Prepared in cooperation with
ALASKA WATER STUDY COMMITTEE
and the STATE OF ALASKA, DEPARTMENT OF
NATURAL RESOURCES, DIVISION OF GEOLOGICAL
AND GEOPHYSICAL SURVEYS



# GROUND WATER

The schematic sections in this column show aquifer conditions in various areas of the Cook Inlet basin. Vertical distance is greatly exaggerated.

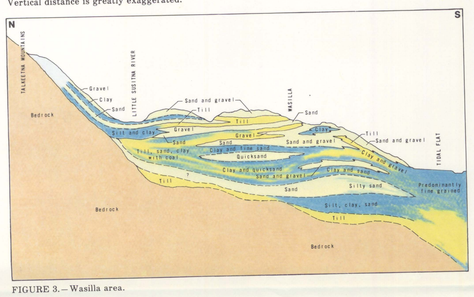



FIGURE 3.—Wasilla area.

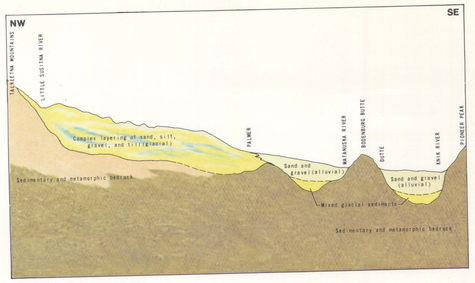



FIGURE 4.—Palmer-Butte area.

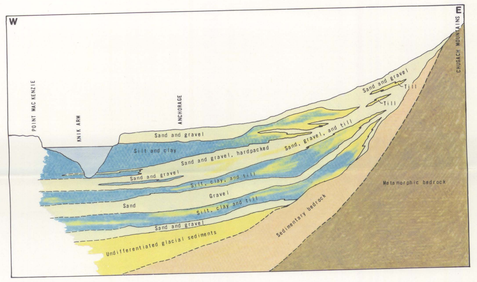



FIGURE 5.—Anchorage area.

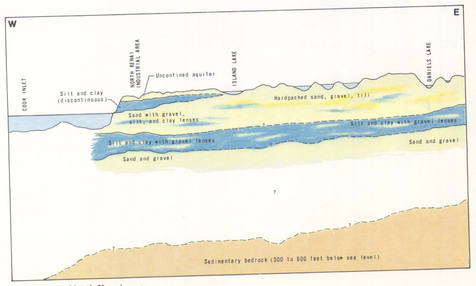



FIGURE 6.—North Kenai area.

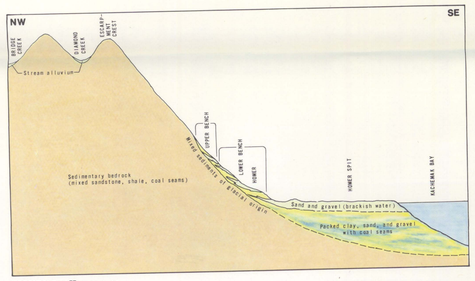



FIGURE 7.—Homer area.

## Aquifers and their potential

Aquifers used for domestic, industrial, and public water supplies in the Cook Inlet basin vary widely in the hydrologic characteristics that determine water-yielding potential. Knowing the size and hydraulic properties of aquifers and the availability of recharge generally leads to a relatively confident prediction of the potential yield of any given aquifer. However, stratigraphic complexities normally associated with glacially derived deposits cause great variability in physical characteristics within individual aquifers and give rise to various degrees of hydraulic connection between aquifers. Discontinuities and variable hydraulic conductivity in confining layers affect leakage between aquifers and ground-water storage capacity. As a result, an aquifer's potential yield is greatly dependent on the characteristics of adjoining confining beds (less permeable deposits) and aquifers.

Five schematic sections (figs. 3-7) illustrate the variety of aquifer systems beneath the most populous areas of the basin. In each system the aquifer interconnection, recharge sources, and size are dissimilar, yet hydraulic characteristics of individual aquifers can be quite similar.

In the Matanuska Valley near Wasilla, extensive domestic development has occurred in the past 10 years. The aquifers underlying the area are interfingered with silt, clay, and till beds (fig. 3) produced during marine, glacial, and alluvial deposition. During the early development of the area the shallowest aquifer system, that available to hand-dug wells, was used. As development progressed, deeper wells were drilled to obtain water of better quality and higher yields and to reduce the potential of pollution from waste disposal systems. The large water supplies needed for schools and commercial operations are now obtained from some of the deepest and most productive confined aquifers underlying the area. The areal extent of these aquifers is not yet defined.

Recharge in the Wasilla area is from several sources. Shallow aquifer zones mostly unconfined by silt or clay layers derive most recharge from lakes, streams, and infiltrating precipitation. The deeper confined aquifers must rely on leakage through the confining layers from adjacent aquifers for their major source of recharge. Some confined aquifers may have additional recharge at some distance upgradient where they are exposed to surface-water sources.

Well yields near Wasilla vary with depth and geographic location and with design of the well. Generally, yields are higher [50-300 gal/min (gallons per minute)] in deeper confined aquifers than in the shallower zones (1-50 gal/min).

The schematic section of the Palmer-Butte area (fig. 4) differs from that at Wasilla in that the deposits beneath the present valley floors of the Matanuska and Knik Rivers are generally unconfined; that is, ground water exists under atmospheric pressure. Till sheets and less permeable lenses cause some local confinement, but nearly the entire area is readily rechargeable by infiltrating precipitation and seepage from the Matanuska and Knik Rivers. Numerous bedrock outcrops indicate that the thickness of alluvium is not great. Ground water is being withdrawn from relatively continuous sand-and-gravel beds in outwash deposits and Holocene stream alluvium (Trainer, 1960). Well yields range from 5 to 75 gal/min in areas away from large recharge sources and (or) where localized confinement occurs; yields may exceed 4,000 gal/min in alluvium adjacent to present rivers.

By far the greatest development of ground-water resources has taken place in the Anchorage bowl where more than 3,000 wells penetrate various aquifers (fig. 5). The two best defined aquifer systems are an unconfined system, usually less than 30 ft below land surface, and a system beneath an extensive confining silt and clay layer. The unconfined system is virtually continuous throughout the Anchorage area. It is recharged by infiltrating precipitation, by seepage from several streams transecting the area, and by leakage from the underlying confined aquifer. Well yields range from 200 to 2,000 gal/min in the alluvial fill of Ship Creek and Campbell Creek but are much lower in domestic wells not located in the valley fills.

The confined aquifer system is used to supply the Municipality of Anchorage, two military bases, and numerous commercial and industrial endeavors. The system consists of two or more aquifers hydraulically connected. Yields are generally greater than 750 gal/min but decrease as the aquifer sediments grade to finer grained materials south of Campbell Creek and north of the military bases. Recharge for these confined aquifers is most likely to be by infiltration from streams and precipitation along the foot of the Chugach Mountains where there is no confining layer and by leakage from the unconfined aquifer system down through the confining layers.

Ground water in the North Kenai area (fig. 6) is supplied by aquifers in the unconsolidated Quaternary sediments which are 500 to 600 ft thick. The uppermost aquifer is unconfined and supplies almost all the private homes and part of the industry of the area. Well yields range from 10 to 75 gal/min for the domestic wells and from 200 to 600 gal/min for the larger industrial wells. Recharge is almost exclusively from infiltrating precipitation and the numerous lakes. The uppermost confined aquifer is well defined adjacent to the coastline. Confinement may become discontinuous farther inland, and hydraulic connection between this and the uppermost aquifer system may be direct. Well yields from the uppermost confined aquifer range from 10 to 1,200 gal/min. Only a few industrial wells withdraw water from a deeper confined aquifer, and yields in these wells range from 50 to 2,000 gal/min.

Most of the Homer area (fig. 7) is underlain at shallow depths by the Tertiary Kenai Formation which in that area consists of sand, silt, clay, and lignite lenses (Waller, Feulner, and Morris, 1968). Quaternary sediments are found in the stream valleys and on benches adjacent to Cook Inlet. Most of the wells in the Kenai Formation yield less than 10 gal/min in the bench areas and more than 50 gal/min north of the escarpment crest. Typical well yields from Quaternary deposits range from 5 to 25 gal/min.

## Surface- and ground-water relationships

The interchange of water between the surface water and aquifers forms an integral part of the hydrologic cycle of a basin. This interchange is constantly occurring but is most evident during low-streamflow periods and during long periods of lower than normal precipitation. During these minimum flows, streamflow is derived almost entirely from the unconfined ground-water reservoir. When streamflow is augmented by snow and ice melt or direct runoff from increased precipitation, the flow from ground-water sources becomes less significant. Water removed from ground-water storage during the low flow period can be restored by infiltration. The magnitude of minimum flow per unit area of a stream's drainage basin can be a general indicator of an unconfined ground-water potential for that area. On sheet 4, the map of minimum discharge shows a greater minimum flow per unit of area on the western side of the Susitna basin and the western side of Cook Inlet than in the remainder of the study area. However, there is little ground-water information to support the higher ground-water potential that the minimum discharges seem to indicate.

Seepage investigations are a means of measuring quantities of water interchanged between streams and ground-water reservoirs. The investigations include nearly simultaneous discharge measurements along a reach of a stream, usually during a low-flow period. Water losses and gains for reaches of the stream between sites of discharge measurements can then be calculated. Seepage investigations cannot be used to predict ground-water potential, but they can give a relative indication of how permeable the alluvial materials of a stream valley are and whether the unconfined ground-water level is above or below the level of the stream. Generally, a stream gains water where the water table adjacent to the stream is higher and it loses water where the water table is below the stream level.

Seepage investigations have been performed on four streams in the Cook Inlet basin. Figure 8 shows the gain or loss of water per mile of stream length for stream reaches between sites of discharge measurements. Twenty seepage investigations have been performed on Ship Creek, but only the most detailed is shown. Data for the remaining 19 were given by Scully and others (1978).

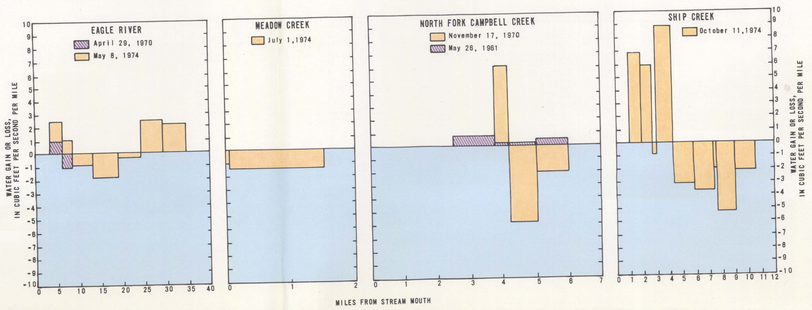



FIGURE 8.—Relative stream gains and losses per mile of stream length for four streams near Anchorage, Alaska.

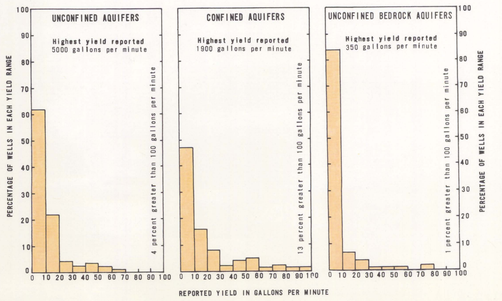
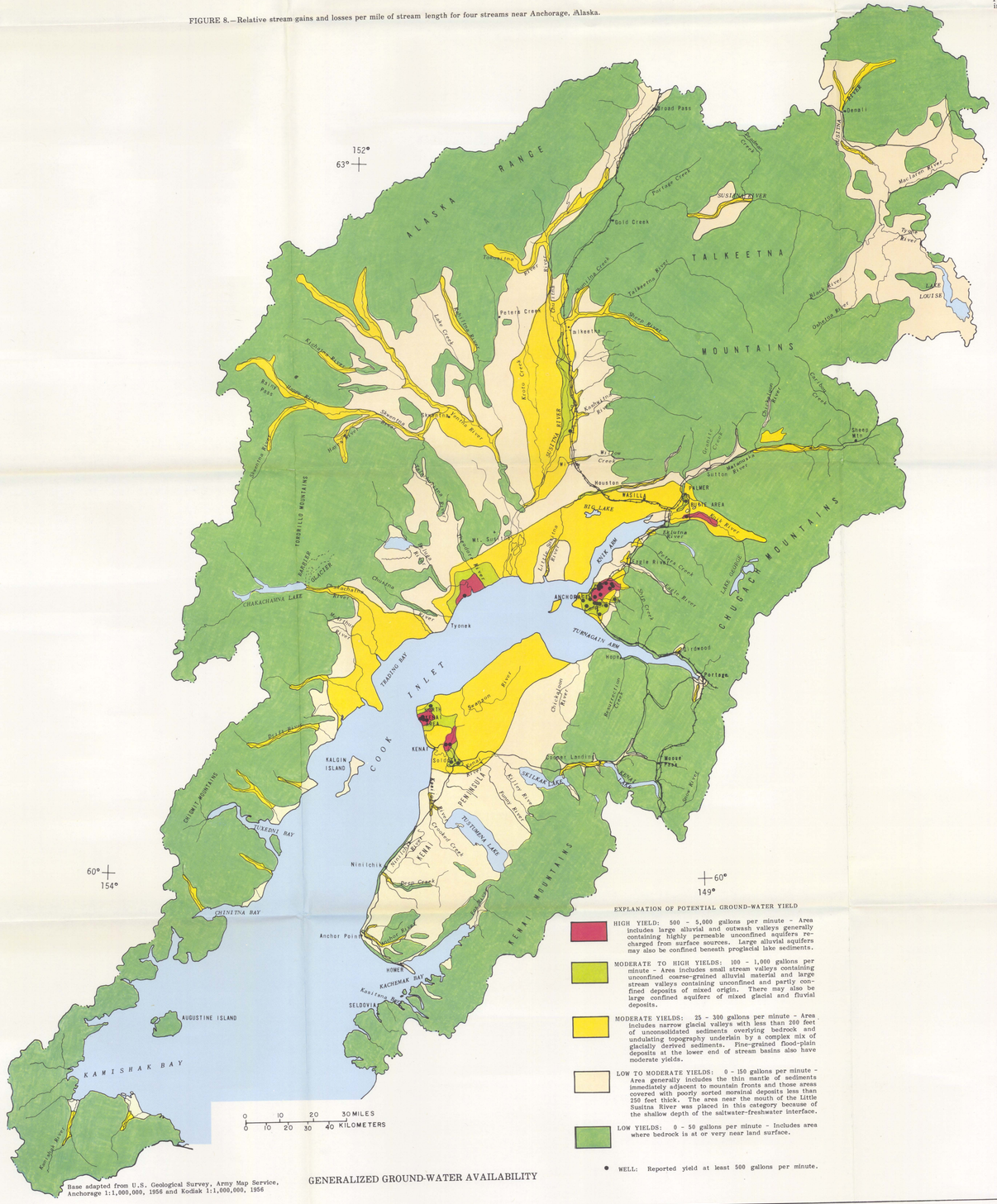



FIGURE 9.—Distribution of reported well yields in unconfined and confined aquifers in the unconsolidated sediments and in bedrock materials.


152°
63°
146°
63°
60°
154°
60°
149°
ALASKA RANGE
TALKEETNA MOUNTAINS
CHUGACH MOUNTAINS
KENAI MOUNTAINS
COOK INLET
KAMISHAK BAY
Broad Pass
Denali
Anchorage
Palmer
Wasilla
Homer
Seldovia
Kenai
Soldotna
Tyonek
Cordova
Valdez
Whittier
Portage
Girdwood
Hope
Sunrise
Talkeetna
Trapper Creek
Willow
Houston
Big Lake
Eagle River
Chugiak
Eklutna Lake
Knik Arm
Turnagain Arm
Cook Inlet
Kalgin Island
Ninilchik
Anchor Point
Homer
Kachemak Bay
Augustine Island
Chinitna Bay
Tuxedni Bay
Chakachatna Lake
Tustumena Lake
Skilak Lake
Lake Louise
Susitna River
Matanuska River
Knik River
Eklutna River
Kenai River
Kasilof River
Ninilchik River
Anchor River
Deception Creek
Portage Creek
Gold Creek
Peterson Creek
Peterkin Creek
Talkeetna River
Sheep Creek
Kashwitna River
Willow Creek
Little Susitna River
Matanuska River
Sutton
Palmer Creek
Eagle River
Chugach Mountains
Sheep Mtn.
Mt. Spurr
Redoubt Volcano
Iliamna Volcano
Redoubt Creek
Chakachatna River
Tyonek
Beluga River
Susitna River
Chickaloon River
Snow River
Placer River
Twentymile River
Portage Glacier
Bear Creek
Moose Creek
Ptarmigan Creek
Resurrection Creek
Sixmile Creek
Fivemile Creek
Ship Creek
Campbell Creek
Chugach Mountains
Kenai Mountains
Tustumena Lake
Skilak Lake
Kenai Lake
Kenai Peninsula
Kalgin Island
Tuxedni Bay
Chinitna Bay
Kamishak Bay
Kachemak Bay
Seldovia
Homer
Anchor Point
Ninilchick
Kasilof River
Kenai River
Kenai
Soldotna
Sterling
Cooper Landing
Moose Pass
Hope
Girdwood
Portage
Whittier
Cordova
Valdez
Sunrise
Talkeetna
Trapper Creek
Willow
Houston
Wasilla
Palmer