay, and (3) deposits comprising complex mixtures of both coarse- and fine-grained materials.

Bedrock Geology

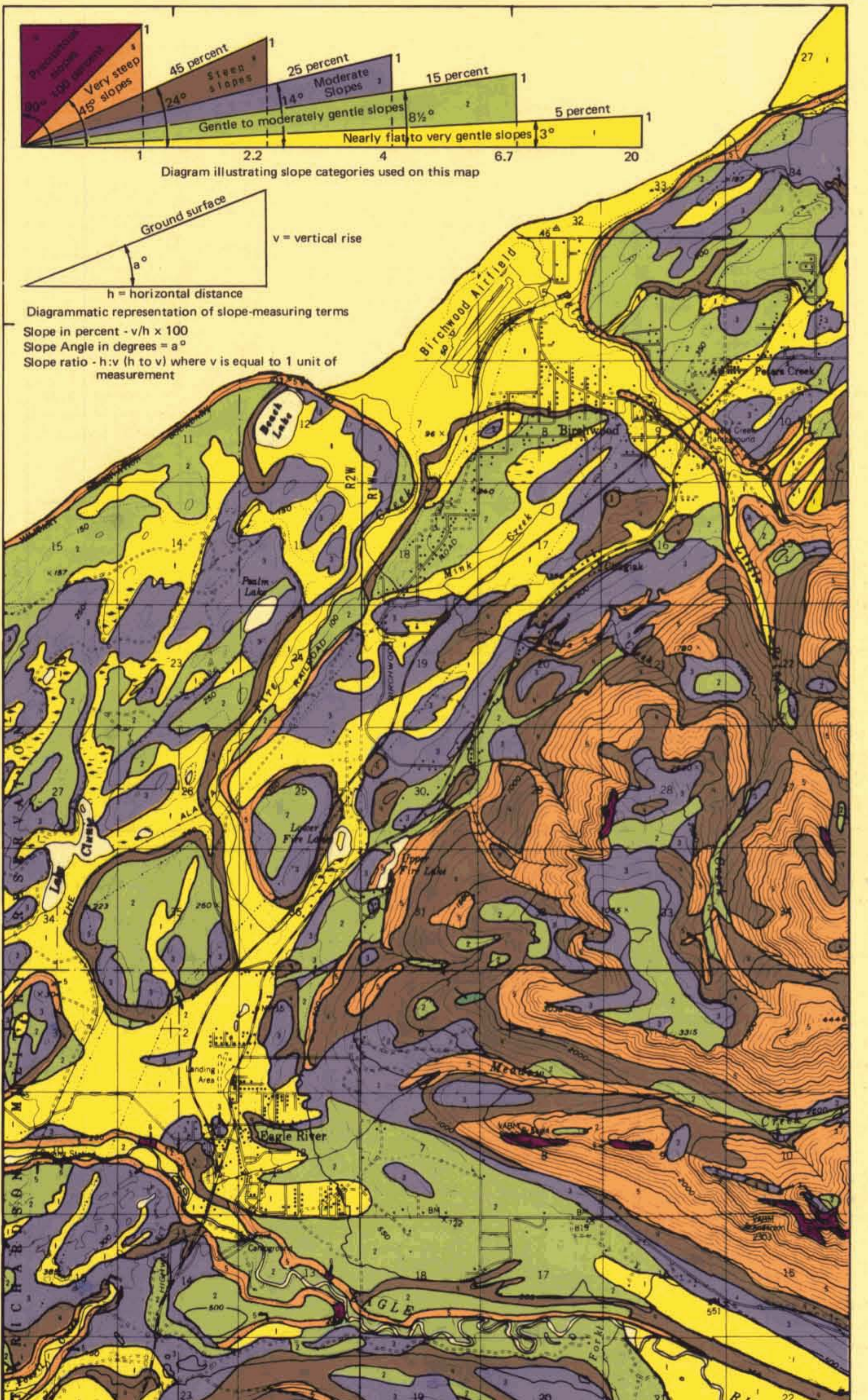
The Chugach Mountains are composed of crystalline metamorphic and related igneous rocks. The descriptions of these rocks given with figure 4a are derived largely from the work of Clark and Bartsch (1971). Most of these rocks have recently been named the McHugh Complex (Clark, 1973), but some along the Glenn Highway and near Peters Creek are part of an as yet unnamed older complex. The rocks range in age from more than 200 million years to less than 100 million years and are chiefly of marine origin. They were deformed by mountain-building forces, uplifted to form the Chugach Mountains, and are highly sheared, folded, and fractured.



Base from U.S. Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

Figure 2.-- Landform of the Eagle River-Chugiak area, Alaska.

Slopes	Geology	Geologic Materials	Potential sources of construction materials	Foundation Conditions	Excavation Conditions	Drainage Conditions	Slope Stability
Nearly flat to gentle.	Estuarine deposits.	Chiefly silt; some clay & fine-grained sand.	None	Very poor	Difficult, due to unstable material and high water content.	Poor; surface runoff high.	Stable, but subject to continual erosion.
Nearly flat to gentle	Coarse-grained alluvium.	Chiefly gravel.	Good source of gravel & crushed aggregate; may lack sand.	Good.	Easy; some boulders may cause hindrance.	Good	Stable.
Hills moderately gentle to moderate; terrane hummocky in part; channels nearly flat to gently sloping.	Ground moraine w/ drumlinoid hills; kames, eskers, & related deposits; late glacial & postglacial alluvium.	Chiefly diamicton gravel & sand; minor amts. of silt and clay	Good souces of gravel & sand; crushed aggregate locally.	Generally good; only fair in some depressions.	Generally easy; more difficult where diamicton is compact; boulders present locally.	Generally good; poor to fair in some depressions and small channels.	Generally stable; areas adjacent to bluffs possibly unstable.
Moderate to steep; nearly flat in some depressions and on a few terrace surfaces; otherwise hummocky.	Chiefly end and lateral moraines; includes some kames & kame terrace complexes.	Chiefly diamicton and poorly sorted gravel; some better sorted gravel and sand.	Gravel & sand available in very few places; mixed coarse- and fine-grained material common.	Generally good; steep slopes may cause problems locally.	Locally difficult due to steep slopes or boulders.	Good to fair; surface runoff generally high.	Generally stable; steep slopes possibly unstable.
Very steep to precipitous	Colluvium covering surficial deposits; includes areas where surficial deposits are being eroded, & bedrock in some canyons.	Diamicton; poorly to well-sorted gravel; sand; & silt.	Gravel & sand available in very few places; mixed coarse- and fine-grained material common.	Poor because of steepness of slopes.	Slopes cause difficult operating conditions.	Good to fair; surface runoff very high.	Potentially unstable; subject to landslides & renewed or continuing erosion.
Nearly flat to gentle; some low escarpments.	Coarse-to-fine grained alluvium.	Gravel & sand; some silt.	Good to fair sources of gravel & sand locally.	Generally good; fair to poor in areas of fine-grained material.	Generally easy;	Good; fair to poor in areas of fine-grained material.	Generally stable; banks along Eagle River subject to erosion.
Nearly flat to moderately gentle in valley bottoms; moderate to steep slopes common on sides of valleys.	Ground moraine, lake deposits, colluvium, & some small alluvial fans.	Diamicton; silt & clay; poorly to well-sorted gravel, sand, and silt.	Gravel & sand available in a very few places; clay present locally; mixed coarse-and fine-grained material common.	Good to poor.	Difficult where diamicton is compact or fine-grained material is unstable.	Good to poor.	Generally stable except in some areas of fine-grained material; subject to rockfalls & landslides from adjacent mtn. slopes.
Moderately gentle to moderate; steep in a few places	Ground moraine & valley fills of older glaciations	Chiefly diamicton; boulders common; locally gravel and sand.	Gravel & sand available in a very few places; mixed coarse and fine-grained material common.	Generally only fair.	Easy except where boulders are present or bedrock is at shallow depth.	Fair to poor; surface runoff moderate.	Generally stable except where solifluction may occur on some slopes.
Steep to very steep; locally precipitous.	Bedrock; locally mantled by colluvium, especially on lower parts of ridge slopes.	Chiefly metamorphic rocks; locally includes colluvium consisting of rubble, diamicton, & poorly to moderately well sorted gravel and sand.	Good source of crushed aggregate; rock locally suitable for riprap.	Generally good in bedrock; fair to poor in colluvium.	Bedrock generally requires blasting; steep slopes cause difficult operating conditions.	Poor to good; surface runoff high.	Rockfalls and landslides possible.



Base from U.S. Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

Figure 3.-- Generalized slope of the Eagle River-Chugiak area, Alaska. (modified from Schmoll and Dobrovolny, 1971)

EXPLANATION

1 ½ 0 1 MILE
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Less than 5 percent
Less than about 3° | 1 | More than 20:1

NEARLY FLAT TO VERY GENTLE SLOPES — Principally on alluvial surfaces in channels formerly occupied by large streams; also includes parts of a low terrace complex along the Eagle River. Small terrace escarpments occur locally, otherwise steeper slopes absent. Slopes present few problems to urban development; some of the nearly flat areas, however, are poorly drained.

5-15 percent
About 3° – 8 1/2° | 2 | 20:1 – 6.7:1

GENTLE TO MODERATELY GENTLE SLOPES — Principally areas underlain by glacial deposits that have a gently rolling to slightly hummocky surface; also includes some small alluvial fans. Along the Eagle River, includes low terraces comprising several levels within a small area. Some small irregular areas and long narrow areas of more gentle slope, as well as minor bands of steeper slope on some hillsides and terrace escarpments, are present. Slopes may present minor grading problems, but they are not a hindrance to residential subdivision or other types of land development.

15-25 percent
About 8 1/2° – 14° | 3 | 6.7:1 – 4:1

MODERATE SLOPES — Hummocky topography on glacial deposits in the lowland areas, and small areas high in the mountains. The hummocky topography includes gentler slopes on hilltops and in depressions, and small areas of steeper slope on some hillsides. Near the mountains, these slopes generally merge into slopes of the next steeper unit. Slopes must be given considerable attention in the design of any construction, but particularly linear features such as drainage lines and access roads, so that they have proper gradients. Excessive grading may be necessary to create the less steeply sloping ground suitable for most types of development.

25-45 percent
About 14° – 24° | 4 | 4:1 – 2.2:1

STEEP SLOPES — In the lowland includes unusually steep slopes associated with hummocky topography, and the more subdued escarpments adjacent to some alluvial channels; in the mountains includes most of the lower slopes where bedrock commonly does not crop out. Slopes pose significant problems to most types of land development. Subdivision-development practices followed in areas of more gentle slope are generally precluded here, because freedom of movement and other choices necessary to obtain proper gradients for roads and other uses are highly restricted by direction of slope. Extensive grading required for most types of development must be carefully planned to prevent slope instability.

45-100 percent
About 24° – 45° | 5 | 2.2:1 – 1:1

VERY STEEP SLOPES — Long narrow escarpments along river and sea bluffs where underlying deposits are generally concealed by colluvium; includes most of the mountain slopes where bedrock is commonly exposed. Slopes make most types of development difficult, as direction of movement is severely limited to nearly along the contour of the slope and disturbing the natural slopes is likely to cause slope instability.

More than 100 percent
45° – 90° | | Less than 1:1

PRECIPITOUS SLOPES — Small areas in the lowland where rivers are eroding their bluffs; major cliffs in the mountains. Development of almost any kind is precluded by difficulty of access and problems of continuing erosion.

Clark (1972) showed the concealed Knik fault zone (see fig. 4b) which coincides with the the Chugach Mountain front from the shore of Turnagain Arm southeast of Anchorage to a point near the valley of Peters Creek. Clark also showed two short exposed traces of a (Eagle River) thrust fault which lies east of and is approximately parallel to the mountain front. Whereas these faults were probably the sites of major crustal movement in the past, they are not known to be active at present.

The sedimentary rocks are part of the Kenai Formation and are about 30 million years old. They were deposited largely on land in approximately their present relationship to the rocks of the mountains. They are comparable to the rocks beneath the Cook Inlet basin from which oil is produced and are similar to but younger than the coal-bearing rocks of the Matanuska Valley (Wolfe and others, 1966; Wahrhaftig and others, 1969).

Geology of Surficial Deposits

The surficial deposits comprise the unconsolidated materials that have accumulated on the land surface above the bedrock. Although commonly quite thin and of minor geologic significance, in places such as the Cook Inlet Lowland they form a major geologic unit of considerable thickness and importance.

The materials that make up the surficial deposits are commonly classified according to their grain size and sorting. Grain sizes range from the microscopic to house size, described by the common terms clay, silt, sand, gravel, pebbles, cobbles, and boulders. Sorting is an expression that indicates the range of grain sizes in a material; most of the grains in a well sorted (clean) material are similar in size, whereas, the grains in a poorly sorted (dirty) material extend over a wide range of sizes. Degree of sorting varies considerably, but in most materials grain sizes described by one of the common terms cited above are sufficiently dominant that the material is called by that name. A very poorly sorted deposit, in which grain sizes extend over much or all of the range from clay to boulders, may be called diamicton, a general term for this material (Flint, 1971, p. 154). Glacial till is one type of diamicton. The term till should be applied only to a diamicton that has been deposited directly by and beneath a glacier and that has not been subsequently reworked by water from the glacier (American Geological Inst., 1972).

The surficial deposits of the Eagle River – Chugiak area have accumulated within the last 1 million years, during which time the area was glaciated several times (Karlstrom, 1964). Most of these materials were deposited during the latter part of the last (Wisconsin) glaciation, from about 25,000 to 10,000 years ago, when glacier ice flowed from the Knik, Matanuska, and Eagle River valleys. The individual ice streams coalesced to cover the lowland and lower slopes of the Chugach Mountains. The glaciers eroded some of the bedrock and much of the older unconsolidated materials and deposited till that formed moraines and other glacial landforms. Later, as the glacier fronts receded, melt-water streams deposited clean permeable sand and gravel; the silt and clay accumulated in lakes and ponds or was carried into Cook Inlet. After the ice melted, stream, pond, and estuarine deposits continued to form. During and after glaciation, colluvium accumulated on the mountain slopes and along steep slopes or cliffs formed by river and sea erosion. Colluvium is a general term for material on or at the bases of slopes that has moved down from higher areas largely by gravity; landslide deposits are included in this category. Erosion and deposition continue along streams, in Cook Inlet, and on some slopes. Several older glaciations were more extensive than the last, so remnants of the older glacial deposits are found at higher altitudes than those of the last glacial advance. In a few roadcuts in the lowlands, older glacial deposits are exposed beneath deposits of the last (youngest) glaciation.

Because of the wide range of geologic processes which produced the surficial deposits and the complexity of the area's glacial history, the deposits vary widely in grain size and sorting. Although the glaciers were large masses, most of the individual streams that reworked the glacial deposits were relatively small. Consequently, few individual geologic units have any great thickness or lateral extent, and many combinations of interbedding and mixtures of materials occur. In addition, erosion removed much material; redeposition resulted in a complex juxtaposition of older and younger deposits.

The surficial deposits range in thickness from a feather-edge at the steep bedrock slopes of the Chugach Mountains to at least 300 feet (90.1 m) on the alluvial fan of Meadow Creek. Also, there are local variations in thickness which have at least three causes: (1) the irregular bedrock erosion surface beneath the unconsolidated deposits, (2) uneven topography of glacial deposits resulting from accumulation on and adjacent to glacier ice which subsequently melted, and (3) repeated erosion and deposition of unconsolidated material by streams. Drillers' logs are available for about 170 of the 350 wells inventoried in the area (table 1). These logs, some of which are given in table 2, show great variation in grain size and sorting of materials, both with depth and over short lateral distances.

INTERPRETIVE MAPS

Interpretive Maps

The general characteristics and physical properties of geologic materials determine in part their behavior following disturbance of natural conditions by engineering and construction activities.

Interpretive maps (figs. 5-8) show some of the important physical properties of geologic materials in the Eagle River – Chugiak area. These properties and other characteristics are discussed in the text accompanying each map.

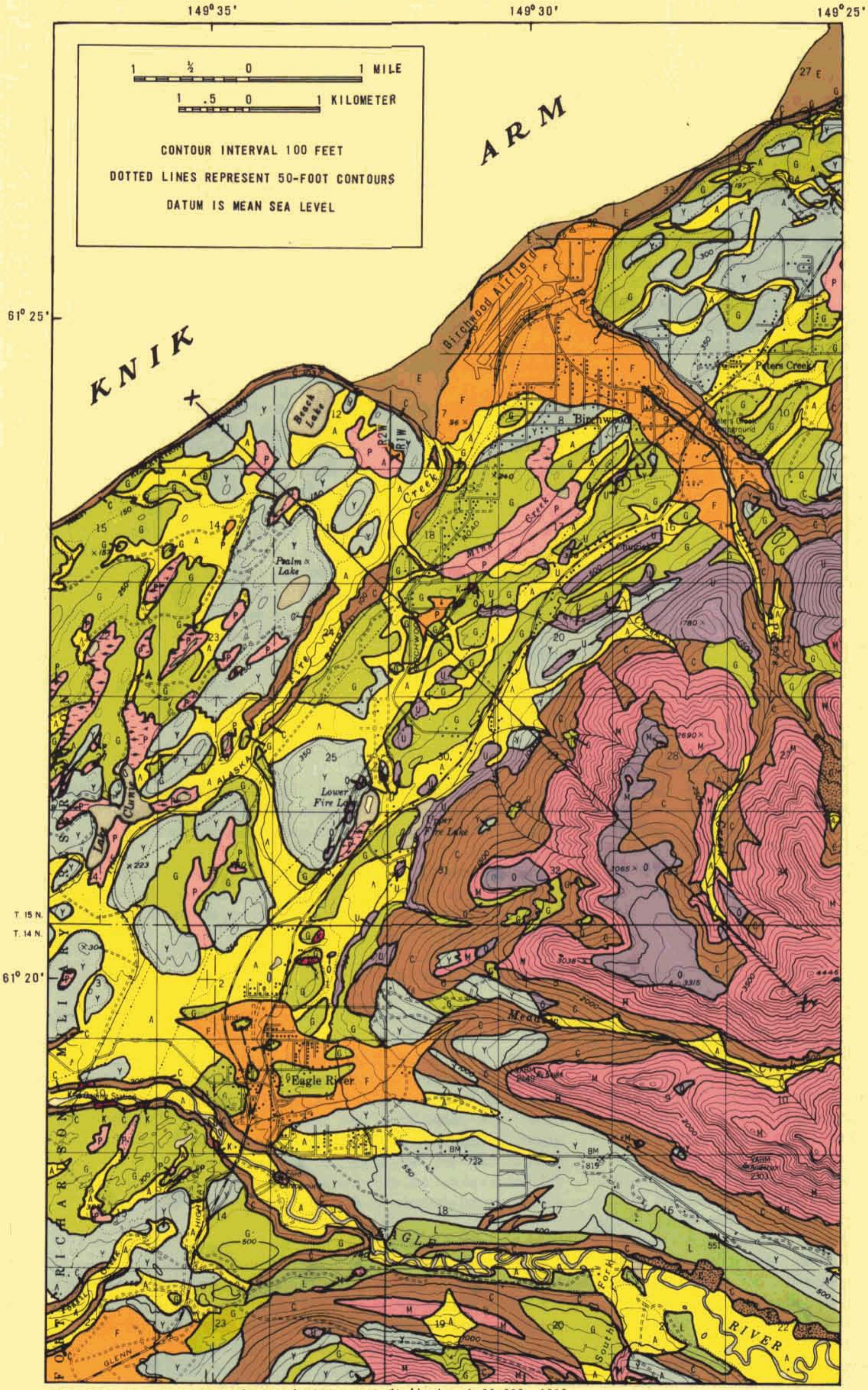
Construction Materials

Potential sources of construction materials are shown in figure 5. There are five map units, three of which indicate source areas of sand and gravel ranging from present nearly everywhere to present in only a few places; one map unit indicates source areas containing material suitable for crushed aggregate and man-placed riprap; the other map unit indicates presence of impervious material. Estimates of quantity and evaluation of material for specific uses are not made; to determine these facts a more detailed exploration and testing program would be needed for each potential site prior to development.

Foundation and Excavation Conditions

Figure 6 shows the variation of foundation and excavation conditions throughout the mapped area. Two map units indicate generally good conditions, with different degrees of suitability. The remaining three units indicate successively poorer conditions.

Text continued on page 18



Base from U S Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

Figure 4a.-- Generalized geology of the Eagle River-Chugiak area, Alaska. (modified from Schmoll and others, 1971)

EXPLANATION for Figures 4a and 4b

UNCONSOLIDATED SURFICIAL DEPOSITS

COARSE-GRAINED DEPOSITS

F

LARGE ALLUVIAL FAN DEPOSITS — Chiefly gravel and sand, with cobbles and small boulders common. Small amount of silt and clay are present. Deposited by larger streams at the mountain front, these fans have been mapped separately from other alluvium because their areal extent and thickness make them exceptionally suitable for construction materials and ground-water development. Foundation conditions and drainage are very good. These deposits are good water-bearing materials and may yield relatively large quantities of water to wells. Reported yields are as great as 300 gpm (gallons per minute) on the alluvial fan of Meadow Creek.

A

ALLUVIUM IN CHANNELS, TERRACES, FLOOD PLAINS, AND SMALL ALLUVIAL FANS — Coarse gravel, sand and gravel, and some sand and silt. These deposits include relatively large channel fillings which are chiefly of coarse gravel and resemble the large alluvial fan deposits, smaller deposits that contain sand and gravel, and terraces (along Eagle River and Fire Creek) that may be chiefly sand and silt. In general, the larger of these alluvial units tend to be coarse grained, contain relatively abundant sources of good aggregate, and provide excellent foundation conditions; internal drainage is good. The smaller units tend to be finer grained and more poorly drained. This unit may yield moderate (5-50 gpm) quantities of water to wells.

G

GLACIAL ALLUVIUM IN KAMES, ESKERS, AND RELATED LANDFORMS — Chiefly gravel and sand, but in places includes interbedded silt, clay, or diamicton; generally more poorly sorted than the other alluvial deposits. Most of the glacial alluvium is intimately related to other deposits mapped as "younger moraine deposits." In some places it is difficult to distinguish between glacial alluvium and the other glacial deposits. This unit occurs in small hills and terraces and commonly comprises the entire deposit beneath the landform. Locally, the deposits provide good construction materials, but elsewhere the admixtures of finer materials make them less desirable than other mapped alluvium units. Usually these sediments are well drained, but, where topography is hummocky, small depressions may be poorly drained; foundation conditions are generally good. The unit may yield small quantities (1-10 gpm) of water to wells.

FINE-GRAINED DEPOSITS

E

ESTUARINE DEPOSITS — Silt, with minor amounts of fine sand and some clay. This unit occurs along the edge of Knik Arm and includes the deposits of the present intertidal zone as well as older tidal deposits that accumulated during a former period of higher sea level. The area is unsuitable for most uses because of poor drainage and flooding at highest tides. This is not a water-bearing unit.

P

POND AND BOG DEPOSITS — Intermixed clay, silt, peat, and other organic debris; peat commonly forms the upper part of the deposit, and in places makes up most of the material; thin local beds of marl present. These deposits commonly occupy depressions in the surface of older glacial deposits and in some channels. They are thin at the edges, but may thicken to 30 feet or more in the center. These areas are poorly drained and will be

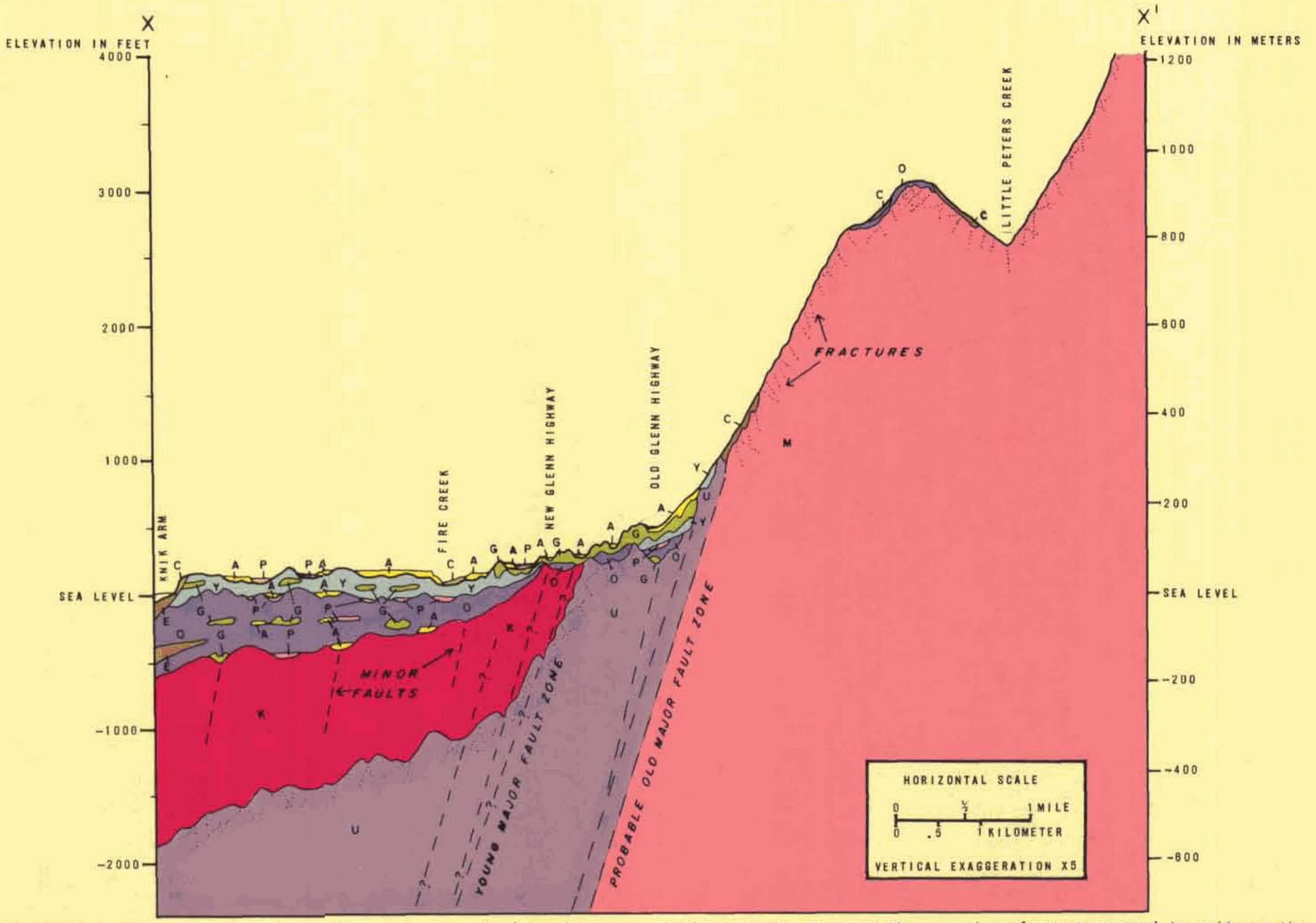


Figure 4b.-- Schematic geologic section along line X-X' in figure 4a. Geologic units shown at the ground surface correspond to units on the geologic map. All features shown below the ground surface are hypothetical and are intended only to illustrate the kinds of features and materials thought to be present at depth.

suitable for development only after poor foundation materials and poor drainage conditions have been accommodated. This is not a water-bearing unit.

L

GLACIAL LAKE DEPOSITS – Clay and silt; contains sand in marginal parts of mapped areas. This unit was deposited in a large glacier-dammed lake in the Eagle River valley during the last glaciation. Foundation conditions and drainage are generally poor except in sandy areas; excavated and natural slopes may be unstable. This is not a water-bearing unit.

MIXED COARSE- AND FINE-GRAINED DEPOSITS

Y

YOUNGER GLACIAL MORAINE DEPOSITS – Chiefly till, composed commonly of diamicton and poorly sorted gravel which contains only small amounts of silt and clay. Locally, beds of moderately well-sorted gravel, sand, and silt equivalent to glacial alluvium may be present or even dominant. This unit was deposited directly from glaciers during the last glaciation. Thicknesses of 30 feet or more are common. The unit is generally underlain by similar material deposited during earlier glaciations. It may be difficult, especially in well logs, to distinguish between the younger and older deposits. The poorly sorted material is not well suited for most construction purposes, but foundation conditions and drainage are generally good. The deposits may yield small (1-10 gpm) to moderate (10-50 gpm) quantities of water locally from gravelly or sandy zones.

O

OLDER GLACIAL MORAINE DEPOSITS – Chiefly till composed commonly of diamicton. These deposits are found in two areas: (1) a large relatively flat area in the mountains northeast of Eagle River where thickness may be 15 feet or more and large granitic blocks are common; foundation conditions here are fair to poor except where bedrock is at shallow depth; locally, drainage may be poor and the deposits are of little use as construction materials; and (2) in a few roadcuts in the lowland where the deposits are exposed beneath younger glacial deposits (Y). Although of limited extent at the surface, materials of this unit are probably quite extensive in the subsurface. The material is not well suited for most construction purposes, but foundation conditions are generally good; drainage conditions fair to good. The unit is probably a poor aquifer in both areas.

C

COLLUVIUM (SLOPE DEPOSITS) – Generally heterogeneous material, reflecting the composition of upslope deposits and containing a wide range of grain size, generally resembling a loosely packed diamicton. Well-sorted deposits, including gravel, sand, and silt, are present where running water has been an important transporting agent. In the mountains, rubble (angular bedrock fragments) is common or dominant on the steeper slopes; material derived from older glacial moraines is dominant in areas downslope from these deposits. In the lowland, colluvium is deposited along escarpments formed by river and sea erosion. Drainage conditions are fairly good, but the steep slopes are not well suited to development. Colluvial deposits are usually poor sources of construction materials because of their variability from place to place and wide range of grain size. Although relatively unexplored for ground water, this unit is probably not a good aquifer.

Where indicated by overprint, deposits have been identified as landslide debris. Here they are a chaotic mixture of bedrock rubble, boulders, cobbles, and finer grained material. These areas contain loose and potentially unstable material; they are not suitable for development.

BEDROCK

SEDIMENTARY ROCKS

K

KENAI FORMATION – Chiefly siltstone and sandstone; beds of coal up to a few feet thick common, but not of economic significance. The formation is exposed only along cut banks of the Eagle River and in a few roadcuts. Well-log information indicates that the rocks occur at depth beneath the glacial deposits in much of the lowland area. They are not suitable for construction purposes because they are rather soft, especially where the upper several feet has been weathered, but they do provide good foundations and fairly good drainage. Considered a poor aquifer, though one relatively large yield (275 gpm) well has been developed within these rocks.

METAMORPHIC AND IGNEOUS ROCKS

M

McHUGH COMPLEX – Chiefly metamorphosed sedimentary rocks of marine origin, including metasandstone and metaconglomeratic sandstone containing abundant feldspar and rock fragments but little quartz; also includes greenstone, chert, and argillite. In the southeast corner of the map area, the unit includes some similar rocks of the Valdez Group. Small bodies of unmetamorphosed igneous rocks are present in places, notably the canyon of South Fork of Eagle River. These rocks provide good foundations and drainage, but steep slopes hinder development. The rocks may be used for riprap locally, but have not been found to contain minerals of economic importance. Fracture zones may yield small to moderate quantities (2-20 gpm) of water locally. Further descriptions of these rocks are given in Clark and Bartsch (1971).

U

UNNAMED COMPLEX – Chiefly metamorphosed igneous rocks, including greenstone, greenschist, gneiss, and some metadiorite and metaquartz-diorite; chert, argillite, and marble are present locally. Foundation and drainage conditions, potential for construction materials, and sources of ground water are similar to those in the McHugh Complex.

Table 1.--*Reported data on wells and springs in the Eagle River-Chugiak area.*

Section and Well no.1/	No. in Waller (1960)	Owner or user	Well depth (ft)	Casing depth (ft)	Diameter (in)	Altitude (ft)2/	Depth to water (ft)3/	Measurement date	Yield (gpm)	Water qual. data4/	Water-bearing material
T14N, R1W											
Sec. 6, No. 1		Ruegerg	275	275	6	1030			10		Gravel
2		Griffis	148		6	1260				F	Gravel
3		Befford, Ernest	302	119	6	1525	129	10/73	2		Bedrock
Sec. 7, No. 1	12	Nelson, Jim	110		4	540	99	2/67		F	Sand
2		Miller, C. E.	236		6	560	214	/66	5	F	Fine gravel
3		Lecorchik, J.	261	256	6	710	225	10/58	8	F	Sand and fine gravel
4		Weitzel	240	240	6	720				F	
5		Croxford, S.	300			730				F	
6		Hayes, Wm.	280			720				F	
7		Wimple, Barney	300		6	730				F	
8	13	Roberson, Floyd	165			750				F	
9		Jones, Paul	215	105	6	830			10	F	Bedrock
10		Bell, Dan B. #2	250	250	6	580	165	/64	326	F	Gravel
11		Douthit, Bob				750				F	
12		Lecorchik, J.	223	223	6	705				C	Sand
13		Wright, B.	153	153	6	705	134	/65	10	C	Sand and gravel
14		Preuss, G.	155	155	6	595				F	
15		Bell, Dan B. #1	300		6	560	85	10/63	15		Sand
16		Pylant, Fritzi	136	135	6	720	122	9/63	8	F	Gravel
17		Donaho, D. E.	350	219	6	805	90	/65	50	C	
18		Davis, Lloyd	130		6	750				F	
19		Patnode, Edmund	40	40		795				F	
20		Pajak, Joe	228	206	6	780			1.2	F	Bedrock
21		Harris, Walter				780				F	
22(1)		Bell, Dan B. #5	260	230	6	550	177	12/69	115	C	Sand and gravel
22(2)		Bell, Dan B. #3	268	268	12	550	178	3/70		C	Sand and gravel
23		Schnuerle, M. D.	217	217	6	610	202	7/72	15		Sand and gravel
24		Schumann, S.	110	108	6	650	93	7/73	2		Gravel, sandy
25		Wachsmuth, D. C.	305	305	6	640	294	8/73	9		Sand and gravel
26		Smith, Ronald	323	323	6	640	307	8/72	5		Sand and gravel
27		Jackson, R.	350	338	6	660	300	5/73	2		Gravel, sandy
28		Cloud	102	102	6	670	72	9/70	10		Sand and gravel
Sec. 8, No. 1		Stewart, Jack	70	55	6	880				F	
2		Smith, Lester	113		6	790	88	2/65	10		Gravel
3		Rossman, N.	107	24	6	890	97	1/61	6	C	Bedrock
4		Wooten, Jess	346	346	6	780	331	9/73	20		Gravel
5		Wood, T.	80	77	6	770	60	5/73	5		Gravel, sandy
6		Folsom, W. A.	369	369	6	770	355	4/73	10		Gravel
7		Dean, E.	55	52	6	800	38	8/73	2		Gravel, sandy
Sec. 9, No. 1		Trainer, Bob	99			1000	70	9/66	20	F	Bedrock
2		Hurst	354			1330					Bedrock (?)
3		Jones, Douglas	72	72	6	805	7			F	
Sec. 15, No. 1		Baumer, Patrick	70	40	6	830				F	Bedrock (?)
2		Daniel, Virgil	102	36	6	800	50		3	C	Bedrock
3		Roessner, Eugene	9	9	48	790	6	10/69		F	Gravel
4		Lenin, R.	175	75	6	680	75	1/73	2-3		Bedrock
5		Dickey, Brad	160	86	6	660	50	8/73	2		Bedrock
6		Woods, Charlie	125	112	6	610	100	6/73	2		Gravel, silty
Sec. 16, No. 1		Haeg, Harold	106		6	580				F	Sand
2		Malone, M. D.	15		24	610				F	
3		Porter, Larry	10			510					
4		Pilant, Wesley	18	16	24	600	6				
5		Bullard, Doug	73	73	6	690	21		2	F	Gravel
6		City of Anchorage	445	445	6	345	0	11/73			Sand and gravel
7		Thern, P.	75	69	6	820	50	10/73	3		Gravel, cobbles
8		Jones, John	145	135	6	550	115	5/73	2		Gravel, silty-sandy
Sec. 17, No. 1	15	Johnson, M. B.	178	14	4	340	115	/56			Sand
2		Kindred, Russell	240		6	730	181	4/68	30	C	Sand
3		Heaston, M.	228	228	6	760				C	Bedrock
4		Fitzpatrick, W.	107	107	6	720				F	
5		Bell, David	58		6	670	40	10/64	12	F	Gravel
6		Bush, Donald E.	75	72	6	680	45	3/66	10	F	Sand and gravel
7		Moore, Vernon, L.	110		6	730			4	F	
8		Chapman, Robert	90	90	6	750				F	
9		Arnold, Clifton	85			750				F	
10		McLeod, Duncan	120	95	6	720	60	9/73	3		Gravel, silty-sandy

1/ Locate by well no. on Plate I
2/ Above mean sea level
3/ Below land surface
4/ F=field determination (table 4)
C=complete laboratory analysis
P=partial laboratory analysis

Table 1.--*(Continued)*

Section and Well no.[1]	No. in Waller (1960)	Owner or user	Well depth (ft)	Casing depth (ft)	Diameter (in)	Altitude (ft)[2]	Depth to water (ft)[3]	Measurement date	Yield (gpm)	Water qual. data[4]	Water-bearing material
T14N, R1W											
Sec. 18, No. 1		Clemons, Robert	267	267	6	740	251	10/69			
2		Bell, Dan	168	168	6	610	110	6/65	10	F	Sand and gravel
Sec. 23, No. 1		Schroeder, D. C.	33	16	6	900				F	
2		Boddie	260	23	6	1060	100	6/73	5		Bedrock
Sec. 25, No. 1		Roop, Raymond	16	16	30	705	14	10/69		F	
2		Lee, James	11		48	350	10	10/69		F	Gravel
Sec. 28, No. 1		Janke, Joe	215		6	1000	10	10/69		F	Sand and gravel
Sec. 29, No. 1		Davis	200	200	4	1200				F	Gravel
T14N, R2W											
Sec. 1, No. 1	67	Schroeder, Robert	550	550	6	289	10	11/54			Coal(?)
2		Gilcregse, C. G.	42	42	6	275				C	Clay and gravel
3		Harry's Auto Pts.	80	35	6	275	32		5		Sand and gravel
4		Peterson, William	180		6	360	83		30		Sand
5		Todd, Leslie	46	46	6	340	43	4/58	10	F	Gravel
6		Edwards	55		6	355	47			F	
7		Seidier, Russell	9	9	48	600	1	10/69		F	Gravel
8		Viau, Raymond	45	45	6	505				F	Bedrock
9		Gibbs, Chris	129	127	6	510			2	F	Bedrock
10		Tuck Const. Co.	90			350					
11		Lentz, Paul	78		6	330				F	
12		Charles, Willy	65			320				F	
13		Fly, Gene	250			510					Bedrock
14		Hall, Neil	52	52	6	325				C	
15		Baker, Ted	67	67	6	355				F	
16		Czerski, Edward	94	92	4	325	28	7/61	25	F	Gravel
17		Zmuda	100		6	320				F	
18		Wooten	55		6	345	41	8/64	25		Sand and gravel
19		Mahoney, Pat	101		6	340	30	7/65	50		Glacial till
20		Mahoney, Pat	98	98	6	315	27	10/68	10	F	Gravel
21		Berbes, Russell	80			275				C	
22		Strain, E.	92			280				F	
23		Grubb, Johnle	63		6	280	49			F	Sand
24		Baker, John W.	145		6	370	18	5/65	6	F	Sand and gravel
25		McFarland, Don	256		6	375	100	6/65	3		Sand and gravel
26		Gibbs, Paul	155	78	6	320	16	5/65	9	F	Glacial till
27		Delucia, Tony	75	75	6	340				C	
28		Herbert, Les	60		6	325				F	
29		Ripley	52	52	6	310	34	/65	8	F	Sand
30		Pippel, Mrs. W.	20		48	350				F	
31		Cox, Bill	160		6	350				C	
32		Rust	15	12	48	375				F	
33		Burke, William	12	12	36	400				F	
34		Jenkins	14	11	48	400				F	
35		Burke, George	14	14		390				F	
36		Devries, D.	135		6	325				F	
37		Unknown	90		6	275				F	
38		Michal, J. H.	63	63	6	275		6/72	20		Sand and gravel
39		Worthington, Norman	265	194	6	380		6/71			Shale
40		Dennison, Ronald	175	100	6	380	30	9/72	1		Silt
Sec. 2, No. 1		Dee, Chester	175	90	6	297					
2	52	Whitt, Ed	110	65	4	280	20	8/55	10		Glacial till
3	55	Ivie, Orin, J.	199			270					Bedrock(?)
4		Larson, Allen	75	28	6	260			22		Sandy gravel
5		Mullholland	57	57	6	275			1		Glacial till
6		Dennis, Ernest	25		48	310	2	10/69		F	Sand
7		Young, Ed	80		6	260				F	
8		Mason	45		6	260				F	
9		Bannister, Jack	47	47	6	260	37	/67		F	
10		Fischer, William, E.	78	78	6	265	65	/64		F	
11		Unknown	55		6	260				F	
13		Russell, Floyd	50		6	255				F	Gravel
15		Forrester, J.	73		6	310				C	
16		Wooten	78			310				F	
17		Charles, Wade	85	67	6	275	30			C	Sand
18		Webb, Floyd	95	95	6	275	26		40	F	Clay(?)
20		Greenstreet	87	64	6	260				F	Shale(?)
21		Carlson	160			260					
22		Johnson	42		6	250	16	6/69	40	F	Gravel
23		Peterman, R.	52	52	6	260	26	7/69	1	F	Sand
24		Deardorf	65	65	4	260	13		3	F	

Table 1.--*(Continued)*

Section and Well no. 1/	No. in Waller (1960)	Owner or user	Well depth (ft)	Casing depth (ft)	Diameter (in)	Altitude (ft) 2/	Depth to water (ft) 3/	Measurement date	Yield (gpm)	Water qual. data 4/	Water-bearing material
T14N, R2W											
Sec. 11, No. 1		Collins, W. M.	14		48	210	7	5/65			
3		Balzwin	126	124	6	325	90	7/57	5		Glacial till
6		ABS Eagle River School	265	260	8	350				C	
7		Mauldin, L. B.	316	265	6	275	49	7/68	2	F	
8		Cooper	120			305				F	
11		Nelson	95		6	310	22	5/65	60	F	Sand
12		DeLa Cruz	154		6	310	30	5/65	11		Gravel
13		Yarbrough	72		6	245	14	5/65	60	C	Gravel
14		Carter, Earl	42	42	6	290	18	6/60	10	F	Sand
15		Shipman	56		6	290				F	
16		Jones, Roy	30	30	48	310				F	Gravel(?)
17		St. Andrew Church	40		6	310				F	
18		Falcone, J.	127	127	6	310				F	
19		Hutchinson, Ray	25	25	48	310	17			F	Gravel(?)
Sec. 12, No. 1		Carpenter, Len	95	94	6	350	66		5	F	Sand
2		Folden, M. L.	134		6	460	25	9/55	10		Sand
2(2)		Waldrop, John	148		6	460	96	/54	3		
3		Lowe, Robert	139	95	6	400	99	8/59			Bedrock
4	44	Tedrow, R. L.	400	102	6	450	130	/55			Bedrock
5	46	Schroeder, Don	143	90		480	98	/55			Bedrock
6	26	Brasnahan, R.	120		4	500	42				Glacial till
7	23	Willis, Ed	68	68	6	450	12		10		Glacial till
8	25	Mitchell, Harold	85	85	6	475	42	9/64	10	F	Sand and gravel
9		Briggs, Dale	78		6	350	26	4/52			
11		Tedrow, R.	76		6	350	32	7/51		P	Boulders and gravel
12		McClusky	90		6	325	40	/55			Gravel
14		Phillips, Grady	94		6	413					Gravel(?)
16		Pogamy	75	75	6	400	54	7/65	45		Sand
17		Brosnahan, Robert	92		6	520	15	/56	10		Sand(?)
18		Zib, M.	150	150	6	480				F	
19		Lee, Willie	90	90	6	470				F	
20		Thomas, David	168	168	6	770				C	
21		Graham, M. L.	102	102	6	475	48	/66	8	F	Bedrock(?)
22		Townsend	104	104	6	450					
23		Metzgar	160	125	6	450				F	
24		Long, Ralph	156		6	450			5	F	
25		Welch, Wesley	140	140	6	410				F	
26		McFadden	25		36	340				F	
27		Carlos, Harold	86		6	440				F	
28		Rourke, Ken	109	109	6	440				C	
29		Easterday, Jack	80	80	72	460				F	Gravel(?)
30		Vanover, J.	94	90	6	375	38		17	F	Sand and gravel
31		Briggs, Glen	94	94	6	270				F	
32		Randall, Richard	52	52	6	390				C	
33		Briggs, Richard	40		6	360				F	
34		Reiman, Roy	80		6	410				F	
35		Pottle, Holman	40	40	6	340	33	4/65	7	F	Coarse gravel
36		Sunny Slopes System	150			380				P	
37		Crandall	130		6	405				C	
38		Broach, John	145	145	6	410	99	9/60	10	F	Sand and gravel
41		Kissee, Eugene	502	150	6	550		4/73	1		Bedrock
42		Kissee, Eugene	354	154	6	560	300	3/73	2-3		Bedrock
Sec. 14, No. 1		State of Alaska	305	200	6	310	31	2/71			
2		State of Alaska	260	201	6	460	175	4/71	1		Bedrock
3		State of Alaska	45	32	6	250	9	4/71	72		Gravel
4		State of Alaska	115	107	6	250	43	/71	1		Sand and gravel
5		State of Alaska	50	50	6	250			1		Gravel
T15N, R1W											
Sec. 3, No. 1	120	Aubrey, Robert	124		6	350	64	5/65			
2	125	Halfway House	145		6	300	8				Gravel
3	113	Rosenberg, G.	65		6	386	49	6/55	10		Sand and gravel
4	114	Michlig, R.	80		6		50	3/59	5		Sand and gravel
5	115	Johnson, G.	57			361	25	6/55			
6	116	Stockhausen	87		6	368	67	11/52			Gravel
7	118	Jahr, Layland	115		6	365	110	7/57	5		Sand and gravel
8	119	Elliot, R.	206		6	398	160	4/60			
9	121	Bellringer	53		6	346	41	12/55	4		Sand and gravel
10	124	Allen's Grocery	138		6	350	131	6/53			Sand and gravel
11	126	Kenicott	147		6	350	140	5/56			
12		Thompson, M. G.	210	210	6	350				C	
13	123	Mackey	63	63	6	350					Gravel

Table 1.--*(Continued)*

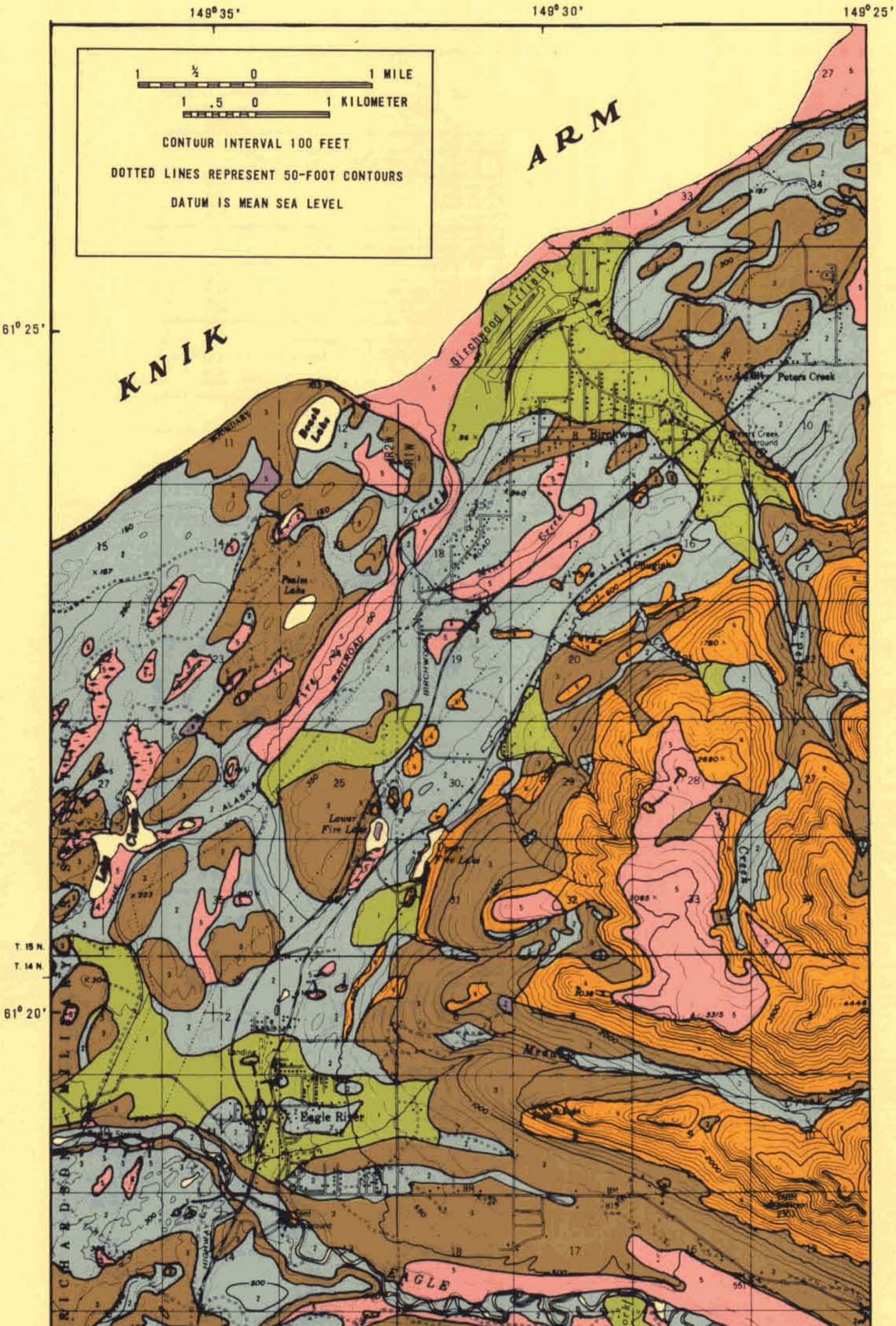
Section and Well no. 1/	No. in Waller (1960)	Owner or user	Well depth (ft)	Casing depth (ft)	Diameter (in)	Altitude (ft) 2/	Depth to water (ft) 3/	Measurement date	Yield (gpm)	Water qual. data 4/	Water-bearing material
T15N, R1W											
Sec. 5, No. 1	77	U.S. Army	402	212	6	70			7		
2		Walton, Ike	46	46	6	55	28	3/60	8	C	Sand and gravel
3		Zimmerman	205	205	6	105	0			P	
4		Undola	14	14	40	100					
Sec. 7, No. 2		Fay				200					
3		Call, B. B.	80	80	6	200					
Sec. 8, No. 3		Soto, A.	63	63	6	250				P	
4		French	62	62	6	200	14			P	
5		Weehunt	155	155	6	180				P	
6		Boyer	225	225	6	250					
7		Davis, J.	75	75	6	180				P	
8		Simpson	12	12		125					
9		Cruthers	81	81	6	190					
10		McGowan	165	165	6	170					
11		Jones, F.	50	50	6	130				P	
12		Berg Kennels	159	159	6	110	19	3/68	10	P	Gravel
13		Turnbull	109	109	6	100					
14		Higbee	15	15	30	100					
15		Johnson	spring			170	0				
16		Roushe	270	270	6	160			12		Sandstone(?)
17		Tanner	35	35	30	150					
18		McAllister	35	35		125					
19		Armstrong	142	137	6	180				C	
20		Kolvek, D. A.	15	15	48	200					
21		Kincaid	300	14	6	300					Bedrock(?)
22		Matlock	40	40	6	250	12			C	
23		Schimpf				255				P	
24		Sauvageau	57	57	6	250				P	
25		Philes, May	28	28	48	230					
26		Harrison	80	80	6	210				P	
27		Church, Al	20	20	48	210				P	
28		Sheppard	20	20		220					
29		Kroner				200					
30		Jordan	120	120	6	220				P	
31		Steeby	270	270	6	230					
32		Lovell	300	300	6	210					
33		Bowlby	53	53	6	200				C	
34		Unknown	126	126	6	210				P	
35		Tolfson	124	124	6	200				P	
36		Dahlman	158	158	6	200				P	
37		Selk	65	65		200					Sand
Sec. 9, No. 1		Bullington, Bill	160	160	6	360	148	/64	10		Gravel
2		DeLucia, D.	107		6	426	100				Gravel
3	105	Oberg, Russell	196		6	365	181	7/54	11		Sand and gravel
4		Thompson, M.	54	54	6		30	/59	7		Sand
5		Crownwell, M.	110	110	6		95	/63	7		Sand and gravel
6		Brittain, Jack	107	107	6	280			19	P	
7	86	Lamoreaux, Al	140	140	6	270					
8	85	Mullins, Floyd	148	148	6	280	60				
9		Reuter	79	79	6	200				P	
10		Preg, Z.	227	227	6	200	20			P	
11		Lumley, R.	27	27	30	180					
12		Steffes	20	20	30	120	12			P	
13		Newton	57	57	6					F	
14		Elliot	103	103	6	300				P	
15		Kersten	57	57	6	280				P	
16		Garsik, George E.	142	142	6	350	130				Sand and gravel
17		Landreth	165	165	6	400					
18		Epplei, J.	164	124	6	400					
19		Kohler	81	78	6	200			25		Sand
20		GAAB School District	250		6	360		10/72	25		Sand, silt
Sec. 10, No. 1	106	Ray, Earl	175	175	6	455	158	10/54	13		
2	107	Dari-Delite	145		6	347	126	9/54	13		Gravel
3	108	Whaley, Bud	188	188	6	525	165	10/56	10		Sand and gravel
4		Great Land Realty	163	144	6	440	118	7/73	70		Sand, gravelly
5		Walden, Dennis	170	163	6	470	145	6/73	5		Gravel
6		Hickey	223	223	4	550	192	9/73	10		Gravel, silty
7		Kachline, Dale	223	223	4	560	210	4/73	10		Gravel
8		Passmore	176	175	6	420	155	10/73	15		Gravel
9		Mt. Eklutna Devel. Co.	150	149	8	500	102	7/73	240		Gravel with sand
10		Cook	175	116	6	340	100	8/73	1		Bedrock
11		Spare, Thomas	100	88	6	410	75	5/73	5		Gravel, sandy

Table 1.--*(Continued)*

Section and Well no. 1/	No. in Waller (1960)	Owner or user	Well depth (ft)	Casing depth (ft)	Diameter (in)	Altitude (ft) 2/	Depth to water (ft) 3/	Measurement date	Yield (gpm)	Water qual. data 4/	Water-bearing material
T15N, R1W											
Sec. 16, No. 1	102	Chugiak Chapel	121	121	6	450	114				Gravel and boulders
2		Cullenberg	130	126	6	350	75	/64	1		Glacial till
3		Mcelhannon, E.	220	220	6	450					
4		Roderick				480					
5		Kirk, Andrew	200	200	6	600					
6		Swanson	30	30	6	600	15		1		
7		ABS Chugiak Elm.	500	42	8	360	45	4/71	5		Bedrock
8		GAAB School District	300		8	360					Bedrock
9		Williams, L.	160	157	6	400	145	6/73	6		Gravel
Sec. 17, No. 1	99	ABS Chugiak Elm.	123		6	360	24	/53	20	C	Bedrock
2		Chugiak Luthern	28	18	6	355	17	9/64	20		Gravel and rocks
3		U.S. Post Office	30	30	6	380					
4		Lee, F. S.				450					
5		Fetrow	28	28	48	430					
Sec. 18, No. 1		Mongeau, W.	80	80	6	210				P	
2(1)		Juhnke, Larry	147	145		240				C	
2(2)		Juhnke, Larry	150	150	6	240					
2(3)		Juhnke, Larry	125	125	6	240				F	
3		Juhnke,	30	30	48	230				P	
4		Kohring, H.	32	32	6	220					
5		Selk	100	100	6	220					
6		Monroe, Elvis	52	52	6	200					
7		Hazel, A. M.	42	42	6	200					
8		Powers	53	53	6	220					
9		Scharber				220					
10		Gunkel	73	73	6	220				C	
11		Holmson, Ray	147	147	6	200				P	
12		Parker	90	90	6	150					
Sec. 19, No. 4		Gould, W. R.	28	28		215					
5		Meller	28	28	48	200				P	
6		Dixon				250					
7		Moody	55	55	6	250					
8		Pennington	41	41	6	250				P	
9		Hutsman, John				220					
10		Hill, T. D.	108	27	6	265	20	/57	1		Bedrock
11		Roberts, Joe	25	25		225					
12		ABS Chugiak HS	500		8	250			275	C	Bedrock
Sec. 20, No. 1		Eberhart, Betty	49	49	6	480	0		2		Glacial till
2		Wallace, Gravel	spring			480					
3		Moosehorn, Gar	120	120	6	500					
4		Call, C. C.				450					
5		Wallace, Patio	22	22	72	500			200(?)		
6		Wallace, F. T.	38	38	48	500					
7		Chugiak Gardens	spring			520					
Sec. 29, No. 1		Hughes	41	41	6	575	12		50		Gravel
2		Smith	54	54	6	525	13		20		Sand and weathered
3		Crounce, Edward	175	106	6	550	90	6/73	3		Bedrock (claystone)
Sec. 30, No. 1	13	Fire Lake Lodge	218	22	6	450					Bedrock
2		Unknown	60								
3		Dixon, S.	200								
4		McMahon, H.	133								
5		McMahon, H.	775								
6		Davis, J.	155								
7	95	Burns, Quiller	64	64	6	550	12		20		Sand
8		Doyle, R.	44	44	6	420			8		
9		Brink	80	80	6	510					
10		Polyefco, J.	20	20	48	500					
Sec. 31, No. 1		Ryan, Ed J.	50		6						Gravel
2		Arnold	78	78	6	600			2		Sand and gravel
T15N, R2W											
Sec. 25, No. 1		Chimakamia, P.	160	160	4	265	65	10/63	1		Bedrock
2		Hilltop Apts.	130	130	6	270			35		
3		Sabo, B. C.	80	80	6	230					
4		Rasmussen, A.D.	30	30	6	280					Bedrock(?)
5		Eastham, Larry	123	118	6	380	100	5/73	6		Gravel, silty sand
6		Belsey, Walter	175	4	6	300	15	6/73	1/2		Bedrock
7		Hancock, Herbert	400	15	6	300	230	6/73	2		Bedrock
8		Smith, W.	69	69	6	260	37	4/71	8		Sand

Table 2.--*Drillers' logs of representative wells in the Eagle River-Chugiak area.*

Material	Depth Interval (feet)
Well No. 14-1-6-1 Township 14 North, Range 1 West, Seward B&M [Altitude 1030 feet; yield=10 gpm; Log by S. Cotten]	
"Overburden"	0-12
Hardpan (compact sand)	12-56
Till	56-89
Blue clay	89-123
Rocks and sand, clean	123-133
Till	133-245
Rocks and sand, clean	245-261
Clay, yellow-brown	261-267
Gravel, with water	267-275
Well No. 14-1-7-2 Township 14 North, Range 1 West, Seward B&M [Altitude 560 feet; yield-5 gpm; Log by L. G. Augustson]	
Rock and gravel	0-21
Sand	21-31
Till	31-38
Clay, silty	38-59
Till	59-224
Sand	224-230
Sand and gravel with water	230-236
Well No. 14-1-7-3 Township 14 North, Range 1 West, Seward B&M [Altitude 710 feet,; yield=8 gpm; Log by A. R. McInroy]	
Clay and gravel (till?)	0-100
Sand	100-115
Hardpan, water seep near bottom	115-190
Till, seep in lower 5 feet	190-201
Hardpan	201-204
Till	204-217
Sand and fine gravel with water	247-261
Well No. 14-1-9-1 Township 14 North, Range 1 West, Seward B&M [Altitude 1,000 feet; yield=20 gpm; Log by S. Cotten]	
Rock, slate and gravel	0-18
Slate, brown	18-67
Slate, gray, with water	67-99
Well No. 14-1-15-2 Township 14 North, Range 1 West, Seward B&M [Altitude 800 feet; yield=3 gpm; Log by M & W Drilling]	
Gravel, with occasional small boulders	0-18
Clay, silty, with occasional rock fragments, slight water seep at 24 feet	18-24
Gravel in coarse sand matrix	24-35
Bedrock = shale (sandy, grey-black) to sandstone (silty, argillitic); water from fracture at 100 feet	35-102
Well No. 14-1-16-5 Township 14 North, Range 1 West, Seward B&M [Altitude 690 feet; yield=2 gpm; Log by D. Pierson]	
Glacial till (bouldery silty gravel)	0-55
Sand, with water seep	55-56
Glacial till	56-68
Sand, with water seep	68-70
Glacial till	70-73
Gravel, with water	73-75
Large rock or bedrock	75-
Well No. 14-2-1-5 Township 14 North, Range 2 West, Seward B&M [Altitude 340 feet; yield=10 gpm; Log by W. Swafford]	
Sand and gravel	0-10
Till	10-34
Silt and sand	34-38
Till	38-45-1/2
Gravel with water	45-1/2-46
Well No. 14-2-1-18 Township 14 North, Range 2 West, Seward B&M [Altitude 345 feet; yield=25 gpm; Log by Lee Sullivan]	
Sand and gravel	0-35
Hardpan	35-50
Sand and gravel	50-53
Sand and gravel with water	53-54-1/2
Well No. 14-2-1-19 Township 14 North, Range 2 West, Seward B&M [Altitude 340 feet; yield=50 gpm; Log by Lee Sullivan]	
Clay and boulders (=till?)	0-24
Sand and gravel	24-70
Sand and gravel, some water	70-75
Silt	75-98
Water (nature of material not given)	98-100-1/2
Well No. 14-2-1-20 Township 14 North, Range 2 West, Seward B&M [Altitude 315 feet; yield=10 gpm; Log by S. Cotten]	
Clay with sand	0-27
Clay with gravel	27-45
Hardpan	45-81
Quicksand	81-95
Hardpan	95-97
Gravel with water	97-98
Hardpan	98-100
Note: The previous four wells are aligned on curving west-east line in the order 20-5-18-19 (SW quarter of section 1). The wells are approximately equally spaced and wells 20 and 19 are 700 feet apart; notice the variability in the materials over this relatively short lateral distance.	
Well No. 14-2-11-7 Township 14 North, Range 2 West, Seward B&M [Altitude 275 feet; yield=2 gpm; Log by S. Cotten]	
Topsoil, some fine gravel	0-4
Gravel, coarse to fine mixed	4-20
Clay, gravel and "rocks"	20-54
Hardpan	54-72
Blue clay	72-107
Clay with gravel, streak of fine sand with water at 126 feet	107-126
Clay	126-152
Clay with thin layers of sand and fine gravel; some water	152-221
Clay, hard	221-233
Gravel, fine, and sand, coarse; wet	233-236
Sand, fine, and clay; dry	236-247
Gravel, fine, and clay	247-250
Sand and clay	250-268
Clay and gravel, fine; gravel grades to sand near 200 feet	268-282
Sand, clean	282-288
Sand and clay	288-300
Clay, red and grey with minor sand	300-315
Well No. 14-2-11-13 Township 14 North, Range 2 West, Seward B&M [Altitude 245 feet; yield=60 gpm; Log by D. Pierson]	
Gravel; perforated at 24 to 25 feet	0-30
Clay and gravel	30-38
Sand, heaving	38-41
Clay and gravel	41-64
Clay, blue	64-72
Well No. 14-2-12-1 Township 14 North, Range 2 West, Seward B&M [Altitude 350 feet; yield=5 gpm; Log by W. Swafford]	
Till	0-6
Clay and gravel	6-59
Sand and gravel with clay	59-94
Sand with clay; "dirty" water	94-95
Sand, clean, with water	95-
Well No. 14-2-12-12 Township 14 North, Range 2 West, Seward B&M [Altitude 325 feet; Log by P. Brandl]	
Gravel and boulders	0-54
Silt, soft	54-69
Gravel	69-90
Well No. 14-2-12-30 Township 14 North, Range 2 West, Seward B&M [Altitude 375 feet; yield=17 gpm; Log by Lee Gohr]	
Topsoil, sand and gravel	0-38
Till	38-89
Sand and gravel with water	89-94
Clay	94-100
Well No. 14-2-12-35 Township 14 North, Range 2 West, Seward B&M [Altitude 340 feet; yield=7 gpm; Log by D. Pierson]	
Sand and clayey	0-14
Gravel, clayey	14-38
Gravel, coarse, black	38-40
Well No. 14-2-12-38 Township 14 North, Range 2 West, Seward B&M [Altitude 410 feet; yield=10 gpm; Log by Lee Gohr	
Sand and gravel	0-28
Till, gray, hard	28-58
Sand, brown, soft	58-65
"Large rocks"	65-70
Till, gray, hard	70-96
Sand and gravel with clay; water	96-100
Clay, blue, soft	100-126
Clay, sand and gravel; water	126-136
"Gray stone", very hard	136-139
Sand and pea gravel with water	139-145
Well No. 15-1-3-7 Township 15 North, Range 1 West, Seward B&M [Altitude 365 feet; yield=5 gpm; Log by Penn-Jersey Drilling Co.]	
Rocks and gravel	0-60
Hardpan, gravelly and rocky	60-109
Sand and gravel with water	109-113
Hardpan, rocky	113-115
Well No. 15-1-8-12 Township 15 North, Range 1 West, Seward B&M [Altitude 110 feet; yield=10 gpm; Log by Lee Gohr	
"Old well" (no description given)	0-57
Clay; contains pea gravel from 98-108 feet	57-125
Mud, very soft	125-132
Sand and gravel with water	132-136
Clay and gravel; water seepage	136-154
Gravel with water	154-159
Well No. 15-1-10-3 Township 15 North, Range 1 West, Seward B&M [Altitude 525 feet; yield=10 gpm; Log by G & G Drilling Co.]	
Topsoil	0-2
Hardpan	2-100
Boulders, large	100-130
Clay	130-180
Sand and pea gravel with water	180-188
Well No. 15-1-16-2 Township 15 North, Range 1 West, Seward B&M [Altitude 450 feet; yield=1 gpm; Log by A & L Drilling Co.]	
Gravel and boulders	0-36
Clay, sand and gravel	36-50
Sand and gravel	50-62
Clay and gravel	62-65
Sand, fine, angular	65-71
Clay and gravel, some water in gravel lens at 81-82; casing perforated at 78-81	71-104
"Boulders"	104-107
Clay and gravel	107-115
Gravel and boulders	115-121
Clay and gravel	121-126
Bedrock, green	126-130
Well No. 15-1-17-1 Township 15 North, Range 1 West, Seward B&M [Altitude 360 feet; yield=20 gpm; Log by P. Brandl]	
Gravel, sandy, with boulders	0-40
Bedrock (water bearing material not indicated)	40-123
Well No. 15-1-19-10 Township 15 North, Range 1 West, Seward B&M [Altitude 265 feet; yield less than 1/2 gpm; Log by Lee Gohr]	
Dug old well (no description of material)	0-5
Soil, sand and gravel	5-10
Silt	10-20
Till, water seep at 27-30	20-55
"Stone", grey and brown	55-108
Well No. 15-2-25-1 Township 15 North, Range 2 West, Seward B&M [Altitude 265 feet; yield 1/2 gpm; Log by C. Foss, Swafford Drilling Co.]	
Sand and gravel	0-20
Gravel with clay	20-28
Greenstone (?)	28-70
Shale, brown	70-78
Greenstone	78-80
Shale, brown	80-123
Greenstone	123-128
Shale, brown	128-142
Greenstone	142-154
Shale, with "white streaks"; water	154-160



Base from U.S. Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

Figure 5.-- Potential sources of construction materials in the Eagle River-Chugiak area, Alaska.

EXPLANATION

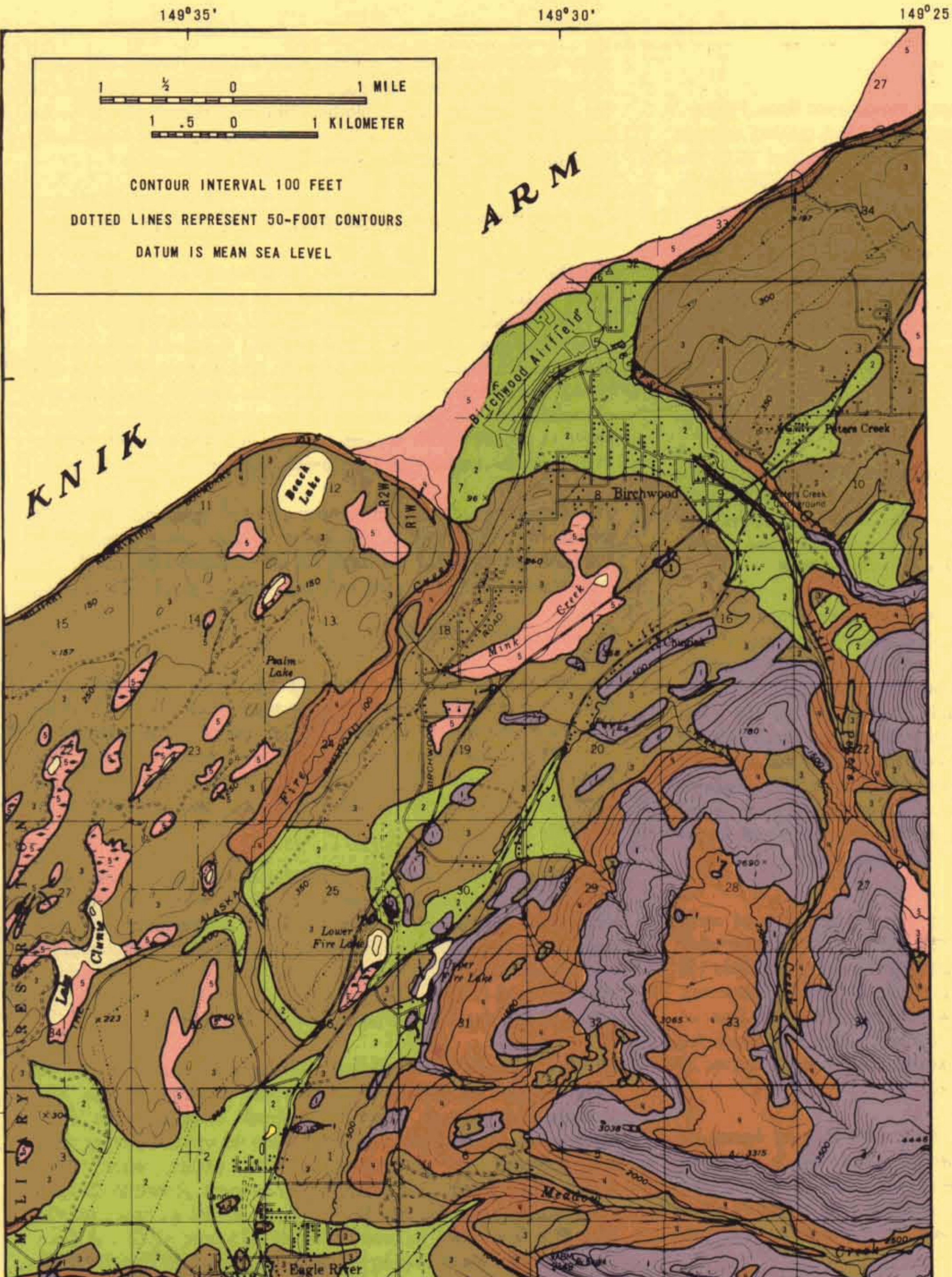
1 — Best sources of gravel and sand, which are likely to be present in considerable thickness everywhere. Cobbles and boulders are common; gravel is more prevalent than sand; sorting is good to fair. The coarse fraction may serve as a source of crushed aggregate.

2 — Good to fair sources of gravel and sand, which are likely to be present at some places in considerable thickness free of other materials. Elsewhere gravel and sand is thin or interbedded with fine-grained sand, silt, or diamicton. In places these latter materials are prevalent.

3 — Mostly diamicton, which may be used for material that does not require size-grade specification. Gravel and sand present in only a few places in significant amounts.

4 — Good sources of material to make crushed aggregate common; sources of riprap material present in places where bedrock is sufficiently massive and free of closely spaced fractures. Elsewhere bedrock is likely to be too highly fractured or too finely bedded or foliated.

5 — Poor sources of construction materials for most uses, but, if impervious material is desired, clay is obtainable in a few places along Eagle River. The unit is chiefly silt and clay, but includes some diamicton and fine-grained sand. It also includes small areas of soft bedrock (Kenai Formation).



Base from U.S. Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

EXPLANATION

1

Foundation conditions excellent. Hard bedrock is at the surface or at shallow depth and can support very heavy loads. Excavations require blasting. In many places slopes range from steep to precipitous, and operation of heavy equipment would be restricted; in some places cliffs and canyon walls preclude uses as foundation sites for most structures.

2

Foundation conditions good. The unit is chiefly homogeneous gravel and sand that is generally 20 feet or more thick and can accommodate heavy loads. Excavation by power equipment is generally easy except in isolated places where large boulders are present.

3

Foundation conditions generally good to fair, but locally poor. Conditions good in most of the map area, where various materials, including gravel, sand, and diamicton, can support heavy to moderately heavy loads. In areas of hummocky topography, the conditions are fair to poor in depressions where fine-grained material has lower bearing capacity and on some steep slopes of limited extent where instability problems are likely. Excavation by power equipment is generally easy, but may be moderately difficult where diamicton is compact or where boulders are present. The material varies widely in texture, and in places where it is fine grained, cuts may be unstable.

4

Foundation conditions generally fair to poor. Silt and clay may lack sufficient bearing capacity for heavy loads. Moderate to very steep slopes are potentially unstable. In places in the lowland, peat is at the surface and the water table may be high; in some of these places peat can be removed, the water table lowered relatively easily, and foundation conditions thereby improved. Excavation is hindered where steep slopes pose difficult operating problems and where fine-grained material causes unstable cuts; bedrock may be found at shallow depths in the mountainous part of this map unit area.

5

Foundation conditions poor. The chiefly fine-grained materials (silt and clay) have low bearing capacity; this unit also includes extensive areas of poorly drained material, and sea and river bluffs that either are composed mostly of unstable fine-grained material or are now being eroded. In places, considerable thicknesses of peat and/or marsh conditions may prevail; the peat is generally underlain by silt and clay, and these areas are more difficult to modify to provide suitable foundation conditions than the peat-covered areas of the preceding map unit. Excavation is hindered by unstable material and high water table.

Figure 6.-- Foundation and excavation conditions in the Eagle River-Chugiak area, Alaska.

Drainage Conditions

Several criteria may be used to judge drainage conditions. Figure 7 shows the areal variation of drainage conditions, ranging through five units--from well drained (1) to poorly drained (5). The drainage units are mapped largely on the basis of dominant grain size of the materials; drainage generally becomes poorer as the proportion of fine-grained particles (silt and clay) increases. Fine material fills the space between coarser particles of sand and gravel so there is less infiltration into the surface and movement of water in the subsurface. Surface runoff also depends on slope. Ponding of water may be caused by low gradients or depressions. Finally, a high-water table, where saturated material is very near the surface, constitutes very poor drainage conditions.

Slope Stability

Slope stability is the ability of the surface of the ground to remain fixed in position and to resist failure by landsliding or other earth movement. Figure 8 gives an interpretation of the relative stability of natural slopes in the Eagle River – Chugiak area; there are five categories that range from most stable to least stable.

A primary criterion for determining stability is the degree of slope; steeper slopes generally are less stable than more gentle slopes. Stability also depends considerably on the geologic materials underlying the slope. Slopes underlain by metamorphic rocks are generally more likely to be stable than slopes of the same steepness underlain by coarse-grained surficial deposits. The latter slopes are, in turn, generally more likely to be stable than slopes of the same steepness underlain by fine-grained surficial deposits. Accordingly, these interpretations of slope stability are based chiefly on information contained in the slope map and in the generalized geologic map (figs. 3 and 4a, respectively).

Factors which modify slope stability are: (1) exposure of earth materials to running water which may cause either direct erosion or loss of lateral and vertical support because of erosion; (2) chemical and physical changes in the material, caused by exposure to the atmosphere (weathering) which may result in loss of cohesiveness, (3) increase in water content which may cause the material to lose strength, and (4) excavation or other activities of man which may induce slope instability.

Major instability may be triggered by ground shaking during an earthquake. Because all of south-central Alaska lies in a zone in which large-magnitude earthquakes can be expected, the likelihood of earthquake-triggered instability is relatively high throughout the area, but the probability of occurrence of such large-scale earthquakes is low.

Ground movement along a fault, either during an earthquake or by nearly imperceptible creep, can also cause instability. The Knik fault zone, discussed earlier in this report, has not been known to be active in historical times, but there is a small possibility, however remote, that renewed activity along the fault zone could occur.

The slope-stability map is intended to supply backgtound information in establishing guidelines in land-development planning. The map shows the relative potential for slope failure. No firm prediction can be made from the map as to where failure will occur within a given map unit. Within map units that indicate some potential for slope failure, a more detailed study of slope stability would be needed prior to development. Such a study may show that overall ground conditions at a particular site are safe if certain regulations and methods of construction are followed. On the other hand, detailed investigations may show the site to be unsafe for the intended facility, and an exceptional engineering solution will be requireed as a condition of development.

OCCURRENCE AND AVAILABILITY OF GROUND WATER

Reliable predictions of obtaining an adequate supply of ground water in the Eagle River – Chugiak area cannot be made beyond the very localized areas near existing wells. However, a few general statements can be made. Weathered and fractured bedrock will yield small amounts of water to wells. The surficial deposits that mantle the bedrock may be thin and often have low porosities and permeabilities. However, ground water generally is obtained from surficial deposits with greater success and in greater abundance than from the underlying less porous and less permeable bedrock.

The locations and depth ranges of 350 ground-water wells inventoried by the U.S. Geological Survey are plotted on a 1:24,000-scale map of the Eagle River – Chugiak area (pl. 1). The reported data on the plotted wells are included in table 1.

Ground Water in Bedrock

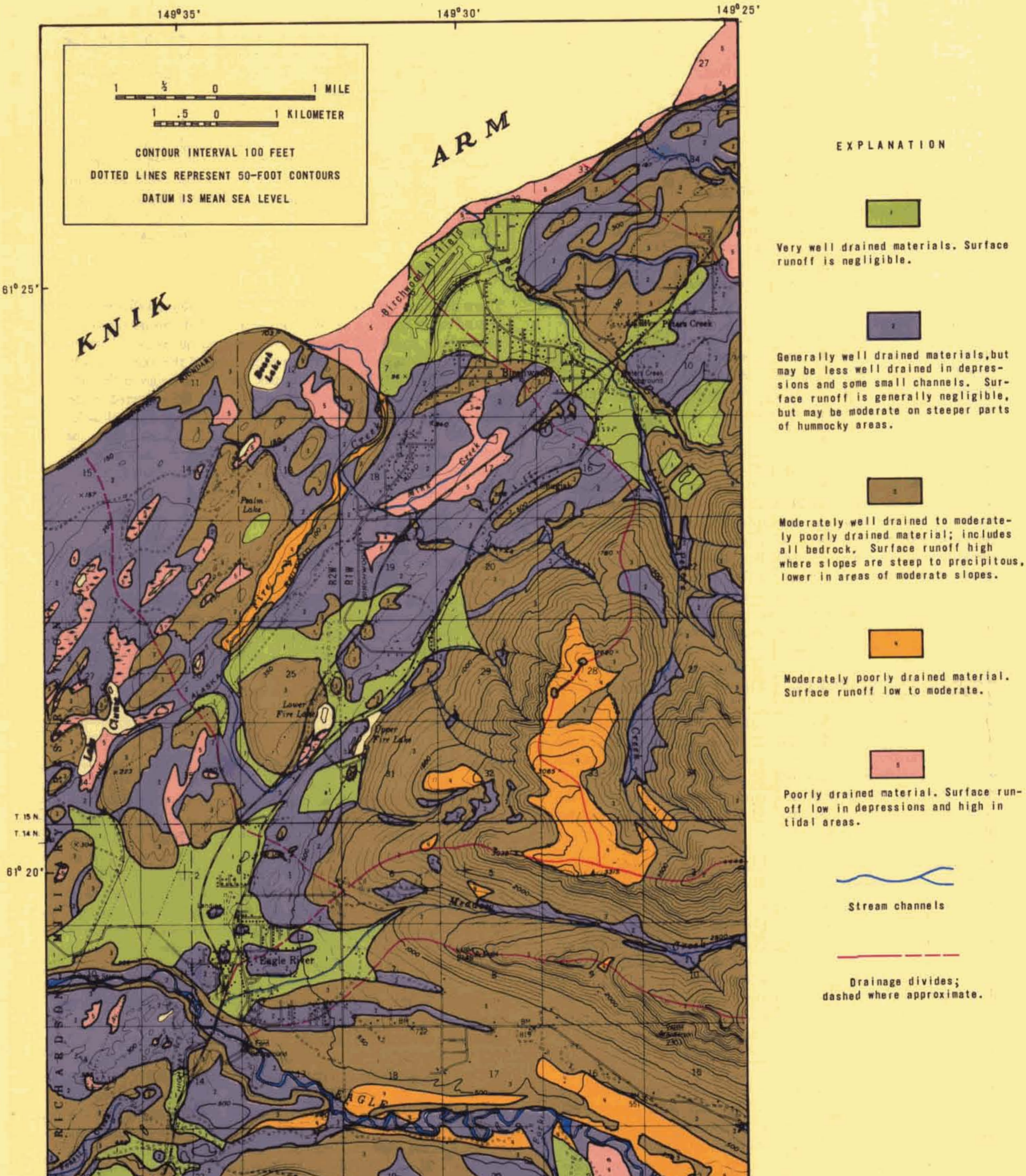
Bedrock wells in this area commonly are dry or have yields from less than 5 gpm (0.3 l/s) to no more than 10 gpm (0.6 l/s). These low yields are due to the very low porosity and permeability of the dense, unaltered metamorphic and igneous rocks. The sedimentary rocks of the younger Kenai Formation, which underlies most of the lowland area, are also relatively poor aquifers.

The highest degree of success in obtaining water from wells drilled into bedrock would be expected at places where the rock has developed appreciable porosity and permeability through weathering and fracturing. However, these effects diminish rapidly with depth. Weathered bedrock is commonly found in association with fractures related to faults or fault zones, and in this particular area may be related to the postulated Knik fault zone.

Of the 170 wells for which some lithologic data are available, 48 were reported as completed in bedrock. However, drillers' logs indicate that bedrock, weathered bedrock, or broken rock is the water-bearing material in only 28 of those 48 wells; the other wells are screened or perforated in and obtain water from unconsolidated materials overlying the bedrock. A well at Chugiak High School (well 12, sec. 19, T15N, R1W) has an exceptionally high (for this area) reported yield of 275 gpm (17.3 l/s) from bedrock. The water-bearing material consists of 40 feet (12.2 m) of interbedded shale and sandstone in the Kenai Formation. Other wells that produce water from bedrock have reported yields that range from less than 0.5 gpm (0.03 l/s) to 55 gpm (3.5 l/s).

Ground Water in Surficial Deposits

Ground water can be found at depths of less than 20 feet (6.1 m) where water-saturated pockets or lenses of sand and gravel are at or near the surface. Where the top of the saturated zone has no impermeable beds immediately overlying it, the water is unconfined, or under water-table conditions. However, most wells in the Eagle River – Chugiak area are completed in permeable water-bearing deposits that underlie relatively impermeable layers of glacial material. These impermeable layers tend to at least partially restrict or confine the upward movement of the water;



Base from U S Geological Survey Anchorage (B-7) Alaska. 1:63,360, 1960

Figure 7.-- Drainage conditions of the surficial materials in the Eagle River-Chugiak area, Alaska.

thus the term "confined ground water." The water-bearing deposits may comprise: (1) pockets, stringers, or layers of permeable sand and gravel within relatively impermeable tills and clays, or (2) similar sand and gravel deposits overlain by impermeable strata but directly overlying the bedrock.

The hydrologic properties suggested by a surficial geologic map unit, as shown in figure 4a, may not be applicable to the underlying material. Inspection of well logs from the area indicates that the deeper permeable zones are generally of no greater extent than those shown at the surface on the geologic map (fig. 4a). A surface map unit designated as favorable for obtaining ground water may be locally only a thin, 20 feet (6.1 m) or less, veneer over materials that have a very low porosity and permeability (see geologic section in fig. 4b).

The ground-water supply in the Eagle River – Chugiak area seems to be characterized by the large number of relatively small-yield (less than 20 gpm or 1.3 l/s) wells. Most of these wells have been drilled and developed specifically for such small quantities of water. Data from several wells suggest that larger yields are possible.

Large alluvial fans generally contain deposits favorable for ground-water exploration--coarse gravel with minor amounts of sand and finer material. A highly productive water-bearing formation for the area is an earlier fan deposit of Meadow Creek (beneath unit F, fig. 4A). Two wells near Meadow Creek (wells 10 and 22, sec. 7, T14N, R1W), completed in sand and gravel at an approximate depth of 250 feet (76.2 m), yield 326 and 115 gpm (20.6 and 7.3 l/s), respectively. The two wells are among the highest yielding wells in the area for which data are available. The larger yield is from an aquifer that consists of loose, coarse gravel between 237 and 268 feet (72.2 and 81.7 m) below land surface. During a 24-hour production test, the well was pumped at 550 gpm (34.7 l/s) and the water-level drawdown was 44 feet (13.4 m) below the static level. Drawdown also was measured in two wells (not identified) completed in the same aquifer that are 88 feet (26.8 m) southwest and 220 feet (67.0 m) west, respectively, of the pumped well. Both of the observation wells had a water-level drawdown of about 21 feet (6.4 m) from static level at the end of the test. It is estimated that the production well could be pumped at 700 gpm (44.2 l/s) for periods of as much as 24 hours.[1]

The area bordering Peters Creek below altitudes of 500-600 feet (152-183 m) is also mapped as an alluvial fan (fig. 4a). The logs for wells drilled within the fan indicate that the subsurface material is a complex of glacial and alluvial deposits. The deposits contain only thin layers or lenses of water-bearing sand and gravel; fine silt and clay dominate the lithologic section. "Blue clay," 84 feet (25.6 m) thick, is reported at one well (well 16, sec. 8, T15N, R1W) on the mapped boundary of the fan. Although available well logs suggest that the Peters Creek alluvial fan is a thin surficial feature, additional drilling may reveal more extensive aquifers at depth.

Relatively large yields have been reported for two wells in the Peters Creek area outside the alluvial fan. The wells supply water to two subdivisions. At the Lampert Estates well (SE¼ sec. 4 and NE¼ sec. 9, T15N, R1W), the driller's log describes the chief water-bearing formation as cobble gravel, containing coarse sand, between 233 and 253 feet (71.0 and 77.1 m) below land surface. Reported yield was 100 to 200 gpm (6.3 and 12.6 l/s). The log also lists boulder, cobble gravel, and silty gravel units but indicates no clay-sized material such as that found at well 15-1-8-16. The entire thickness of deposits penetrated may thus be glaciofluvial material reworked from glacial deposits that would generally contain the finer-sized particles.

The well that serves the Dawn Subdivision (SE¼ sec. 3, T15N, R1W) was reported to yield 100 gpm (6.3 l/s) from medium- to coarse-grained gravel between 88 and 105 feet (26.8 to 32 m) below land surface. The topography and gravel deposit indicate that this well site near the foot of the steep mountain slope, may once have been within the channel of an ice-margin stream.

Ground-Water Development

There has been no major (large-production wells) development of ground water in the area. Most wells are drilled and developed to obtain only small (10 gpm or 0.6 l/s or less) quantities of water. Data have been collected on perhaps one-half the existing water wells in the Eagle River – Chugiak area. It is believed that the range of ground-water conditions that might be expected in the area is represented by the inventoried wells. For individual wells, the scope of the data ranges from complete information on the depth, yield, water level, and geologic material to cases in which the only information available is that a well was drilled. A brief summary of the collected data is given below.

Well Depths and Yields

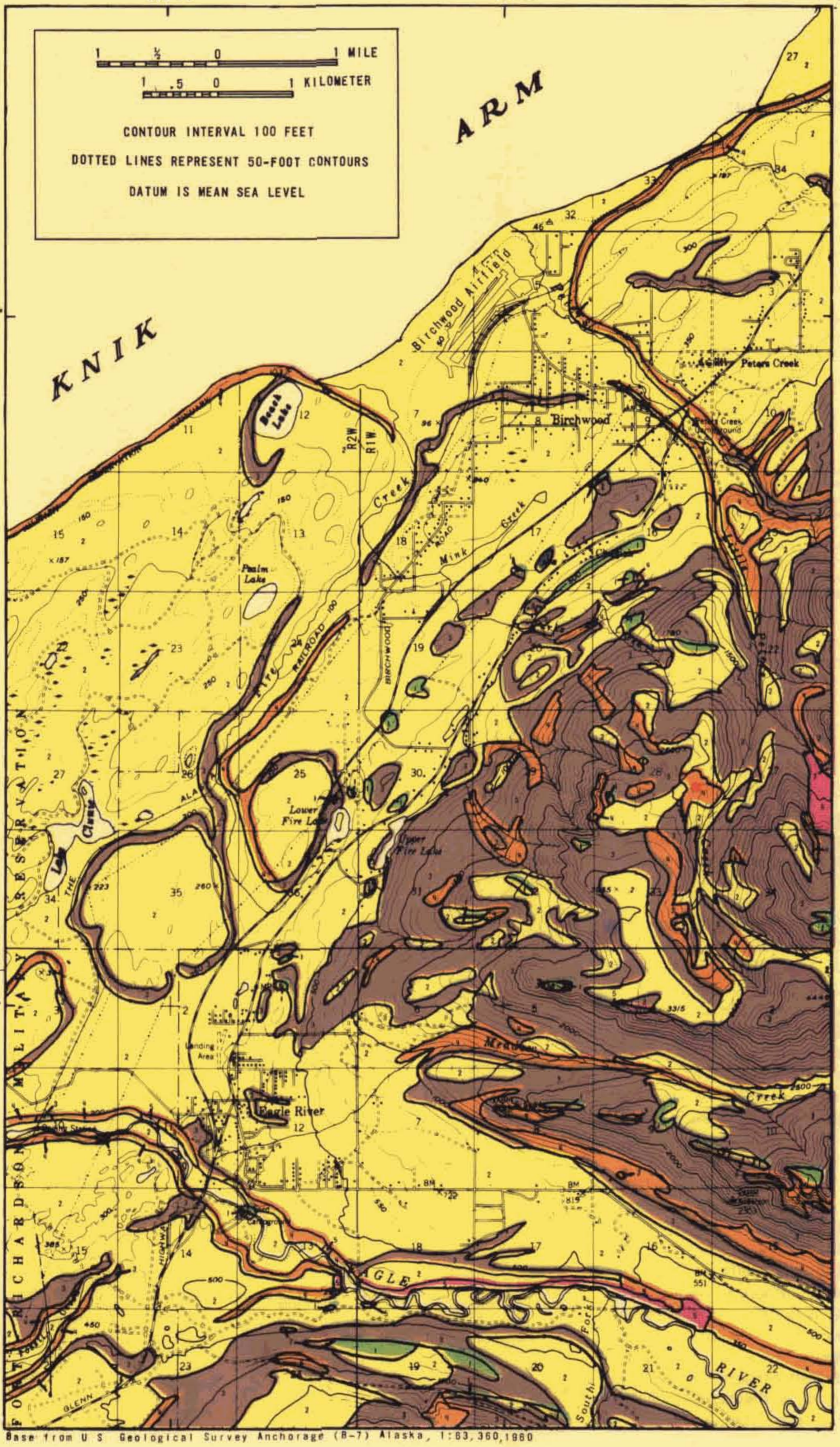
Reported depths of water wells in the Eagle River – Chugiak area range from 9 feet (2.7 m) to as much as 775 feet (230 m). The reported yields range from less than 0.5 gpm (0.03 l/s) to 326 gpm (20.6 l/s). No meaningful boundaries can be drawn on a map that shows the depth or yield values. Both shallow and deep wells having either very low (less than 5 gpm or 0.3 l/s) or moderately high (20 to more than 50 gpm or 1.3 to more than 3.1 l/s) yields are found in close proximity. These variations occur on the steeper mountain slopes east of the community of Eagle River as well as on the lowland to the west and north.

Water Levels in the Confined System

The geologic and hydrologic information indicate that there is no continuous, areawide aquifer system at depth in the Eagle River – Chugiak area. Water levels in wells tapping confined aquifers do, however, indicate the regional hydrologic system and give an indication of the areas of recharge and discharge. Most wells are completed in and produce water from confined aquifers. The water levels in these wells reflect the variations and discontinuities of the hydrologic system--changes in aquifer thickness, changes in lateral or vertical permeability within an aquifer, and partial penetration of the aquifer by a well.

In figure 9, the altitudes of the water levels in wells tapping confined aquifers were used to draw water-level contours. These contours represent the altitude to which water will rise in a well that is completed in a confined aquifer--the potentiometric surface. The direction of ground-water flow, perpendicular to the contours on the potentiometric surface, is generally from the slopes of the Chugach Mountains (areas of recharge) toward either Knik Arm or the Eagle River valley (areas of discharge). It should be emphasized that the contours do not indicate the depth to which a well must be drilled in order to obtain water. However, the minimum pumping lift at a point can be roughly estimated by subtracting the altitude of the potentiometric surface from the ground-surface altitude at that point.

1 Data from unpublished engineering report by Dickinson-Oswald and Partners, Consulting Engineers.



Base from U.S. Geological Survey Anchorage (B-7) Alaska, 1:63,360,1960

EXPLANATION

COLOR CODE (Detail explanation below and on following page.)

1 HIGHEST STABILITY

2 GENERALLY HIGH STABILITY

3 MODERATE STABILITY

4 GENERALLY LOW STABILITY

5 LOWEST STABILITY

1. HIGHEST STABILITY — Nearly flat to moderate slopes underlain by metamorphic and sedimentary rocks. Loose material is thin or absent in most places. There is little likelihood of any significant downhill movement of rock or loose material.

2. GENERALLY HIGH STABILITY — Nearly flat to moderately gentle slopes underlain by surficial deposits; moderate slopes underlain by surficial deposits consisting of gravel and sand, and mixed gravel, sand, silt, and clay; and steep slopes underlain by metamorphic rock. In most of this area there is little likelihood of significant downslope movement. However, in some places the following situations may produce minor and, at times, major slope failures: (1) In response to strong earthquake shock, nearly flat areas behind the tops of sea and river bluffs may be incorporated into landslides on the bluffs, and the nearly flat areas at the base of the bluffs may be overridden by landslide debris. (2) Areas along major streams may be subject to erosion and become unstable. (3) The modern tidal flats are covered intermittently by water and are subject to some instability caused by minor erosion. (4) In areas of steep slope the metamorphic bedrock is covered in places by loose surficial deposits (chiefly stream deposits and colluvium) and by weathered bedrock; such deposits may be subject to some downslope movement.

3. MODERATE STABILITY — Steep slopes underlain chiefly by gravel and mixed gravel, sand, silt, and clay; and very steep slopes underlain by metamorphic and sedimentary rocks. In hummocky topography, small hills are stable in their natural state of vegetation but can become unstable when disturbed. On steep slopes at lower elevations in the mountains, slope deposits are generally unstable and continually move downward; the likelihood of instability increases when the surface is disturbed. At higher altitudes on the very steep slopes, bedrock is at or near the surface and is inherently more stable than the surficial deposits, but locally these slopes are thinly covered by loose material that is easily disturbed and subject to more frequent and more rapid downward movement here than on the lower slopes. Snow avalanches occur most commonly on these slopes and carry some rock debris with them. One area of steep slope contains a landslide deposit; the occurrence of similar future landslides in other places cannot be ruled out, although such a probability at any one point is small.

Figure 8.-- Relative stability of natural slopes in the Eagle River-Chugiak area, Alaska.

Explanation for figure 8 continued

4. GENERAL LOW STABILITY – Steep slopes underlain chiefly by silt and clay; very steep slopes underlain chiefly by gravel and sand, and mixed gravel, sand, silt, and clay; and precipitous slopes underlain by metamorphic and sedimentary rocks. Sea and river bluffs and other escarpments have some slight degree of natural stability, especially where vegetated; however, they become unstable when disturbed either by natural processes such as eqrthquakes or erosion, or by excavation and other activities which disturb natural ground cover. Small-scale downslope movement may occur in many places; erosion in gullies produces unstable slopes on which small landslides are to be expected locally. Cliffs high in the mountains are the sites of frequent minor rockfalls that enlarge talus accumulations at the base of these slopes; occasional major rockfalls or landslides may release substantial quantities of material to encroach on the slopes below.

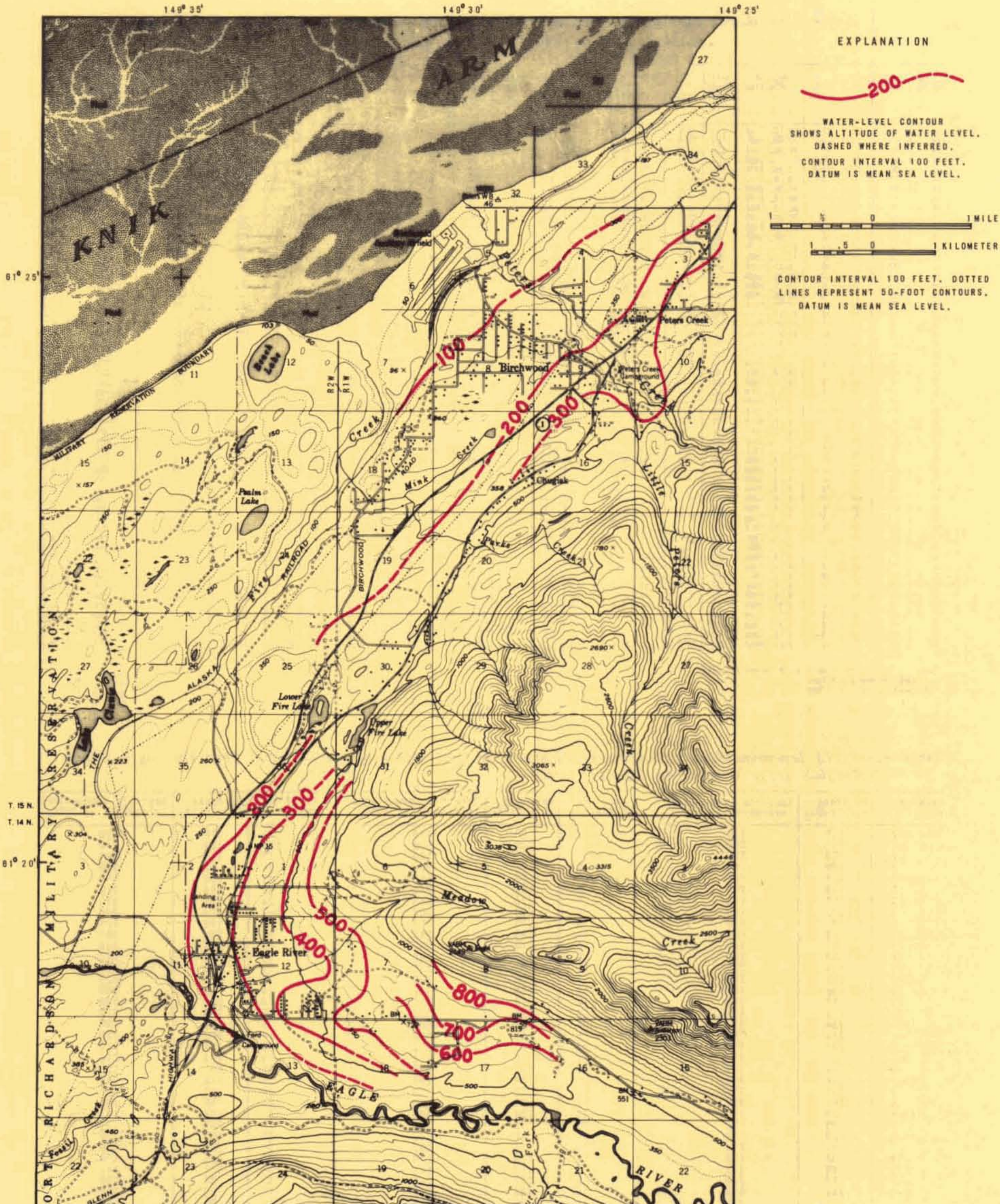
5. LOWEST STABILITY – Very steep slopes underlain by sand, silt, and clay, and by landslide deposits; and precipitous slopes underlain by the entire suite of surficial deposits. The least stable slopes occur mainly in river bluffs, where erosion is active, thereby preventing stabilization and producing continuous downslope movements that range from nearly imperceptible soil creep, through observable viscous earth flows and talus accumulation, to small landslides. Elsewhere in areas shown on this map unit the slopes can readily fail when disturbed by natural or manmade processes.

Ground-Water Quality

Laboratory chemical analyses of ground water from the Eagle River – Chugiak area are given in table 3. Additional quality data from field determinations of hardness and specific conductance are listed in table 4.

The ground water in the Eagle River – Chugiak area is of acceptable chemical quality for domestic use, although it commonly is moderately hard to hard. With a few isolated exceptions, all chemical constituents analyzed are in concentrations well below the recommended limits for drinking water set by the Federal Water Pollution Control Administration (now the Environmental Protection Agency) in 1968 (FWPCA, 1968). The water is a calcium bicarbonate type. For the laboratory-analyzed samples, the dissolved-solids concentrations range from 84 mg/l (milligrams per liter) to 366 mg/l; hardness ranges from 14 mg/l to 224 mg/l.

The problem of potential water pollution in the high-density residential section of Eagle River, where both shallow wells and septic tanks are used, was referred to earlier in this report. Occasional cases of bacteriologically unsafe water (usually confined to a single well) within the community of Eagle River have been reported by the Greater Anchorage Area Borough Department of Environmental Quality (R. Strickland, oral commun., 1971). Such incidences can be expected to continue and probably increase in frequency as long as individual sewage-disposal units are used in high-density housing areas. Pollution potentials will be reduced as the sewage-collection system is extended to serve more of the population.



Base from U S Geological Survey Anchorage (B-7) Alaska, 1:63,360, 1960

Figure 9.-- Water-level contours for wells that are completed in confined aquifers in the Eagle River-Chugiak area, Alaska.

Table 3.--*Laboratory chemical analyses of ground water from the Eagle River-Chugiak area.*

(Results expressed in milligrams per liter, except as noted. Analyses by U.S. Geological Survey)

Local well number: Twp. No.	Rge. W.	Sec.	Map No.	Date of collection	Well* depth (ft)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calcium, magnesium	Specific conductance (micromhos at 25° C)	pH
14	01	07	12	10 13, 1969	223	8.6	.14	31.0	5.4	2.4	.5	108	0	17.0	.4	.1	.0	142	116	201	8.20
14	01	07	13	10 28, 1969	153	22.0	.19	29.0	16.0	4.8	.3	156	0	18.0	.7	.2	2.0	121	100	269	8.40
14	01	07	17	10 16, 1969	350	19.0	.00	45.0	18.0	8.5	.1	228	0	20.0	1.1	.0	.0	168	138	371	8.60
14	01	07	22-1	12 31, 1969	260	11.0	.05	18.0	11.0	4.3	1.2	96	0	18.0	3.2	.2	.9	225	187	190	8.20
14	01	07	22-2	3 10, 1970	268	10.0	.05	31.0	13.0	4.5	1.2	151	0	18.0	1.4	.2	.7	115	89	265	7.40
14	01	08	3	8 9, 1961	107	12.0	---	56.0	14.0	5.6	.4	237	0	15.0	2.0	.2	.0	153	132	380	7.80
14	01	15	2	11 24, 1969	102	14.0	.02	55.0	21.0	15.0	.9	241	15	33.0	1.4	.1	.0	222	192	441	8.70
14	01	17	2	10 6, 1969	240	9.8	.12	56.0	12.0	5.0	.6	208	4	21.0	.4	.3	.3	260	224	354	8.30
14	01	17	3	10 7, 1969	228	9.2	.01	48.0	15.0	4.8	1.0	206	0	23.0	1.4	.0	1.1	218	189	343	8.40
14	02	01	2	10 29, 1969	42	12.0	.20	48.0	16.0	9.2	1.0	145	6	11.0	14.0	.0	.2	204	181	393	8.60
14	02	01	14	11 5, 1969	52	20.0	.04	58.0	13.0	8.6	.8	230	14	.0	2.1	.1	---	246	129	364	8.80
14	02	01	21	11 10, 1969	80	11.0	1.70	38.0	8.8	4.1	.8	138	0	14.0	4.6	.1	.2	218	197	263	8.20
14	02	01	27	11 5, 1969	75	9.7	.04	4.4	.8	150.0	1.1	300	14	.0	48.0	.2	8.3	158	131	625	8.80
14	02	01	31	11 7, 1969	160	9.4	.30	1.2	.2	120.0	.5	274	18	.8	.0	.8	2.6	366	14	465	8.60
14	02	02	15	8 23, 1966	73	---	---	----	---	---	---	---	--	---	--	--	---			385	8.40
14	02	02	17	10 30, 1969	85	7.8	---	1.6	.2	73.0	.5	174	0	6.3	6.7	--	---	--	--	279	8.50
14	02	11	6	8 1, 1966	265	9.6	.16	32.0	6.3	2.8	.1	110	0	31.0	.7	.2	1.3	183	36	167	6.80
14	02	11	13	10 28, 1969	72	19.0	.06	28.0	5.7	3.5	.3	94	0	22.0	.0	.1	1.9	--	106	199	8.20
14	02	12	11	8 23, 1966	76	---	.14	----	---	---	---	---	--	---	--	.2	1.8	127	94	268	8.40
14	02	12	20	10 17, 1969	168	20.0	---	23.0	7.1	2.2	.2	98	0	13.0	.7	--	---	--	--	194	8.30
14	02	12	28	10 20, 1969	109	23.0	.07	30.0	6.6	3.4	.2	107	0	20.0	.7	.2	1.0	116	87	207	8.30
14	02	12	32	10 21, 1969	52	23.0	.04	37.0	7.8	4.1	.2	134	0	19.0	.7	.2	1.7	139	102	253	8.40
14	02	12	36	8 10, 1966	150	---	.00	----	---	---	---	---	--	---	--	.2	6.1	164	126	273	7.80
14	02	12	37	10 30, 1969	130	9.9	---	30.0	8.2	4.2	.7	126	0	14.0	.0	--	---	--	--	219	8.40
15	01	03	12	10 4, 1968	210	12.0	.02	20.0	18.0	4.1	.0	122	2	23.0	1.0	.3	.1	142	70	245	8.60
15	01	05	2	4 3, 1968	46	14.0	---	38.0	11.0	2.1	1.0	162	0	15.0	1.8	.2	.0	140	124	277	7.90
15	01	05	3	4 3, 1968	205	---	.08	----	---	---	---	---	--	---	11.0	.0	1.8	165	140	289	9.10
15	01	08	3	4 1, 1968	63	---	---	----	---	---	---	---	--	---	2.5	--	---	--	--	159	7.00
15	01	08	4	4 1, 1968	62	---	---	----	---	---	---	---	--	---	1.8	--	---	--	--	176	7.20
15	01	08	5	4 2, 1968	155	---	---	----	---	---	---	---	--	---	4.3	--	---	--	--	213	7.70
15	01	08	7	4 2, 1968	75	---	---	----	---	---	---	---	--	---	22.0	--	---	--	--	257	8.40
15	01	08	11	4 2, 1968	50	---	---	----	---	---	---	---	--	---	29.0	--	---	--	--	308	8.50
15	01	08	12	4 2, 1968	159	---	---	----	---	---	---	---	--	---	11.0	--	---	--	--	339	9.50
15	01	08	19	4 3, 1968	142	6.6	---	.3	.3	85.0	1.0	194	28	.0	4.3	--	---	--	--	349	9.40
15	01	08	22	4 4, 1968	40	11.0	.43	16.0	8.4	2.2	.4	84	0	1.0	2.1	.6	.0	207	2	151	7.80
15	01	08	23	4 4, 1968		---	.30	----	---	---	---	---	--	---	.4	1.0	1.3	84	74	208	8.10
15	01	08	24	4 4, 1968	57	---	---	----	---	---	---	---	--	---	3.5	--	---	--	--	214	7.90
15	01	08	26	4 4, 1968	80	---	---	----	---	---	---	---	--	---	.7	--	---	--	--	155	8.50
15	01	08	27	4 4, 1968	20	---	---	----	---	---	---	---	--	---	.0	--	---	--	--	98	6.90
15	01	08	30	4 4, 1968	120	---	---	----	---	---	---	---	--	---	1.1	--	---	--	--	246	9.10
15	01	08	33	4 5, 1968	53	14.0	---	17.0	9.1	1.9	.3	91	0	3.0	3.9	--	---	--	--	167	7.30
15	01	08	34	4 5, 1968	126	---	.18	----	---	---	---	---	--	---	.0	.0	3.7	98	80	359	8.40
15	01	08	35	4 5, 1968	124	---	---	----	---	---	---	---	--	---	.4	--	---	--	--	244	8.00
15	01	08	36	4 5, 1968	158	---	---	----	---	---	---	---	--	---	.7	--	---	--	--	244	9.10
15	01	09	6	4 1, 1968	107	---	---	----	---	---	---	---	--	---	.7	--	---	--	--	161	7.60
15	01	09	9	4 1, 1968	79	---	---	----	---	---	---	---	--	---	2.8			--	--	170	7.60
15	01	09	10	4 1, 1968	227	---	---	----	---	---	---	---	--	---	--	--	---	--	--	200	8.50
15	01	18	2	4 5, 1968	*147[1]	7.7	.01	3.4	3.0	38.0	1.6	118	8	.0	.0	--	---	--	--	191	8.60
15	01	18	3	4 5, 1968	30	---	.14	----	---	---	---	---	--	---	6.4	.1	.0	116	21	145	7.40
15	01	18	10	4 11, 1968	73	7.6	---	1.0	.1	97.0	.6	209	10	.0	27.0	--	---	--	--	392	8.80
15	01	18	11	4 11, 1968	147	---	.23	----	---	---	---	---	--	---	1.4	.4	.0	242	3	215	7.60
15	01	19	5	4 11, 1968	28	---	---	----	---	---	---	---	--	---	.0	--	---	--	--	160	7.00
15	01	19	8	4 12, 1968	41	---	---	----	---	---	---	---	--	---	13.0	--	---	--	--	360	7.00
15	01	19	12	1 26, 1967	*500[2]	12.0	.14	22.0	5.6	15.0	.0	120	0	6.0	6.4	.0	.6	113	96	213	8.00

*Sampling depth same as well depth except as noted.
1 sampling depth 125 feet
2 sampling depth 460 feet

Table 4.--*Field determinations of hardness and specific conductance of ground water from the Eagle River-Chugiak area. (October to December 1969)*

Local well number	Hardness mg/l $CaCO_3$	Specific conductance (micromhos at 25°C)	Local well number	Hardness mg/l $CaCO_3$	Specific conductance (micromhos at 25°C)	Local well number	Hardness mg/l $CaCO_3$	Specific conductance (micromhos at 25°C)
14-1-6-2	155	280	14-1-29-1	189	320	14-2-1-13	120	220
7-1	155	240	30-1	206	300	16	138	270
2	120	220	32-1	155	280	18	171	340
3	103	180	2	155	280	20	52	290
4	138	220	14-2-1-5	189	320	22	155	310
5	138	220	6	138	240	23	68	210
7	103	190	7	120	240	24	155	270
8	103	180	8	206	360	11-7	34	340
9	172	240	9	206	320	8	103	220
10	115	143	11	120	240	11	258	500
11	155	280	12	206	380	14	138	240
14	138	220	15	206	380	15	138	240
16	138	220	16	155	260	16	206	380
18	155	280	17	155	260	17	103	220
19	103	190	20	155	300	18	52	200
20	155	280	22	138	260	19	138	280
21	172	210	23	206	360	12-1	120	210
8-1	258	390	24	17	1500	8	120	180
9-1	224	390	26	189	380	17	155	260
3	224	400	28	189	360	18	120	210
15-1	241	410	29	189	310	19	120	200
3	224	320	30	138	280	21	103	180
16-1	224	398	32	86	290	23	103	180
2	258	410	33	86	160	24	103	200
5	241	320	34	120	220	26	86	180
17-4	120	160	35	138	300	27	103	160
5	86	50	36	52	400	29	103	180
6	120	100	37	52	230	30	138	230
7	120	200	2-6	138	280	31	120	220
8	103	170	7	120	230	33	153	270
9	86	115	8	189	340	34	103	180
18-2	120	210	9	103	210	35	86	180
23-1	344	510	10	189	360	38	120	210
25-1	292	390	11	103	220	15-1-9-13	89	156
2	189	310	12	103	200	18-2(3)	21	191
28-1	120	240						

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APPENDIX

FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply English units	by	To obtain SI units
feet (ft.)	.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
gallons per minute (gpm)	.06309	liters per second (l/s)
million gallons per day (mgd)	.04381	cubic meters per second (m^3/s)