GROUND-WATER INVESTIGATION AT THE ALLUVIAL FAN OF THE SOUTH FORK EAGLE RIVER, ANCHORAGE, ALASKA - RESULTS OF TEST DRILLING, 1976

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GEOLOGICAL SURVEY

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By

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CONVERSION FACTORS

Multiply English units	By	To obtain SI units
feet (ft)	.3048	meters (m)
gallons per minute (gal/min)	.06309	liters per second (L/s)
gallons per minute per foot (gal/min/ft)	.01923	liters per second per meter (L/s/m)
inches (in)	25.40	milliliters (mL)

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ABSTRACT

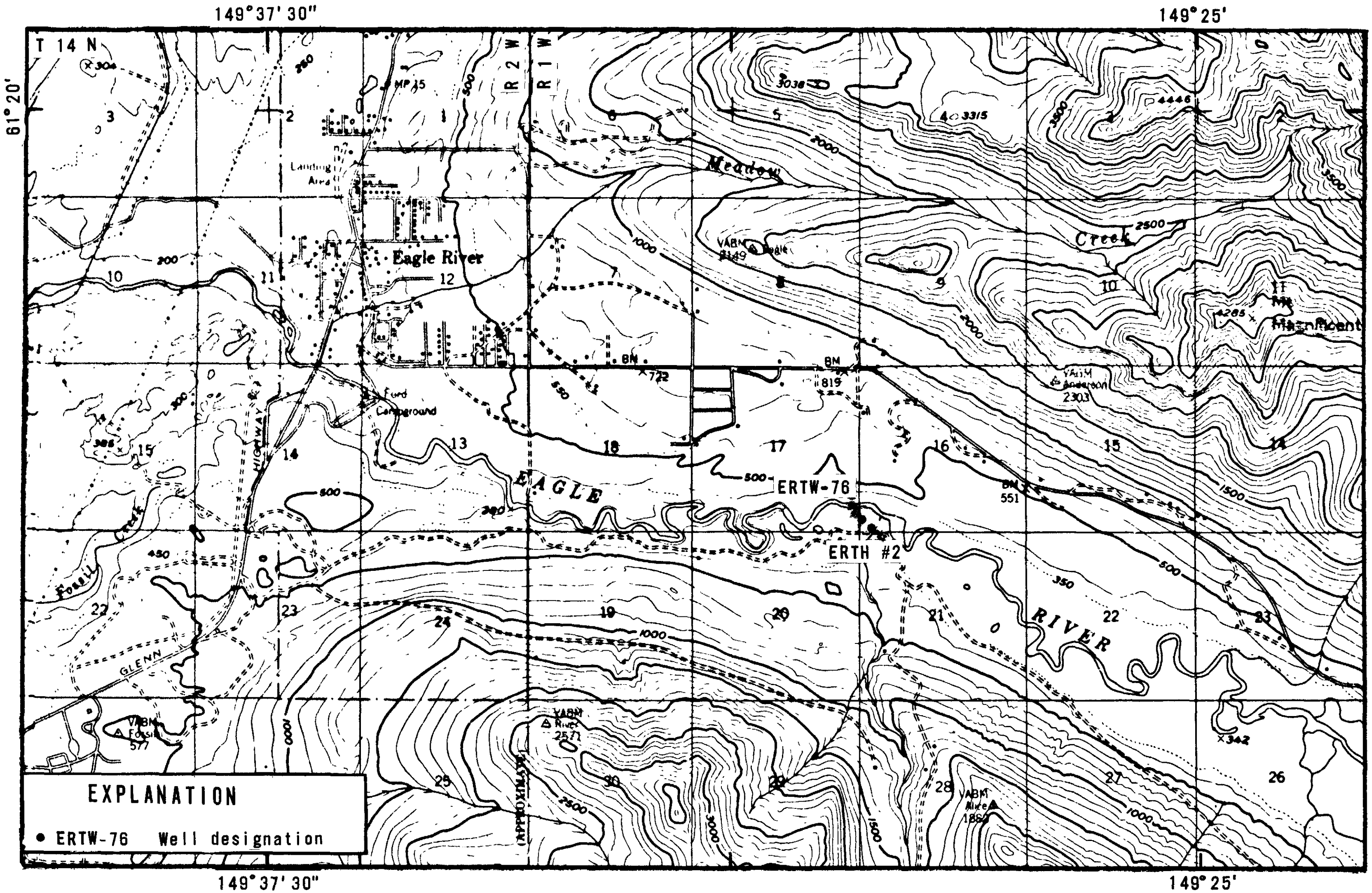
In late 1976, a ground-water exploration well was drilled to a depth of 487 feet on the South Fork Eagle River fan near the confluence with the mainstream. The well penetrated four sand and gravel strata of low water-yielding capacity and extended 37 ft into metamorphic bedrock. Each water stratum was pumped for several hours, and the best aquifer yield was found to be 1.7 gal/min/ft of drawdown. These test results support the conclusion, previously inferred from drilling data at a nearby test hole drilled in 1973, that larger yield, confined aquifers are not present in the subsurface at this locality.

INTRODUCTION

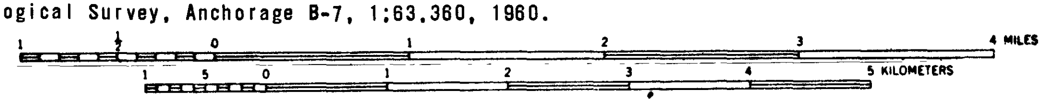
This report presents geologic and hydrologic data collected by the U.S. Geological Survey during drilling of an exploratory water well in the Eagle River valley near the confluence of the South Fork Eagle River with the mainstream (fig. 1). The well was drilled by the U.S. Army Corps of Engineers, Alaska District, as part of its Metropolitan Anchorage Urban Study (MAUS). This report is a product of the Geological Survey's participation in a phase of the water-availability and water-supply element of MAUS.

In drilling the test well, the immediate objective of MAUS was to evaluate ground-water supply potential at the selected site. Additionally, it was hoped that aquifer test results at the South Fork fan could be extended to provide an estimate of the potential for developing large, public, ground-water supplies in the Eagle River valley. The role of the Geological Survey was limited to hydrologic-data collection and analysis at the drilling site, with emphasis on analysis of data from pumping tests of the aquifer.

Drilling of the 8-inch-diameter test well, referred to as ERTW-76 (USGS well no. AK-2454) began on September 20, 1976, using a cable-tool drill rig. The drilling site was 195 ft (feet) downvalley from an existing test well, ERTH #2 (USGS well no. AK-2153). Well ERTH #2 was drilled as part of an earlier water-availability study conducted for local water utilities (Tryck, Nyman and Hayes, and others, 1973). A



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



CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL

Figure 1.--Location of test wells in Eagle River valley.

major factor in choosing to drill a test hole at this locality was that previous testing of an apparently promising aquifer, between 320 and 390 ft below the land surface was inconclusive in defining the potential for public supply (Tryck, Nyman and Hayes, and others, 1973). It was presumed that the proximity of the older well could also prove useful for measuring drawdown during testing of deep aquifers at the new site. Because well-completion difficulties left ERTH #2 in poor hydraulic connection to the deep water-bearing strata, the Corps of Engineers and USGS agreed that rehabilitation of this well would be undertaken only if an aquifer judged capable of supplying 100-200 gal/min (gallons per minute) was indicated by preliminary pumping tests at the new well.

GEOLOGIC DATA AND LITHOLOGY

A lithologic log recorded by the driller (Henry Thomas of the Corps of Engineers) and four geophysical well logs recorded by the author are presented in plate 1. Unconsolidated alluvial, glacial, and perhaps estuarine sediments, ranging in particle size from cobbles to clay, were penetrated to a depth of 450 ft below land surface (-110 ft MSL). The remainder of the hole (to a final depth of 487 ft) was drilled into consolidated rock of varying hardness, believed to be bedrock.

The lithologic sequence of ERTW-76 is closely similar to that logged for ERTH #2 (Tryck, Nyman and Hayes, and others, 1973). As in the earlier well, silt was the dominant geologic material between the shallow alluvium (of the South Fork fan) and deep-lying, till-like material. Several permeable strata, less than 6 ft in thickness and consisting mainly of sand and gravel, were penetrated in the sedimentary material below the 300-ft depth. Water yields from these strata are discussed in the following section.

Hard, seemingly competent rock was recorded at a depth of 450 ft, on the basis of drill cuttings, much slower drilling rates, and resistance of the 6-inch liner casing to driving. (The 8-in casing was terminated at the 388 ft depth.) The rock appeared to be greenstone, a typical component of Chugach Mountain bedrock (Clark, 1972). A layer of "softer" rock, which reportedly yielded some silt particles to bailing, was penetrated from 460 to 464 ft. Thereafter, the rock became progressively harder (and slower) to drill to the bottom of the hole.

Geophysical logs (pl. 1 in pocket), particularly the natural-gamma log, strongly support the drilling evidence that the top of bedrock was at about 450 ft. The gamma-gamma density log and the neutron-porosity log show typical responses (shift to the right), but an unknown amount of the shifting is due to exiting the steel casing close to the sediment-bedrock contact. The presence of relatively soft material lying between harder rock suggests a narrow fracture filled with silt.

TESTS FOR WATER YIELDS

Short pumping tests were conducted as drilling progressed. Flowing artesian conditions were noted during drilling through all of these strata. A summary of pertinent information from tests made on these individual strata follows:

343-348 feet

Approximately 5 ft of no. 40 slot screen was exposed and the section was surged, bailed and pumped for several days, but less than 20 gal of fine material were removed. During much of this time 5 to 10 gal/min of water flowed over the top of the 8-in-diameter casing that extended 2.7 ft above ground level. A final pumping test was run at a rate of 30 gal/min on November 4, 1976, and resulted in 18 ft of drawdown after 90 minutes pumping. The drawdown was increasing very gradually when the test was terminated, and the water contained very few suspended particles. A semi-log plot of the drawdown and recovery data for the test is shown in figure 2.

A graphic water-level record of ERTH #2, 195 ft away, showed drawdown in response to pumping at ERTW-76 on October 20. The "sluggishness" (i.e. poor hydraulic connection to aquifer) of ERTH #2 was demonstrated by a delay in drawdown response of about one hour. Therefore, this well was not monitored during the November 4 test or tests of deeper zones because the data would not represent the true response of the aquifer to pumping stress. The relatively low yield of the new well did not justify redevelopment of ERTH #2.

363-366 feet

Three feet of no. 40 slot screen was set in this interval. During brief bailing to develop this water-bearing zone, excessive amounts of fine sand entered the well. A centrifugal pump was then operated to produce about 15 gal/min, but drawdown quickly reached the level of the pump intake. The volume of sand pumped indicated that this interval contained too much fine material to be developed effectively.

392-396 feet

A no. 40 slot screen was set, but development failed to improve the yield. Before abandoning this water-bearing zone, a centrifugal pump was installed and pumped at about 15 gal/min. The water level was rapidly drawn down to the pump intake; however, water level recovery was rapid when pumping stopped, and water soon flowed over the casing again.

414-416 feet

This water-bearing zone appeared promising because of the large size of the gravel and its low silt and clay content. Apparently the uncased hole remained open in this interval. A centrifugal pump was run for two hours at a rate of 35 gal/min. Twenty-four feet of drawdown resulted, and the thin layer was judged not worthy of screening. The static level was more than 4 ft above ground surface, as indicated by artesian flow over the casing.

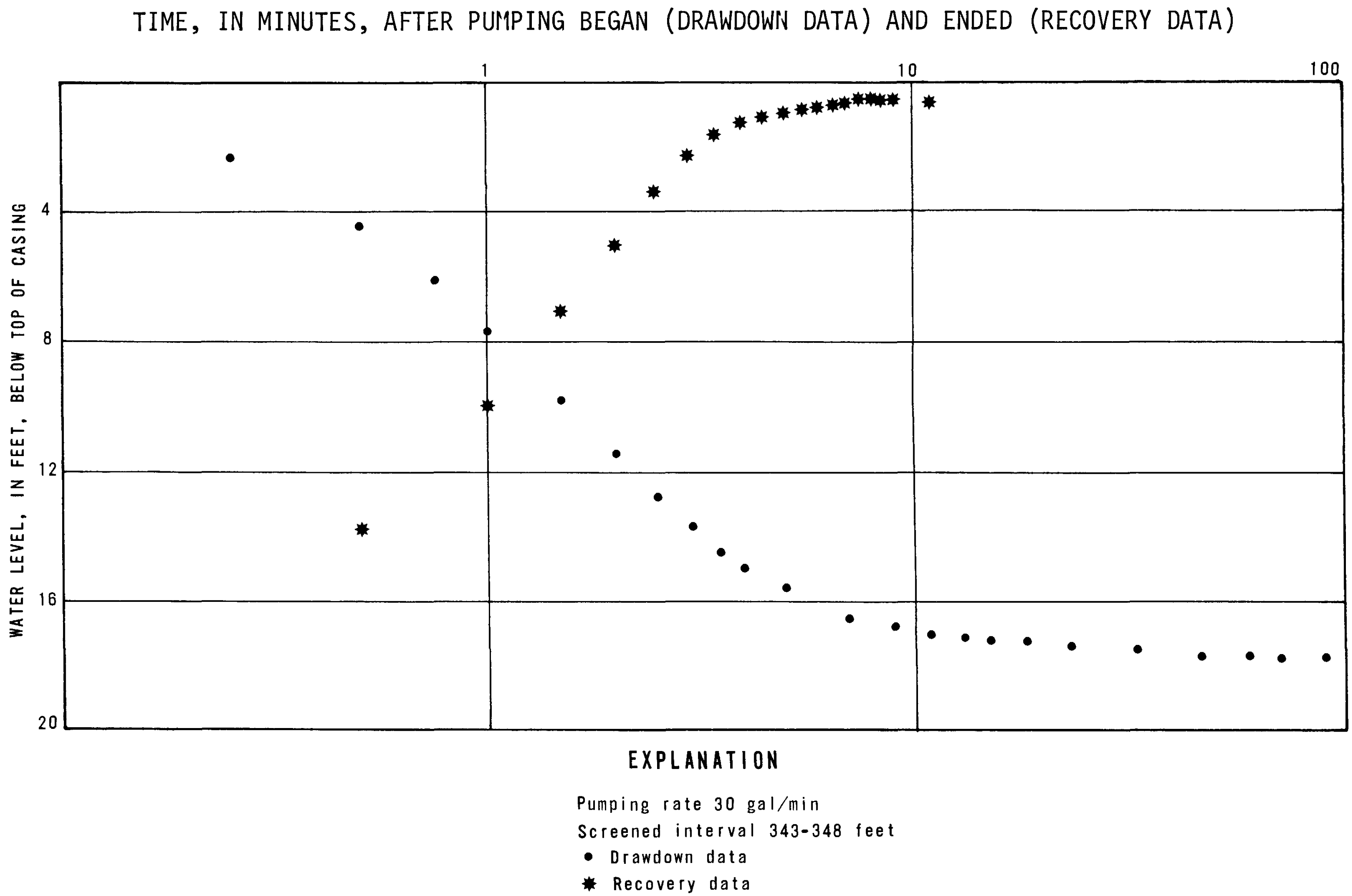


Figure 2.--Water-level drawdown and recovery in well ERTH-76 during aquifer tests on November 4, 1976.

WATER-QUALITY DATA

An analysis was made by the U.S. Geological Survey of water pumped from the stratum at 343 to 348 feet (see table 1). Field water-quality tests on November 4 showed a specific conductance of 480 µmhos per centimeter at 25°C, pH of about 9 units, and the sampled water had a temperature of 6.8°C. These values are nearly identical to those obtained during aquifer development activities two weeks earlier. About 6,300 gallons had been pumped from the well in 3.5 hours prior to sampling. The water had a hydrogen-sulfide odor and an objectionable taste when sampled.

Water samples were collected from the intervals 394 to 399 ft and 414 to 416 ft for field analysis. Conductivities of 230 µmhos and 600 µmhos were determined for these samples, respectively. Both sample bottles contained some sand particles, but no appreciable silt. Upon settling, a reddish (iron) precipitate formed in the sample bottle from the 392- to 396-ft stratum. Also, the driller reported that water pumped from the 414- to 416-ft stratum had a strong sulfide odor and a temperature of 7.5°C. Although a continuous temperature log was not obtained in ERTW-76, temperature measurements obtained during pumping from strata at various depths indicate a warming gradient with depth similar to that in well ERTH #2, logged in 1973.

CONCLUSIONS

Relatively good geologic and hydrologic correlation can be made between ERTW-76 and the previous test well, ERTH #2. The data from ERTW-76, like those from ERTH #2, indicated no water-bearing strata capable of sustaining moderate- to large-yield public supply wells (200 gal/min or more). The highest specific capacity attained during testing of aquifers at ERTW-76 was 1.7 gal/min/ft of drawdown from the interval 343 to 348 ft. Tryck, Nyman and Hayes, and others (1973) reported specific capacities of 4 gal/min/ft and 16.6 gal/min/ft from brief bailing tests at depths of 344 and 346 ft, respectively, in well ERTH #2. Also, because only 1 foot of relatively permeable aquifer material (at a depth of 48-49 ft) was penetrated in the unconfined system in ERTW-76, the extent of the shallow aquifer tested at well ERTH #2 is questionable. However, a surprisingly large yield (60 gal/min) was pumped from a 12-ft-deep, open-end casing beside the new test well, which suggests an abundance of very shallow ground water here.

The information gained from the two test wells on the South Fork Eagle River alluvial fan is only a first step in evaluation of the ground-water resource potential of Eagle River valley. Several additional test wells will be required to define the thickness, distribution and hydraulic character of the unconsolidated sediments. The test wells might then be used as control points for surface geophysical surveys, such as electrical resistivity exploration; these data in conjunction

Table 1.--Chemical analysis of water from the 343- to 348-ft stratum of well ERTW-76, November 4, 1976.

Parameter	Value or Concentration	Unit
Time	12:45	hours
Pump period prior to sampling	210	minutes
Flow rate	30	gal/min
Specific conductance (at 25°C)*	480	µmhos/cm
pH*	9(approx.)	units
Temperature, water*	6.8	°C
Color	6	platinum-cobalt units
Hardness, as $CaCO_3$ (Ca, Mg)	34	mg/L
Hardness, noncarbonate	0	mg/L
Calcium, dissolved	10	mg/L
Magnesium, dissolved	2.2	mg/L
Sodium, dissolved	95	mg/L
Potassium, dissolved	0.8	mg/L
Bicarbonate (HCO_3)	188	mg/L
Alkalinity (total as $CaCO_3$)*	154	mg/L
Sulfate, dissolved	1.8	mg/L
Chloride, dissolved	68	mg/L
Fluoride, dissolved	0.4	mg/L
Silica, dissolved	8.1	mg/L
Dissolved solids, residue at 180°C	284	mg/L
Nitrite plus nitrate, dissolved as N	0.02	mg/L
Phosphorus, dissolved orthophosphate as P	0.14	mg/L
Arsenic, dissolved	38	µg/L
Iron, dissolved	110	µg/L
Manganese, dissolved	20	µg/L

*determined in field at time of sampling with the test-well data would guide selection of the most favorable areas for drilling of possible production wells.

Other investigations might consist of drilling to define the potential for shallow ground-water development in the South Fork fan area, or to define the hydraulic connection of the shallow aquifer with the present Eagle River channel. In the latter case, interpretation of data to determine the degree of ground-water inflow from the river would be difficult and complex, and extension of results to other areas would be tenuous. Any shallow test-drilling program here should include ideally an array of small diameter observation wells around a central pumped well.

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