Overview of Environmental and Hydrogeologic Conditions at Galena, Alaska

By Allan S. Nakanishi and Joseph M. Dorava

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
millimeter (mm)	0.03937	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
liter (L)	0.2642	gallon
cubic meter per second (m^3/s)	35.31	cubic foot per second
liter per day (L/d)	0.2642	gallon per day
degree Celsius (°C)	°F = 1.8 x °C + 32	degree Fahrenheit (°F)

Sea level:

In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality unit used in this report:

mg/L, milligram per liter

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Abstract

The remote Native village of Galena along the Yukon River in west-central Alaska has long cold winters and short summers that affect the hydrology of the area. The Federal Aviation Administration owns or operates airway support facilities in Galena and wishes to consider the subsistence lifestyle of the residents and the quality of the current environment when evaluating options for remediation of environmental contamination at these facilities. Galena is located on the flood plain of the Yukon River and obtains its drinking water from a shallow aquifer located in the thick alluvium underlying the village. Surface spills and disposal of hazardous materials combined with annual flooding of the Yukon River may affect the quality of the ground water. Alternative drinking-water sources are available but at significantly greater cost than existing supplies.

INTRODUCTION

The Federal Aviation Administration (FAA) owns and (or) operates airway support, and navigational facilities throughout Alaska. At many of these sites, fuels and potentially hazardous materials such as solvents, polychlorinated biphenyls, and pesticides may have been used and (or) disposed of. To determine if environmentally hazardous materials have been spilled or disposed of at the sites, the FAA is conducting environmental studies mandated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund Act") and the Resource Conservation and Recovery Act (RCRA). To complete these environmental studies, the FAA requires information on the hydrology and geology of areas surrounding the sites. This report is the product of a compilation, review, and summary of existing hydrologic and geologic data by the U.S. Geological Survey, in cooperation with the FAA, for the FAA facilities and nearby areas at Galena, Alaska.

BACKGROUND

Location

Galena (fig. 1) is in the western interior of Alaska at latitude 64°44'10" N., longitude 156°56'04" W., approximately 910 km west of Fairbanks. The village is within the Koyukuk Flats (Wahrhaftig, 1965) on the north bank of the Yukon River, approximately 35 km upstream from the mouth of the Koyukuk River. It is the largest community of this region and serves as the transportation, government, and commercial center for the western Interior (Fison and Associates, 1987). A flood containment dike located immediately north of the old village of Galena, surrounds a 2,300-m runway, the Galena Air Force Station (AFS), and many of the FAA facilities (fig. 2).

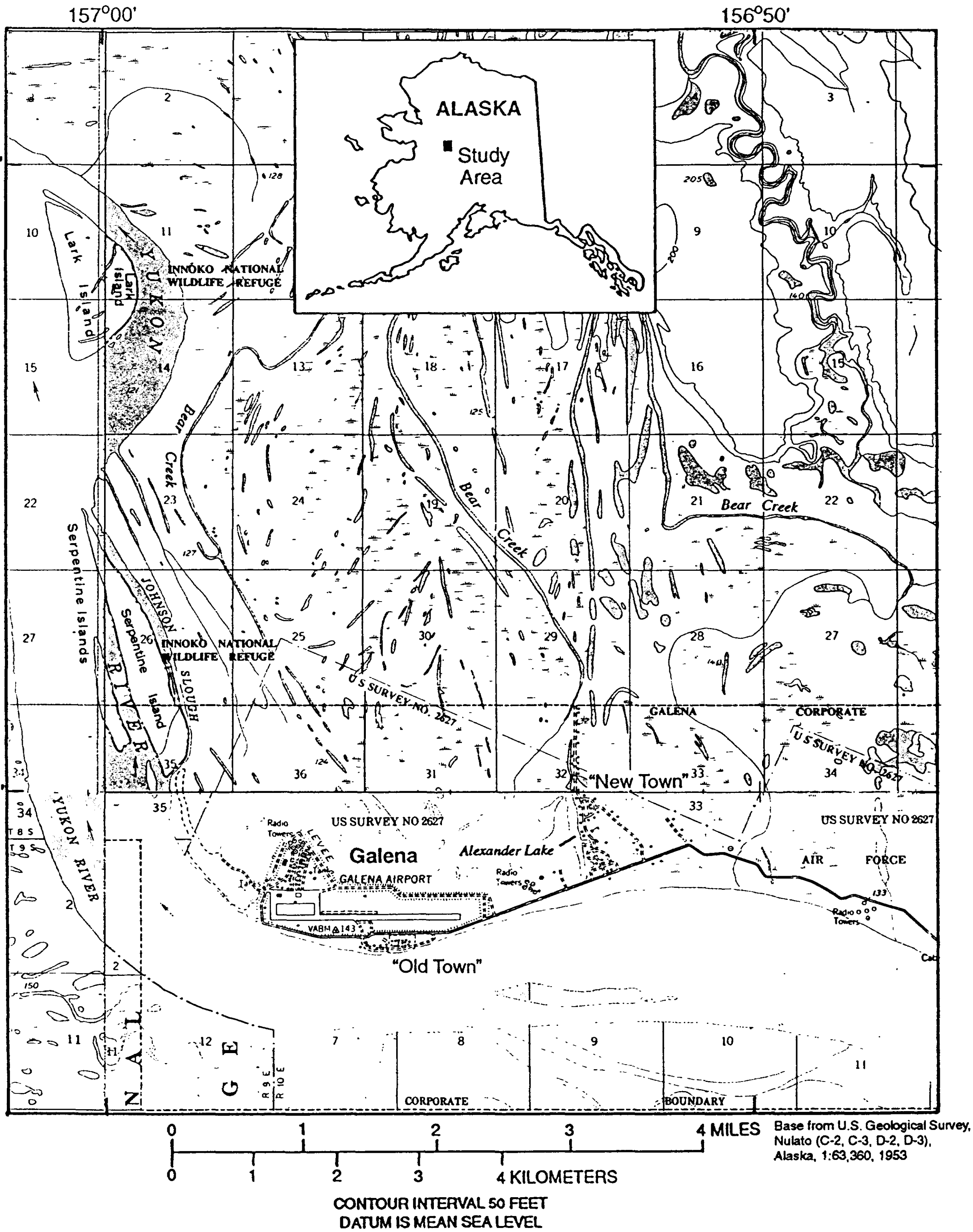

Figure 1. Location of Galena.

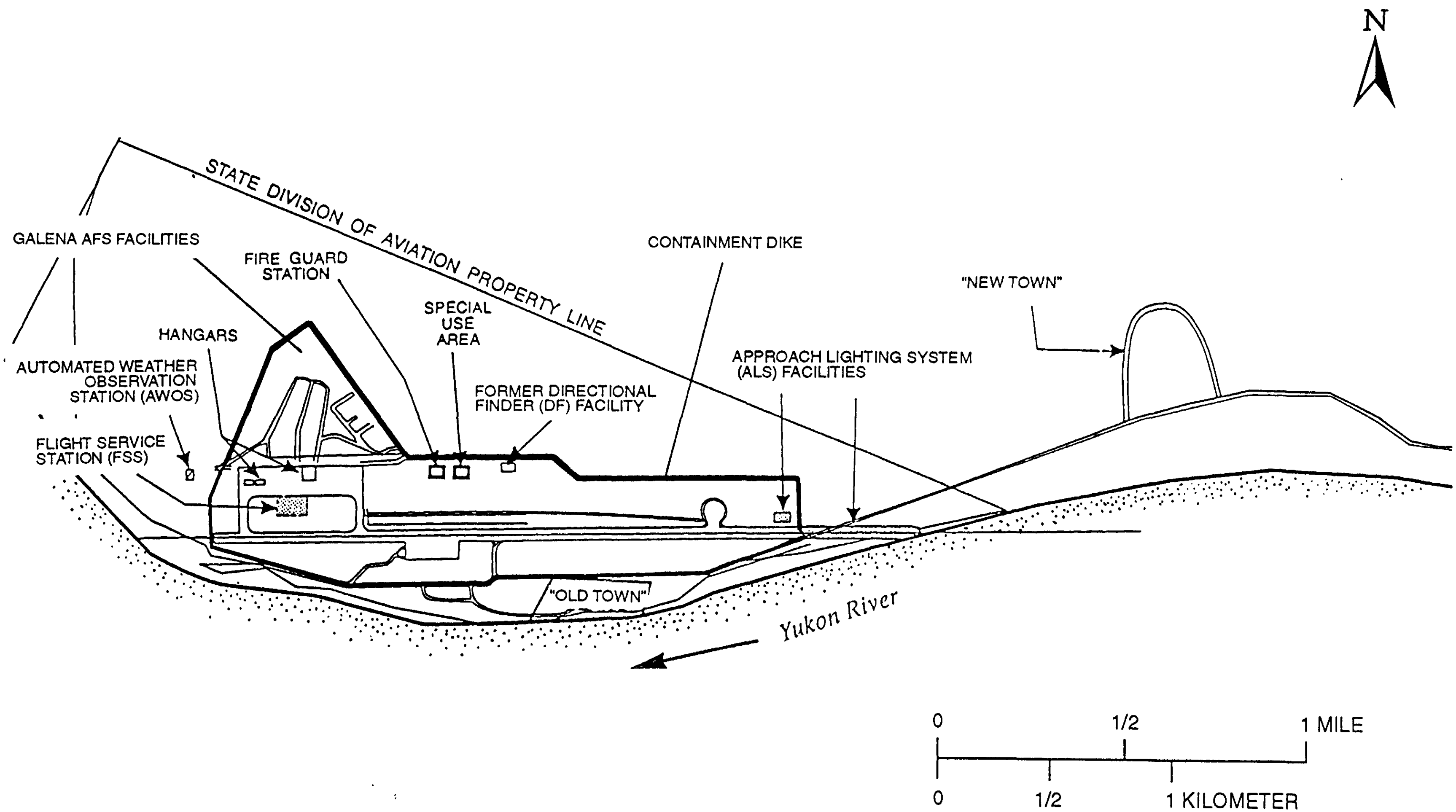

Figure 2. Location of Federal Aviation Adminstration (FAA) facilities and Galena Air Force Station (AFS) (modified from Ecology and Environment Inc., 1992).

History and Socioeconomics

Galena is in traditional Koyukon Athabaskan Indian territory. The Koyukon frequently occupied large semi-permanent villages during the summers--most commonly near the primary fishing grounds--and hunted and trapped in the fall and winter along the rivers. Galena, located near an old fish camp site, was established in 1918 as a supply and trans-shipment point for the area lead ore mines. Significant community growth did not begin until the early 1950's, when the military established Galena AFS and Campion AFS, located 23 km southeast of Galena (Fison and Associates, 1987).

Galena is divided into two townsites (fig. 1). The original site "Old Town" is located immediately south of the airport. The other townsite, near Alexander Lake, is commonly referred to as "New Town" and was established in 1971, after flooding severely damaged the original townsite. Galena was incorporated as a first-class city in 1971. The municipal government is directed by a city manager who administers local programs.

In October 1993, the U.S. Air Force completed the drawdown (closing) of the Galena AFS. However, the facilities are being maintained by contractors to minimize deterioration should the Air Force decide to reopen the station. This drawdown had a significant economic effect on the village of Galena. Approximately 325 Air Force personnel were relocated, resulting in a population decline of more than one-third from the 1990 population of 829 (Alaska Department of Community and Regional Affairs, 1993). The percentage of Native population, which includes American Indian, Eskimo, and Aleut, has increased from 45 percent to an estimated 70 percent as a result of the station closure (Chris Hladick, Galena City Manager, oral commun., 1994). Federal, State, and village government jobs dominate the economy, but Galena has many other jobs in air transportation and retail businesses. Strong cultural, historic, and family ties to subsistence activities make subsistence foods a major portion of the diet for many Galena residents.

PHYSICAL SETTING

Climate

The climate of Galena is continental which characteristically has low precipitation, low cloudiness, low humidity, light surface winds, and large annual temperature variations (Hartman and Johnson, 1984). Freezing of the Yukon River typically occurs in October and break-up occurs in mid-May (Fountain, 1984; Fountain and Vaughn, 1984). The mean annual temperature is -4.4 °C, but temperatures range from a July mean maximum of 19.7 °C to a January mean minimum of about -27.6 °C. Mean annual precipitation is about 327 mm; approximately 1,537 mm of snow falls annually (Leslie, 1989). Most rainfall occurs in July and August. Mean monthly temperature, precipitation, and snowfall are summarized in table 1.

Vegetation

The Galena area forest consists of a closed spruce-hardwood forest along the Yukon River (Viereck and Little, 1972). Well-drained, high relief areas contain aspen, birch and white spruce (Elias and Vosburgh, 1946; Weber and Péwé, 1970). The flat, poorly drained terraces consist predominantly of black spruce, larch, and moss undergrowth. Poorly drained, flat-lying sloughs and sediment-filled lakes contain moss, lichen, tufted grass, alder brush, Labrador tea and scattered willows (Elias and Vosburgh, 1946; Péwé, 1948; Weber and Péwé, 1970).

Table 1. Mean monthly temperature, precipitation, and snowfall for the combined periods, 1922-76 and 1985-87, Galena

[Modified from Leslie (1989); °C, degree Celsius; mm, millimeter]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Mean maximum	-18.8	-16.6	-8.8	-0.3	11.5	18.8	19.7	16.7	10.4	-1.5	-11.2	-18.5	0.1
	(Record maximum, 33.3 °C, June 1969)												
Mean minimum	-27.6	-26.8	-20.8	-10.9	1.4	9.2	10.9	8.7	2.6	-7.8	-18.7	-26.7	-8.9
	(Record minimum, -53.3 °C January 1951)												
Mean	-23.2	-21.7	-14.8	-5.6	6.5	14.0	15.3	12.7	6.5	-4.7	-15.0	-22.5	-4.4
Precipitation (mm of moisture)	17.5	19.6	17.5	14.2	14.0	30.0	49.0	59.7	37.6	25.1	21.8	21.1	326.9
Snowfall (mm)	208.3	223.5	198.1	144.8	12.7	0.0	0.0	0.0	12.7	213.4	259.1	261.6	1536.7

Bedrock Geology

The broad flats surrounding Galena are bounded by hills and mountains to the south, northwest and northeast ranging from 300 m to more than 600 m in elevation. Mueller Mountain, Bishop Rock, and Pilot Mountain -- located 25 km east, 25 km northwest, and 20 km west of Galena, respectively -- are the closest bedrock exposures to Galena. These outcrops have been studied for use as potential construction sites and as sources for construction material (Elias and Vosburgh, 1946; U.S. Army Corps of Engineers, 1986). Bedrock exposures consist primarily of sedimentary, igneous, and volcanic rocks. The sedimentary rock consists of Cretaceous age sandstone, shale, and conglomerate. Volcanic rock of undetermined age is found in isolated exposures and consists of basaltic to andesitic rock (Cass, 1959). Exposed metamorphic rocks of Paleozoic age consist of schist, phyllite, slate and quartzite (Cass, 1959). The depth to bedrock at Galena is unknown. A well at Campion AFS was drilled to 130 m without reaching bedrock.

Surficial Geology and Soils

Rieger and others (1979) classified soils in the State of Alaska, which included the Yukon Flats area, using the Soil Classification System developed by the U.S. Soil Conservation Service. Weber and Péwé (1970) characterized the surficial deposits and engineering properties of the soils for the Koyukuk Flats.

Thick deposits of Quaternary sediment overlie most of the bedrock in the Galena area (Cass, 1959). These deposits consist of flood-plain alluvium and river terrace deposits. Flood plain alluvium is divided into organic-rich and organic-poor deposits. Organic-rich alluvial deposits consist of well-stratified layers and lenses of silt with wood, peat, and other intermixed organic materials. Organic-rich deposits occupy the upper layers of the flood-plain alluvium and are formed in abandoned channels and cutbanks of major streams. Deposit thickness ranges from 2 to 20 m and depth to permafrost ranges from 0.3 to 0.7 m.

Organic-poor alluvial deposits consist of well-stratified layers and lenses of silt with some sand, gravel, and minor quantities of clay and slightly organic-rich silt. These deposits occupy the lower layers of flood-plain alluvium and are formed in the borders of major streams and in abandoned channels. Deposit thickness ranges from 1 to 20 m. Permafrost is probably absent or at depths of more than 6 m near rivers, but at interlake areas, permafrost depth can be as little as 0.3 to 1 m and possibly more than 3 m under the lake basins.

Terrace deposits consist of well-stratified layers and lenses of silt, organic-rich silt, and localized deposits of well-stratified fine to coarse-grained sand. Terrace deposits are found bordering the Yukon and Koyukuk River flood plains as remnant ridges on low flat areas 10 to 60 m above the river level or as outer margins of the lowland bordering the hills and extending up some of the smaller stream valleys. The total deposit thickness may be more than 150 m and the depth to permafrost is about 0.3 m.

The local area is underlain by a layer of discontinuous permafrost (Ferrians, 1965). Seasonal frost commonly penetrates to a depth of about 2 m; however, ground temperatures measured near the airport indicate that soil temperatures at a depth below about 2 m were consistently above freezing continuously for more than 11 years (Aitken, 1963). Significant melting of permafrost has occurred since the construction of the Galena AFS. A geotechnical study by Péwé (1948) showed that the depth to permafrost was about 2 to 3 m and was continuously present at all locations except in areas nearest to the Yukon River. Recent geotechnical investigations at the airport facilities have found isolated lenses of permafrost or no permafrost during a monitoring well-drilling program (Wes Lannen, U.S. Air Force, 11th CEOS, Installation Restoration Program, Project Manager, oral commun., 1994).

HYDROLOGY

Surface Water

The Koyukuk Flats is drained by the Koyukuk and the Yukon Rivers. The Yukon River is Alaska's largest river and the fifth largest river in North America in terms of drainage area and run-off (Feulner and others, 1971). The Yukon River flows roughly from east to west and drains into the Bering Sea about 310 km downstream from Galena. The Koyukuk River drains into the Yukon River about 35 km west of Galena. Numerous meander scars, sloughs, and oxbow lakes indicate a dynamic fluvial system within the Koyukuk Flats.

Surface-water bodies within a 3-km radius of the airport include the Yukon River, Alexander Lake, and the headwaters for Bear Creek (fig. 1). Galena is on the interior and upstream section of a meander bend on the north bank of the Yukon River and is subject to bank erosion. Riverbank erosion at an average rate of 4.7 m/yr between 1946 to 1978 was measured by the U.S. Army Corps of Engineers (1986) and threatens the eventual destruction of the airstrip, military facilities, FAA facilities, and parts of the old village of Galena.

Floods

Historically, flooding near Galena occurs in mid-May during the break-up of the Yukon River. Flood hazards in Galena are considered high by the U.S. Army Corps of Engineers (1993); 95 houses and 1 public facility are within the 100-year flood zone. The primary cause of flooding in the Galena area is ice jams.

Ice-jam flooding occurs when river ice broken during spring thawing is transported downstream and its downstream movement is blocked in locations where a constriction, a sandbar, or other obstruction such as a sharp meander bend exists (Beltaos, 1990). The blockage prevents ice movement and restricts water flow as the ice jam builds in thickness and length. This subsequently slows the water velocity and produces a rise in water level or backwater effect that propagates upstream from the ice jam. When the ice jam releases, a flood wave propagates downstream.

Significant floods have been reported since 1925, when records of flooding began. In 1945, ice-jam flooding destroyed most of the village. The flood of record is the 1971 ice-jam flood, during which water reached depths of 2.4 m at "Old Town" and 1.9 m at the Galena airport. Most of the town was destroyed by the flood and the new townsite was established 2.4 km to the east. Most of the population, however, still remains in the old townsite (Ecology and Environment Inc., 1992).

Flooding at Galena not only damages structure and roads, but also causes contaminants on the surface of the land to mobilize and move into inadequately sealed wells. Flood waters can reach depths that are higher than the top of well casings. Even for wells that are effectively sealed, flood water may move contaminants into previously uncontaminated areas, where they can then infiltrate into the aquifer.

The flood frequency table for Ruby (table 2) was obtained using the graph of discharge to drainage area for the Yukon River developed by Jones and Fahl (1994, fig. 10). The drainage area for the Yukon River basin upstream from Galena is about 716,800 km^2 (Federal Emergency Management Agency, 1983). The flood frequency curves developed by Jones and Fahl apply only to floods generated by rainfall and snowmelt runoff and are not applicable to ice-jam floods.

Table 2. Estimated peak discharges of the Yukon River at Ruby for various recurrence intervals

[Discharge is in cubic meters per second]

Recurrence interval						
2 years	5 years	10 years	25 years	50 years	100 years	500 years
18,700	23,100	25,600	28,500	30,300	32,300	36,000

Flood Protection Measures

The Air Force began construction of a flood containment dike (fig. 2) north of "Old Town" in 1944 after the runway and camp area were inundated by an ice-jam flood during the spring. An ice-jam flood in May 1945 overtopped the dike which was subsequently raised another 4.3 m. The flood containment dike surrounding the Air Force Station was constructed at an elevation of 41.5 m. The Federal Emergency Management Agency (1983) considers the flood containment dike as adequate protection from the 100-year flood.

The base flood elevation for ice-jam floods is about 40.8 m at "Old Town" and about 41.0 m in "New Town." Both townsites, however, are located outside of the flood containment dike (U.S. Army Corps of Engineers, 1983, 1986, 1993).

Ground Water

Ground-water recharge to the Galena area occurs from precipitation, infiltration, and ground-water movement from areas near the slopes of the surrounding highlands. Ground-water discharges into local surface-water streams and sloughs which drain into the Yukon River. Ground water-movement is influenced by impermeable lenses or layers of permafrost. The area-wide variability in the presence of permafrost accounts for the local occurrence of sub-, intra-, and suprapermafrost ground water (Woodward-Clyde Consultants, 1989). Previous studies on the subject of ground water and permafrost include reports by Cederstrom and others (1953), Hopkins and others (1955), and Williams and Waller (1963).

Alluvium is probably unfrozen beneath the bed of the Yukon River throughout its course in Alaska and is probably frozen beneath the flood plain adjacent to the river. Frozen alluvium is probably thickest beneath sections of the flood plain and low terraces that are away from present rivers and lakes. Most of the wells in the Yukon River villages from Canada to the Bering Sea are along the riverbank where the warming effect of the river affects the thickness of frozen ground (Smith, 1986). Water levels, where observed in these wells, fluctuate with the stage of the river.

Frozen alluvium forms wedge-shaped masses that are thin near the river, but thicken up to 34 m in the northern part of the Galena AFS (Péwé, 1948; Woodward-Clyde Consultants, 1989). Suprapermafrost ground water was found at an average depth of 6 m in a site contamination study by Woodward-Clyde Consultants (1989). Subpermafrost ground water confined beneath the frozen ground rises to a static level between 6 to 12 m below the ground surface. Campion AFS, on a high terrace 23 km east of Galena, is supplied by wells drilled though frozen silt, clay, and sand to depths of 123 to 129 m where they reached unfrozen water-bearing gravel (Williams, 1970). Water confined beneath the frozen ground rose approximately 46 m above the base of the permafrost in these wells (Williams, 1970).

Ground-Water and Surface-Water Interaction

The variations in river stage and ground-water elevations at Galena will generally follow the pattern of the discharge hydrograph for the Yukon River at Ruby (fig. 3). Continuous streamflow records are not available for the Yukon River at Galena; however, the mean daily discharge record for the period 1956-78 is available for the Yukon River at Ruby located about 80 km upstream from Galena (U.S. Geological Survey, 1957-79). The stream-gaging station at Ruby has a record of discharge representing approximately 671,000 km^2 of drainage area (Federal Emergency Management Agency, 1983). The Ruby gaging station represents about 94 percent of the Yukon River drainage basin upstream from Galena.

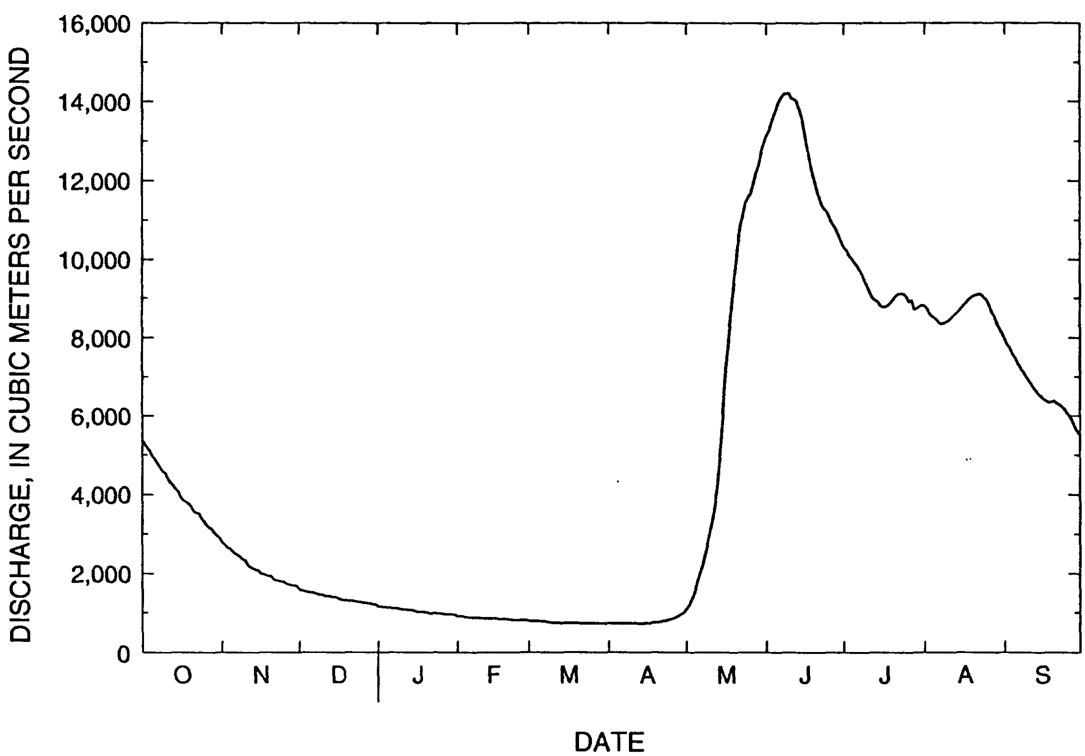

Figure 3. Mean daily discharge for the Yukon River at Ruby, water years 1966-76.

Adjacent to the river, shallow ground-water flows into and out of the riverbanks depending on the elevation of water in the river relative to the water table. Seasonally, the discharge of the river will fluctuate from a maximum in late May or early June to a minimum in late April or early May (fig. 3). The river also rises during late-summer rainstorms. The water table generally rises and falls in response to these river fluctuations and is attenuated with distance from the river. This flow of water into and out of the aquifer in response to changing stage of the river is termed "bank storage effects" (Linsley and others, 1982). Bank storage effects have not been studied at Galena. Because the airport, FAA facilities and village utilities are adjacent to the river, bank storage effects could have a significant influence on the movement and extent of contamination.

Simulation of Ground-Water Movement

A mathematical ground-water model approximates the directions and rates of water movement through an aquifer system. Partial-differential equations thought to represent the physical processes of ground-water flow are solved by the model and require that the hydraulic properties and boundaries be defined for the modeled area. The aquifer system was overlain by a grid, which was extended in the third dimension to form blocks or "cells." The cells form rows, columns, and layers. Each cell in the model grid represents a block of permeable material within which the hydraulic properties are assumed to be uniform. Any specific cell may be referenced by citing its row, column, and layer location. The limits of the modeled area were selected to include or nearly coincide with natural flow boundaries. The "boundary surface" of the flow region corresponds to identifiable hydrogeologic features at which some characteristic of ground-water flow can be described. For the conceptual model, these features could be a drainage divide, a river bank, or artificially induced (depending on the modelled area). In cases where there is no apparent natural flow boundaries, such as in an open flood plain, the model grid was extended far enough away from the area of study so the error created from the artificial boundary is minimized.

Ground-water flow in the Galena area was simulated using a computer program, MODFLOW (McDonald and Harbaugh, 1988), as a simple steady-state conceptual model. Under steady-state conditions, the recharge to the system is equal to the discharge from the system, no water is derived from storage, and there is no change in head with time. Output from MODFLOW was graphically presented using METAZ, a contouring program specifically designed for MODFLOW and developed by S.A. Leake and R.T. Hanson (U.S. Geological Survey, written commun., 1993). The conceptual model requires that the hydraulic head at the aquifer boundaries is known, all recharge and discharge is assumed to occur at the river, flow is horizontal, and the aquifer materials are homogeneous and isotropic. The data, assumptions, justifications, and data sources used in the model packages are summarized in appendix 1. An example output file of the model is shown in appendix 2. The purpose of undergoing a mathematical ground-water simulation was to identify hydrologic features that may have a significant influence on the ground-water flow direction in the Galena area. Two ground-water flow simulations were used to identify features having the greatest influence on ground-water flow direction.

The westward-flowing Yukon River is an important factor in establishing the general westward direction of ground-water flow. The hydraulic gradient of the aquifer is strongly influenced by the surface-water gradient of the Yukon River which was measured by the U.S. Army Corps of Engineers (1983). The hydraulic continuity of the unconsolidated alluvium away from the river will have a profound influence on the directions of ground-water flow. If the permafrost in the area is discontinuous, the unconsolidated alluvium will behave like an aquifer. If it is continuous, the unconsolidated alluvium will act as a confining layer.

The first simulation is based on the assumption that permafrost north of Galena is continuous and blocks northward ground-water flow. The thawed alluvium near the Yukon River was simulated as a narrow, strip aquifer running parallel to the Yukon River. The strip aquifer was estimated to be approximately 500 m in width along the north bank of the Yukon River. This aquifer width was extended to about 800 m at cleared sites in the vicinity of Galena to reflect the thawing conditions of vegetation-free areas. Under steady-state conditions and assuming the conditions stated above, the simulated ground-water flow direction at Galena is generally towards the west-southwest (fig. 4), parallel to the river.

A second simulation was based on the assumption that the permafrost near Galena is not a barrier to ground-water flow north of the Yukon River. In this simulation, Bear Creek (fig. 1), a northward flowing stream system located immediately north of Galena, gains water from the shallow aquifer and may have a significant influence on ground-water flow directions at Galena. In the absence of permafrost, the influence of the Bear Creek drainages on ground-water flow depends primarily on the vertical hydraulic conductance of its streambed. Higher streambed conductances permit greater quantities of water to flow between the aquifer and the stream.

Two model runs were performed simulating the Bear Creek drainage with low and high streambed conductances. The model simulation of low streambed conductance shows that ground water at Galena remains flowing generally in a southwestward direction, towards the Yukon River (fig. 5). The model simulation of high streambed conductance shows that ground water at Galena now flows in a westward to northwestward direction, towards the Bear Creek drainage (fig. 6). The simulations of low and high streambed conductance show that ground-water flow can be influenced, up to a 90 degree difference in direction, by altering the model input of the hydraulic properties of Bear Creek. Stream property information such as discharge, depth, stage, bed thickness, bed slope, and permafrost conditions are needed to refine the definition of the effects of the Bear Creek drainage on the ground-water flow in the Galena area. These shallow ground-water models, however, define the constraints in possible flow direction.

Three model simulations, each using different assumptions of the continuity of the permafrost and streambed conductance (figs. 4, 5, and 6), illustrate the importance of field investigations to identify the role of permafrost and the hydraulic connection between Bear Creek and the aquifer. Without field data, flow directions can not be ascertained exactly, but can only be described generally on the basis of assumed boundary conditions.

DRINKING WATER

Present Drinking Water Supplies

Residents of Galena obtain their drinking water from wells (U.S. Army Corps of Engineers, 1987), which are owned by the military, the municipal government, and other institutions. The Galena AFS obtained its water supplies from two 60-m deep wells constructed into the alluvium near the banks of the Yukon River. A U.S. Army Corps of Engineers report (appendix 3) describes an early contaminant rehabilitation study on one of the two primary wells used by the Air Force. The two wells provided a domestic water supply for approximately 300 personnel at the Air Force station. The water wells at the airport have been found to contain petroleum and chlorinated solvents (Woodward-Clyde Consultants, 1989). As a result of this contamination, two wells serving the air passenger terminals have been abandoned.

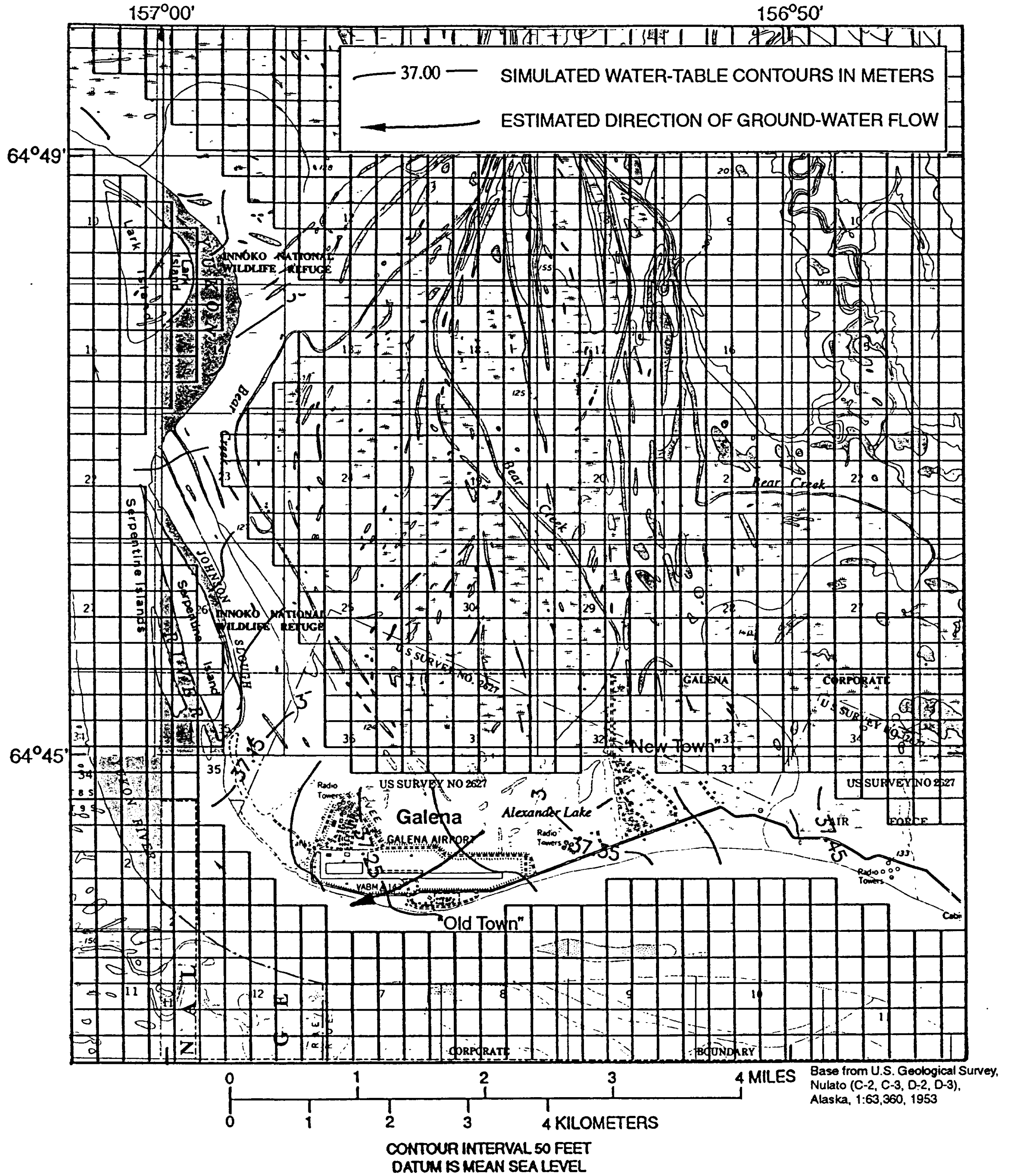

Figure 4. Simulated water-table contours and estimated flow direction of shallow ground water with continuous permafrost effects in the Galena area.

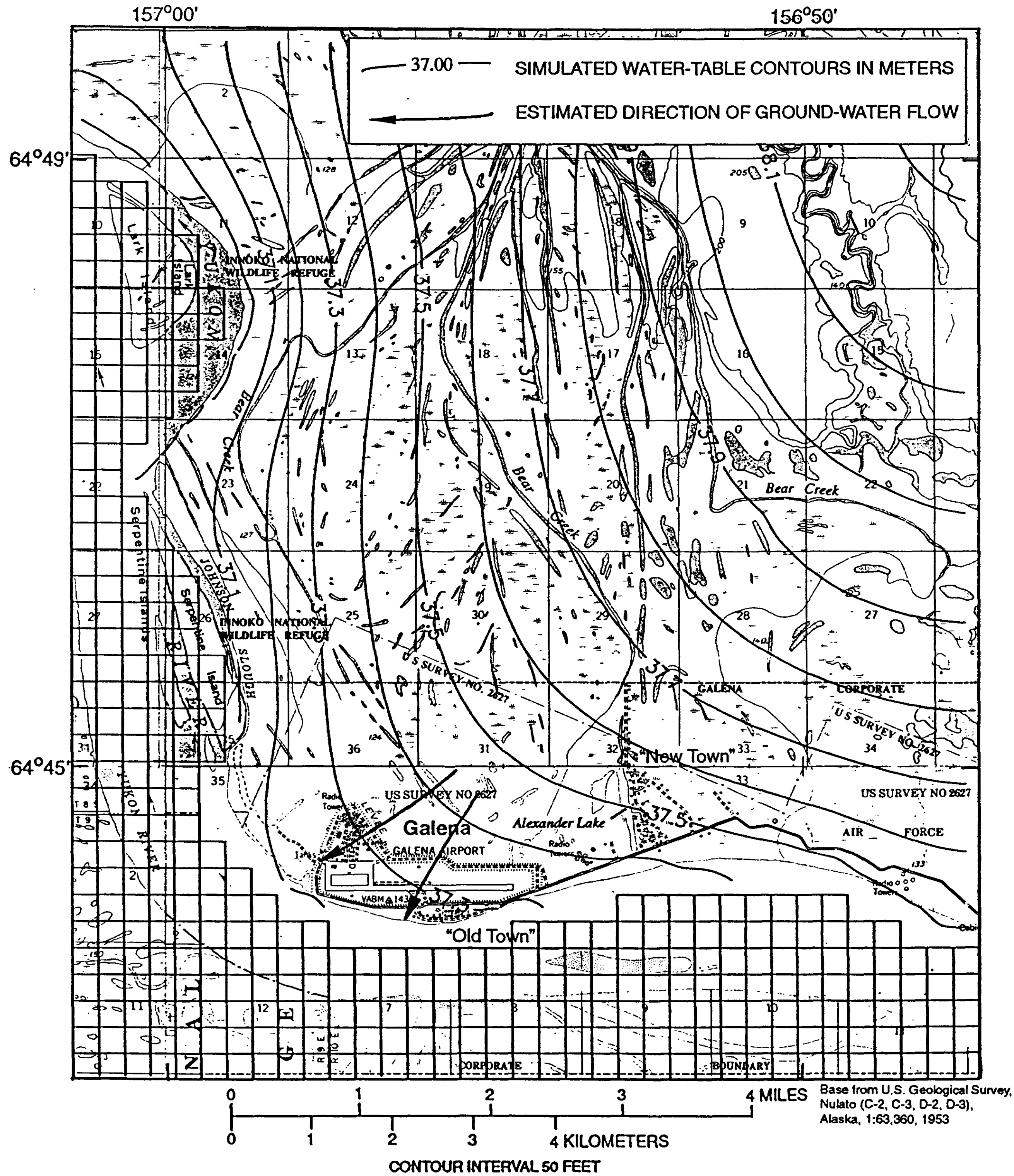

Figure 5. Simulated water-table contours and estimated flow direction of shallow ground water with no permafrost effects and low streambed conductance in the Galena area.

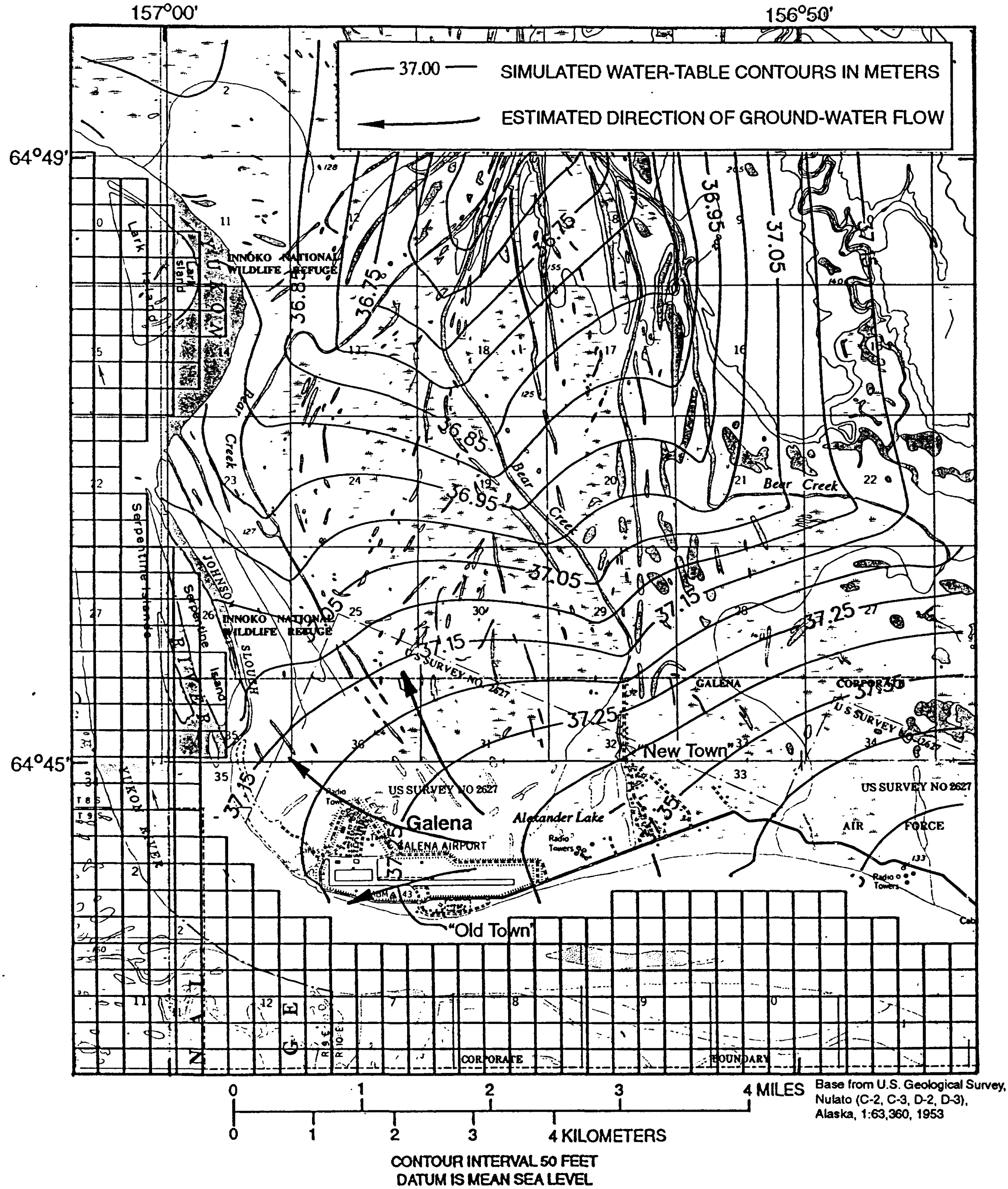

Figure 6. Simulated water-table contours and estimated flow direction of shallow ground water with no permafrost effects and high streambed conductance in the Galena area.

The village of Galena operates its own municipal water system. Drinking water is obtained from a 47-m drilled well with a 15.2-cm diameter steel casing. The water is pumped from the well to the water-treatment facility and then stored in a 98,400-L wood stave storage tank (Fison and Associates, 1987). Water is distributed to a central watering point (washeteria) and by a pipe system primarily to the newer homes in the area.

Quality of Present Supplies

Williams (1970) characterized the water quality of ground water in permafrost regions. Permafrost may have a strong influence on the water quality in the area. Water found above the permafrost (suprapermafrost water) is generally unpotable unless treated extensively. Usually found within 1 to 8 m of the surface, it commonly has a high mineral and (or) organic content and is susceptible to surface contamination. The quantity of water from this source is often low and unreliable. Water found below permafrost (subpermafrost water) is generally deficient in dissolved oxygen. As a result, high concentrations of some minerals are present, such as iron and manganese, which are soluble under these conditions. Subpermafrost ground water is commonly hard and occasionally contains dissolved organic substances (Williams, 1970).

Sporadic records on the water quality in the Galena area are available from the U.S. Public Health Service for the periods 1977-78 (appendix 4), from the USGS for the periods 1959-70 (appendix 5), and from the U.S. Army Corps of Engineers for 1963 (appendix 6). Analysis of untreated samples taken from various locations in Galena indicated an average silica content of 31 mg/L, an average hardness as $CaCO_3$ of 214 mg/L, and an average iron content of 2.2 mg/L. Silica and hardness may create scale in plumbing and boilers but are of little health concern to most users. The average iron content for Galena wells is higher than the 0.30 mg/L secondary maximum contaminant level regulations set by the USEPA (1993) for drinking water. A high iron content, however, does not prohibit this water from being used for drinking.

Alternative Drinking Water Sources

Information on alternative drinking-water sources in the Galena area is needed in order to plan actions that would be taken if the present drinking-water source became contaminated. Alternative sources might be a nearby surface-water source or aquifers that are separated from the present water-supply aquifer by a tight confining layer. The aquifer system at Galena has not been mapped in sufficient detail to define individual aquifers and confining layers. It is possible that multiple aquifers exist, separated by a permafrost confining layer. The areal continuity of the permafrost is uncertain, however, as is its role in inhibiting movement of ground water and possibly contaminants to the subpermafrost aquifer.

According to Elias and Vosburgh (1946), Alexander Lake (fig. 1), located near "New Town," could be a perennial supply of water. Other surface-water bodies in the Galena area, such as ponds and sloughs, may not be viable alternatives to ground water as a drinking-water source. If the water body is too shallow, it could potentially freeze completely in the winter. The U.S. Army Corps of Engineers has performed a feasibility study for an infiltration gallery at the Galena AFS (appendix 6). To date, however, infiltration galleries have not been utilized at Galena. The Yukon River is a possible water source for Galena, but the cost of water treatment is significant. Flowing ice during freeze-up and break-up periods may damage or destroy water intake structures (Smith, 1986). The Yukon River represents a nearly inexhaustible supply of water for the village of Galena. The estimated water use for Galena is about 60,900 L/d. Mean annual flow of the Yukon River at Galena is about 4,600 m^3/s (U.S. Geological Survey, 1957-76). This discharge is more than 6.5 x 10^6 times the water usage in the village of Galena and more than 360 times the quantity of water used in the entire State of Alaska in 1990 (Solley and others, 1993).

Quality of Alternative Sources

Alexander Lake may be a continuous source of water; however, no records of water quality data are available. Water quality of shallow arctic lakes in winter may decline as impurities such as salts and soluble inorganics become concentrated in the water under the ice (Smith, 1986).

The water quality of the Yukon River varies with the season and is generally better in the winter and than in the summer. Water from the Yukon River in winter is usually clear and concentrations of sediment are reduced. The high sediment concentrations in the Yukon River during the summer, however, would require treatment. Operation, development, and maintenance expenses would be high compared to those of existing supplies.

Water quality measured on the Yukon River at the Ruby gaging station is probably similar to the water quality at Galena. Analysis of water sample data for the period of record for the Yukon River at the Ruby station shows that iron content is typically below 0.30 mg/L, but a peak of 1.86 mg/L was recorded on July 9, 1967 (appendix 7). Maximum and minimum sediment concentrations of 867 mg/L and 2 mg/L correlate with high and low river flow conditions (appendix 7).

SUMMARY

Galena serves as the transportation, government, and commercial center for the western Interior of Alaska and depends on the airport or the river for transportation. The subsistence lifestyle of the Native residents makes them dependent upon a sustainable environment. Frequent ice-jam flooding is hazardous to residents and their property. The ground-water flow is strongly influenced by the Yukon River and the continuity of permafrost in the area. The Yukon River could be an alternative drinking water supply, but may not be economical to develop and water intakes may be susceptible to damage from river ice flow. Local lakes that are deep enough not to freeze completely may also provide alternative sources of drinking water.

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APPENDIX 1

Data, assumptions, justifications, and data sources used in the MODFLOW packages

Ground-water flow at Galena, Alaska - Modflow Notes

BAS Package

Packages Used: BAS, BCF, OC, PCG2, RCH, RIV, STR
- STR package not used in the Continuous permafrost model

Single-layer model
Grid size: 35 columns x 40 rows
IBOUND:
Continuous perfrost model run:
- cells south of RIV nodes set at no-flow (0)
- cells three to four cells north of RIV nodes set at no-flow (0)
- all other cells set at variable head (1)

No permafrost, low stream conductivity run:
- cells south of RIV nodes set at no-flow (0)
- all other cells set at variable head (1)

No permafrost, high stream conductivity run:
- cells south of RIV nodes set at no-flow (0)
- all other cells set at variable head (1)

Anisotropy: 1.00

BCF Package

Layer thickness: 200 ft (-80 ft below MSL)
DELR: 1056 ft (0.2 mile)
DELC: 1056 ft
Hydraulic Conductivity (K) along columns and rows: 80 ft/day

RCH Package

Net annual recharge (recharge minus evapotranspiraton): 0.2300E-03 ft/day (1 inch/year)

RIV Package

River Reaches: 57
Slope of Bottom Elevation was obtained from U.S. Army Corps of Engineers (COE) (1981).
River Stage was estimated from USGS Nulato C-2, C-3, D-2, and D-3, 1:63,360 scale maps
River profile was extended by above and below the original COE (1981) survey
River Conductance: 0.3300E+08 ft2/day (K = 4.0E-02 cm/s), estimated
Reach Length (L): 1056 ft, unit cell size
Reach Width (W): 1056, unit cell size
Reach riverbed depth (D): 3 ft, estimated
Conductivity Equation: (LW/D)K
River Stage Height estimated to be 49 ft higher than bottom elevation, COE (1981)

STR Package

Stream modelled was Bear Creek, known locally as Crow Creek.
Assumed to be northward flowing
Assumed that upper reaches are affected by Yukon River stage height
Number of stream Reaches: 77
Number of stream Segments: 5
Streambed Conductance:
- low streambed conductance model value: 1.5E02 ft^2/day
- high steambed conductance model value: 1.5E03 ft^2/day

Reach Length (L): 1056 ft, unit cell size
Reach Width (W): 50, estimated
Reach streambed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Stream slope: 0.00008
- estimated from USGS Nulato C-2, C-3, D-2, and D-3, 1:63,360 scale maps

Stream bed thickness: 0.5 ft, estimated
Stream bed bottom elevation: 0.5 ft below streambed top elevation, estimated
Streambed top elevation: 4 ft below stream stage, estimated
Stream stage: estimated from USGS Nulato C-2, C-3, D-2, and D-3, 1:63,360 scale maps

APPENDIX 2

Example output file of the U.S. Geological Survey

Modular Finite-Difference Ground-Water Model

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                         U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER MODEL

TWO DIMENSIONAL MODEL OF GROUND-WATER FLOW AT GALENA                                   1 layer, 40 rows, 35 columns, 0.2 mile grid
   1 LAYERS          40 ROWS          35 COLUMNS
  1 STRESS PERIOD(S) IN SIMULATION
MODEL TIME UNIT IS DAYS

I/O UNITS:
ELEMENT OF IUNIT:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
        I/O UNIT: 31  0  0 34  0  0  0 38  0  0  0 42 39  0  0  0  0 35  0  0  0  0  0  0

BAS1 -- BASIC MODEL PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT  5
ARRAYS RHS AND BUFF WILL SHARE MEMORY.
START HEAD WILL BE SAVED
   12679 ELEMENTS IN X ARRAY ARE USED BY BAS
   12679 ELEMENTS OF X ARRAY USED OUT OF  350000

BCF2 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 2, 7/1/91 INPUT READ FROM UNIT 31
STEADY-STATE SIMULATION
CELL-BY-CELL FLOWS WILL BE RECORDED ON UNIT 21
HEAD AT CELLS THAT CONVERT TO DRY=  0.00000E+00
WETTING CAPABILITY IS NOT ACTIVE
     LAYER  AQUIFER TYPE
     -------------------
        1         1
    2801 ELEMENTS IN X ARRAY ARE USED BY BCF
   15480 ELEMENTS OF X ARRAY USED OUT OF  350000

RCH1 -- RECHARGE PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 38
OPTION 1 -- RECHARGE TO TOP LAYER
CELL-BY-CELL FLOW TERMS WILL BE RECORDED ON UNIT 21
    1400 ELEMENTS OF X ARRAY USED FOR RECHARGE
   16880 ELEMENTS OF X ARRAY USED OUT OF  350000

RIV1 -- RIVER PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 34
MAXIMUM OF   57 RIVER NODES
CELL-BY-CELL FLOWS WILL BE RECORDED ON UNIT 21
     342 ELEMENTS IN X ARRAY ARE USED FOR RIVERS
   17222 ELEMENTS OF X ARRAY USED OUT OF  350000

PCG2 -- CONJUGATE GRADIENT SOLUTION PACKAGE, VERSION 2, 5/1/88
MAXIMUM OF  50 CALLS OF SOLUTION ROUTINE
MAXIMUM OF  10 INTERNAL ITERATIONS PER CALL TO SOLUTION ROUTINE
MATRIX PRECONDITIONING TYPE :    1
   9600 ELEMENTS IN X ARRAY ARE USED BY PCG
  26822 ELEMENTS OF X ARRAY USED OUT OF 350000

STRM -- STREAM PACKAGE, VERSION 2, 12/18/90 INPUT READ FROM UNIT 35
MAXIMUM OF   77 STREAM NODES

NUMBER OF STREAM SEGMENTS IS     5

NUMBER OF STREAM TRIBUTARIES IS     2


STREAM STAGES WILL BE CALCULATED USING A CONSTANT OF**********
    1257 ELEMENTS IN X ARRAY ARE USED FOR STREAMS
   28079 ELEMENTS OF X ARRAY USED OUT OF 350000

TWO DIMENSIONAL MODEL OF GROUND-WATER FLOW AT GALENA                                   1 layer, 40 rows, 35 columns, 0.2 mile grid


                                    BOUNDARY ARRAY FOR LAYER  1 WILL BE READ ON UNIT 61 USING FORMAT:  (35I2)
                              ------------------------------------------------------------------------------------------

            1          2          3          4          5          6          7          8          9         10
           11         12         13         14         15         16         17         18         19         20
           21         22         23         24         25         26         27         28         29         30
           31         32         33         34         35
 ...............................................................................................................

   1           1          1          1          1          1          1          1          1          1          1
               1          1          1          1          1          1          1          1          1          1
               1          1          1          1          1          1          1          1          1          1
               1          1          1          1          1

   2           1          1          1          1          1          1          1          1          1          1
               1          1          1          1          1          1          1          1          1          1
```

	1	1	1	1	1					
19	0	0	0	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
20	0	0	0	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
21	0	0	0	0	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
22	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
23	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
24	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
25	0	0	0	0	0	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
26	0	0	0	0	0	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
27	0	0	0	0	0	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
28	0	0	0	0	0	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
29	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
30	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
31	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
32	0	0	0	0	0	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
33	0	0	0	0	0	0	0	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1					
34	0	0	0	0	0	0	0	0	1	1
	1	1	1	1	1	1	1	1	1	1
	1	0	0	0	0	0	0	0	0	0
	1	1	1	1	1					

	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
9	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
10	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
11	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
12	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
13	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
14	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
15	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
16	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
17	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
18	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
19	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
20	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
21	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
22	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
23	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	123.2					
24	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0
	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0

121.0 121.0 121.0 121.0 123.2

HEAD PRINT FORMAT IS FORMAT NUMBER 3 DRAWDOWN PRINT FORMAT IS FORMAT NUMBER 3

HEADS WILL BE SAVED ON UNIT 20 DRAWDOWNS WILL BE SAVED ON UNIT 0

OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP

COLUMN TO ROW ANISOTROPY = 1.000000

DELR WILL BE READ ON UNIT 31 USING FORMAT: (10F5.0) 3

1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0					

DELC WILL BE READ ON UNIT 31 USING FORMAT: (10F5.0) 3

1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0
1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0	1056.0

HYD. COND. ALONG ROWS = 80.00000 FOR LAYER 1

BOTTOM = -80.00000 FOR LAYER 1

SOLUTION BY THE CONJUGATE-GRADIENT METHOD

MAXIMUM NUMBER OF CALLS TO PCG ROUTINE = 50
MAXIMUM ITERATIONS PER CALL TO PCG = 10
MATRIX PRECONDITIONING TYPE = 1
RELAXATION FACTOR (ONLY USED WITH PRECOND. TYPE 1) = 0.10000E+01
PARAMETER OF POLYMOMIAL PRECOND. = 2 (2) OR IS CALCULATED : 0
HEAD CHANGE CRITERION FOR CLOSURE = 0.10000E-01
RESIDUAL CHANGE CRITERION FOR CLOSURE = 0.10000E-01
PCG HEAD AND RESIDUAL CHANGE PRINTOUT INTERVAL = 1
PRINTING FROM SOLVER IS LIMITED(1) OR SUPPRESSED (>1) = 0

STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

RECHARGE = 0.2300000E-03

57 RIVER REACHES

LAYER	ROW	COL	STAGE	CONDUCTANCE	BOTTOM ELEVATION	RIVER REACH
1	5	1	120.8	0.3300E+08	71.80	1
1	6	2	120.9	0.3300E+08	71.90	2
1	6	3	120.9	0.3300E+08	71.90	3
1	7	4	121.0	0.3300E+08	72.00	4
1	8	5	121.0	0.3300E+08	72.00	5
1	9	6	121.0	0.3300E+08	72.00	6
1	10	6	121.1	0.3300E+08	72.10	7
1	11	7	121.1	0.3300E+08	72.10	8
1	12	7	121.2	0.3300E+08	72.20	9
1	13	6	121.2	0.3300E+08	72.20	10
1	14	6	121.2	0.3300E+08	72.20	11
1	15	5	121.3	0.3300E+08	72.30	12

1	17	17	2	9	0.0000E+00	122.8	150.0	118.3	118.8
1	16	17	2	10	0.0000E+00	122.8	150.0	118.3	118.8
1	16	16	2	11	0.0000E+00	122.7	150.0	118.2	118.7
1	15	16	2	12	0.0000E+00	122.6	150.0	118.1	118.6
1	14	15	2	13	0.0000E+00	122.5	150.0	118.0	118.5
1	13	15	2	14	0.0000E+00	122.4	150.0	117.9	118.4
1	12	15	2	15	0.0000E+00	122.3	150.0	117.8	118.3
1	11	15	2	16	0.0000E+00	122.2	150.0	117.7	118.2
1	10	16	2	17	0.0000E+00	122.2	150.0	117.7	118.2
1	9	16	2	18	0.0000E+00	122.1	150.0	117.6	118.1
1	8	16	2	19	0.0000E+00	122.0	150.0	117.5	118.0
1	7	16	2	20	0.0000E+00	121.9	150.0	117.4	117.9
1	7	16	3	1	-1.000	121.9	150.0	117.4	117.9
1	6	17	3	2	0.0000E+00	121.8	150.0	117.3	117.8
1	5	17	3	3	0.0000E+00	121.7	150.0	117.2	117.7
1	4	17	3	4	0.0000E+00	121.7	150.0	117.2	117.7
1	3	17	3	5	0.0000E+00	121.6	150.0	117.1	117.6
1	2	18	3	6	0.0000E+00	121.5	150.0	117.0	117.5
1	21	34	4	1	0.0000E+00	123.8	150.0	119.3	119.8
1	20	33	4	2	0.0000E+00	123.7	150.0	119.2	119.7
1	19	32	4	3	0.0000E+00	123.6	150.0	119.1	119.6
1	19	31	4	4	0.0000E+00	123.5	150.0	119.0	119.5
1	19	30	4	5	0.0000E+00	123.4	150.0	118.9	119.4
1	19	29	4	6	0.0000E+00	123.3	150.0	118.8	119.3
1	19	28	4	7	0.0000E+00	123.3	150.0	118.8	119.3
1	19	27	4	8	0.0000E+00	123.2	150.0	118.7	119.2
1	19	26	4	9	0.0000E+00	123.1	150.0	118.6	119.1
1	19	25	4	10	0.0000E+00	123.0	150.0	118.5	119.0
1	18	25	4	11	0.0000E+00	122.9	150.0	118.4	118.9
1	17	25	4	12	0.0000E+00	122.8	150.0	118.3	118.8
1	16	25	4	13	0.0000E+00	122.8	150.0	118.3	118.8
1	15	25	4	14	0.0000E+00	122.7	150.0	118.2	118.7
1	14	24	4	15	0.0000E+00	122.6	150.0	118.1	118.6
1	13	24	4	16	0.0000E+00	122.5	150.0	118.0	118.5
1	12	24	4	17	0.0000E+00	122.4	150.0	117.9	118.4
1	11	24	4	18	0.0000E+00	122.3	150.0	117.8	118.3
1	10	24	4	19	0.0000E+00	122.2	150.0	117.7	118.2
1	9	24	4	20	0.0000E+00	122.2	150.0	117.7	118.2
1	8	23	4	21	0.0000E+00	122.1	150.0	117.6	118.1
1	7	22	4	22	0.0000E+00	122.0	150.0	117.5	118.0
1	6	21	4	23	0.0000E+00	121.9	150.0	117.4	117.9
1	5	20	4	24	0.0000E+00	121.8	150.0	117.3	117.8
1	4	20	4	25	0.0000E+00	121.7	150.0	117.2	117.7
1	4	19	4	26	0.0000E+00	121.7	150.0	117.2	117.7
1	3	18	4	27	0.0000E+00	121.6	150.0	117.1	117.6
1	2	18	4	28	0.0000E+00	121.5	150.0	117.0	117.5
1	2	18	5	1	-1.000	121.5	150.0	117.0	117.5
1	1	18	5	2	0.0000E+00	121.4	150.0	116.9	117.5

LAYER	ROW	COL	SEGMENT NUMBER	REACH NUMBER	STREAM WIDTH	STREAM SLOPE	ROUGH COEF.
1	24	10	1	1	50.00	0.7800E-04	0.3000E-01
1	23	10	1	2	50.00	0.7800E-04	0.3000E-01
1	22	9	1	3	50.00	0.7800E-04	0.3000E-01
1	21	9	1	4	50.00	0.7800E-04	0.3000E-01
1	20	8	1	5	50.00	0.7800E-04	0.3000E-01
1	19	8	1	6	50.00	0.7800E-04	0.3000E-01
1	18	7	1	7	50.00	0.7800E-04	0.3000E-01
1	17	7	1	8	50.00	0.7800E-04	0.3000E-01
1	16	7	1	9	50.00	0.7800E-04	0.3000E-01
1	15	8	1	10	50.00	0.7800E-04	0.3000E-01
1	14	8	1	11	50.00	0.7800E-04	0.3000E-01
1	13	9	1	12	50.00	0.7800E-04	0.3000E-01
1	13	10	1	13	50.00	0.7800E-04	0.3000E-01
1	13	11	1	14	50.00	0.7800E-04	0.3000E-01
1	12	12	1	15	50.00	0.7800E-04	0.3000E-01
1	11	12	1	16	50.00	0.7800E-04	0.3000E-01
1	10	13	1	17	50.00	0.7800E-04	0.3000E-01
1	9	14	1	18	50.00	0.7800E-04	0.3000E-01
1	9	15	1	19	50.00	0.7800E-04	0.3000E-01
1	8	16	1	20	50.00	0.7800E-04	0.3000E-01
1	7	16	1	21	50.00	0.7800E-04	0.3000E-01
1	25	22	2	1	50.00	0.7800E-04	0.3000E-01
1	24	22	2	2	50.00	0.7800E-04	0.3000E-01
1	23	21	2	3	50.00	0.7800E-04	0.3000E-01
1	22	21	2	4	50.00	0.7800E-04	0.3000E-01
1	21	20	2	5	50.00	0.7800E-04	0.3000E-01
1	20	19	2	6	50.00	0.7800E-04	0.3000E-01
1	19	18	2	7	50.00	0.7800E-04	0.3000E-01
1	18	17	2	8	50.00	0.7800E-04	0.3000E-01

RESIDUAL	LAYER,ROW,COL	RESIDUAL	LAYER,ROW,COL	RESIDUAL	LAYER,ROW,COL	RESIDUAL	LAYER,ROW,COL
-0.4273E+06	(1, 35, 34)	-0.1604E+06	(1, 34, 32)	-0.8923E+05	(1, 34, 32)	-0.4170E+05	(1, 34, 31)
-0.1408E+05	(1, 34, 31)	7197.	(1, 1, 34)	-4161.	(1, 2, 33)	-2912.	(1, 34, 35)
-1742.	(1, 34, 35)	-783.1	(1, 34, 35)	-677.4	(1, 34, 35)	-527.2	(1, 34, 35)
-282.9	(1, 34, 35)	-125.7	(1, 34, 35)	-54.63	(1, 34, 35)	-27.04	(1, 34, 32)
-23.89	(1, 34, 32)	-17.60	(1, 35, 33)	-12.29	(1, 35, 33)	-7.435	(1, 35, 33)
-6.653	(1, 35, 33)	-5.754	(1, 35, 33)	-4.123	(1, 34, 32)	-2.546	(1, 34, 32)
-1.536	(1, 35, 33)	-0.9108	(1, 35, 33)	-0.6851	(1, 11, 7)	-0.4910	(1, 11, 7)
-0.3154	(1, 11, 7)	-0.1945	(1, 11, 7)	-0.1807	(1, 11, 7)	-0.1503	(1, 11, 7)
-0.9569E-01	(1, 11, 7)	-0.5782E-01	(1, 22, 6)	-0.3386E-01	(1, 22, 6)	-0.2240E-01	(1, 22, 6)
-0.1676E-01	(1, 22, 6)	-0.1023E-01	(1, 22, 6)	-0.5468E-02	(1, 11, 7)	-0.4930E-02	(1, 11, 7)

HEAD/DRAWDOWN PRINTOUT FLAG = 1   TOTAL BUDGET PRINTOUT FLAG = 0   CELL-BY-CELL FLOW TERM FLAG =21

OUTPUT FLAGS FOR ALL LAYERS ARE THE SAME:

HEAD PRINTOUT	DRAWDOWN PRINTOUT	HEAD SAVE	DRAWDOWN SAVE
1	0	1	0

" CONSTANT HEAD" BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP 1, STRESS PERIOD 1
"FLOW RIGHT FACE " BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP 1, STRESS PERIOD 1
"FLOW FRONT FACE " BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP 1, STRESS PERIOD 1
" RECHARGE" BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP 1, STRESS PERIOD 1
" RIVER LEAKAGE" BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP 1, STRESS PERIOD 1

LAYER	ROW	COLUMN	STREAM NUMBER	REACH NUMBER	FLOW INTO STREAM REACH	FLOW INTO AQUIFER	FLOW OUT OF STREAM REACH	HEAD IN STREAM
1	24	10	1	1	0.000E+00	-408.	408.	119.60
1	23	10	1	2	408.	-424.	833.	119.51
1	22	9	1	3	833.	-414.	0.125E+04	119.41
1	21	9	1	4	0.125E+04	-430.	0.168E+04	119.31
1	20	8	1	5	0.168E+04	-405.	0.208E+04	119.32
1	19	8	1	6	0.208E+04	-419.	0.250E+04	119.22
1	18	7	1	7	0.250E+04	-406.	0.291E+04	119.12
1	17	7	1	8	0.291E+04	-414.	0.332E+04	119.02
1	16	7	1	9	0.332E+04	-418.	0.374E+04	118.92
1	15	8	1	10	0.374E+04	-451.	0.419E+04	118.82
1	14	8	1	11	0.419E+04	-437.	0.463E+04	118.83
1	13	9	1	12	0.463E+04	-481.	0.511E+04	118.73
1	13	10	1	13	0.511E+04	-532.	0.564E+04	118.63
1	13	11	1	14	0.564E+04	-582.	0.622E+04	118.53
1	12	12	1	15	0.622E+04	-626.	0.685E+04	118.43
1	11	12	1	16	0.685E+04	-642.	0.749E+04	118.34
1	10	13	1	17	0.749E+04	-688.	0.818E+04	118.24
1	9	14	1	18	0.818E+04	-716.	0.889E+04	118.24
1	9	15	1	19	0.889E+04	-754.	0.965E+04	118.14
1	8	16	1	20	0.965E+04	-792.	0.104E+05	118.04
1	7	16	1	21	0.104E+05	-808.	0.112E+05	117.95
1	25	22	2	1	0.000E+00	-614.	614.	119.51
1	24	22	2	2	614.	-639.	0.125E+04	119.41
1	23	21	2	3	0.125E+04	-651.	0.190E+04	119.31
1	22	21	2	4	0.190E+04	-660.	0.256E+04	119.32
1	21	20	2	5	0.256E+04	-668.	0.323E+04	119.22
1	20	19	2	6	0.323E+04	-674.	0.391E+04	119.12
1	19	18	2	7	0.391E+04	-676.	0.458E+04	119.03
1	18	17	2	8	0.458E+04	-675.	0.526E+04	118.93
1	17	17	2	9	0.526E+04	-691.	0.595E+04	118.83
1	16	17	2	10	0.595E+04	-693.	0.664E+04	118.83
1	16	16	2	11	0.664E+04	-686.	0.733E+04	118.73
1	15	16	2	12	0.733E+04	-702.	0.803E+04	118.64
1	14	15	2	13	0.803E+04	-694.	0.872E+04	118.54
1	13	15	2	14	0.872E+04	-708.	0.943E+04	118.44
1	12	15	2	15	0.943E+04	-722.	0.102E+05	118.34
1	11	15	2	16	0.102E+05	-738.	0.109E+05	118.24
1	10	16	2	17	0.109E+05	-763.	0.117E+05	118.25
1	9	16	2	18	0.117E+05	-777.	0.124E+05	118.15
1	8	16	2	19	0.124E+05	-791.	0.132E+05	118.05
1	7	16	2	20	0.132E+05	-807.	0.140E+05	117.95
1	7	16	3	1	0.253E+05	-803.	0.261E+05	117.98
1	6	17	3	2	0.261E+05	-848.	0.269E+05	117.88
1	5	17	3	3	0.269E+05	-864.	0.278E+05	117.78
1	4	17	3	4	0.278E+05	-865.	0.287E+05	117.78
1	3	17	3	5	0.287E+05	-880.	0.295E+05	117.68
1	2	18	3	6	0.295E+05	-912.	0.304E+05	117.58
1	21	34	4	1	0.000E+00	-705.	705.	119.81
1	20	33	4	2	705.	-726.	0.143E+04	119.71

12	999.0	999.0	999.0	999.0	999.0	999.0	121.2	121.6	121.9	122.2	122.4	122.6	122.8	123.0	123.2
	123.3	123.5	123.7	123.8	124.0	124.1	124.2	124.3	124.4	124.5	124.6	124.7	124.8	124.9	125.0
	125.0	125.1	125.1	125.1	125.1										
13	999.0	999.0	999.0	999.0	999.0	121.2	121.4	121.7	121.9	122.2	122.4	122.6	122.8	123.0	123.2
	123.3	123.5	123.7	123.8	124.0	124.1	124.2	124.3	124.4	124.5	124.6	124.7	124.8	124.9	124.9
	125.0	125.0	125.1	125.1	125.1										
14	999.0	999.0	999.0	999.0	999.0	121.2	121.5	121.7	122.0	122.2	122.4	122.7	122.8	123.0	123.2
	123.3	123.5	123.7	123.8	123.9	124.1	124.2	124.3	124.3	124.4	124.6	124.6	124.7	124.8	124.9
	124.9	125.0	125.0	125.0	125.0										
15	999.0	999.0	999.0	999.0	121.3	121.4	121.6	121.8	122.1	122.3	122.5	122.7	122.9	123.0	123.2
	123.3	123.5	123.6	123.8	123.9	124.0	124.1	124.2	124.3	124.4	124.5	124.6	124.7	124.7	124.8
	124.9	124.9	124.9	125.0	125.0										
16	999.0	999.0	999.0	121.3	121.4	121.5	121.7	121.9	122.1	122.3	122.5	122.7	122.9	123.0	123.2
	123.3	123.5	123.6	123.8	123.9	124.0	124.1	124.2	124.3	124.3	124.4	124.5	124.6	124.7	124.7
	124.8	124.8	124.9	124.9	124.9										
17	999.0	999.0	121.3	121.4	121.5	121.6	121.8	122.0	122.2	122.3	122.5	122.7	122.9	123.0	123.2
	123.3	123.4	123.6	123.7	123.9	124.0	124.1	124.2	124.2	124.3	124.4	124.5	124.5	124.6	124.7
	124.7	124.8	124.8	124.8	124.8										
18	999.0	999.0	121.4	121.4	121.5	121.7	121.8	122.0	122.2	122.4	122.5	122.7	122.9	123.0	123.2
	123.3	123.4	123.6	123.7	123.8	123.9	124.0	124.1	124.2	124.2	124.3	124.4	124.5	124.5	124.6
	124.6	124.7	124.7	124.7	124.8										
19	999.0	999.0	999.0	121.4	121.6	121.7	121.9	122.0	122.2	122.4	122.6	122.7	122.9	123.0	123.2
	123.3	123.4	123.5	123.7	123.8	123.9	124.0	124.1	124.1	124.2	124.3	124.3	124.4	124.5	124.5
	124.6	124.6	124.6	124.7	124.7										
20	999.0	999.0	999.0	121.5	121.6	121.7	121.8	122.0	122.2	122.4	122.6	122.7	122.9	123.0	123.2
	123.3	123.4	123.5	123.6	123.7	123.8	123.9	124.0	124.1	124.2	124.2	124.3	124.4	124.4	124.5
	124.5	124.5	124.6	124.6	124.6										
21	999.0	999.0	999.0	999.0	121.5	121.6	121.8	122.0	122.2	122.4	122.5	122.7	122.9	123.0	123.1
	123.3	123.4	123.5	123.6	123.7	123.8	123.9	124.0	124.0	124.1	124.2	124.2	124.3	124.4	124.4
	124.4	124.5	124.5	124.5	124.5										
22	999.0	999.0	999.0	999.0	999.0	121.5	121.8	122.0	122.2	122.4	122.5	122.7	122.8	123.0	123.1
	123.2	123.4	123.5	123.5	123.6	123.7	123.8	123.9	124.0	124.1	124.1	124.2	124.2	124.3	124.3
	124.4	124.4	124.4	124.4	124.4										
23	999.0	999.0	999.0	999.0	999.0	121.6	121.8	122.0	122.2	122.3	122.5	122.7	122.8	123.0	123.1
	123.2	123.3	123.4	123.5	123.6	123.7	123.7	123.8	123.9	124.0	124.0	124.1	124.2	124.2	124.3
	124.3	124.3	124.3	124.4	124.4										
24	999.0	999.0	999.0	999.0	999.0	121.6	121.8	122.0	122.1	122.3	122.5	122.7	122.8	122.9	123.1
	123.2	123.3	123.4	123.5	123.5	123.6	123.7	123.8	123.8	123.9	124.0	124.0	124.1	124.1	124.2
	124.2	124.2	124.3	124.3	124.3										
25	999.0	999.0	999.0	999.0	999.0	999.0	121.7	121.9	122.1	122.3	122.5	122.6	122.8	122.9	123.0
	123.1	123.2	123.3	123.4	123.5	123.5	123.6	123.7	123.7	123.8	123.9	123.9	124.0	124.0	124.1
	124.1	124.1	124.2	124.2	124.2										
26	999.0	999.0	999.0	999.0	999.0	999.0	121.7	121.9	122.1	122.3	122.5	122.6	122.7	122.9	123.0
	123.1	123.2	123.2	123.3	123.4	123.5	123.5	123.6	123.7	123.7	123.8	123.8	123.9	123.9	124.0
	124.0	124.0	124.1	124.1	124.1										
27	999.0	999.0	999.0	999.0	999.0	999.0	121.7	121.9	122.1	122.3	122.4	122.6	122.7	122.8	122.9
	123.0	123.1	123.2	123.2	123.3	123.4	123.4	123.5	123.5	123.6	123.7	123.7	123.8	123.8	123.8
	123.9	123.9	123.9	124.0	124.0										
28	999.0	999.0	999.0	999.0	999.0	999.0	121.8	122.0	122.1	122.3	122.4	122.5	122.7	122.8	122.9
	122.9	123.0	123.1	123.2	123.2	123.3	123.3	123.4	123.4	123.5	123.5	123.6	123.6	123.7	123.7
	123.8	123.8	123.8	123.8	123.9										
29	999.0	999.0	999.0	999.0	999.0	121.8	121.9	122.0	122.1	122.3	122.4	122.5	122.6	122.7	122.8
	122.9	122.9	123.0	123.1	123.1	123.2	123.2	123.2	123.3	123.3	123.4	123.4	123.5	123.5	123.6
	123.6	123.7	123.7	123.7	123.7										
30	999.0	999.0	999.0	999.0	999.0	121.8	121.9	122.0	122.1	122.3	122.4	122.5	122.6	122.6	122.7
	122.8	122.8	122.9	122.9	123.0	123.0	123.1	123.1	123.1	123.2	123.2	123.3	123.3	123.4	123.4
	123.5	123.5	123.6	123.6	123.6										
31	999.0	999.0	999.0	999.0	999.0	121.9	121.9	122.0	122.1	122.2	122.3	122.4	122.5	122.6	122.6
	122.7	122.7	122.8	122.8	122.9	122.9	122.9	122.9	123.0	123.0	123.1	123.1	123.1	123.2	123.3
	123.3	123.4	123.4	123.5	123.5										
32	999.0	999.0	999.0	999.0	999.0	999.0	121.9	122.0	122.1	122.2	122.3	122.3	122.4	122.5	122.5

APPENDIX 3

U.S. Army Corps of Engineers

"Report on rehabilitation of well no. 1 water supply well, Galena AP"

REPORT ON REHABILITATION OF
WELL NO. 1 - WATER SUPPLY WELL
GALENA AP

Corps of Engineers
U. S. Army Engineer District, Alaska
Anchorage, Alaska

Prepared by
Foundations and Materials Branch
31 October 1963

REPORT ON REHABILITATION OF
WELL NO. 1 - WATER SUPPLY WELL
GALENA AP

1. REFERENCE:

Directive No. NPD-2, Job No. Galena AP-64-MRA & MC-AF, dated 25 July 1963.

2. SCOPE OF REPORT:

This report covers the rehabilitation and subsequent testing of Well No. 1 at Galena AP. Well No. 1 had not been in use for several years, because of a reported but unproved contamination by petroleum products, with the result that the base water supply system was completely dependent on one well (Well No. 2 at Bldg 1578, the water treatment building). In order to eliminate this dependence on a single well, it was decided to rehabilitate and reactivate Well No. 1. Rehabilitation of the well was authorized as set forth in Par. 1 above, and the rehabilitation work was performed by personnel of the Foundations and Materials Branch, USAED Alaska.

3. DESCRIPTION OF WELL:

Well No. 1 is located at coordinates N 101,575; E 98,265, with an original ground elevation of approximately 120 ft MSL. The well is in the southeast corner of a lean-to structure on the east side of the fire station, the F.F. elevation of the lean-to being within a few inches of the original ground elevation. Access to the well is attained through a hatch in the roof of the lean-to. The well was drilled in 1944 under the direction of the CAA (now FAA), and was cased throughout its entire depth with 6-inch diameter casing. The total depth of the well was reported to be 210 ft, and the old CAA records indicate that a well screen was scheduled for installation at the bottom of the well. No records could be found pertaining to the extent of development of the well, but the well was reported to have been test-pumped at a rate of 13 gpm with a drawdown of 0.8 ft. At the time the rehabilitation work was started the well was equipped with a Jacuzzi jet pump, type 75-T-44M, serial No. 50290, with a 7.5 HP electric motor (220 V, 3 phase, 1800 RPM). This pump had been installed in the well at some time prior to 1954. The electric wires to the pump installation had been removed at some time in the past, and there was no way of activating the pump motor without extending new electric lines to the well location.

4. PRELIMINARY PUMPING TEST:

The Alaska Air Command had requested that rehabilitation of the well commence by performing a 72-hour pumping test with the old Jacuzzi jet pump, in order to determine the extent of fuel-oil contamination, if any, of the water in the aquifer zone, and to determine if the specific yield of the well was sufficiently high and the degree of contamination sufficiently low to render feasible any further efforts at rehabilitation. Therefore, an electric power line was extended to the well, the pump activated, and a pumping test was made. Pumping was started at 10:00 a.m. 7 June 1963 and continued steadily for 70 hours until 8:00 a.m. 10 June 1963. Pumping was carried on at a rate of 46 gpm, the maximum production rate of which the Jacuzzi pump was capable, and the drawdown at this rate was found to be about 3 feet. Details of the pumping test are set forth in Table 1. The pumping rate was determined by collecting the discharge water in a container of known capacity and measuring the length of time 46 gpm required to fill the container. Water levels were determined by means of an electric water level indicator. The discharge water was found at the beginning of the pumping test to be free of any fuel oil contamination, and no trace of any petroleum product appeared in the discharge water at any time during the test. Three water samples were collected during the course of the pumping test and were analyzed in the laboratory for total solids and for total iron content. Details of these chemical tests are set forth below:

Sample No.	Total Solids	Total Iron, as Fe
1, at start of pump test	776 ppm	140.0 ppm
2, after 24 hr pumping	298 ppm	4.40 ppm
3, after 30 hr pumping	212 ppm	4.68 ppm

The high initial values for total solids and total iron are a reflection of the fact that the water column in the unused well was standing essentially stagnant for a number of years. Three water samples were collected during the pumping test by the Base Medical Technician and were tested for bacteriological contamination, the first sample being collected immediately at the beginning of the pumping test. The rather limited tests performed by the Base Medical Technician were negative, indicating that the well water was free from harmful bacteria. The pumping test demonstrated that the water was uncontaminated, that it was essentially the same in total solids and iron content as the water from Well No. 2, the current base supply well, and that the specific yield of the well was sufficiently high to justify a complete rehabilitation of the well and installation of a larger pump.

5. REHABILITATION OF WELL:

The Jacuzzi jet pump was removed from the well through the hatch in the roof 17 and 18 July 1963, and the well was explored for foreign objects. It was evident from the results of the preliminary pumping test that little or no sand had collected at the bottom of the well. Nuts, bolts, and miscellaneous small items of hardware, sufficient to fill a small sack, were removed from the bottom of the well 19 July 1963, together with a number of large pebbles. No significant amount of sand was found. No screen was encountered in the well, and the bottom of the casing was found by measurement to be 205 ft below the lean-to floor. The casing was scrubbed with strong detergent throughout its entire depth; in scrubbing the bottom portion of the casing there was some indication that the lowermost 8 ft of the casing might be perforated. Seven and a half pounds of dry chlorine were introduced into the well and allowed to stand overnight. On 20 July 1963 the chlorine solution was bailed from the well, the well was surged and bailed vigorously, and the casing was swabbed, until only insignificant amounts of sand, rust, and scale could be extracted from the well. The total amount of material removed from the well was small in bulk, and the cleaning and developing of the well was considered to be complete. After completion of development, the static water level was measured at 8.6 ft below the lean-to floor level. On 20-22 July 1963 a Myers 5 HP submersible pump (60 cycle, 3 phase, 220 volt) was placed in the well as a permanent installation, the water intake being set at a depth of 76 ft below the top of the casing. An air line for a permanent air-pressure drawdown gauge was installed at the same time, the lower end of the air line being set at 73 ft below the top of the casing.

6. DESCRIPTION OF FINAL TESTS:

The Myers submersible pump installed in the well was used in making the final pumping test. Pumping was begun at 1:30 p.m. 24 July 1963 and continued steadily for nineteen hours until 8:30 a.m. 25 July 1963, at which time the pumping test was considered complete and the pumping was stopped. Pumping was carried on at a rate of 130 gpm. The pumping rate was determined by collecting the discharge water in a container of known capacity and measuring the length of time required to fill the container. Water levels were determined by means of the installed air line and a pressure gauge. Just before pumping was stopped, a water sample was obtained for chemical analysis.

7. RESULTS OF TESTS:

The static water level was determined to be 8.0 ft below the floor level immediately before pumping started. The drawdown level at the 130 gpm pumping rate assumed a depth of 18.0 ft below the floor level a few moments after pumping had been started, and remained stable at that depth for the duration of the pumping test. Upon stopping the pump, the water level returned to static level immediately. A drawdown curve for the well, based on both the final pumping test and the preliminary pumping test, is shown on Chart 1. The water sample collected at the end of the pumping test for chemical analysis was tested in the laboratory, and the details of the chemical analysis are shown on Table 2. The discharge water cleared almost immediately after pumping started, and remained clear throught the duration of the pumping test.

8. CONCLUSIONS:

The tests show that the water from the well was not contaminated by either petroleum products or bacteria, and that the rehabilitated well will produce potable water at a rate of 130 gpm with a drawdown of approximately 10 ft. The well is an excellent producer, and has the capability to produce water considerably in excess of the capacity of the Myers submersible pump installed as a permanent pump. This well is able to meet by itself the demands on the base water supply system. The water has an iron content only slightly less than that of the water from the well which currently furnishes the base water supply, and the same type of water treatment for iron is applicable to the water from both wells.

* * * * *

TABLE 1

TEST DATA
PRELIMINARY PUMPING TEST
WELL NO. 1 - 6-INCH DIA. WATER SUPPLY WELL
GALENA AP

Date & Time	Gal per Min Pumped	Depth in Ft to Water Level	Remarks
7 June 63 - 1000	0	5.3	Static water level - started pumping at 46 gpm rate, discharge water momentarily greenish color, clearing rapidly, no sand.
1001	46	7.3	Discharge water clearing. Collected water sample for determination of total solids and iron content. Collected water sample for bacteriological testing.
1100	46	7.3	Discharge water clear.
1200	46	7.5	
1300	46	7.8	
1400	46	7.5	Collected water sample for bacteriological testing.
1500	46	7.5	
1800	46	7.6	
2000	46	7.5	
2100	46	7.8	
8 June 63 - 0600	46	7.8	
0700	46	7.9	
0800	46	8.0	
0900	46	8.3	
1000	46	8.4	Collected water sample for determination of total solids and iron content. Collected water sample for bacteriological testing.
1100	46	8.2	
1200	46	8.3	
1300	46	8.2	
1400	46	8.2	
1500	46	8.3	
1600	46	8.3	Collected water sample for chemical analysis.
10 June 63 - 0800	46	Not measured	Stopped pumping - pump test complete.

REPORT ON WATER

TABLE 2

CONTRACT NO. DA- Exp
DE LAB FILE NO. 198-63

REPORT DATE: 28 Aug 63
SUBMITTERS SAMPLE NO.________

SOURCE: Galena AFS. Fire Station Well, Sampled after 19 hours of pumping at a rate of 130 gpm. Sampled 0830 hrs 25 July 63. Permanent Water Well No. 1.

SAMPLE & LABEL:

REQUEST: Water Analysis

TEST RESULTS:

pH	6.92	
Conductivity at 27° C	431	mmhos
Total solids	283	ppm
Calcium, as Ca	59	ppm
Magnesium, as Mg	14	ppm
Sodium & Potassium, as Na	0.65	ppm
Total Iron, as Fe	5.0	ppm
Organic Iron, as Fe	-------	ppm
Manganese, as Mn	-------	ppm
Silica, as SiO_2	40.0	ppm
Sulfate, as SO_4	0.4	ppm
Chloride, as Cl	1.0	ppm
Nitrate, as NO_3	7.0	ppm
Alkalinity, Methyl Orange, as $CaCO_3$	226	ppm
Alkalinity, Phenolphthalein, as $CaCO_3$	0.0	ppm
Total hardness, as $CaCO_3$	226	ppm
Carbonate hardness, as $CaCO_3$	226	ppm
Non-Carbonate hardness, as $CaCO_3$	0	ppm
Free Carbon Dioxide, as CO_2	-------	ppm
Free Oxygen, as O_2	-------	ppm

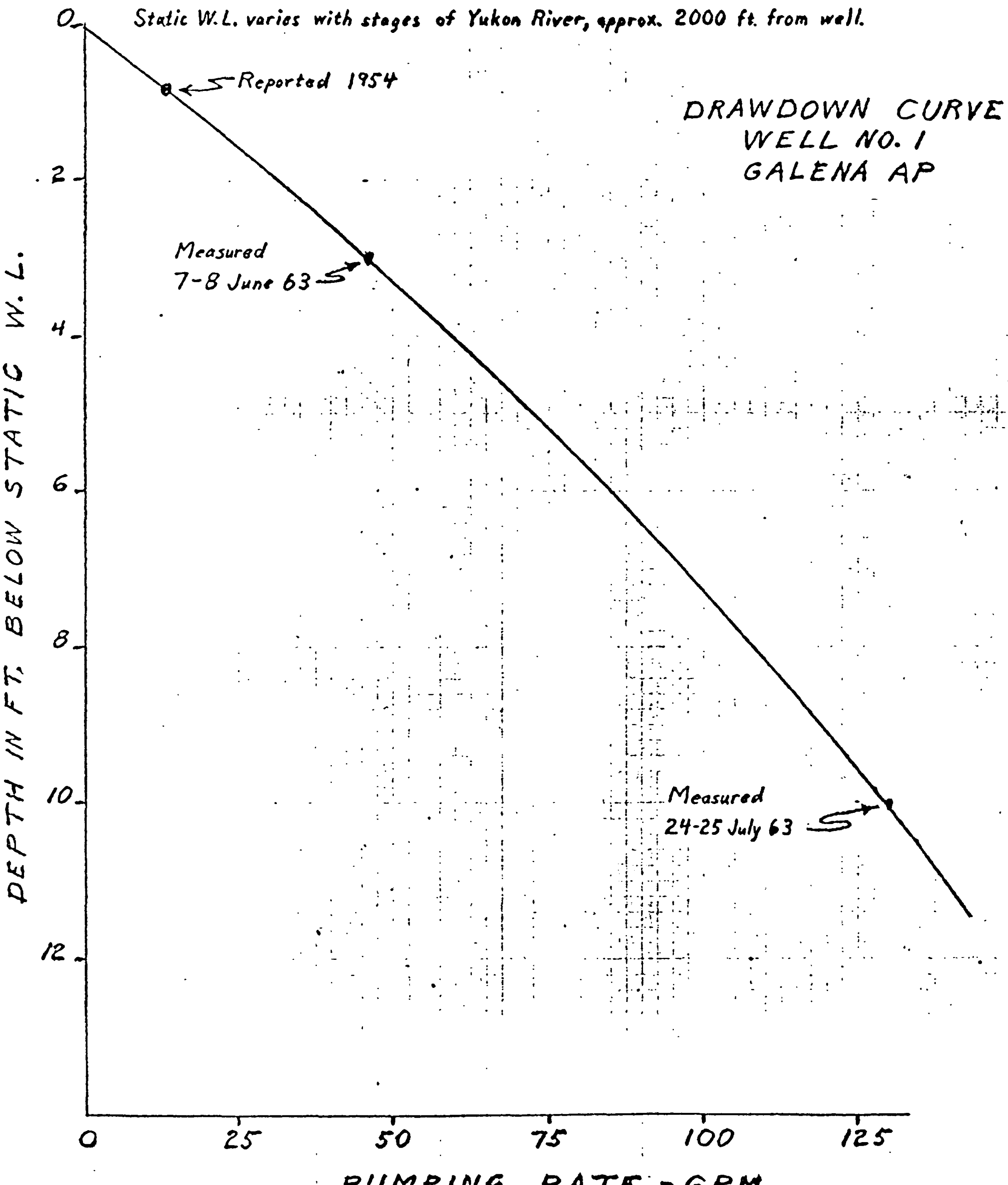
REMARKS:

W M Knoppe

W. M. KNOPPE
Chief, Testing Section

NPA FORM
AUG 1961 43 (One-Time)

CHART 1



F&M BRANCH - ADE

APPENDIX 4

Selected well drillers' logs, aquifer test data,

and ground-water quality data for Galena

from U.S. Public Health Service village files

WELL LOG

U.S. PUBLIC HEALTH SERVICE, DIVISION OF INDIAN HEALTH

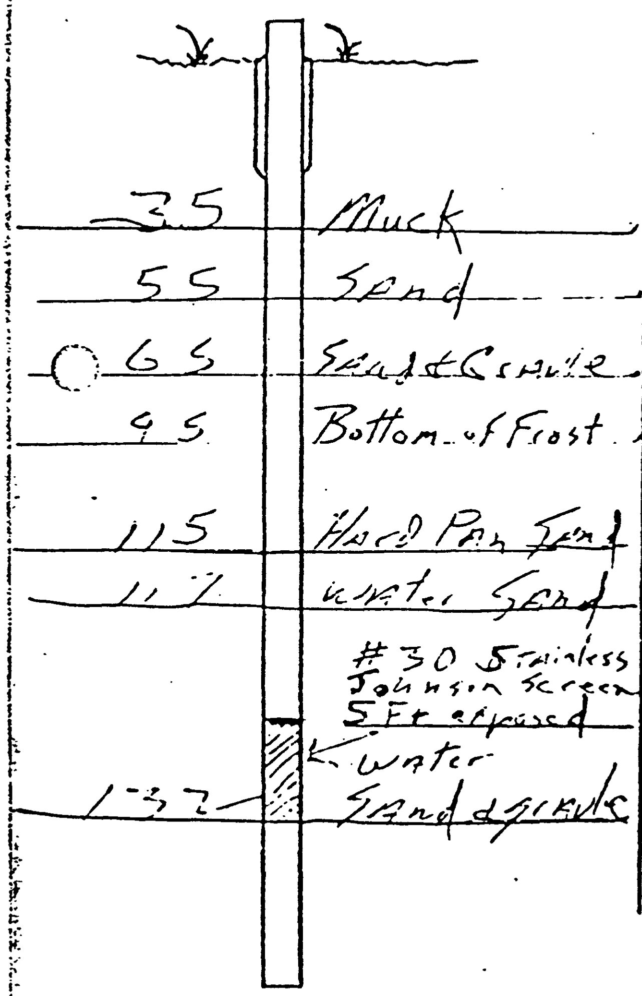
LOCATION Galena New Housing Project DATE STARTED 3/13/72

DATE COMPLETED 4/9/72 DRILLER

TOTAL DEPTH OF WELL 132 3/4 FT. CASING INSTALLED 127 3/4 DIAMETER 6"

GROUT None SCREEN SIZE #30 MFG Johnson Stainless LENGTH 5 Ft

STATIC WATER LEVEL 40 HRS. PUMPED 24 @ 26 GPM. DRAWDOWN 18 FT



DATE	DEPTH FROM - TO	FORMATION	DRILLER
	0 - 35	Muck	
	35 - 55	Sand	
	55 - 65	Sand & gravel	
	65 - 95	Sand & gravel	Frozen
	95 - 115	Hard pan Sand	
	115 - 117	Sand	
	117 - 132	Sand & gravel	

SPECIAL NOTES:

Frost 0 - 95

WELL LOG

U.S. PUBLIC HEALTH SERVICE, DIVISION OF INDIAN HEALTH

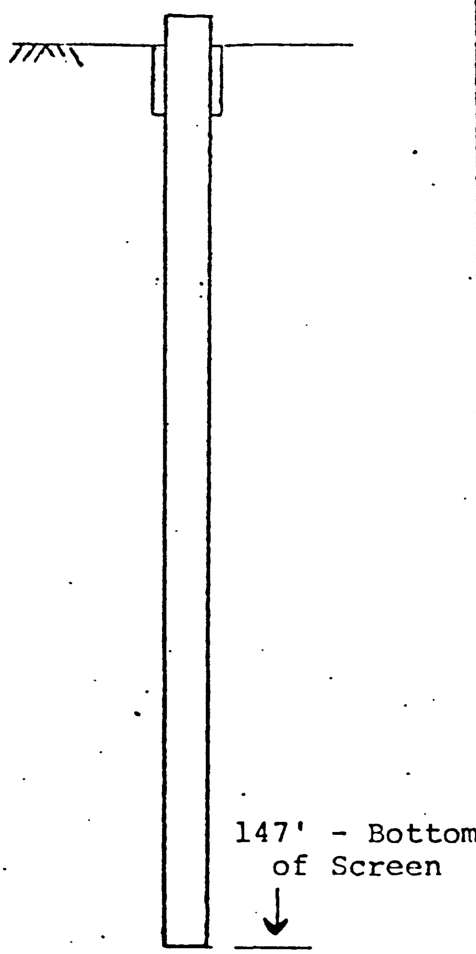
LOCATION GALENA, ALASKA DATE STARTED 6-18-74

DATE COMPLETED 7-5-74 DRILLER Grinder

TOTAL DEPTH OF WELL 147 FT. CASING INSTALLED 142 DIAMETER 6"

GROUT X SCREEN SIZE 40 MFG LENGTH 5"

STATIC WATER LEVEL 20 Ft HRS. PUMPED 36 @ 28 GPM. DRAWDOWN 100 FT.



DATE	DEPTH FROM	TO	FORMATION	DRILLER
6-19-74	0	30	Mud	Grinder
6-20-74	30	50	Sand	
6-21-74	50	75	Sand	
6-22-74	75	85	Sand and Gravel, 85 End of Frost	
6-22-74	85	95	Sand	
6-23-74	95	100	Sand	
6-24-74	100	110	Sand Gravel	
6-25-74	110	120	Sand	
6-26-74	120	125	Sand	
6-27-74	125	130	Sand	
6-28-74	130	135	Sand	
6-29-74	135	140	Sand	

SPECIAL NOTES: End of frost 85 Ft water level 20 Ft from ground level screen set from 142' to 147'.

Pump Set 143

WATER ANALYSIS REPORT FORM C 70

Report to: ARCH HAMMETT, ADMIN. OFFICER
OFFICE OF ENVIRONMENTAL HEALTH
P. O. BOX 7-741
ANCHORAGE, AK 99510

OR LOCATION: Galena - Well #2 at Alexander Lake site
ECTED BY: Irvin Grinder DATE 7/8/74 HOUR:

WATER SYSTEM

Well Type Drilled Depth 147' Gallons per minute 30
Surface Water: Temporary [ ] Permanent [ ]
Number of Homes Served:
Treatment: [ ] Yes [X] No New or Existing Source New

PURPOSE OF ANALYSIS

/ 1. Water Approval for Building Permit. (Column 1)
/ 2. Routine Analysis. (Column 1 & 2)
/ 3. Special: Check Specific Items for Analysis (Columns 1,2,3)

COLUMN 1

	Analysis	Limits
n (Fe)	4.98	0.3
oride (F)	.17	1.5
oride (Cl)	7	250
(PO4) sphate	0.03	.05 good .30 poor
al Hardness	174	50 soft 300 hard
ergents	0	0
	7.65	6.5 8.5
cific ductance	343	

> 7/15/74

COLUMN 2

	Anal.	Limit
Magnesium (Mg)	30	125
Calcium (Ca)	49	300
Turbidity	300	1
Color	5	15
Bicarbonate (HCO3)	224	25 good 500 poor
Carbonate	0	350
Alkalinity	192	350
Total Dissolved Solids	214	500

COLUMN 3

	Analysis	Limits
Sodium (Na)		200
Potassium (K)		
Sulfate (SO4)		250
Sulfite **(SO3)		5.0
Nitrate (NO3)		10
Suspended Solids		
Arsenic (As)		0.01
Copper (Cu)		1.0
Cyanide (Cn)		0.01
Phenols		0.00
Zinc (Zn)		5.0
Barium (Ba)		1.0
Cadmium (Cd)		0.01
Lead (Pb)		0.05
Silver (Ag)		0.05
Mercury (Hg)		0.05
Manganese (Mn)		0.05

MENTS:

STRUCTIONS:

Rinse container several times in water source to be sampled. 7/15/74

Place cap on sample container firmly.

Place sample in carton mailer, and forward to:

Public Health Laboratory
SRO, Medical Arts Bldg.
Pouch J
Juneau, AK 99801

**Requires Special Container

AQUIFER TEST FIELD DATA SHEET

Project No. ________ Project Name Galena Well # 7-5-78

Location of Well First test before treatments

Depth of Well 147½ ft. Length of Casing 54' ft. Pumped Well / Observation Well

Observation Well, Dist. to Pumped Well ____ ft. Top of Casing to Static Level 32'5"

Date Drilling Completed ________ Driller 10gpm Date Tested 10-7-78

Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ gpm ~~or~~ Recovery	Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ ~~or~~ Recovery
	1	35' 6"			1	36' 4"	
	2	36' 6"			2	34'	
	3	37' 3"			3	33' 3"	
	4	37' 11"			4	32' 9"	
	5	38' 4"			5	32' 6"	
	6	38' 7"			6	32' 5"	
	7	38' 10"			7		
	8	38' 11"			8		
	9	39' 3"			9		
	10	39' 6"			10		
	11	39' 7.5"			11		
	12	39' 9"			12		
	15	40' 2.5"			15		
	20	40' 8"			20		
	25	41'			25		
	30	41' 4"			30		
	40				40		
	50				50		
	60				60		
	80				80		
	100				100		
	140				140		
	180 (3 hrs.)				180 (3 hrs.)		
	240 (4 hrs.)				240 (4 hrs.)		
	300	Ran for 45 minutes			300		
	360				360		
	420				420		
	480				480		
	540				540		
	600				600		
	660				660		
	720				720		

8'11" drawdown

AQUIFER TEST FIELD DATA SHEET 2

oject No. ________ Project Name Galena Well # 7-5-79

cation of Well Second test after 1st acid & Cl

pth of Well 147' ft. Length of Casing 154' ft. Pumped Well / Observation Well

Observation Well, Dist. to Pumped Well ____ ft. Top of Casing to Static Level 29'

e Drilling Completed ________ Driller 10 gpm Date Tested 10/8/

ock me	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ gpm or Recovery	Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ or Recovery
	1	30' 2"			1	38' 4"	
	2	31' 9"			2	31' 6"	
	3	33' 5"			3	30' 4"	
	4	34' 7"			4	29' 7"	
	5	35' 7"			5	29' 5"	
	6	36'			6	29' 1"	
	7	36' 6"			7	29'	
	8	36' 10"			8		
	9	37' 2"			9		
	10	37' 6"			10		
	11	37' 8"			11		
	12	37' 11"			12		
	15	40' 5"			15		
	20	41' 5"			20		
	25	41' 8"			25		
	30	41' 8"			30		
	40				40		
	50				50		
	60				60		
	80				80		
	100				100		
	140				140		
	180 (3 hrs.)				180 (3 hrs.)		
	240 (4 hrs.)				240 (4 hrs.)		
	300				300		
	360				360		
	420				420		
	480				480		
	540				540		
	600				600		
	660				660		
	720						

12'8" drawdown

AQUIFER TEST FIELD DATA SHEET

Project No. ______ Project Name Galena Well # 7-5-7

Location of Well Third test after 2ND closing

Depth of Well ______ ft. Length of Casing ______ ft. Pumped Well / Observation Well

If Observation Well, Dist. to Pumped Well ______ ft. Top of Casing to Static Level 34'2"

Date Drilling Completed ______ Driller 10 gpm Date Tested 10-7-77

Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ gpm or Recovery	Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ gpm or Recovery
	1	36'1"			1	34'2"	
	2				2		
	3				3		
	4				4		
	5				5		
	6				6		
	7				7		
	8				8		
	9				9		
	10				10		
	11				11		
	12				12		
	15				15		
	20	36'-1"			20		
	25				25		
	30		Ran for	30	minutes		
	40				40		
	50				50		
	60				60		
	80				80		
	100				100		
	140				140		
	180 (3 hrs.)				180 (3 hrs.)		
	240 (4 hrs.)				240 (4 hrs.)		
	300				300		
	360				360		
	420				420		
	480				480		
	540				540		
	600				600		
	660				660		
	720				720		

1'11" Drawdown

(47)

Project No. ____________ Project Name Galena Well # 7-5-74

Location of Well Pump house well (4th test)

Depth of Well 147 ft. Length of Casing ____ ft. Pumped Well / Observation Well

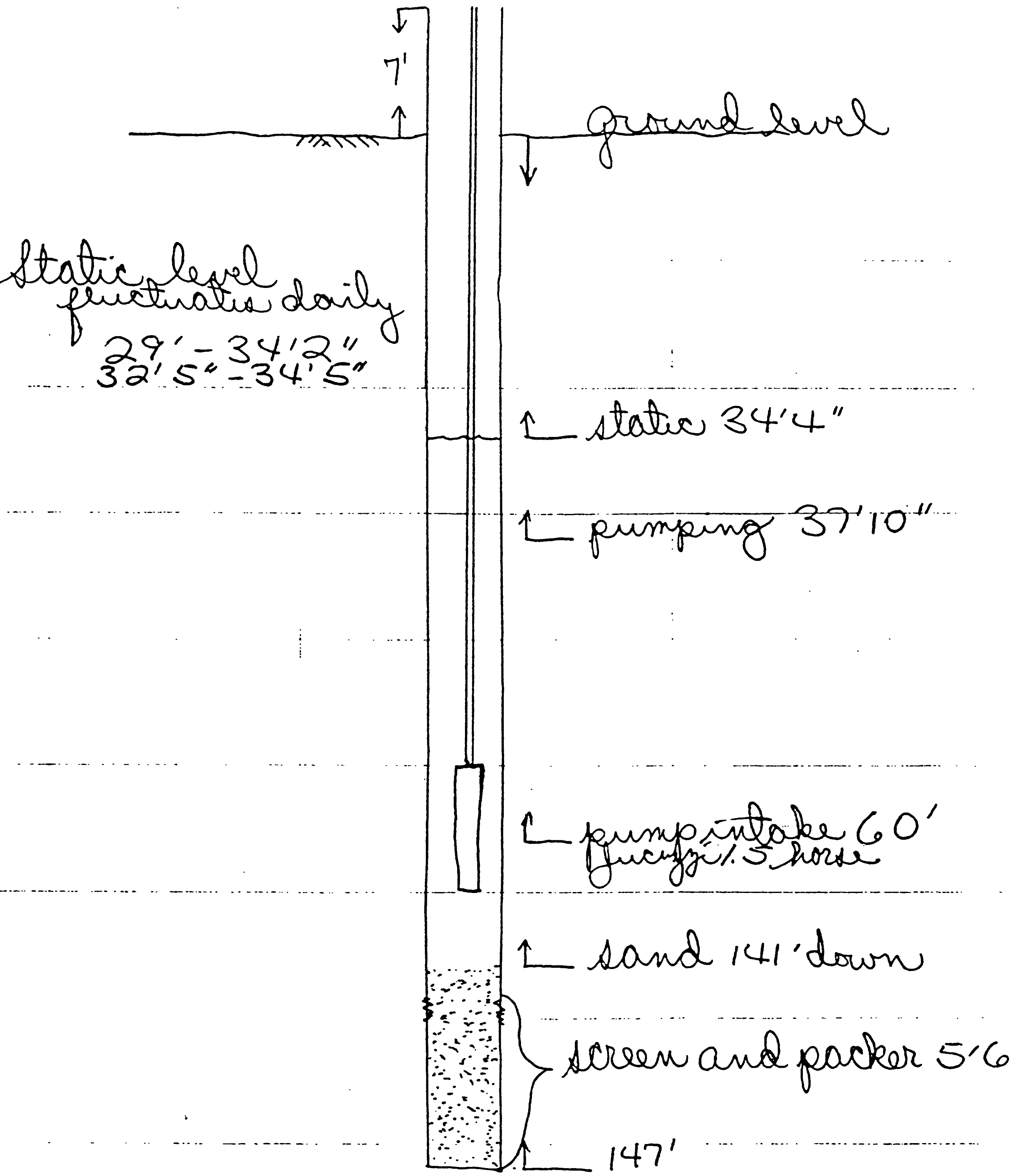
Observation Well, Dist. to Pumped Well ____ ft. Top of Casing to Static Level 34'5"

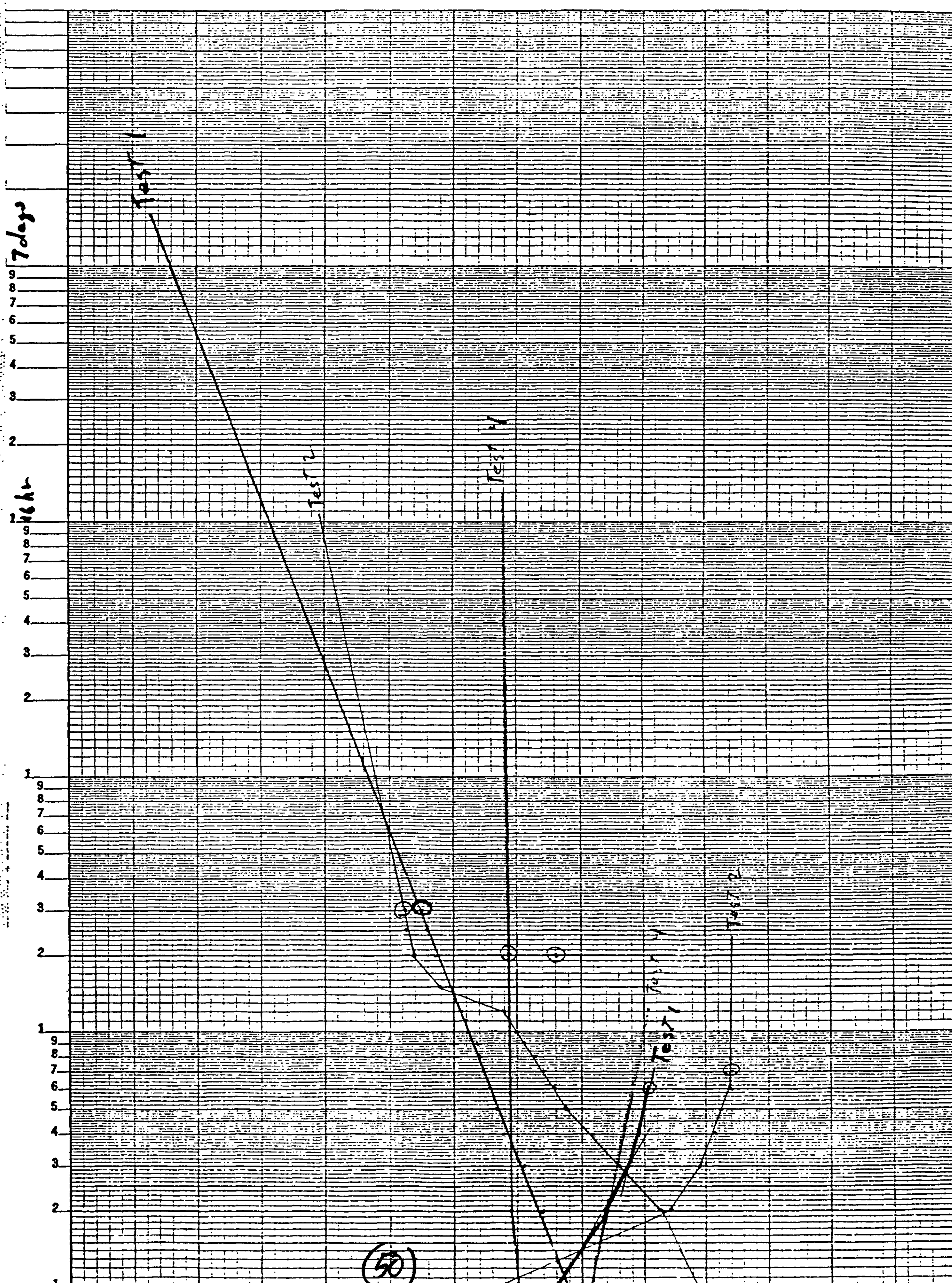
Date Drilling Completed ________ Driller ____________ Date Tested 10-11-7?

Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ 10 gpm or Recovery	Clock Time	Elapsed Time Since Pumping Started/Stopped	Depth to Water From TOC	Drawdown @ ___ or Recovery
	1	37'6"			1	34'8"	
	2	37'10"			2	34'5"	
	3				3		
	4				4		
	5				5		
	6				6		
	7				7		
	8				8		
	9				9		
	10				10		
	11				11		
	12				12		
	15				15		
	20				20		
	25				25		
	30				30		
	40				40		
	50				50		
	60				60		
	80				80		
	100				100		
	140				140		
	180 (3 hrs.)				180 (3 hrs.)		
	240 (4 hrs.)				240 (4 hrs.)		
	300				300		
	360				360		
	420				420		
	480				480		
	540				540		
	600				600		
	660				660		
	720				720		

3½' drawdown

Galena Wellname 7-5-74




7 days
Test 1
Test 2
Test 4

WELL LOG

U.S. PUBLIC HEALTH SERVICE, DIVISION OF INDIAN HEALTH

LOCATION ______ DATE STARTED ______

DATE COMPLETED ______ DRILLER [signature]

TOTAL DEPTH OF WELL ______ FT. CASING INSTALLED ______ DIAMETER ______

GROUT ______ SCREEN SIZE ? MFG. ______ LENGTH ?

STATIC WATER LEVEL 32' HRS. PUMPED 12 @ 30 GPM DRAWDOWN 8 FT.

DEPTH	HOLE DIAMETER / CASING DIAMETER	FORMATION
Static Water		LEVEL 32'
Pumping Level 40'		AT 30 GPM
Pump Set AT 75'		
Top of Screen		146' 4"
Bottom of Well		150' 9"

SOIL DATA TO 15 FT.
FEET THAWED ______
BOTTOM OF FROST & MATERIAL ______
SEASONAL OR PERMA FROST ______

WATER DATA FIELD TEST
TASTE ______
APPEARANCE FRESH ______
AFTER 24 HOURS ______
IRON ______
CHLORIDES ______
TDS ______

PUMP TEST 32' - STATIC LEVEL
PUMPING LEVEL 40 @ 30 GPM
AFTER 12 HRS.

HIGHEST RECOMMENDED PUMP RATE
WILL STATIC LEVEL CHANGE WITH
TIDES NO OR FROST NO

SCREEN HAS 2' SAND ON BOTTOM

DEVELOP PROCEDURE ______

ESTIMATED MAN HOURS FOR DRILLING ______ HOURS FOR TOTAL JOB ______

CREW ______

Mail Report to: [illegible] OFFICE OF ENVIRONMENTAL HEALTH
P.O. BOX 7-741
ANCHORAGE, ALASKA 99510

Date: 04-11-77

C-997

Name of Village: Galena   Name of Source: P.H.S. Water System

Sampling Site: Health Clinic   Collected By: Steven Cohen

WATER SOURCE (circle one)

(Well), Spring, Lake, River, Creek, Ditch, Slough, Other: ______

Sample Description: Raw, (Treated), Other: (Describe) ______

PURPOSE OF ANALYSIS

RECEIVED
APR 20 1977
BRANCH OF PUBLIC HEALTH LABORATORIES

/_/ 1. Water Approval for Building Permit. (Column 1)

/_/ 2. Routine Analysis. (Columns 1 & 2)

/X/ 3. Special: Circle Specific Items for Analysis (Columns 1, 2, 3)

COLUMN 1

		Limits
Iron (Fe)		0.3
Fluoride (F)	0.2	1.5
Chloride (Cl)		250
Phosphate (PO_4)		.05 good 30 poor
Total Hardness		50 soft 300 hard
Detergents		0
pH		6.5 8.5
Specific Conductance		

COLUMN 2

	Anal.	Limit
Magnesium (Mg)		125
Calcium (Ca)		300
Turbidity		5
Color		15
Bicarbonate (HCO_3)		25 good 500 poor
Carbonate		350
Alkalinity		350
Total Dissolved Solids		500

APR 2? RECD

COLUMN 3

	Analysis	Limits
Sodium (Na)		
Potassium (K)		
Sulfate (SO_4)		250
Sulfite **(SO_3)		3.
Nitrate (NO_3)		
Suspended Solids		
Arsenic (As)		
Copper (Cu)		
Cyanide (Cn)		
Phenols		
Zinc (Zn)		
Barium (Ba)		
Cadmium (Cd)		
Lead (Pb)		
Silver (Ag)		
Mercury (Hg)		
Manganese (Mn)		

Rec'd 4/14/77

Comments: ______

4/18/77
[illegible signature]

Instructions:

1. Rinse container several times in water source to be sampled.

2. Place cap on sample container firmly.   Public Health Laboratory

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907) 279-4014 P.O.BOX 4-1276 ANCHORAGE, ALASKA 99509 4649 BUSINESS PARK BLVD.

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health Service

Date Collected: June 3, 1977 Time Collected: ---- By: Bill Hubbard

Source of Sample: treated water, Galena, Alaska.

Physical Observations, Remarks:

[]	mg/l	Aluminum	[]	mmhos	Conductivity	[X] 143	mg/l	Hardness as $CaCO_3$
[]	mg/l	Arsenic	[X] 7.0	units	pH	[X] 190	mg/l	Alkalinity as $CaCO_3$
[]	mg/l	Barium	[]	mg/l	Ammonia Nitrogen-N	[]	mg/l	Acidity-T as $CaCO_3$
[]	mg/l	Boron	[]	mg/l	Kjedahl Nitrogen-N	[]	mg/l	Acidity Free as $CaCO_3$
[]	mg/l	Cadmium	[]	mg/l	Organic Nitrogen-N	[]	/100ml	Coliform-T
[X] 41	mg/l	Calcium	[]	mg/l	Nitrate(N)	[]	/100ml	Coliform-F
[]	mg/l	Copper	[]	mg/l	Nitrite(N)	[]	/100ml	Strep-F
[]	mg/l	Chromium-Total	[]	mg/l	Phosphorus (Ortho)-P	[]	units	Color
[]	mg/l	Chromium-Tri	[]	mg/l	Phosphorus (Total)-P	[]		
[]	mg/l	Chromium-Hex	[]	mg/l	Chloride	[]		
[X] 0.3	mg/l	Iron-Total	[]	mg/l	Fluoride			
[]	mg/l	Iron-Dissolved	[]	mg/l	Cyanide			
[]	mg/l	Lead	[]	mg/l	Sulfate			
[X] 9.9	mg/l	Magnesium	[]	mg/l	Phenol			
[]	mg/l	Manganese	[]	mg/l	MBSA			
[]	mg/l	Mercury	[]	mg/l	BOD			
[]	mg/l	Nickel	[]	mg/l	COD			
[]	mg/l	Potassium	[]	mg/l	TD Solids			
[]	mg/l	Selenium	[]	mg/l	TV Solids			
[]	mg/l	Sodium	[]	mg/l	Suspended Solids			
[]	mg/l	Silver	[]	mg/l	SV Solids			
[]	mg/l	Zinc	[]	JTU	Turbidity			

(53)

Transported by:
Received by:

Transported by:
Received by:

FOR LAB USE ONLY

Lab# 6015 Rec'd by: Se

Date sample rec'd: June 9, 1977

Date analysis completed: 6-13-77

Date results reported: 6-14-77

Signed: Archie L. Green

Date: June 14, 1977

CORRECTED COPY

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.
P.O. BOX 4-1276 ANCHORAGE, ALASKA 99509 4649 BUSINESS PARK BLVD.
TELEPHON (907) 279-4(

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health Service

Date Collected: 3-31-78 Time Collected: ---- By: P. Besaw

Source of Sample: Galena, Alaska Well No. 2

Physical Observations, Remarks: Treatment: None Preservative: None

Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit	Parameter
~~<0.05~~	mg/l	Aluminum	320	mmhos	Conductivity	222	mg/l	Hardness as $CaCO_3$
<0.05	mg/l	Arsenic	6.5	units	pH	200	mg/l	Alkalinity as $CaCO_3$
	mg/l	Barium		mg/l	Ammonia Nitrogen-N		mg/l	Acidity-T as $CaCO_3$
	mg/l	Boron		mg/l	Kjedahl Nitrogen-N		mg/l	Acidity Free as $CaCO_3$
	mg/l	Cadmium		mg/l	Organic Nitrogen-N		/100ml	Coliform-T
54	mg/l	Calcium		mg/l	Nitrate(N)		/100ml	Coliform-F
	mg/l	Copper		mg/l	Nitrite(N)		/100ml	Strep-F
	mg/l	Chromium-Total		mg/l	Phosphorus (Ortho)-P		units	Color
	mg/l	Chromium-Tri		mg/l	Phosphorus (Total)-P			
	mg/l	Chromium-Hex	2	mg/l	Chloride			
~~14~~ ≈25 (5/5/78 phone call)	mg/l	Iron-Total		mg/l	Fluoride			
	mg/l	Iron-Dissolved		mg/l	Cyanide			
	mg/l	Lead	< 1	mg/l	Sulfate			
12	mg/l	Magnesium		mg/l	Phenol			
1.3	mg/l	Manganese		mg/l	MBSA			
	mg/l	Mercury		mg/l	BOD			
	mg/l	Nickel		mg/l	COD			
<1	mg/l	Potassium	204	mg/l	TD Solids			
	mg/l	Selenium		mg/l	TV Solids			
2.4	mg/l	Sodium		mg/l	Suspended Solids			
	mg/l	Silver		mg/l	SV Solids			
	mg/l	Zinc		TU	Turbidity			

Transported by:
Received by:

Transported by:
Received by:

FOR LAB USE ONLY

Lab# 7638 Rec'd by: SE

Date sample rec'd: 4-5-78

Date analysis completed: 4-14-78

Date results reported: 4-17-78

Signed: [signature]

Date: April 19, 1978

APPENDIX 5

Summary of USGS Ground Water Site Inventory Data

and selected well drillers' logs and water-quality data for Galena

from U.S. Geological Survey village files

9-185
ober 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena

LL SCHEDULE

te ...., 19...... Field No. 22½

ord by .... Office No. ....

rce of data CE St Paul 1948 Invest. AF Constr. Arctic + Subarctic regions

Location: State .... County ....

Map near toe of fill of 255-ft wide concrete apron on S side hangar + CAA Bldg.

.... ¼ .... ¼ sec. .... T .... N/S R .... E/W

Owner: .... Address ....

Tenant .... Address ....

Driller .... Address ....

Topography level - stripped + clear

Elevation 120 ft. above/below ....

Type: Dug, drilled, driven, bored, jetted 7/18 19 46

Depth: Rept. 22½ ft. Meas. .... ft.

(56)

Casing: Diam. 2 in., to ...... in., Type ...... iron pipe

Depth .... ft., Finish ....

Chief Aquifer .... From .... ft. to .... ft.

Others ....

Water level .... ft. rept./meas. .... 19...... above/below ....

.... which is .... ft. above/below surface

Pump: Type .... Capacity .... G. M. ....

Power: Kind .... Horsepower ....

Yield: Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....

Drawdown .... ft. after .... hours pumping .... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

Quality .... Temp .... °F.

Taste, odor, color .... Sample Yes/No ....

Unfit for ....

Remarks: (Log, Analyses, etc.) frozen @ 15.5 feet

U. S. GOVERNMENT PRINTING OFFICE 16—62891-1

0-2 sand + gravel
2-11 coarse sand
11-14 gravel + sand
14-17 sand
17-19 coarse sand
19-21 sand
21-22 coarse sand
22-22½ sand

frozen @ 15½ ft

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

CAMPION

WELL SCHEDULE

Date Nov. 21, 61, 19...... Field No. ~~H423~~ 423

Record by ASF Office No.

Proc. Paper 55-34
Source of data Water Sources used by USAF in Alaska

1. *Location:* State Alaska County
   Map
   ¼ ¼ sec. T N/S R E/W
2. *Owner:* USAF Address Galena
   Tenant 743 AC+W – A2 Address
   Driller Address
3. *Topography*
4. *Elevation* ft. above/below
5. *Type:* Dug, drilled, driven, bored, jetted 11 19 50
6. *Depth:* Rept. ~~423~~ 423 ft. Meas. 330 ace well ft.
7. *Casing:* Diam. 8 in., to in., Type
   Depth 330 ft., Finish 329
8. *Chief Aquifer* From ft. to ft.
   Others
9. *Water level* ft. rept./meas. 19 above/below
   which is ft. above/below surface
10. *Pump:* Type Capacity G. M.
    Power: Kind Horsepower
11. *Yield:* Flow G. M., Pump G. M., Meas., Rept. Est.
    Drawdown ft. after hours pumping G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs.
    Adequacy, permanence
13. *Quality* Temp °F.
    Taste, odor, color Sample (Yes) No
    Unfit for
14. *Remarks:* (Log, Analyses, etc.)

(57)

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Sample	Depth	Material
1	0.5	Tundra
2	2.0	Silt
3	2.5	Silt (Permafrost)
4	40.0	Silt (Permafrost)
5	173.0	Silt-Sand (Permafrost)
6	278.0	Silt-Sand-Gravel (Permafrost)
7	295-305	Clay-Gravel (Permafrost)
8	305-310	Clay & Little Sand (PF)
9	376	Clay Sand Perma Frost
10	423	Pea Gravel, Sand & Silt. Water Out of PF.
11	433	Pea Gravel, Sand & ~~silt~~ Silt. No Frost.

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October 1950)

UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Campion

WELL SCHEDULE

Date ____, 19__ Field No. 428

Record by ____ Office No. Campion well

Source of data driller log

1: *Location:* State ____ County ____
Map ____
__ ¼ __ ¼ sec. __ T __ N/S R __ E/W

2. *Owner:* ____ Address ____
Tenant ____ Address ____
Driller ____ Address ____

3. *Topography* ____

4. *Elevation* ____ ft. above/below

5. *Type:* Dug, drilled, driven, bored, jetted Sept 28 1955

6. *Depth:* Rept. 428 ft. Meas. ____ ft.

7. *Casing:* Diam. 10 in., to 19'3" 8" to 409 ft in., Type ____
Depth ____ ft., Finish 16 ft Johnson screen

8. *Chief Aquifer* Gravel From 405 ft. to 416 ft.
Others ____

9. *Water level* 275 ft. rept./meas. ____ 19__ above/below ____ which is ____ ft. above/below surface

10. *Pump:* Type ____ Capacity ____ G. M.
Power: Kind ____ Horsepower ____

11. *Yield:* Flow ____ G. M., Pump 30 G. M., Meas., Rept. Est.
Drawdown 38 ft. after ____ hours pumping 30 G. M.

12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs.
Adequacy, permanence ____

13. *Quality* ____ Temp ____ °F.
Taste, odor, color ____ Sample Yes/No
Unfit for ____

14. *Remarks:* (Log, Analyses, etc.) ____ Over perf 17(?) to 402

(58)

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Depth (ft)	Material
0-7	silt fill
7-9	ft rubble
17-302	frozen silt
302-342	frozen gravel
342-368	large boulders
368-372	frozen gravel
372-390	frozen silt
390-402	frozen gravel
402-405	sand + water
405-416	nice water bearing gravel
416-428	cemented gravel, seems to be no water

Do Marsh record aquifer that FM Awe mentioned? [illegible] 3-13-62

FM Awe 9-62 says it wasn't cemented, just normal gravel.

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(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena base

WELL SCHEDULE

Date ______, 19___ Field No. 187

Record by Chapman and rept to Turnbull 1944 Office No. ______

Source of data Turnbull rept p. 5 1944

1. *Location:* State ______ County ______
   Map ______
   ______ ¼ ______ ¼ sec. ______ T ______ N/S R ______ E/W
2. *Owner:* ______ Address ______
   Tenant ______ Address ______
   Driller ______ Address ______
3. *Topography* ______
4. *Elevation* ______ ft. above/below ______
5. *Type:* Dug, drilled, driven, bored, jetted ______ 19___
6. *Depth:* Rept. 187 ft. Meas. ______ ft.
7. *Casing:* Diam. ______ in., to ______ in., Type ______
   Depth ______ ft., Finish ______
8. *Chief Aquifer* ______ From ______ ft. to ______ ft.
   Others ______
9. *Water level* ______ ft. rept./meas. ______ 19___ above/below ______
   ______ which is ______ ft. above/below surface
10. *Pump:* Type ______ Capacity ______ G. M. ______
    Power: Kind ______ Horsepower ______
11. *Yield:* Flow ______ G. M., Pump ______ G. M., Meas., Rept. Est. ______
    Drawdown ______ ft. after ______ hours pumping ______ G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ______
    Adequacy, permanence ______
13. *Quality* hard - very much [illegible] Temp ______ °F.
    Taste, odor, color ______ Sample Yes/No ______
    Unfit for ______
14. *Remarks:* (Log, Analyses, etc.) [illegible]

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9-183
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

[illegible] / Camp [illegible] Powerhouse #1

WELL SCHEDULE

Date ______, 19___ Field No. 420

Record by ______ Office No. ______

Source of data ______

well No. 1 in powerhouse

1. *Location:* State ______ County ______
   Map ______
   ______ ¼ ______ ¼ sec. ______ T ______ N/S R ______ E/W
2. *Owner:* ______ Address ______
   Tenant ______ Address ______
   Driller ______ Address ______
3. *Topography* ______
4. *Elevation* ______ ft. above/below ______
5. *Type:* Dug, drilled, driven, bored, jetted Aug 22 to Sept 14 1951
6. *Depth:* Rept. about 420 ft. Meas. ______ ft. [illegible] FM Awe 3-1[illegible]-62
7. *Casing:* Diam. ______ in., to ______ in., Type ______
   Depth ______ ft., Finish ______
8. *Chief Aquifer* ______ From ______ ft. to ______ ft.
   Others ______
9. *Water level* ______ ft. rept./meas. ______ 19___ above/below ______
   ______ which is ______ ft. above/below surface
10. *Pump:* Type ______ Capacity ______ G. M. ______
    Power: Kind ______ Horsepower [illegible]
11. *Yield:* Flow ______ G. M., Pump ______ G. M., Meas., Rept. Est. ______
    Drawdown ______ ft. after ______ hours pumping ______ G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ______
    Adequacy, permanence ______
13. *Quality* [illegible] Temp ______ °F.
    Taste, odor, color [illegible] Sample Yes/No ______
    Unfit for ______
14. *Remarks:* (Log, Analyses, etc.) [illegible]
    [illegible] 320 [illegible]
    [illegible] 330 [illegible] 420 [illegible] FM Awe 3/1[illegible]/62

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UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena (town)

WELL SCHEDULE

Date ...., 19........ Field No. 100
Record by .... Office No. ....
Source of data Trumbull rept 1949 p. 5

1. *Location:* State .... County ....
   Map ....
   .... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* Stanley Nichols Address store
   Tenant .... Address ....
   Driller .... Address ....
3. *Topography* ....
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, drilled, driven, bored, jetted .... 19....
6. *Depth:* Rept. 100 ft. Meas. .... ft.
7. *Casing:* Diam. .... in., to .... in., Type ....
   Depth .... ft., Finish ....
8. *Chief Aquifer* .... From .... ft. to .... ft.
   Others ....
9. *Water level* .... ft. rept./meas. .... 19.... above/below ....
   .... which is .... ft. above/below surface
10. *Pump:* Type .... Capacity .... G. M.
    Power: Kind .... Horsepower ....
11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
    Drawdown .... ft. after .... hours pumping .... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
    Adequacy, permanence ....
13. *Quality* .... Temp .... °F.
    Taste, odor, color hard Sample Yes/No ....
    Unfit for ....
14. *Remarks:* (Log, Analyses, etc.) ....

9-185 (October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena (valley)

WELL SCHEDULE

Date 7/7, 1946 Field No. 46
Record by Illinois Galena rept Office No. ....
Source of data C.R. Ross, Galena merchant in [illegible] (oral)

1. *Location:* State .... County ....
   Map Galena Valley 200 ft. from cut bank (1946)
   .... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* Mel Allen Address Galena
   Tenant .... Address ....
   Driller C.R. Ross Address ....
3. *Topography* ....
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, drilled, driven, bored, jetted .... 19....
6. *Depth:* Rept. 46 ft. Meas. .... ft.
7. *Casing:* Diam. .... in., to .... in., Type ....
   Depth .... ft., Finish ....
8. *Chief Aquifer* .... From .... ft. to .... ft.
   Others ....
9. *Water level* .... ft. rept./meas. .... 19.... above/below ....
   .... which is .... ft. above/below surface
10. *Pump:* Type .... Capacity .... G. M.
    Power: Kind .... Horsepower ....
11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
    Drawdown .... ft. after .... hours pumping .... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
    Adequacy, permanence ....
13. *Quality* .... Temp .... °F.
    Taste, odor, color .... Sample Yes/No ....
    Unfit for ....
14. *Remarks:* (Log, Analyses, etc.) No permafrost
    0-3 ft silt, 3-46 ft gravel

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena

WELL SCHEDULE

Date ...., 19...... Field No. 55
Record by .... Office No. ....
Source of data Sevastly + Shepard 1946, DH4

1. *Location:* State .... County ....
Map 11S/11SE of point 290 ft SW of SE ...
.... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* .... Address ....
Tenant .... Address ....
Driller .... Address ....
3. *Topography* ....
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, drilled, driven, bored, jetted .... 19....
6. *Depth:* Rept. 55 ft. Meas. .... ft.
7. *Casing:* Diam. ...... in., to ...... in., Type ......
Depth ...... ft., Finish ....
8. *Chief Aquifer* .... From .... ft. to .... ft.
Others ....
9. *Water level* .... ft. rept./meas. .... 19...... above/below ....
.... which is .... ft. above/below surface
10. *Pump:* Type .... Capacity .... G. M. ....
Power: Kind .... Horsepower ....
11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
Drawdown .... ft. after .... hours pumping .... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
Adequacy, permanence ....
13. *Quality* .... Temp .... °F.
Taste, odor, color .... Sample Yes/No ....
Unfit for ....
14. *Remarks:* (Log, Analyses, etc.) ....

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DH4

Arctic from graphic log

0-1½ peat + silt
1½-4 peat, mostly silt, frozen
4-5 ice
5-8 frozen silt, some peat
8-9 ice
9-11 frozen silt
11-14 ice
14-16 peaty sand & clayey sand frozen
16-32 ice
32-55 frozen gravel + sand

N 13
could be peat in ice

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE [illegible] well [illegible] [illegible]

Date ...., 19...... Field No. [illegible]

Record by .... Office No. ....

Source of data [illegible] 5/[illegible]/63

1. *Location:* State [illegible] County ....
   Map ....
   ......¼ ......¼ sec. ...... T ...... N/S R ...... E/W
2. *Owner:* .... Address ....
   Tenant .... Address ....
   Driller [illegible] Address ....
3. *Topography* ....
4. *Elevation* ...... ft. above/below ....
5. *Type:* Dug, drilled, driven, bored, jetted [illegible] 1963
6. *Depth:* Rept. [illegible] ft. Meas. ...... ft.
7. *Casing:* Diam. 6 in., to ...... in., Type ......
   Depth ...... ft., Finish ....
8. *Chief Aquifer* .... From ...... ft. to ...... ft.
   Others ....
9. *Water level* 20 ½ ft. rept./meas. ...... 19...... above/below ....
   .... which is ...... ft. above/below surface
10. *Pump:* Type .... Capacity ...... G. M. ......
    Power: Kind .... Horsepower ....
11. *Yield:* Flow ...... G. M., Pump ...... G. M., Meas., Rept. Est. ......
    Drawdown ...... ft. after ...... hours pumping ...... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
    Adequacy, permanence ....
13. *Quality* .... Temp ...... °F.
    Taste, odor, color .... Sample Yes/No ......
    Unfit for ....
14. *Remarks* (Log, Analyses, etc.) ....

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(62)

[illegible] [illegible]
[illegible] [illegible]
[illegible] [illegible]
[illegible]
115 V

3/5/63 [illegible]
3/21/63 screen removed, csng stuck – [illegible] Pulled well.

0-9 gravel + gravelly silty fill
9-19 silty sand, tan
19-29 sandy gravel, max 1"
29-52 Sand + gravel stratified
water 38-41, 46-47

9-185
October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date ...., 19...... Field No. 50

Record by .... Office No. ....

Source of data Juhl? & Shepard 1946, DH5

1. *Location:* State .... County ....
Map 125/10E ~~[illegible]~~ of SE corner [illegible]
....¼ ....¼ sec. .... T .... N/S R .... E/W 125 [illegible]

2. *Owner:* .... Address ....
Tenant .... Address ....
Driller .... Address ....

3. *Topography* ....

4. *Elevation* .... ft. above/below ....

5. *Type:* Dug, drilled, driven, bored, jetted .... 19....

6. *Depth:* Rept. 50 ft. Meas. .... ft.

(63) 7. *Casing:* Diam. .... in., to .... in., Type ....
Depth .... ft., Finish ....

8. *Chief Aquifer* .... From .... ft. to .... ft.
Others ....

9. *Water level* .... ft. rept./meas. .... 19.... above/below ....
.... which is .... ft. above/below surface

10. *Pump:* Type .... Capacity .... G. M. ....
Power: Kind .... Horsepower ....

11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
Drawdown .... ft. after .... hours pumping .... G. M.

12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....
Adequacy, permanence ....

13. *Quality* .... Temp .... °F.
Taste, odor, color .... Sample Yes/No ....
Unfit for ....

14. *Remarks:* (Log, Analyses, etc.) ....

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DH5
Added from graphic log

0 - 1½ silt & peat
1½ - 4 Frozen silt
4 - 33 [illegible]
33 - 35 frozen sand
35 - 37 frozen gravel & sand
37 - 40 frozen sand
40 - 50 frozen gravel & sand

9-185
(October 1950)

UNITED STATES
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Galena

WELL SCHEDULE

Date ...., 19...... Field No. 49

Record by .... Office No. ....

Source of data Pewe? + Sheppard 1946 fig 33 DH 2

1. *Location:* State .... County ....

Map 125 ft SE of post 100 ft SW of SE corner ... ¼ ... ¼ sec. ... T ... N/S R ... E/W

2. *Owner:* .... Address ....

Tenant .... Address ....

Driller .... Address ....

3. *Topography* ....

4. *Elevation* .... ft. above/below ....

5. *Type:* Dug, drilled, driven, bored, jetted ...... 19....

6. *Depth:* Rept. 49 ft. Meas. .... ft.

7. *Casing:* Diam. ...... in., to ...... in., Type ......

Depth ...... ft., Finish ....

(64)

8. *Chief Aquifer* .... From .... ft. to .... ft.

Others ....

9. *Water level* .... ft. rept./meas. .... 19...... above/below ....

.... which is .... ft. above/below surface

10. *Pump:* Type .... Capacity .... G. M. ......

Power: Kind .... Horsepower ....

11. *Yield:* Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ......

Drawdown .... ft. after .... hours pumping .... G. M.

12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

13. *Quality* .... Temp .... °F.

Taste, odor, color .... Sample Yes/No ....

Unfit for ....

14. *Remarks:* (Log, Analyses, etc.) frozen 1–49 feet

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Fill 2 SE ...

... frozen ... dry

0–1 ... peat

1–2 frozen silt + peat

2–3 ice

3–5 peat + silt, frozen

5–6 ice

6–7½ silt + peat, frozen

7½–9 frozen silt

9–10 ice

10–15 frozen silt

15–21 frozen gravel + sand

21–22 ice

22–25 frozen sand

25–25½ ice

25½–32 frozen sand

32–36 frozen sand + gravel

36–38 frozen sand

38–40 ice (...)

40–44 frozen gravel + sand

44–49 " sand + gravel

NB ... [illegible]

)-185
)ber 1950)

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WATER RESOURCES DIVISION

Balan

LL SCHEDULE

e ______, 19____ Field No. 43

ord by ______ Office No. ______

rce of data Sweaty & Skypsd 1946 fig 33 DH3

Location: State ______ County ______

Map ~~sec~~ 115 ft S.C. of dike at point 646 SW of SE corner of dike

____ ¼ ____ ¼ sec. ____ T ____ N/S R ____ E/W

Owner: ______ Address ______

Tenant ______ Address ______ 646

Driller ______ Address ______ 115 DH3

Topography ______

Elevation ______ ft. above/below ______

Type: Dug, drilled, driven, bored, jetted ______ 19____

Depth: Rept. 43 ft. Meas. ______ ft.

Casing: Diam. ____ in., to ____ in., Type ______

Depth ____ ft., Finish ______

Chief Aquifer ______ From ______ ft. to ______ ft.

Others ______

Water level ______ ft. rept./meas. ______ 19____ above/below ______

______ which is ______ ft. above/below surface

Pump: Type ______ Capacity ______ G. M. ______

Power: Kind ______ Horsepower ______

Yield: Flow ______ G. M., Pump ______ G. M., Meas., Rept. Est. ______

Drawdown ______ ft. after ______ hours pumping ______ G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ______

Adequacy, permanence ______

Quality ______ Temp ______ °F.

Taste, odor, color ______ Sample Yes/No ______

Unfit for ______

Remarks: (Log, Analyses, etc.) frozen 1-43

(69)

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DH3

Scaled from graphic log

0 - 1 ~~[illegible]~~ silt & peat

1 - 4 frozen silt & peat

4 - 5 ice

5 - 9 frozen silt & peat

9 - 10 ice

10 - 11 frozen silt & peat

11 - 12 ice

12 - 13 frozen silt & peat

13 - 14 sand, frozen

14 - 15 ice

15 - 15½ frozen sand

15½ - 16½ ice

16½ - 17 frozen sand

17 - 18½ frozen gravel & sand

18½ - 19 ice

19 - 23 frozen gravel & sand

23 - 23½ frozen sand

23½ - 24 ice

24 - 25 frozen sand

25 - 25½ ice

25½ - 26 frozen sand

26 - 27½ ice

27½ - 29 frozen sand

29 - 29½ ice

29½ - 30 fr. gravel & sand

30 - 31 ice

31 - 32 gravel ~~[illegible]~~, fr.

32 - 43 TD fr. gravel & sand

interpreted as ice but may be peat or [illegible]

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er 1950)

UNITED STATES
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WATER RESOURCES DIVISION

L SCHEDULE — Galena

, 19...... Field No. 32

rd by ...... Office No. ......

e of data: Davidson & Shepard fig 32 DH 13

Location: State N Edge runway County ......

Map 2570 ft S 70 E of SE corner old hangar

...... ¼ ...... ¼ sec. ...... T ...... N/S R ...... E/W

Owner: ...... Address ......

Tenant ...... Address ......

Driller ...... Address ......

Topography ......

Elevation ...... ft. above/below ......

Type: Dug, drilled, driven, bored, jetted ...... 19......

Depth: Rept. ...... ft. Meas. ...... ft.

Casing: Diam. ...... in., to ...... in., Type ......

Depth ...... ft., Finish ......

(66)

Chief Aquifer ...... From ...... ft. to ...... ft.

Others ......

Water level ...... ft. rept./meas. ...... 19...... above/below ......

...... which is ...... ft. above/below surface

Pump: Type ...... Capacity ...... G. M. ......

Power: Kind ...... Horsepower ......

Yield: Flow ...... G. M., Pump ...... G. M., Meas., Rept. Est. ......

Drawdown ...... ft. after ...... hours pumping ...... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ......

Adequacy, permanence ......

Quality ...... Temp ...... °F.

Taste, odor, color ...... Sample Yes/No ......

Unfit for ......

Remarks: (Log, Analyses, etc.) ......

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DH13
[illegible]

0-3 gravel
3-4 peat?
4-7 silt
7-11 frozen silt
11-18 frozen sand + gravel
18-21 " sand
21-22½ " silt
22½-24 ice
24-29 frozen sand
29-32 frozen gravel

-186
ber 1950)

UNITED STATES
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WATER RESOURCES DIVISION

LL SCHEDULE — Galena

e ...., 19...... Field No. 32
ord by .... Office No. DH6
ce of data [illegible] 1946 [illegible]

Location: State .... County ....

Map ....

.... ¼ .... ¼ sec. .... T .... N/S R .... E/W

Owner: .... Address ....

Tenant .... Address ....

Driller .... Address ....

Topography ....

Elevation .... ft. above/below ....

Type: Dug, drilled, driven, bored, jetted .... 19....

Depth: Rept. 32 ft. Meas. .... ft.

Casing: Diam. .... in., to .... in., Type ....

Depth .... ft., Finish ....

Chief Aquifer .... From .... ft. to .... ft.

Others ....

Water level .... ft. rept./meas. .... 19.... above/below ....

.... which is .... ft. above/below surface

Pump: Type .... Capacity .... G. M. ....

Power: Kind .... Horsepower ....

Yield: Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....

Drawdown .... ft. after .... hours pumping .... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

Quality .... Temp .... °F.

Taste, odor, color .... Sample Yes/No ....

Unfit for ....

Remarks: (Log, Analyses, etc.) [illegible]

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DH6

[illegible] from graphic log

0-3 gravel
3-4 silt
4-5 sand
5-7 silt
7-8 sand
8-10 silt
10-11 sand
11-16 silt
16-18 silt sand gravel
18-32 gravel [illegible]

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena

WELL SCHEDULE

Date ______________, 19____ Field No. 30

Record by ______________ Office No. ______

Source of data Swartz + Shepard 1946 DH 14

1. *Location:* State N edge runway County ______
   Map 1315 ft S 38° E of SE corner old hangar
   ____ ¼ ____ ¼ sec. ____ T ____ N/S R ____ E/W
2. *Owner:* ______ Address ______
   Tenant ______ Address ______
   Driller ______ Address ______
3. *Topography* ______
4. *Elevation* ______ ft. above/below ______
5. *Type:* Dug, drilled, driven, bored, jetted ______ 19____
6. *Depth:* Rept. 30 ft. Meas. ______ ft.
7. *Casing:* Diam. ______ in., to ______ in., Type ______
   Depth ______ ft., Finish ______
8. *Chief Aquifer* ______ From ______ ft. to ______ ft.
   Others ______
9. *Water level* ______ ft. rept./meas. ______ 19____ above/below ______
   ______ which is ______ ft. above/below surface
10. *Pump:* Type ______ Capacity ______ G. M. ______
    Power: Kind ______ Horsepower ______
11. *Yield:* Flow ______ G. M., Pump ______ G. M., Meas., Rept. Est. ______
    Drawdown ______ ft. after ______ hours pumping ______ G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. ______
    Adequacy, permanence ______
13. *Quality* ______ Temp ______ °F.
    Taste, odor, color ______ Sample Yes/No ______
    Unfit for ______
14. *Remarks:* (Log, Analyses, etc.) ______

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[illegible] from graphic log

0 - 2 gravel fill

2 - 3 [illegible], bituminous

3 - 6 silt

6 - 49 frozen silt

97 - 16 silt

16 - 18 silt & sand

18 - 22 gravel & sand

22 - 30 " "

9-185
(October 1950)

UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date ...., 19...... Field No. 30

Record by .... Office No. ....

Source of data Aurey & Shepard 1946 DH 12

1/2 50 [illegible]

Location: State .... County ....

Map 4260 ft S80°E of SE corner [illegible] Kanyak

.... 1/4 .... 1/4 sec. .... T .... N/S R .... E/W

Owner: .... Address ....

Tenant .... Address ....

Driller .... Address ....

Topography ....

Elevation .... ft. above/below ....

Type: Dug, drilled, driven, bored, jetted ......19......

Depth: Rept. 30 ...... ft. Meas. .... ft.

Casing: Diam. ...... in., to ...... in., Type ......

Depth ...... ft., Finish ....

Chief Aquifer .... From .... ft. to .... ft.

Others ....

Water level .... ft. rept./meas. .... 19...... above/below ....

.... which is .... ft. above/below surface

Pump: Type .... Capacity .... G. M. ....

Power: Kind .... Horsepower ....

Yield: Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....

Drawdown .... ft. after .... hours pumping .... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

Quality .... Temp .... °F.

Taste, odor, color .... Sample Yes/No ....

Unfit for ....

Remarks: (Log, Analyses, etc.) Permafrost 4-27 ft

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(69)

[illegible] from [illegible] log

0 - 2 gravel
2 - 2½ bituminous pavement
2½ - 4 silt
4 - 16 frozen silt
16 - 20 frozen peat + silt
20 - 27 frozen gravel + sand
27 - 30 sand

p/f at 4 - 27 ft

9-185
(October 1950)

UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date ...., 19...... Field No. Barbeau 22
Record by .... Office No. ....
Source of data Brady + Sheppard BM-1

Location: State .... County ....
Map Ca 2000 ft ... SE corner old hangar
.... 1/4 .... 1/4 sec. .... T .... N/S R .... E/W
Owner: .... Address ....
Tenant .... Address ....
Driller .... Address ....
Topography ....
Elevation .... ft. above/below ....
Type: Dug, drilled, driven, bored, jetted ...... 19....
Depth: Rept. 22 ft. Meas. .... ft.
Casing: Diam. ...... in., to ...... in., Type ......
Depth .... ft., Finish ....
(90) Chief Aquifer .... From .... ft. to .... ft.
Others ....
Water level .... ft. rept./meas. .... 19..... above/below ....
.... which is .... ft. above/below surface
Pump: Type .... Capacity .... G. M. ....
Power: Kind .... Horsepower ....
Yield: Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....
Drawdown .... ft. after .... hours pumping .... G. M.
Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....
Adequacy, permanence ....
Quality .... Temp .... °F.
Taste, odor, color .... Sample Yes/No ....
Unfit for ....
Remarks: (Log, Analyses, etc.) ....

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Section from graphic log

BM-1

0 - 1½ gravel
1½ - 6 silt
6 - 10 frozen silt
10 - 17 frozen gravel & sand
17 - 20 frozen sand
20 - 22 frozen gravel + sand

9-2750
(Feb. 1954)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Date ...., 19......

Galena

MISCELLANEOUS FIELD NOTES

W.H. Drury, Jr., botanist

Galena airfield located on youngest part of floodplain. On e well 200 ft deep went through 110 ft of permafrost. Frost at depth of 2-16 ft decreases away from the river. Away from the river silt freezes but gravel does not (that is, a thawed zoneoccurs in gravel beneath silt, underlain again by frost).
([illegible] from [illegible])

1949

Pewe ([illegible]) states that there are 2 water wells 200 ft deep [illegible] passed through 110 feet of permafrost

Pewe 1947 Galena - [illegible]
Pewe 1960 [illegible] - Galena [illegible]

No. of sheets 16—68176-3 U. S. GOVERNMENT PRINTING OFFICE

9-185
(October 1950)

UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE — Galena

Date ...., 19....... Field No. 43

Record by TRW Office No. ....

Source of data [illegible] & Shepard 1946 p.36. DH22

[illegible] of Power house N end of base

Location: State .... County ....

Map 1040 ft S 15 W of SW corner of old hangar

.... ¼ .... ¼ sec. .... T .... N/S R .... E/W

Owner: .... Address ....

Tenant .... Address ....

Driller Army Address Galena

Topography ....

Elevation .... ft. above/below ....

Type: Dug, drilled, driven, bored, jetted 8/3 1945

Depth: Rept. 43 ft. Meas. .... ft.

Casing: Diam. ...... in., to ...... in., Type ....

Depth ...... ft., Finish ....

Chief Aquifer .... From .... ft. to .... ft.

Others ....

Water level .... ft. rept./meas. .... 19...... above/below ....

.... which is .... ft. above/below surface

Pump: Type .... Capacity .... G. M.

Power: Kind .... Horsepower ....

Yield: Flow .... G. M., Pump .... G. M., Meas., Rept. Est. ....

Drawdown .... ft. after .... hours pumping .... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

Quality .... Temp .... °F.

Taste, odor, color .... Sample Yes/No ....

Unfit for ....

Remarks: (Log, Analyses, etc.) Permafrost 4–38.8

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Interpreted from scaled graphic log

Depth ft	
0-4	[illegible] gravel
4-25	frozen silt
25-28	frozen silt & sand
28-32	frozen gravel
32-37	frozen gravel & sand
37-38.8	" gravel
38.8-43	~~[illegible]~~ gravel

frozen 4 – 38.8 ft

New [illegible] [illegible]

Temp log 4/15/45 (after drilling 16" [illegible] [illegible])

Depth ft	Temp
1	+3.8°C
3	+3.5
5	1.5
7	-0.2
10	-0.4
13	-0.3
18.4	-0.5
23.8	-0.4
29.2	-0.3
34.6	-0.1
40.0	-0.1

Bottom thermometer still in frost, but [illegible] temperature suggests approach to bottom of permafrost indicated in drill log.

9-185
ober 1950)

UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Galena

LL SCHEDULE

te ...., 19...... Field No. 43

ord by .... Office No. ....

rce of data Schwartz & Shepard 1946 D1421

1571 S, 73 E of D1122 in N Power house

Location: State ...... County ......

Map On north edge unused bldg

...... ¼ ...... ¼ sec. ...... T ...... N/S R ...... E/W

Owner: .... Address ....

Tenant .... Address ....

Driller .... Address ....

Topography ....

Elevation .... ft. above/below ....

Type: Dug, drilled, driven, bored, jetted ...... 19....

Depth: Rept. 43 ft. Meas. .... ft.

Casing: Diam. ...... in., to ...... in., Type ......

Depth ...... ft., Finish ....

Chief Aquifer .... From ...... ft. to ...... ft.

Others ....

Water level ...... ft. rept./meas. .... 19...... above/below ....

.... which is ...... ft. above/below surface

Pump: Type .... Capacity ...... G. M. ......

Power: Kind .... Horsepower ....

Yield: Flow ...... G. M., Pump ...... G. M., Meas., Rept. Est. ......

Drawdown ...... ft. after ...... hours pumping ...... G. M.

Use: Dom., Stock, PS., RR., Ind., Irr., Obs. ....

Adequacy, permanence ....

Quality .... Temp ...... °F.

Taste, odor, color .... Sample Yes/No ......

Unfit for ....

Remarks: (Log, Analyses, etc.) Permafrost 10-16 ft

U. S. GOVERNMENT PRINTING OFFICE 16—62891-1

Log

0-3	gravel	fill?
3-10	silt	
10-15	silt, frozen	
15-16	peat?	frozen symbol
16-27	silt	
27-36	sand	
36-43	gravel	

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	5569	5567	5566	5568		
Date of collection	10/1/59	10/1/59	10/1/59	10/1/59		
Silica (SiO_2)	42	43	37	40		
Iron (Fe)	2.8	0.17	5.2	0.07		
Manganese (Mn)	0.00	0.01	0.02	0.00		
Calcium (Ca)	58	8.7	61	59		
Magnesium (Mg)	20	2.8	17	19		
Sodium (Na)	2.9	122	3.6	3.4		
Potassium (K)	2.6	2.3	2.6	2.8		
Carbon Dioxide (CO_2)	42	19	34	53		
Bicarbonate (HCO_3)	265	307	273	266		
Carbonate (CO_3)	0	0	0	0		
Sulfate (SO_4)	2.0	3.0	2.0	1.0		
Chloride (Cl)	3.0	30	8.5	2.5		
Fluoride (F)	0.1	0.2	0.1	0.1		
Nitrate (NO_3)	5.0	0.2	0.1	8.0		
Dissolved solids						
Calculated	268	363	271	267		
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	226	33	222	225		
Noncarbonate hardness as $CaCO_3$	10	0	0	7		
Alkalinity as $CaCO_3$	217	252	224	218		
Specific conductance (micromhos at 25°C)	420	548	428	430		
pH	7.0	7.4	7.1	6.9		
Color	20	10	0	10		

5569 - Galena Air Base, well #2, raw water.
5567 - Galena Air Base, treated water, collected in water treatment plant.
5566 - Galena Air Base, well 1, chlorinated water (alert hanger well).
5568 - Galena Air Base, well 3, raw water (fire station well).

Table .-- Chemical analyses of water from principal sources at Galena Air Force Base.

7 1

2GW

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER ANALYSIS

Location 5072nd ABS - Galena County 4th Division
Source Yukon Depth (ft) ____ Diam (in.) ____
Cased to (ft) ____ Date drilled ____ Point of coll. at alert cell
____ Owner ____
Treatment untreated Use ____
WBF ____ WL ____ Yield ____
Temp (°F) ____ Appear. when coll. ____
Collected 1 December 1961 By ____
Remarks

	ppm	epm		ppm	epm
Silica (SiO_2)	34		Bicarbonate (HCO_3)	266	4.36
Aluminum (Al)			Carbonate (CO_3)		
Iron (Fe) (dis)	0.09				
Manganese (Mn)	0.25		Sulfate (SO_4)	1.0	0.02
			Chloride (Cl)	0.5	0.01
			Fluoride (F)	0.2	0.01
Calcium (Ca)	62	3.09			
Magnesium (Mg)	15	1.27	Nitrate (NO_3)	0.4	0.01
Sodium (Na)	2.7	0.12			
Potassium (K)	1.7	0.04			
Total		4.52	Total		4.41

	ppm		
		Specific conductance (micromhos at 25° C)	399
Dissolved solids: Calculated	249	pH	7.1
Residue on evaporation at 180° C		Color	10
Hardness as $CaCO_3$	218		
Noncarbonate	0		

Lab. No. Col 6835 Field No. Project

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

2GW

WATER ANALYSIS

Location 5072nd ABS(Galena) County 4th Division
Source Yukon Depth (ft) Diam (in.)
Cased to (ft) Date drilled Point of coll. Upper kitchen - Alert cell
Owner
Treatment treated water Use
WBF WL Yield
Temp (°F) Appear. when coll.
Collected 1 December 1961 By
Remarks

	ppm	epm		ppm	epm
Silica (SiO_2)	33		Bicarbonate (HCO_3)	276	~~4.52~~ 4.52
Aluminum (Al)			Carbonate (CO_3)		
Iron (Fe) (dis)	0.21				
Manganese (Mn)	0.19		Sulfate (SO_4)	1.0	0.02
			Chloride (Cl)	4.0	0.11
			Fluoride (F)	0.1	0.01
Calcium (Ca)	45	~~2.25~~ 2.20			
Magnesium (Mg)	15	~~1.27~~ 1.23	Nitrate (NO_3)	0.4	0.01
Sodium (Na)	29	1.26			
Potassium (K)	0.6	0.02			
Total		~~4.80~~ 4.71	Total		~~4.67~~ 4.71

	ppm		
		Specific conductance (micromhos at 25° C)	403
Dissolved solids: Calculated	264 ~~XXXX~~	pH	8.2
Residue on evaporation at 180° C		Color	20
Hardness as $CaCO_3$	176		
Noncarbonate	---		

Lab. No. Col 6830 Field No. Project

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER ANALYSIS

2GW

Location 5072nd ABS - Galena County 4th Division
Source Yukon Depth (ft) ____ Diam (in.) ____
Cased to (ft) ____ Date drilled ____ Point of coll. Main water plant
____ Owner ____
Treatment treated Use ____
WBF ____ WL ____ Yield ____
Temp (°F) ____ Appear. when coll. ____
Collected 1 December 1961 By ____
Remarks

	ppm	epm		ppm	epm
Silica (SiO_2)	37		Bicarbonate (HCO_3)	312	5.11
Aluminum (Al)			Carbonate (CO_3)		
Iron (Fe) (dis)	0.76				
Manganese (Mn)	0.02		Sulfate (SO_4)	2.0	0.04
			Chloride (Cl)	6.5	0.18
			Fluoride (F)	0.2	0.01
Calcium (Ca)	8.4	0.42			
Magnesium (Mg)	2.4	0.20	Nitrate (NO_3)	1.1	0.02
Sodium (Na)	105	4.57			
Potassium (K)	1.3	0.03			
Total		5.22	Total		5.36

	ppm		
		Specific conductance (micromhos at 25° C)	465
Dissolved solids: Calculated	318	pH	7.5
Residue on evaporation at 180°C		Color	50
Hardness as $CaCO_3$	31		
Noncarbonate	0		

Lab. No. Col 6831 Field No. Project

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER ANALYSIS

2GW

Location 5072nd ABS - Nulato Quadrangle County 4th Division
Source Yukon Depth (ft) Diam (in.)
Cased to (ft) Date drilled Point of coll. Main water plant dormitory #2
Owner
Treatment Use
WBF WL Yield
Temp (°F) Appear. when coll. clear - collection
Collected 1 December 1961 By
Remarks

	ppm	epm		ppm	epm
Silica (SiO_2)	38		Bicarbonate (HCO_3)	315	~~5.16~~ 5.??
Aluminum (Al)			Carbonate (CO_3)		
Iron (Fe) (dis)	1.0				
Manganese (Mn)	0.02		Sulfate (SO_4)	2.0	0.04
			Chloride (Cl)	7.0	0.20
			Fluoride (F)	0.2	0.01
Calcium (Ca)	8.8	0.44			
Magnesium (Mg)	2.9	0.24	Nitrate (NO_3)	0.6	0.01
Sodium (Na)	105	~~4.56~~ 4.63			
Potassium (K)	1.7	0.04			
Total		~~5.28~~ 5.35	Total		~~5.42~~ 5.35

	ppm		
		Specific conductance (micromhos at 25° C)	468
Dissolved solids: Calculated	322	pH	8.0
Residue on evaporation at 180°C		Color	40
Hardness as $CaCO_3$	34		
Noncarbonate	0		

Lab. No. Col 6832 Field No. Project

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	6862	6863	6864	6865	6866	6867
Date of collection	29 Jan. 1962	29 Jan. 1962	29 Jan. 1962	29 Jan. 1962	29 Jan. 1962	29 Jan. 1962
Silica (SiO_2)	38	38	33	33	32	39
Iron (Fe) (dis)	0.03	0.93	0.05	0.12	0.17	0.29
Iron (Fe) (total)	5.6	2.6	5.5	16	12	1.5
Manganese (Mn)	0.00	0.08	0.23	0.34	0.13	0.00
Calcium (Ca)	63	14	48	60	52	8.8
Magnesium (Mg)	18	8.0	16	15	16	7.1
Sodium (Na)	2.6	79	21	2.2	18	100
Potassium (K)	2.6	4.5	1.1	1.8	0.9	3.1
Bicarbonate (HCO_3)	287	272	284	258	275	317
Carbonate (CO_3)						
Sulfate (SO_4)	1.0	1.0	1.0	1.0	1.0	1.0
Chloride (Cl)	1.0	10	4.0	1.0	4.0	7.0
Fluoride (F)	0.2	0.2	0.1	0.1	0.1	0.2
Nitrate (NO_3)	0.3	0.7	0.2	0.2	0.4	0.5
Dissolved solids Calculated	268	290	264	241	260	323
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	230	68	184	210	194	51
Noncarbonate hardness as $CaCO_3$	--	--	--	--	--	--
Alkalinity as $CaCO_3$						
CO_2	46	14	9	7	7	8
Specific conductance (micromhos at 25°C)	438	460	419	403	409	482
pH	7.0	7.5	7.7	7.8	7.8	7.8
Color	20	60	10	20	20	30

6862 - 5072nd ABS - Point of Coll.-Main Water Plant
6863 - " " -Main Water Plant
6864 - " " - Alert cell Kitchen
6865 - " " -Alert cell, purification system
6866 - " " -Alert cell kitchen
6867 - " " -Barracks-hot treated water

All Potable - Treatment

72820

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	6868	6869				
Date of collection	4 Feb. 1962	4 Feb. 1962				
Silica (SiO_2)	36	39				
Iron (Fe) (dis)	0.12	0.31				
Manganese (Mn)	0.08	0.00				
Calcium (Ca)	34	6.8				
Magnesium (Mg)	15	0.5				
Sodium (Na)	2.7	112				
Potassium (K)	2.2	2.2				
Bicarbonate (HCO_3)	192	292				
Carbonate (CO_3)						
Sulfate (SO_4)	1.0	1.0				
Chloride (Cl)	1.0	6.0				
Fluoride (F)	0.1	0.2				
Nitrate (NO_3)	0.3	0.4				
Dissolved solids						
Calculated	186	184				
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	146	19				
Noncarbonate hardness as $CaCO_3$	--	--				
Alkalinity as $CaCO_3$						
CO_2	5	1				
Specific conductance (micromhos at 25°C)	294	473				
pH	7.8	8.6				
Color	10	5				

~~6868~~ - 5072nd ABS - Point of Coll. - barracks - hot treated water, potable
6869 - " " - treated water zeolite & filtration treatment, potable

72820

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	6952	6953	6954			
Date of collection	5 Mar. 1962	5 Mar. 1962	5 Mar. 1962			
Silica (SiO_2)						
Iron (Fe) (dis)	1.9	5.4	4.2			
Manganese (Mn)						
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						
Calculated						
Residue on evaporation at 180°C						
Hardness as $CaCO_3$						
Noncarbonate hardness as $CaCO_3$						
Alkalinity as $CaCO_3$						
Specific conductance (micromhos at 25°C)						
pH						
Color						

6952 - 5072nd ABS; dormitory #2; filtered hot water; iron test only
6953 - " @ main plant; filtered raw water; iron test only
6954 - " @ BOQ; filtered hot water; iron test only

72820

5072nd ABS
Galena AFS
Galena, Alaska

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Numbers	8343	8344				
Date of collection	Jan. 8, 1965					
Silica (SiO_2)	33	37				
Iron (Fe) (dis)	0.06	0.09				
Iron (Fe) (total)	9.60	6.76				
Manganese (Mn)	0.00	0.27				
Calcium (Ca)	59	63				
Magnesium (Mg)	16	16				
Sodium (Na)	2.8	3.2				
Potassium (K)	2.2	2.8				
Bicarbonate (HCO_3)	264	270				
Carbonate (CO_3)	0	0				
Sulfate (SO_4)	1.9	1.9				
Chloride (Cl)	2.1	1.8				
Fluoride (F)	0.1	0.1				
Nitrate (NO_3)	0.6	0.6				
Carbon Dioxide (CO_2)	13	54				
Dissolved solids						
Calculated	248	260				
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	212	221				
Noncarbonate hardness as $CaCO_3$	0	0				
Alkalinity as $CaCO_3$	216	221				
Specific conductance (micromhos at 25°C)	395	430				
pH	7.5	6.9				
Color	20	50				

8343-5072nd ABS, Galena, Alaska, ~~Alert Well~~ Well. Samp. ~~Pt.:~~ Pump. ~~Clear at Collection.~~ Coll.: Seiboldt.
8344-5072nd ABS, Galena, Alaska, Main Plant. Samp. Pt.: before degasifier. Clear at Collection. Coll.: Seiboldt. Only operating well for base supply.

24027

2GW

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER ANALYSIS

Location ~~G... School well~~ GALENA 62°18'05" 145°48'15" County ______
Source ______ Depth (ft) ______ Diam (in.) ______
Cased to (ft) ______ Date drilled ______ Point of coll. ______
______ Owner ______
Treatment ______ Use ______
WBF ______ WL ______ Yield ______
Temp ~~(°F)~~ 4.5°C Appear. when coll. ______
Collected October 3, 1968 1215 hours By ______
Remarks

	~~ppm~~ mg/l	~~epm~~ ep/l		~~ppm~~ mg/l	~~epm~~ ep/l
Silica (SiO_2)	17		Bicarbonate (HCO_3)	224	3.67
Aluminum (Al)	---		Carbonate (CO_3)	0	.00
Iron (Fe)	.05				
			Sulfate (SO_4)	34	.71
			Chloride (Cl)	25	.71
			Fluoride (F)	.2	.01
Calcium (Ca)	66	3.29			
Magnesium (Mg)	14	1.15	Nitrate (NO_3)	.2	.00
Sodium (Na)	19	.83			
Potassium (K)	3.8	.10			
Total		5.36	Total		5.02

	~~ppm~~ mg/l		
Dissolved solids:		Specific conductance (micromhos at 25° C)	472
Calculated	278	pH	7.7
Residue on evaporation at 180°C		Color	5
Hardness as $CaCO_3$	222		
Noncarbonate	39		

Lab. No. Col 11977-69-08 Field No. Project Alaska Dept. of Health and Welfare

.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	13450	13451			
Date of collection	4-30-70	4-30-70			
Silica (SiO_2)	37	39			
Iron (Fe) (total)	4.1	1.1			
Manganese (Mn)	.40	.31			
Calcium (Ca)	62	15			
Magnesium (Mg)	17	6.1			
Sodium (Na)	3.0	87			
Potassium (K)	2.7	1.5			
Bicarbonate (HCO_3)	284	302			
Carbonate (CO_3)	00	00			
Sulfate (SO_4)	.4	.8			
Chloride (Cl)	1.1	5.3			
Fluoride (F)	0.1	0.4			
Nitrate (NO_3)	0.3	1.1			
Dissolved solids Calculated	264	305			
Residue on evaporation at 180°C					
Hardness as $CaCO_3$	232	63			
Noncarbonate hardness as $CaCO_3$	0	0			
Alkalinity as $CaCO_3$	233	248			
Specific conductance (micromhos at 25°C)	453	462			
pH	7.2	7.4			
Color	30	20			

13450 - Galena Raw water, Well #2, collected by Heyward, 4°C. clear appearance, domestic use.
13451 - Galena Treated water, Well #2, coll. by Heyward, domestic use. Iron sample taken after sand filter and before zeolite softener.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	13519
Date of collection	5-23-70
Silica (SiO_2)	13
Iron (Fe) (total)	0.08
Manganese (Mn)	0.60
Calcium (Ca)	13
Magnesium (Mg)	4.4
Sodium (Na)	2.4
Potassium (K)	0.4
Bicarbonate (HCO_3)	51
Carbonate (CO_3)	00
Sulfate (SO_4)	7.5
Chloride (Cl)	2.1
Fluoride (F)	0.1
Nitrate (NO_3)	0.3
Dissolved solids	
Calculated	59
Residue on evaporation at 180°C	
Hardness as $CaCO_3$	50
Noncarbonate hardness as $CaCO_3$	12
Alkalinity as $CaCO_3$	42
Specific conductance (micromhos at 25°C)	108
pH	7.4
Color	20

13519 - White Alice Site well at Kalakaket Creek (20 miles south of Galena), coll. by Paul K. Gray at 4a Latrine basin, clear appearance.

APPENDIX 6

U.S. Army Corps of Engineers

"Report on Galena airport observation wells Galena, Alaska"

REPORT ON
GALENA AIRPORT OBSERVATION WELLS
GALENA, ALASKA

Corps of Engineers
U. S. Army Engineer District, Alaska
Anchorage, Alaska

Prepared by
Foundations and Materials Bramch
10 May 1963

CONTENTS

REPORT ON
GALENA AIRPORT OBSERVATION WELLS
GALENA, Alaska

1. INTRODUCTION

a. Scope of Investigation

Foundations and Materials Branch was advised on 2 August 1962 of a proposed project to construct five observation water wells at Galena Airport for the purpose of securing information on the quantity and quality of water that can be developed by an infiltration gallery. The proposal, submitted by Colonel Harold C. White, Assistant DCS/Civil Engineering, Alaskan Air Command, provided for the drilling and casing of five 6-inch diameter water wells not more than 40 feet in depth. Purpose of the work was to determine the feasibility of an alternate source of water at Galena Airbase. The proposal states in part that "The existing water supply is from wells and carries a high content of dissolved CO_2, FeO and other undesirable chemicals which cause high corrosion of water lines and the steam heating system. According to preliminary studies by the U. S. Geological Survey there is a good possibility of developing a source of water of better quality and requiring less treatment than the existing well supply. This project is required to establish the quantity and quality of infiltrated water by means of observation wells. The work is to be performed by the ADE with their own forces and equipment. . . . Additionally, it is necessary that observation of the ground water be conducted over a period of at least one year to establish feasibility of this source of water." (USAF Project Justification Data Form 161, Dept. Identification No. GAL 72-3 (Rev. 1), Budget Account No. P-458(2525), proposed appropriation $11,400.00).

In addition to this proposal, a temporary electric line and well house would be provided for and accomplished by the Alaskan Air Command under a work order request.

Design instructional Number MC-1/63-HZ17-A/CE/3 dated 10 August 1962 was submitted by Alaskan Air Command to Division Engineer, Portland.

Authority to accomplish work was granted by Division Engineer, Portland on 10 December 1962.

b. Location

Galena Airport is located in west central Alaska adjacent to the north bank of the Yukon River. The site is about 270 miles west of Fairbanks, 250 miles east of Nome, and on the direct air route between these two cities.

c. Previous Investigations

Reports on the area include those of Eardley (1938 a, b) who commented upon the sediments and the meandering of the Yukon River, and Péwé (1948) who studied permafrost conditions at the Airport. A number of unpublished reports concerning investigation of subsurface conditions for design and construction activities at the Airport are available in the files of the Foundations and Materials Branch.

2. GEOGRAPHY

a. Surface Features

The lower Yukon River valley varies considerably in width and is about 35 miles wide in the vicinity of the Galena Air Base. The valley is bounded by bedrock hills on three sides. The Yukon River flows westward in this broad valley and is joined by the Koyukuk River from the north. The valley contains numerous terraces and a wide, irregularly shaped floodplain. In most places the terraces are carved out of the enormous silt deposits in the valley. Gravel, sand and muck are found in lesser quantities. Two small bedrock hills, Bishop Rock and Pilot Mountain, respectively 13 miles and 11 miles west of Galena Airport, are the only protuberances on an otherwise broad, flat floodplain. The floodplain is irregularly shaped and ranges in width from less than 1 mile to a maximum of about 20 miles. From the air, the floodplain appears as a complicated series of sloughs, meander scars, oxbow lakes, creeks, tundra and forest. (Péwé, 1948).

Original elevation of the east-west runway of 93 to 98 ft has been raised by fill and pavement to 128.0 ft MSL.

b. Climatology

The mean annual temperature at Galena is 23.7° F. Mean temperature for month of January is -11.4° F. and for July 59.5° F. Annual precipitation is 13.6 inches including 55.1 inches of snowfall. Climatological data are summarized in Table 1.

c. Development of Area

(1) Airport Facilities

The airfield is situated on low ground and in the summer months is only a few feet above the normal water level. At the time this airfield site was decided upon, recognition was given the fact that the field would be subject to occasional inundation during the spring floods, but the urgency of a field in this area forced acceptance of location.

Floods occur each spring, the flood of 1944 being the best documented. The floods are the result of (1) abnormally high seasonal precipitation and (2) ice jams caused by huge blocks of ice piling up at bends and narrow sections of the river to form a dam. In the spring of 1944 such an ice jam occurred 40 miles below the Galena airfield. Aerial bombardment of the ice jam with 500-pound bombs proved ineffective, and the field was flooded. Water stood seven feet deep in many of the huts and warehouses. It was decided at that time that some flood protection was needed. Plans included filling an area to a point above the normal flood elevations, this area to be in the immediate vicinity of the landing field and of a size large enough to accommodate all the necessary buildings. In addition, a dike was to be constructed around the entire landing field and camp area. This work was largely completed during 1944 and 1945. The dike was eventually built to a crest elevation of 135 ft MSL. Silt was pushed out of borrow pits into a hump to form the dike. A permeable gravel bed underlies the dike and permits water from the river to "boil" up into borrow pits during part of the spring and summer. Most seepage enters through borrow pits on the southwest, and in a drainage ditch between the runway and hangar. (Péwé 1948).

In 1959, 1960, 1961 and 1962, piles were driven along the bank of the Yukon River to retard erosion. This erosion is an immediate threat to the southeast corner of the dike. Erosion continues to be a problem at the present time, and may eventually force relocation of the airport.

The airport facilities include an eastwest runway, hangar, FAA communications transmitter, storage tanks for fuel and water, pumphouse, fire station, storage sheds, housing, chapel, and other facilities.

(2) Transportation

Due to its isolated location, there are but two practical means of transportation to Galena. One is by air and can be used the year round; the other is by barge and boat from the railheat at Nenana, down the Tanana River to its junction with the Yukon, thence down the Yukon to Galena, a distance of 360 miles. River transportation can only be used during the months of June, July, August, and September and is afforded by small, shallow-draft river boats and barges.

(3) Water Supply Development

Water consumption at Galena AFS in 1961 was 18,688,000 gallons per year (Feulner, 1962). In July 1954, F&M Branch made a thorough search for data regarding the water wells existing at Galena (Smith, 1954). At that time there were four known wells that had been pumped or were being pumped. Two of the wells were in use furnishing water for the CAA and Air Force units. Except for Well No. 1, original construction data, logs, drawdown tests, and similar technical information could not be located in the files of either the CAA, AIO, AAC, USARAL, or the ADE. The location of the following wells is shown in Figure 2:

Well No. 1 is in a small pumphouse on the east side of the fire station near the hangar. In 1954, it was the primary source of water for the base. It is a 6-inch diameter well, 210 ft in depth. The static water level in 1954 was 19.6 ft below the surface.

Well No. 2 is located in Building T-120-B (called Water Treatment Bldg) just south of the CAA Fuel Oil Storage Building. The depth of the well is not known but is undoubtedly around 200 ft, since it was drilled by the same contractor about the same time as Well No. 1. Static water level in July 1954 was at 19.6 ft. Very little change (4" to 5") in the level of the water was measured during pumping. At the present time this is the main well supplying water to the Air Force station.

Well No. 3 is situated back of the CAA Fuel Storage Bldg (Corps of Engineer's Bldg T-211). This well is used only for fire protection.

Well No. 4 was used from 1943 to 1946 for the old heat and power plant in the north area. It was situated in the old boiler house No. 2, Bldg T-309, but is now abandoned.

In June 1954 the CAA drilled a 4-inch diameter well near the Control Bldg. This well is designated in this report as CAA Well No. 4. The well was drilled to a depth of 43 feet; water was encountered at 23 ft and the static water level was at 14.6 ft depth. The well was pumped at 10 gpm for 70 hours and at the conclusion of the pumping test the water level was at 19.6 ft. This well is presently in use. Another well, CAA Well No. 5, was drilled in June 1954 adjacent to the fire station to a depth of 64 ft but has since been abandoned. These two wells were drilled in an attempt to obtain water with a lower content of iron. It was believed that water from shallow depths would contain less iron than that obtained from Well Nos. 1 and 2, which obtain water from deeper levels. However, samples of water from CAA Well No. 4 proved to be high in iron (Smith, 1954).

A permanent well is installed at the Alert Hangar but has no numerial designation. The well was drilled in October 1955 by the Air Force under private contract, and is 210 ft deep. The well is separate and supplies the Alert Hangar only. The water is chlorinated but is not treated.

Water treatment facilities are housed in Building T-120-B in which Well No. 2 is located. The facilities for water treatment include degasifiers which oxidize ferrous iron to ferric iron, pressure filters using sand to strain out silt particles and iron oxides in solid form, and zeolite softeners for removing calcium and magnesium. The water is chlorinated and pumped into a 10,000 gallon storage tank from which the station water supply is drawn.

3. GEOLOGY

a. Stratigraphy

The airport is constructed on gray micaceous silt underlain by sand and gravel. The thickness of the silt is about 1 ft at the west end of the field, and increases toward the east to more than 16 ft. The top of the gravel layer rises slightly to the west and was exposed in the bottom of borrow pits at the west end of the field in 1948. The gravel layer is exposed along the river on the southwest and west sides of the field.

b. Permafrost

In 1948, the airport was underlain by a layer of permafrost 110 ft thick; the overlying active layer (seasonally frozen ground) was quite variable in thickness; the depth to permafrost was 3 to 4 ft at the east end of the field and more than 16 ft at the west end (Péwé, 1948).

Drillers of CAA Well No. 4, drilled to depth of 43 ft, and CAA Well No. 5, drilled to 64 ft, apparently did not report any permafrost. It is possible, but not probable, that the main permafrost table in 1954 had receded to a depth of at least 64 ft as far north as the power plant and fire station. Cross-sections prepared by Péwé (1948) show that the depth to permafrost decreases away from the river.

4. GROUND WATER

a. Source of Ground Water

The major source of recharge to shallow wells at Galena Airport is considered to be the Yukon River. Some additional recharge to deep wells probably occurs by normal ground water movement from intake areas at or near the slopes of the surrounding highlands. Recharge to wells by means of downward percolation from the land surface in the immediate vicinity of the airport may not occur in significant amounts because of the relatively impermeable silt mantling the surface.

b. Occurrence of Ground Water

The chief water-bearing formation is the alluvium beneath the permafrost layer at permanent Wells No. 1 and 2. The absence of well logs does not permit any estimation to be made of the character of this alluvium, but it seems quite probable that the material consists of gravelly sand, sandy gravel, or interbedded sand and gravel layers.

Water also occurs between the top of the main permafrost table and the base of the seasonally frozen surface layer. Well logs for CAA Wells No. 4 and 5 indicate this material as "gravel and sand" and "sand". The water table appears to be at a depth of approximately 19 to 24 ft in these wells.

5. OBSERVATION WELLS

The following data are a summary of the methods, procedures and results of the present program involving the drilling of four observation wells. This program took place from 21 February 1963 to 24 April 1963. Location of the test wells is shown in Figure 2. Two drillers equipped with a truck-mounted Star 71 churn drill with 6-inch bit arrived in Galena on 21 February 1963. The drillers met with Major Linton, Base Civil Engineer and Mr. Russell, Assistant Civil Engineer to discuss the location of the first well at the Ammo Storage Bldg and to comply with security regulations on the station.

a. Test Well No. W-345

This well was located 41.0 ft east of the Ammo Storage Bldg at coordinates N 101,481; E 101,976. Elevation of ground surface at the well is about 120 ft. The location of the well was confirmed on 25 February 1963 and the well spudded in on the same day. Drilling was completed on 1 March 1963 at a depth of 50.0 ft. On 2 March 1963, the well was bailed for one hour. On 4 March 1963 a Johnson Everdur No. 30 slot screen, 5 ft 8 inches long with an O.D. of 5-1/2 inch was set in the well with the bottom of the screen at 39 ft 6 inches. The static water level was at 30 ft 6-inches depth. The well was developed by bailing for 4-1/2 hours as the static water was too close to the top of the screen to allow proper surging. The water cleared well but had a slightly turbid appearance. Production was estimated at 8 to 10 gpm. It is noted that only 2.0 ft of the screen was exposed due to failure to pull the casing up far enough.

The pump used in making a pumping test at Test Well No. W-345 and subsequent tests at other holes was a Peerless Hi-lift submersible, 3/4 HP, 115 V, 1 phase electric pump 2.4 ft in overall length. On 6 March 1963, a water sample was taken for Bob Schupp of the U. S. G. S., Palmer. A two-hour pumping test was run on 8 March 1963 in which the water cleared well; three water samples were taken, one at the beginning of the test, a second after forty-five minutes, and a third after two hours at the end of the test. On 21 March 1963, the screen was removed from the well and a start was made on pulling the casing. Hot water was required to loosen the casing. On 22 March 1963, hot water treatments were continued and the casing was eventually removed. The well was then abandoned.

b. Test Well No. W-346

Well No. W-346 is located near the southeast corner of the Guardhouse at coordinates N 101,501; E 101,702. Elevation of ground surface at the well is approximately 120 ft. On 11 March 1963, the well was spudded in and three ft drilled. Drilling to 19 ft was completed on 12 March 1963; to 27 ft on 13 March 1963, and to 37 ft on 14 Mar 1963. On 14 March a water sample was taken by Mr. Willis Morris of Alaskan Air Command at 28 - 29 ft. On 15 March 1963, after overnight settling, a water sample at 37 ft was taken by Mr. Morris; drilling then continued to 46 ft. Permafrost was encountered at 42.5 ft. On 16 March 1963 drilling was completed at a depth of 56 ft. On 18 March 1963 a Johnson Everdur No. 30 slot I.D. Screen 5 ft 9 inches in length was set in the hole with the screen bottom at 54 ft and the casing pulled back so that 5 ft 0 inches of the screen was exposed.

The static water level was found to be at 27 ft 6-inches depth. The hole was bailed for three hours. On 19 March 1963 the well was surged for 1-1/2 hours with a dart bailer. A pumping test of 1/2 duration was carried out at 6 gpm because the pump would stop running at a lesser rate. The 6 gpm rate was excessive and the drawdown could not be stabilized. Water samples were taken at the beginning and end of the test. On 24 April 1963 a Myres 1/2 HP jet pump, Serial No. 46062, was set in the well. The bottom of the strainer on the screen is at a depth of 51 ft 1-inch below the ground surface, the water intake is at 48.0 ft, and the bottom of the airline is at 50 ft 9-inches. The well was tagged "Surface water - may be contaminated". At the request of Mr. Willis Morris, Alaskan Air Command, DE personnel prepared suggestions for attaching the pump to the existing facilities. These suggestions are given in Figure 1.

c. Test Well No. W-347

Well No. W-347 is located on the north side of the pumphouse lean-to on the north side of the Alert Hangar; the coordinates are N 101,314; E 97,558. Elevation of the ground surface at the hole is approximately 120 ft MSL. Hole was spudded in on 23 March 1963 and 7 ft drilled. Drilling continued on 25 - 26 March 1963 and was completed on 27 March 1963 at a depth of 35 ft 6-inches. On 27 March 1963 a Johnson Everdur No. 30 slot I.D. screen 5 ft 9-inches long was set in the well with the bottom of the screen at 34 ft. Static water level was at 26 ft 9-inches depth. The well was bailed for four hours. Water samples were taken at depths of 30 to 35 ft and the samples were field tested for iron by Alvin J. Fuelner, U.S.G.S.

On 28 March 1963 the well was surged and bailed for 8-1/2 hours. At 1300 hours, 29 March 1963 Mr. R. J. Velikanje arrived at Galena to observe a pump test of this well. During work on this well considerable time was lost owing to Air Force restrictions in the area resulting from spillage of jet fuel and special exercises. On 30 March 1963 the well screen was found to be at a depth of 35 ft, having settled one foot since originally placed. The screen was exposed for a length of 5.0 ft. On 1 April 1963 a pump test was made using a Peerless turbine with 3-inch column and 5-inch bowls. Static water level was at 26.9 ft at start of test. The water level indicator, however, would not go past the 5-inch bowls, so drawdown could not be determined. The well was pumped at 28 to 34 gpm for 24 hours. Water samples were taken at intervals of 1/2, 8, 12 and 20 hours, and at the conclusion of the test. The well would appear capable of yielding about 20 gpm at a stabilized drawdown level. On 20 April 1963 the screen was raised to a new setting with bottom of screen at 31 ft 4 inches depth and a 10-12 gpm jet pump installed. Naphtha, paint thinner, and jet fuel were noted on the ground at the site; the Fire Department hosed off the area but it was still dangerous to use a welding torch.

Static water level on 22 April was 26 ft 4-inches from top of the asphalt paving. The well was developed by using a 3-1/2-inch by 21 ft sand pump. The screen settled 5 inches during development to a depth of 31 ft 9 inches from top of asphalt paving. A Myres 3/4 HP 2-pipe jet pump with 1 inch by 1-1/4 inch outlets was installed in the well. The depth to the bottom of the screen on the pump is 33 ft 2 inches (Elev 89.33 MSL) below the top of the casing which extends 1 ft 6 inches above asphalt paving; the depth to the end of the airline is 32 ft 10 inches (Elev 89.66 ft MSL); and the depth to the end of the low water cut-off is 32 ft 6 inches (Elev 90.0 ft MSL). The well was tagged "Surface water - may be contaminated".

d. Test Well No. W-348

Well No. W-348 is located on the east side of the Water Treatment Bldg T-120B; the coordinates are N 101,936; E 98,162. The elevation of the ground surface at this well is approximately 120 ft MSL. Drilling began on 4 April 1963 and continued on 5 April 1963 to a depth of 32.5 ft at which point water was encountered for the first time. The hole was bailed and the static water level stabilized at 29 ft. A pumping test was made using an F&M submersible pump, with the pump intake at 31.4 ft. Pumping at the rate of 5 gpm was continued for three hours with a drawdown of 1.5 ft. Two water samples were taken. On 6 April 63 drilling was continued to a depth of 34.2 ft. A second pump test was carried out at the rate of two gpm for two hours with the pump intake at 32.7 ft; drawdown was 3.2 ft with static level at 29 ft. Three water samples were taken. On 8 April 1963 drilling continued to 36.2 ft. A third pump test was carried out at 4 gpm for 3 hours with the pump intake at 33 ft; drawdown was 2.1 ft with static level at 29 ft. Five water samples were taken during the pump test. On 9 April 1963 drilling was completed at 40.2 ft. A fourth pump test was carried out at 7-1/2 gpm for 3 hours with the pump intake at 33 ft; drawdown was 3 ft with static water level at 29 ft. Two water samples were taken. On 10 April a fifth pump test was carried out for 3 hours; three water samples were taken.

On 12 April 1963 a No. 30 slot Johnson Everdur screen 5.7 ft in length was set in the well with the bottom of the screen at 34 ft depth. The casing was pulled back to the 30.5 ft depth exposing 3.5 ft of the screen and the screen packer was swedged against the inside of the casing. Upon completion of the screen installation, the top of the casing was found to be 2.0 ft above the ground surface. The static water level on 13 April 1963 was at 29 ft depth. On 13 April 1963 the pump was replaced in the well with the water intake at a depth of 32 ft, and the well was test pumped for the sixth time, for a period of 3-1/2 hours. The drawdown was 2.1 ft at a pumping rate of 4 gpm. Water samples were taken for the District Testing Laboratory at the beginning, at 1-1/2 hours, and at the completion of the pumping test. A complete chemical analysis of this well is given in Table 5.

e. Pumps

(1) The pump used in Testing Well No. W-348 was withdrawn from the well at request of Air Force and stored in the Galena Air Force Base electrician's shop and was capped with a welded seal. This pump is as follows: Fair anks Morse submersible 1/2 HP, 115 volt, single phase, 9.4 amp 1.60 SF, 60 cycle, Model C-4004B23DI complete with 42 gallon pressure tank, starter, low water cutt-off, vacumn gauge, pump and tubing, well seal and pressure gauge.

(2) The pump procured for installation in Well No. W-347 is stored in the Base Civil Engineer's office at Galena, except that the jet, two-pipes, low water cut-off, depth tube, and well seal are installed in the well. The pump set is as follows: Pump - Myers HCM-75, Serial No. 460-62, Motor - 3/4 HP Century Type CS Frame J56C EMI 8-101433-01, 60 cycle, single phase, 3450 rpm, 115/230 volts, complete with 80 gallon pressure tank, starter,

low water cut-off control, depth and pressure gauges, pump, and all fittings.

(3) The pump procured for installation in Well No. W-346 is stored in the Base Civil Engineer's office at Galena, except that the jet, two-pipes, low water cut-off, depth tube and well seal are installed in the well. The pump set is as follows: Pump - Myers HP-50-D Serial No. 46062, Motor Wagner Electric, Type RK, 1/2 HP, single phase, 60 cycle, 3450 rpm, 115/230 volts, Model 48-59233-01 complete with 42 gallon pressure tank, starter, low water cut-off control, depth and pressure gauges, bicycle pump, and all fittings.

6. CHEMISTRY OF GROUND WATER

a. Chemical Constituents

The chemical quality of the ground water at Galena Airport has been the chief problem in developing a satisfactory water supply. The water from the aquifer at 200 ft is high in iron, carbonate, and other deleterious substances, and the total amount of dissolved solids is high. Adding to the problem is contamination of the upper water layers by aviation fuels and oil.

Iron may occur in a water sample in both dissolved form and as iron compounds in solid form. Iron in solution in groundwater is present chiefly as ferrous iron; but a smaller amount of iron occurs in the structure of complex organic substances in solution. Samples of water obtained from wells are often clear and appear to be good water. But upon oxidation the ferric iron settles out, the samples become reddish brown in color and the taste is quite pungent. A chemical analysis of water from one of the CAA wells drilled in 1954 was made by E. L. Long, Testing

Section, ADE on 2 March 1955 and showed 4.2 ppm ferrous iron and 5.1 ppm total iron for both an untreated water sample and a chlorinated water sample. Iron in solution as organic complexes is not detected by the analytical methods used for ferrous and ferric iron. Separate analyses made from time to time by W. M. Knoppe of ADE indicate that this organic-complex iron present amounts to approximately 0.6 ppm.

Iron in solid form occurs as coatings of iron oxides around sand and silt grains.

The iron and total solids still remaining in solution after treatment has caused problems of scaling and corrosion in boilers and steam pipes. Petroleum products may cause a scum to form inside boilers and pipes and would also contribute to scaling if present in significant quantities in the shallow ground water.

Chemical analyses of the water presently used are presented for Well No. 2, CAA Well No. 4, and the well at the Alert Building in Tables 2, 3, and 4 of the Appendix.

b. Method of Analysis

Testing methods generally followed are those published in the 1961 ASTM standards, Volume 10. Samples as received contained both precipitated iron and fine-grained soil. In many instances traces of iron precipitate were contained on the sample bottles. To overcome this condition a known portion of the sample was filtered. Total solids in solution were determined for the filtrate by evaporation. The residue on the filter plus the total solids left after evaporation were dissolved in an excess of hydrocloric acid (HCl) and returned to the sample bringing the sample back to the original sample volume. Excess acid in this addition redissolved all available iron in the sample. The sample was again filtered to remove silt and total iron was determined on the filtrate.

7. TEST RESULTS

a. Quality of Water

Table 2 summarizes chemical analyses of both the permanent wells now in use at Galena Airport and the shallow observation test wells drilled in this program. The permanent wells were sampled on various dates from 14 February 1963 to 11 April 1963.

Permanent Well No. 2 located near the Water Treatment Building is the main source of water supply at the present time. The well is probably 200 ft deep. Three chemical analyses of this water, sampled at the well, show that total iron ranges from 4.6 to 7.6 ppm and total solids from 314 to 454 ppm.

The permanent well at the Alert Hangar, 210 feet in depth, shows 8.8 ppm total iron and 461 ppm total solids on the basis of one sample taken at the well.

CAA Well No. 4 in Building 400, Flight Service Station shows 24.8 ppm total iron and 864 ppm total solids.

Of the shallow observation wells drilled in the program, the data for Test Hole No. W-348 at the Water Treatment Bldg. are most complete (Tables 2 and 5). Water samples from this well were taken at four different depths during six pumping tests. The data presented in Table 2 for this test well show that water containing only a trace of iron occurred in the uppermost layer at 32.5 ft, and that deeper layers below a depth of approximately 35 ft contained iron in higher concentrations, up to 41.2 ppm total iron. A significant result of the pumping tests was the marked decrease in iron content with continued pumping at this test well. In each of four pumping tests the total iron content decreased to 1.0 ppm or less after approximately 3 hours of pumping. The total solids content in these samples ranged from 580 to 960 ppm and these values are considerably higher than the total solids in the deeper permanent well No. 2. In Test Well No. W-348 no significant variation in the amount of total solids was noted in water samples taken at various depths as drilling progressed, nor was any significant variation noted with the duration of pumping time.

Test Well No. W-347 was sampled at a depth of 35.5 ft. Five water samples were taken at various times during a 24-hour pumping test. The iron content of 14 ppm for samples from this well is over twice as high as water used at present, and no change in iron content was shown with duration of pumping. The total solids ranged from 474 to 532 ppm, only slightly higher than that in water from permanent well No. 2.

Test Well No. W-346 was sampled when the well had reached depths of 37, 46, and 56 feet. The total iron content at 37 ft was 1.1 ppm; at 46 ft, 16.0 ppm; and at 56 ft, the iron content ranged from 27.5 to 52.2 ppm. The increase in iron content with depth is similar to that which occurred in Test Well No. W-348. The total solids at 37 ft were 824 ppm; at 46 ft, 1880 ppm; and at 56 ft, the concentration ranged from 976 to 1504 ppm. These values for total solids are about two to five times higher than that for water from permanent well No. 2.

Test Well No. W-345 was sampled when the well was 50 feet deep. Three water samples showed a total iron content of 1.6 to 3.6 ppm, and a total solids content of 1109 to 1192 ppm. These samples were obtained at various times during a 2-hour pumping test and no significant change occurred in either iron content or total solids content, with duration of pumping.

No evidence was obtained in the test drilling that the low-iron-content is underlain by an impermeable stratum which would keep it separated from underlying water high in iron. It seems probable that the upper layer of low-iron-content water is the result of oxidation due to contact with astmospheric oxygen present in the overlying strata.

b. Quantity of Water

The water consumption at Galena Airport for 1961 is estimated at 18,688,000 gallons per year (Feulner, 1962). This quantity of water is equivalent to approximately 36 gallons per minute of continuous flow. Data from the test wells indicate that the yield to be expected from a well drawing only the uppermost low-iron-content water could be 2 to 5 gpm. The zone containing this low-iron-content water appears to be no thicker than 10 ft at a maximum, as at Test Well No. W-345.

A tubular well, or a gallery well, constructed to a depth which would draw only the uppermost low-iron-content water would have difficulty maintaining both yield and quality of water because of seasonal fluctuations in the level of the water table. A hole (AH-4) drilled by the Corps of Engineers on 24 July 1953 at the Alert Hangar showed the static water level at an elevation of 103.5 ft. The water level in the permanent well at the Alert Hangar was at an elevation of 82.0 ft on 25 November 1958 (P. R. Lord, U.S.G.S. intra-office Memo). Test Well No. W-347 of this program, also drilled at the Alert Hangar, showed the static water level on 1 April 1963 at an elevation of 91 ft. This comparison of water levels at different times of year would indicate a seasonal fluctuation of the water table of at least 21 ft. Such a fluctuation in the water table would result in either a lack of sufficient water during the winter or low-water stage or the introduction of water high in iron during the summer or high water state, depending on the depth of the well and its relation to the low-iron-content water zone.

8. CONCLUSIONS

The results of the chemical analyses of water samples from these four test wells can be summarized as follows:

a. The total iron content increased with depths to values as much as seven times more than presently used water.

b. The total solids content is considerably higher than presently used water, and remains fairly constant with depth.

c. A thin uppermost layer of relatively iron-free water exists near Test Well Nos. W-345, W-346, and W-348.

A marked decrease in iron content occurred with time in several pumping tests made at Test Well No. W-348, but no decrease in iron content was shown in a pumping test at Test Well No. W-347. The chemical analysis for the shallow CAA Well No. 4 at the Flight Service Station, now in use, indicates an iron content about four times as high, and a total solids content about twice as high, as the water from permanent Well No. 2 which is the present main source of water. This CAA well would appear to indicate that little, if any, lowering of iron content takes place with continued use.

The thin, uppermost layer of relatively iron-free water which occurs in three of the test wells would provide water lower in iron, but higher in total solids, than the water presently treated. From this standpoint, there does not, therefore, appear to be any advantage in the near surface water over the present Well No. 2 water. In addition, the large seasonal fluctuation in the water table would make practical utilization of the uppermost iron-free water difficult or impossible. Furthermore, a shallow water source such as this would be subject to contamination by sewage, aviation fuels, and oil. Such contamination appears likely to occur in the very near future. The treatment of such a shallow water to reduce the content of total solids and contaminants to a level conforming to health standards and practicability would probably be more complicated and expensive than the present water treatment facilities, and would produce water of little, if any, better quality.

Based on a comparison of chemical analyses of treated and untreated water, (Tables 3 and 4) the water treatment facilities are not producing water meeting public health standards with respect to iron and total solids. For the treated water, the iron content of 1.70 ppm is far above the maximum permissable level of 0.3 ppm set by the U.S.Public Health Service. Although the carbonate hardness has been reduced by 100 ppm, the water is still hard. Whether or not the failure to produce water of better is due to inadequate treatment facilities, or to improper maintenance, is considered outside the scope of this report.

Utilization of shallow water would likely increase the scaling in boilers and pipes due to the higher content of total solids in the shallow water. In addition, the high probability of future contamination of shallow water by sewage, fuels, and oils would introduce additional problems of treatment.

The water obtained from permanent wells not presently tied in to the water treatment facilities can be improved by treatment.

* * * * *

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APPENDIX

Table 1

CLIMATOLOGICAL SUMMARY

GALENA

MEANS AND EXTREMES FOR PERIOD OF RECORD

Category	Subcategory	Item	Value
Temperature		Mean Annual	23.7
		Highest Recorded	89° July 1953
		Lowest Recorded	-64° January 1951
		Maximum Freezing Index	6805 degree days 1955 - 56
		Maximum Thawing Index	3540 degree days 1957
Precipitation		Mean Annual	13.59"
		Mean Annual Snowfall	55.1"
		Maximum Monthly	5.36" Aug 1956
		Maximum Monthly Mean	2.64" August
		Maximum Rainfall During 24 hr Period	2.33" July 1948
		Maximum Snowfall During 24 hr Period	9.0 Feb 1951
		Maximum Monthly Snowfall	32.7 Dec 1946
Wind		Mean Hourly Speed	7 mph
		Prevailing Direction	N
		Maximum Velocity	86 mph
		Direction Maximum Velocity	SSW February
	Sunrise to Sunset	Clear	88
		Partly Cloudy	58
		Cloudy	219
Number of Days		Precipitation 0.01 inch or more	125
		Snow, Sleet, or Hail 1.0 inch or more	22
		Heavy Fog	11
		Thunderstorms	5 to 8 per year
Annual Mean	Max Temp	70°	27
		32°	79
	Min Temp	32°	227
		Zero	118

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TABLE 2

Chemical Analyses of Water from Galena Airport
Results in ppm, analysis by F&M Branch, Test Lab

Sample No.	Date Sampled	pH	Total Solids	Total Iron	Depth to Aquifer When Sampled (Ft)
CAA WELL NO. 4 - Bldg 400, Flight Service Station					
1	14 Feb 63	6.8	864	24.8	38 - 43
PERMANENT WELL NO. 2 - Bldg 1578 - Sampled before treatment but after storage					
2	14 Feb 63	6.8	454	4.8	180 - 200
3	8 Apr 63		314	7.6	180 - 200
4	11 Apr 63		343	4.6*	180 - 200
4A	24 Apr 63	7.0	298	5.2	180 - 200
PERMANENT WELL - Bldg 1428, Alert Bldg, untreated water except for chlorination					
5	14 Feb 63	7.0	461	8.8	190 - 200
TEST WELL NO. W-345 - Ammo Storage Bldg, raw water					
6	8 Mar 63	6.8	1109	3.6	34 - 39.5
7	8 Mar 63	6.8	1192	1.6	34 - 39.5
8	8 Mar 63	6.8	1127	2.2	34 - 39.5
TEST WELL NO. W-346 - Guardhouse, raw water					
9	14 Mar 63		824	1.1	28 - 29
10	15 Mar 63		1880	16.0	37
11	16 Mar 63		1236	44.0	51.3 - 54
12	18 Mar 63		1504	27.5	51.3 - 54
13	19 Mar 63		976	52.2	51.3 - 54
14	19 Mar 63		1224	33.5	51.3 - 54
TEST WELL NO. W-347 - Alert Hangar - raw water					
15	1 Apr 63 - 0830 hrs		486	14	30 - 35
16	1 Apr 63 - 1400 hrs		500	14	30 - 35
17	1 Apr 63 - 2000 hrs		532	13.9	30 - 35
18	2 Apr 63 - 0400 hrs		474	14	30 - 35
19	2 Apr 63 - 1115 hrs		522	14	30 - 35

Sample No.	Date Sampled	pH	Total Solids	Total Iron	Depth to Aquifer When Sampled (Ft)
TEST WELL NO. W-348 - Water Treatment Bldg, raw water					
20	5 Apr 63		580	Trace	32.5
21	5 Apr 63		601	Trace	32.5
22	6 Apr 63		592	11	34.2
23	6 Apr 63		844	8.1	34.2
24	6 Apr 63		841	0.33	34.2
25	8 Apr 63		936	34.4	36.2
26	8 Apr 63		781	28.8	36.2
27	8 Apr 63		869	7.2	36.2
28	8 Apr 63		869	2.4	36.2
29	8 Apr 63		815	1.0	36.2
30	9 Apr 63		770	22.4	40.2
31	9 Apr 63		795	17.2	40.2
32	10 Apr 63		756	41.2	40.2
33	10 Apr 63		793	39.5	40.2
34	10 Apr 63		744	32.4**	40.2
35	13 Apr 63	6.70	956	1.04	31.5-34
36	13 Apr 63	6.71	960	1.04	31.5-34
37	13 Apr 63	6.60	952	0.92	31.5-34

* Total R_2O_3 as Fe is 130 ppm.

** Total R_2O_3 as Fe is 199.9 ppm.

Table 3

REPORT ON WATER
FOR

CONTRACT NO. DA-
DE LAB FILE NO.

REPORT DATE:
SUBMITTERS SAMPLE NO.________
6 May 1963

SOURCE: Galena AFS

SAMPLE & LABEL: Permanent Well No. 2, treated water; Sampled 15 March 1963. Data from District Chemist, USGS, Palmer.

REQUEST: Complete Water Analysis

TEST RESULTS:

pH	7.6	
Conductivity	452	mmhos
Total solids	______	ppm
Calcium, as Ca	1.2	ppm
Magnesium, as Mg	______	ppm
Potassium	0.9	
Sodium ~~& Potassium~~, as Na	116	ppm
Total Iron, as Fe	1.70	ppm
Organic Iron, as Fe	______	ppm
Manganese, as Mn	______	ppm
Silica, as SiO_2	35	ppm
Sulfate, as SO_4	1.0	ppm
Chloride, as Cl	5.0	ppm
Nitrate, as NO_3	0.4	ppm
Fluoride	0.2	
Alkalinity, Methyl Orange, as $CaCO_3$	______	ppm
Alkalinity, Phenolphthalein, as $CaCO_3$	______	ppm
Total hardness, as $CaCO_3$	______	ppm
Carbonate hardness, as $CaCO_3$	______	ppm
Non-Carbonate hardness, as $CaCO_3$	______	ppm
Free Carbon Dioxide, as CO_2	12.9*	ppm
Free Oxygen, as O_2		ppm
$NaHCO_3$, as HCO_3	296	
Na_2CO_3 as CO_3	146	

REMARKS: Na_2CO_3 as CO_3
* Calculated

W M Knoppe
W. M. KNOPPE
Chief, Testing Section

NPA FORM

Table 4

REPORT ON WATER
FOR

CONTRACT NO. DA-
DE LAB FILE NO.

REPORT DATE: 7 May 1963
SUBMITTERS SAMPLE NO.________

SOURCE: Galena AFS, Permanent Water Supply (Well No. 2)

SAMPLE & LABEL: Water sample taken from water treatment supply well 24 April 1963.

REQUEST: Complete Ind. Chem. analysis

TEST RESULTS:

pH	7.0	
Conductivity at 23° C	417	mmhos
Total solids	298	ppm
Calcium, as Ca	84	ppm
Magnesium, as Mg	14	ppm
Sodium & Potassium, as Na	7	ppm
Total Iron, as Fe	5.2	ppm
Organic Iron, as Fe	Trace	ppm
Manganese, as Mn	0.0	ppm
Silica, as SiO_2	35	ppm
Sulfate, as SO_4	6	ppm
Chloride, as Cl	4.4	ppm
Nitrate, as NO_3	0.6	ppm
Alkalinity, Methyl Orange, as $CaCO_3$	245	ppm
Alkalinity, Phenolphthalein, as $CaCO_3$	0.0	ppm
Total hardness, as $CaCO_3$	245	ppm
Carbonate hardness, as $CaCO_3$	245	ppm
Non-Carbonate hardness, as $CaCO_3$	0.0	ppm
Free Carbon Dioxide, as CO_2 — Field Reliable Only		ppm
Free Oxygen, as O_2 — Field Reliable only		ppm

REMARKS:

V

W. M. Knoppe
W. M. KNOPPE
Chief, Testing Section

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Table 5

REPORT ON WATER
FOR

CONTRACT NO. DA-
DE LAB FILE NO.

REPORT DATE:
SUBMITTERS SAMPLE NO. 23
3 May 1963

SOURCE: Galena AFS, Test Well No. W-348

SAMPLE & LABEL: Sampled 13 April 1963, 3½ hrs of pumping after setting screen. Depth 34'

REQUEST: Complete Water Analysis

TEST RESULTS:

pH	6.60	
Conductivity	1176	mmhos
Total solids	952	ppm
Calcium, as Ca	256	ppm
Magnesium, as Mg	30	ppm
Sodium & Potassium, as Na	8	ppm
Total Iron, as Fe	0.92	ppm
Organic Iron, as Fe	Trace	ppm
Manganese, as Mn	____	ppm
Silica, as SiO_2	9.6	ppm
Sulfate, as SO_4	11.0	ppm
Chloride, as Cl	4.4	ppm
Nitrate, as NO_3	0.8	ppm
Alkalinity, Methyl Orange, as $CaCO_3$	455	ppm
Alkalinity, Phenolphthalein, as $CaCO_3$	0.0	ppm
Total hardness, as $CaCO_3$	739	ppm
Carbonate hardness, as $CaCO_3$	454	ppm
Non-Carbonate hardness, as $CaCO_3$	285	ppm
Free Carbon Dioxide, as CO_2	____	ppm
Free Oxygen, as O_2	____	ppm

REMARKS:

W. M. Knoppe
W. M. KNOPPE
Chief, Testing Section

NPA FORM

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT GALENA AIRPORT OBSERVATION WELLS — SHEET 1 OF 4

LOCATION (Coordinates or Station) Ammo Storage Bldg — N. 101,481 — E. 101,976

DRILLING AGENCY [X] CORPS OF ENGINEERS [ ] OTHER

HOLE NO. FIELD Test Well #1 — PERMANENT W-345

NAME OF DRILLER W. Dotten — WEATHER Cloudy, cool.

TYPE OF HOLE: TEST PIT [ ] AUGER HOLE [ ] CHURN DRILL [X]

DEPTH TO — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE 50.0'

SIZE AND TYPE OF BIT 6-inch — DATUM FOR ELEVATION SHOWN [ ] TBM. [X] MSL. — TYPE OF EQUIPMENT Star 71

TOTAL NO. OF SAMPLES 3 — TYPE OF SAMPLES Water — DEPTH TO GROUND-WATER — DATE HOLE STARTED 25 Feb 63 — COMPLETED 1 Mar 63

EL.-TOP OF HOLE 120' MSL — Geologist A.W.Patscheck — Chief, Geology Section [signature] — Chief, Foundations & Materials Branch [signature] — Date 15 May 63

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–9			GM	Gravel and gravelly silty FILL F-1		
9–19			SM	Silty SAND F-2		Tan, not frozen.
19–29			GP	Sandy GRAVEL F-1	1"	
29–50			GW/SW	Sand and GRAVEL F-1		W. L. 1 Mar 63 Stratified; clear water from 38-40 ft, 46-47 ft.

Bottom of hole at 50.0 ft.

A Johnson Everdur 30-slot screen 5'-8" long set with bottom of screen at 39'-6". Well developed by bailing. Screen & casing pulled and well abandoned on 22 Mar 1963.

NPA FORM 19 (REV) DEC. 1959

PROJECT GALENA AIRPORT OBSERVATION WELLS — PERMANENT HOLE NO. W-345

Figure 3a.

1892-60

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT GALENA AIRPORT OBSERVATION WELLS — SHEET 2 OF 4

LOCATION (Coordinates or Station) Guardhouse — N. 101,501 E. 101,702

DRILLING AGENCY [X] CORPS OF ENGINEERS [ ] OTHER

HOLE NO. FIELD Test Well #2 PERMANENT W-346

NAME OF DRILLER W. Dotten — WEATHER Cloudy, cold

TYPE OF HOLE: TEST PIT [ ] AUGER HOLE [ ] CHURN DRILL [X] — DEPTH TO — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE 56.0'

SIZE AND TYPE OF BIT 6-inch — DATUM FOR ELEVATION SHOWN [ ] TBM. [X] MSL. — TYPE OF EQUIPMENT Star 71

TOTAL NO. OF SAMPLES 6 — TYPE OF SAMPLES Water — DEPTH TO GROUND-WATER — DATE HOLE STARTED 11 Mar 63 COMPLETED 16 Mar 63

EL. TOP OF HOLE 120' MSL — Geologist A.W.Patscheck — Chief, Geology Section Alvin W Patscheck — Chief, Foundations & Materials Branch [signature] — Date 15 May 63

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX. SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
				FILL F-1		Frozen.
10			SM	Silty SAND F-2		
20			GM	Silty GRAVEL F-1		
			GP	GRAVEL NFS		Dry, medium. W.L. 18 Mar 63
			GP	Silty SAND F-2		
30			GW	Sand and GRAVEL NFS		Medium to coarse, water clear.
40			GM	Silty GRAVEL F-1		Little water, high iron content; permafrost at 42.5 ft. Gravel stands up 2 to 3 ft ahead of casing. Pipe drives very hard. Bailings have ice crystals as though they were drilled up and held in suspension.
			GP	GRAVEL NFS		Medium to coarse, frozen.
50			SP	SAND NFS		Medium, unfrozen, water.
			SP	SAND F-2		Fine, gray; water.
			GP	GRAVEL NFS	1"	Coarse to fine; strong water.

Bottom of hole at 56.0 ft.

A Johnson Everdur 30-slot screen 5'-9" in length was set with bottom of screen at 54', 5'-0" of screen is exposed.

NPA FORM 19 (REV.) DEC. 1959

PROJECT GALENA AIRPORT OBSERVATION WELLS — PERMANENT HOLE NO. W-346

Fig. 3b 1892-60

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT GALENA AIRPORT OBSERVATION WELLS — SHEET 3 OF 4
	LOCATION (Coordinates or Station) Alert Hangar N. 101,314 E. 97,558
	DRILLING AGENCY [X] CORPS OF ENGINEERS [ ] OTHER
HOLE NO. FIELD Test Well#3 PERMANENT W-347	NAME OF DRILLER W. Dotten & Ruff. — WEATHER Clear, Cloudy, Cold.
TYPE OF HOLE: TEST PIT [ ] AUGER HOLE [ ] CHURN DRILL [X]	DEPTH TO — DEPTH DRILLED INTO — TOTAL DEPTH OF HOLE 35.5'
SIZE AND TYPE OF BIT 6-inch — DATUM FOR ELEVATION SHOWN [ ] TBM. [X] MSL.	TYPE OF EQUIPMENT Star 71
TOTAL NO. OF SAMPLES 5 — TYPE OF SAMPLES Water	DEPTH TO GROUND-WATER — DATE HOLE STARTED 23 Mar 63 COMPLETED 27 Mar 63
EL. TOP OF HOLE 120' MSL — Geologist A.W. Patscheck — Chief, Geology Section Alvin W Patscheck	Chief, Foundations & Materials Branch Claude W. Smith — Date 15 May '63

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION	MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
0–3				Asphalt paving		
5			SP	Gravelly SAND NFS		
10–15			SW	Sandy gravel with some silt F-2		
20–25			SP	Sand and gravel NFS		Poorly graded, dry* (*Looks like it would have water during part of season.) W. L. 30 Mar 63
30			SP	SAND F-2		Dark brown, water at 30.5 ft.
35			GP	GRAVEL NFS	1"	Coarse, poorly graded. Water bearing.

Bottom of hole at 35.5 ft

Frozen soil not reported.

A Johnson Everdur 30-slot screen 5'-9" long was set in well with bottom of screen at 31 ft-9" depth. Well was developed by bailing. Five ft. of screen is exposed.

NPA FORM 19 (REV) DEC. 1959

PROJECT GALENA AIRPORT OBSERVATION WELLS — PERMANENT HOLE NO. W-347

1892-60

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA

EXPLORATION LOG

PROJECT GALENA AIRPORT OBSERVATION WELLS — SHEET 4 OF 4

LOCATION (Coordinates or Station) Water Treatment Bldg
N. 101,936 E. 98,162

DRILLING AGENCY [X] CORPS OF ENGINEERS [ ] OTHER

HOLE NO. FIELD Test Well #4 PERMANENT W-348

NAME OF DRILLER W. Dotten

WEATHER Clear, cloudy, cold

TYPE OF HOLE: TEST PIT [ ] AUGER HOLE [ ] CHURN DRILL [X]

DEPTH TO: — DEPTH DRILLED INTO: — TOTAL DEPTH OF HOLE 40.2'

SIZE AND TYPE OF BIT 6-inch

DATUM FOR ELEVATION SHOWN [ ] TBM. [X] MSL.

TYPE OF EQUIPMENT Star 71

TOTAL NO. OF SAMPLES 18

TYPE OF SAMPLES Water

DEPTH TO GROUND-WATER —

DATE HOLE STARTED 4 Apr 63 COMPLETED 9 Apr 63

EL. TOP OF HOLE 120' MSL

Geologist A.W.Patscheck

Chief, Geology Section Alvin W Patscheck

Chief, Foundations & Materials Branch [signature]

Date 15 May 63

DEPTH FEET	% WATER CONTENT	SAMPLE NO.	SOIL LEGEND	CLASSIFICATION		MAX SIZE PARTICLE	FORMATION DESCRIPTION & REMARKS
			GW	TILL Fill?	F-1		
10			SM	Silty SAND	F-2		
			ML	SILT	F-4		
20			SM	Silty SAND	F-2		
30			GP	Sandy & GRAVEL	NFS	1"	W. L. 13 Apr 63 Dry, poorly graded.
			GW	Sandy & GRAVEL	NFS		Coarse, water at 32.5 ft
			SW	SAND	NFS	1"	Medium to fine, dark brown, minor gravel to 1".
40			SP	Sand & GRAVEL	NFS	1-1/2"	Sand medium; wood; water with iron color.

Bottom of hole at 40.2 ft.

Frozen soil not reported.

A Johnson Everdur screen with 30-slot openings and 5'-9" in length was set with bottom of screen at 34'-0" depth. Casing was pulled back to expose 3'-6" of the screen.

NPA FORM 19 (REV) DEC. 1959

PROJECT GALENA AIRPORT OBSERVATION WELLS

PERMANENT HOLE NO. W-348

Fig. 3d

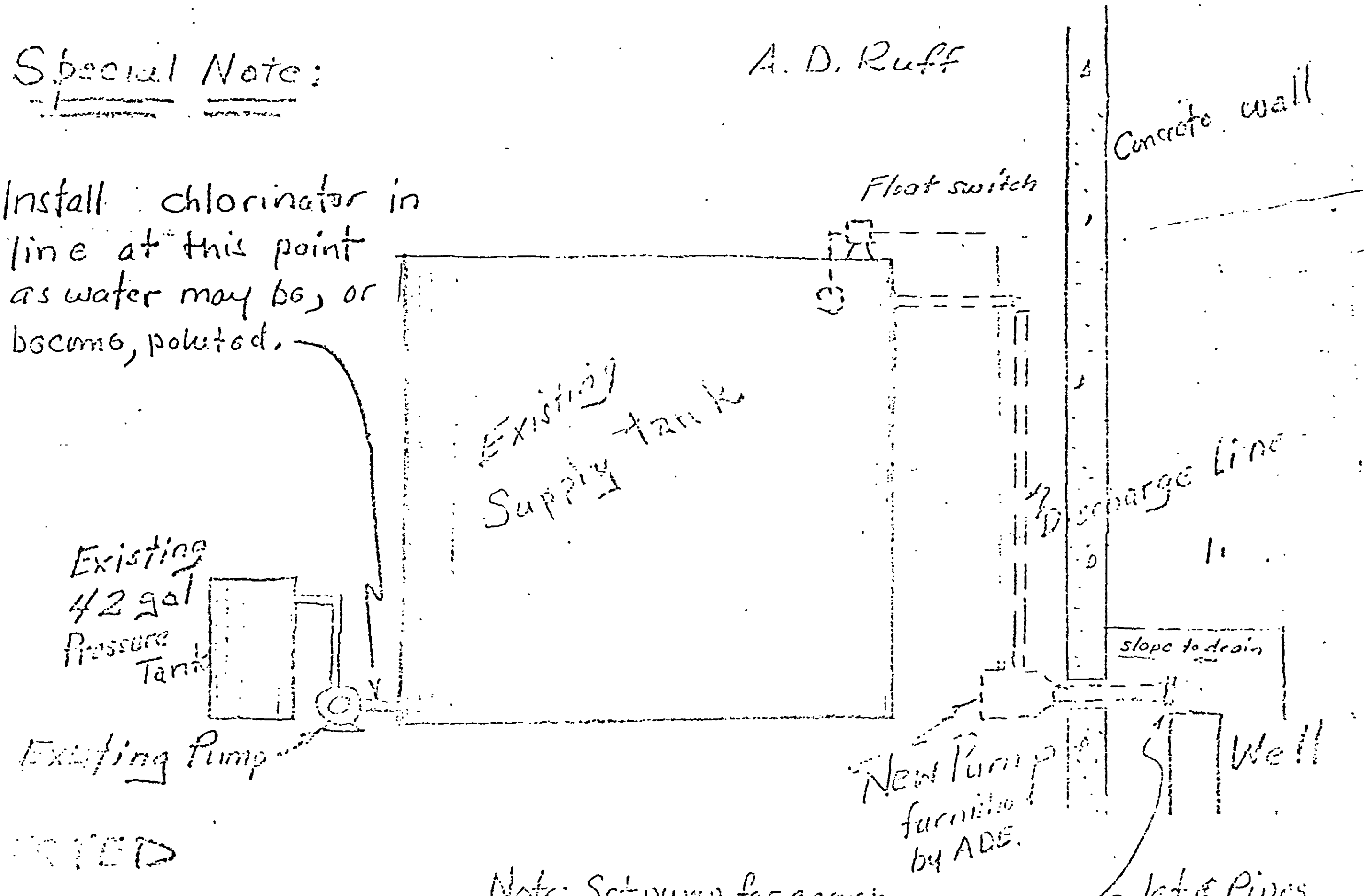
1892-60

Due to the only available [illegible] pump records which show the well made less than six (6) g.p.m. I feel hooking the pump into the existing 42 gal. pressure tank would cause the large capacity (5 gpm) jet pump to suck air [illegible] its prime when any water tap was left running for a few minutes. This would be the ideal system if well & pump were balanced, & would eliminate the need of the large 4.5 X 6.5 foot storage tank.

Taking these factors into consideration, I feel a hole should be made thru the concrete wall, high enough to allow the horizontal pipeing from well head to pump to be on a slight incline, by fabricating suitable support for the pump. The discharge could go directly into the large existing storage tank with a float controll to stop and start the pump.

A. D. Ruff

Special Note:



Note: Set pump far enough away from wall to avoid freezing in winter. Heat pump line & well head.

[illegible]TED
[illegible]OK-UP FOR
[illegible]EW WELL & PUMP AT
[illegible]UARD HOUSE WELL-GALENA

1 May '63 JCL.

Figure 1

SUPPLEMENT NO. 1 TO REPORT OF FOUNDATIONS AND MATERIALS BRANCH GALENA AIRPORT OBSERVATION WELLS GALENA, ALASKA

Prepared by
Foundations and Materials Branch
25 June 1963

CONTENTS

APPENDIX

SUPPLEMENT NO. 1 TO REPORT OF
FOUNDATIONS AND MATERIALS BRANCH
GALENA AIRPORT OBSERVATION WELLS
GALENA, ALASKA

1. SCOPE: This report, which is a supplement to the report on the Galena Airport Observation Wells dated 10 May 1963, covers pumping tests, water sampling, chemical analyses, gradation curves, and interpretations of data at Test Well W-347 (adjacent to the Alert Hangar) and Test Well W-348 (adjacent to the Water Treatment Building). Also reported are results of a pumping test on Permanent Water Well No. 1.

2. GENERAL: The basic report dated 10 May 1963 discusses the geology, groundwater, and general development of the area; locations of the test water wells and permanent wells are given in this report together with the results of earlier chemical analyses of water from the test wells. Pumping tests described in the present report were made with a Fairbanks Morse 1/2 HP, 115 volt, 3450 RPM submersible pump only on Test Well No. 348. A jet pump was used on Test Well No. W-347, and the presently installed Jacuzzi jet pump was used on Permanent Well No. 1. Soils have been classified on the basis of mechanical analysis of samples; the gradation curves accompany this report.

3. TEST WELL NO. W-347

a. Pumping Test

Well No. W-347 adjacent to the Alert Hangar was test pumped on 3 June 1963 from 1010 to 1610 hours. The static water level at the start of pumping was at 1.1 ft depth (elevation 118.9 ft), measured from the top of the asphalt pavement which exists at the site (elevation of pavement 120.0 ft). The well was pumped at the rate of 12.4 gallons per minute for six hours. The drawdown level, measured from the top of the asphalt pavement, was at 2.58 ft depth at 1010, and at 2.83 ft depth at 1610. A small amount of fine sand was present in the water pumped during the test. The data on this pump test are given in Table 3.

b. Water Sampling

The first sample of well water was taken at the start of the pump test at 1010, 3 June 1963. A second sample was taken at 1310 hours and a third and final sample at 1610 hours, just before the pump test was concluded.

c. Chemical Analyses

Chemical analysis of the three water samples mentioned above consisted of determination of the total solids and the total iron (as Fe). Results of the analysis are given in Table 1.

Total iron decreased during pumping from 28.5 ppm to 8.0 ppm. A smaller percentage decrease occurred in total solids, from 606 ppm at the start of the pump test to 500 ppm at the conclusion.

d. Soil Classification

The results of mechanical analysis of four soil samples obtained during drilling from Well No. W-347 are shown graphically in the gradation curves in the Appendix of this report. The results of these tests are summarized in Table 2.

4. TEST WELL NO. W-348

a. Pumping Test

Well No. W-348 adjacent to the Water Treatment Building was test pumped on 31 May 1963 from 0920 to 1640 hours. The static water level at the start of pumping was 2.33 ft depth (elevation 117.67 ft), measured from the ground surface (elevation 120.0 ft). The well was pumped at the rate of 20.2 gallons per minute for 7 hours 40 minutes. The drawdown level, measured from the ground surface, was at 8.4 ft depth at 0920, and at 8.73 ft depth at 1640, just before concluding the pumping test. A small amount of sand was present in the water pumped during the test. The data on this pump test are given in Table 4.

b. Water Sampling

The first sample of well water was taken at the start of the pump test at 0920, 31 May 63. A second sample was taken at 1240 hours, and a third and final sample at 1520 hours.

c. Chemical Analyses

Chemical analysis of the three water samples mentioned above were made to determine total solids and total iron (as Fe). Results of the analysis are given in Table 1.

Total iron decreased during pumping from 64 ppm to 0.35 ppm. A smaller percentage decrease occurred in total solids, from 1664 ppm at the start of the test to 1320 ppm at the conclusion.

d. Soil Classification

The results of mechanical analysis of three soil samples obtained during drilling from Well W-348 are shown graphically in the gradation curves in the Appendix of the report. The results of these tests are summarized in Table 2.

5. TEST WELL W-345

Gradation curves for six soil samples obtained during drilling from this well are given in the Appendix. The results of these tests are summarized in Table 2.

6. TEST WELL W-346

Gradation curves for two soil samples obtained during drilling from this well are given in the Appendix. The results of these tests are summarized in Table 2.

7. PERMANENT WATER WELL NO. 1

a. General: Well No. 1 is located in an addition to the east end of the Fire Station, Galena Airport. In 1954 this well was the primary source of water for the base. The well is 210 ft deep and is cased with 6 inch standard steel casing. Whether or not a well screen was installed is not definitely known, but, according to construction drawing file 157-F-N dated 9 September 1944 of the Federal Aeronautics Administration, a perforated screen was to be installed. The pump now installed in the well is a Jacuzzi Jet Pump, type 75-T-44M, Serial No. 50290, with 60 feet of 4 inch jet pipe column, 40 feet of 2-1/2 inch jet pipe column above the jet and 22 feet of 2 inch jet pipe tail below the jet. The pump is driven by a 7-1/2 HP 1800 rpm, 3 phase U.S.Electric motor, Serial 355426. This pump is mounted on an open steel frame 17 inches high by 17 inches square, and was installed a considerable time before 1951. The top of the casing is 18 inches below the pump house floor level. The discharge line is 2 inch in diameter. In 1954 this set up produced between 12,000 and 15,000 gallons per day with a static water level of 19.6 ft and a pumping water level of 20 feet ±, or a drawdown of less than one foot. The well has been unused for several years; meanwhile the pump room has been used as a Fireman's office.

b. Pumping Test - Permanent Well No. 1 was pump tested on 7 - 10 June 63, using the Jacuzzi jet pump installed on the well head. It was necessary for the Base electrician to run in 3-phase AC power in order to energize the pump motor. The test was begun at 1000 hours 7 June and concluded 0800 hours 10 June. The data on this test are given in Table 5. The discharge was clear soon after the initial start up of the test, and no sand was reported. Static water level at the beginning of the test was 5.25 ft below the top of casing. Drawdown to initial pumping level was 2.0 feet and to the pumping level at 1600 hours 8 June was 3.08 ft. A recovery rate was not run in view of the obvious competence of the well at the 46 gpm pumping rate. This pump test demonstrated this well is capable of continuously producing 46 gpm or 66,240 gallons per day.

c. Water Sampling - The first chemical sample of pumped water was taken by Mr. Alfred Ruff, Alaska District Engineer Driller, 7 June 63, 1000 hours, at the start of the test; the second, 8 June at 1000 hours; and the final, 8 June at 1600 hours. The first biological sample of the pumped water was taken 7 June 63, 1000 hours, at the start of the test by Sgt. Dennis, Base Medical Technician; the second 7 June at 1400 hours, and the final 8 June at 1000 hours.

d. Analysis of Water Samples:

(1) Chemical Tests - Chemical analysis of three water samples, taken by Mr. Ruff, was performed by the Alaska District Testing Laboratory to ascertain total solids and total iron content (as Fe). Results of the analysis are given in Table 1. Total iron decreased from 140 ppm at start up to 4.40 and 4.68 ppm after pumping 24 and 30 hours, respectively. This iron content is the same essentially as shown by samples from Permanent Well No. 2 at the water treatment plant. Total solids also decreased during the test to a value somewhat lower than the values obtained from test samples of Well No. 2 taken in March, April and May.

(2) Biological Tests - On 18 June 63 Sgt Dennis advised Mr. Ireton of this office that his biological test samples were all NEGATIVE. His test consisted of incubating the water samples for twenty-four hours and examining the plates for bacteria. THIS IS NOT AN ACCEPTED BIOLOGICAL TEST FOR WATER POTABILITY.

8. CONCLUSIONS:

a. Test Wells - Observations to date indicate that marked fluctuations occur in the test wells in the dissolved iron content, the total solids content, and the static water level.

(1) Fluctuations in Static Water Level - It has been observed that the static water level in the test wells rises with the rise in Yukon River water after the spring ice-breakup, and that the static water level falls when the river water returns to a lower elevation in early summer. The rises and falls in the static water level of the test wells are closely tied in

time with the corresponding rises and falls of river water, there being very little lag between them. This would indicate that the sediments are highly permeable and permit easy movement of river water toward the wells when the hydraulic gradient is in this direction. At other times of year, scant evidence suggests that the static water levels of the test wells are at a higher elevation than that of the river water, and that the hydraulic gradient is toward the south, causing water to move from the wells to the river. The source of recharge to the wells during this part of the year would be the highlands to the north. When the level of the Yukon River rises after the spring ice break-up, this water could enter the higher permeable strata lying above the lower aquifers which contain water from the north. The static rise in water level observed in the wells would then be due in part to this influx or infiltration of Yukon River water into the upper strata. The two groundwaters, perhaps differing markedly in quality, could remain largely separated along a more or less horizontal interface. Some intermixing would undoubtedly take place however in the immediate vicinity of the interface. A well with the screen set close to this interface would tend to produce water of variable quality. Also, it may be inferred that the rise in static water levels in the wells is attributable in part to a rise in the groundwater level in the lower aquifers, resulting from increased movement of water from the north at the time of the spring thaw. The position of the screen relative to this apparent interface would then become a critical factor in interpreting the fluctuations in iron and total solids observed in the wells.

(2) Fluctuations in Total Solids - Land to the north is almost level for about 15 miles before a rise to the highlands takes place. Much of this relatively level area consists of lakes, swamps, and bogs. The hydraulic gradient would be low and groundwater movement toward the south would be slow. It appears likely that such groundwater would contain a high amount of dissolved solids because of the long distance traveled and the slow movement which would allow time for more complete solution of any soluble materials through which the groundwater moved. At the present time there is a lack of data on the chemical quality of this water to the north. It is assumed to be high in total solids for the purpose of this discussion and as a possible explanation for observed fluctuations in total solids in the test wells. At Test Well W-348, the total solids content on 31 May 63 was considerably higher than during 5 - 13 April 63. This would indicate a rise in groundwater level of the lower aquifers containing this water from the north. During the earlier pump test of 5 - 13 April 63, this well could have been drawing water from an upper layer containing less total solids. At Test Well W-347, closer to the Yukon River, the total solids content on 3 June 63 was approximately the same as on 1 - 2 April 1963. A condition of equilibrium with respect to the upper and lower groundwaters could, therefore, have been in effect between these two dates insofar as the total solids content is concerned. Test Well W-347 contained less than half the total solids found in Test Well W-348, but the content of total solids in Well W-347 is apparently considerably higher than that of the Yukon River. Chemical analyses of Yukon River water at Galena are lacking. The nearest point to

Galena where systematic samples of river water have been taken is at Rampart which is above the confluence of the Tanana and Yukon rivers.

(3) Fluctuations in Iron Content - Fluctuations in the iron content of the test wells are not considered in the foregoing discussion. The behavior of iron in the test wells is not well understood at this time. The ferrous state in which most of the iron exists in solution indicates a lack of oxygen. With sufficient oxygen, ferrous iron is converted to the ferric state and precipitates out of solution as ferric hydroxide. During the late spring and summer, with increased movement of groundwater and exposure of the ground surface to atmospheric oxygen, more oxygen may be present in the groundwater than during the winter months. The increased oxygen would precipitate some of the dissolved iron from solution and thereby lower the dissolved iron content. In addition, the uppermost layer of relatively iron-free groundwater, mentioned in the basic report as present at several test wells, would likely increase in thickness. If a significant increase in thickness occurs during the summer it could explain the lower content of iron which occurs on pumping at Well W-348, and possibly at Well W-347. Pumping at these wells may draw a large portion of the water from the iron-free surface layer, and the iron content could fluctuate according to the thickness and oxygen content of this layer. These wells may also receive contribution of oxygen from the apparent infiltration of Yukon River water into the upper strata.

(4) Additional Data Required - The tentative hypothesis outlined in the preceding paragraphs requires additional data for confirmation

of its validity or its replacement by another hypothesis. The data needed are as follows:

(a) The direction of groundwater movement at various times of year with particular note of the time and extent of any reversals in this movement. These data would permit a firmer correlation of changes in well water with the source of recharge and the position of any interface between Yukon River water and water from the north. The data could be accumulated by regular coincident determinations of the static water level in the test wells, the elevation of the Yukon River water, and chemical analyses of well water.

(b) Regular determinations of the oxygen content and pH, as well as dissolved iron and total solids, of test well water from specified depths. These data would enable the role of oxygen in lowering the dissolved iron content of well water to be evaluated more accurately, and a significant correlation of high oxygen with low iron content might be established. The data on dissolved iron and total solids could help to establish the presence of an interface and its behavior.

(c) A chemical analysis of groundwater from a point north of the station. Determination of the pH and the content of iron, total solids, and oxygen of this water is needed, and preferably of samples taken at several different time of year. These data could be obtained by means of a test well in this area, and such a well would also be useful in confirming a hydraulic gradient toward the south.

(d) Determine iron and total solids content at Yukon River water at Galena.

b. Permanent Water Well No. 1

The pumping test of this well, plus data on our records, indicates this well is satisfactory as a backup well for the Base potable water supply. To set up a well-engineered permanent-type backup supply, the following should be done:

(1) The existing overage pump in this well should be pulled and replaced. It should be replaced with a submersible pump so that the Fireman's office space will be uncluttered. Use of a pump having a capacity of about 100 gpm at the T.D. head for discharge through the treatment plant iron precipitator will be appropriate.

(2) Piping to the head of the well should be kept underfloor and the casing protected with a carefully installed sanitary seal.

(3) At the time the pump is replaced, the well should be cleaned and the screen checked so that a satisfactory well-service life of another 10 - 15 years will be possible.

Emergency Use - If the present unsanitary and unsealed conditions at the well head were rectified, this well coule be used as is for an emergency raw water source for delivery to the water treatment plant. Water should not be used from this well without chlorination, however. The probable capacity of this well, as is, when connected to the water treatment plant would be around 35-40 gpm. Therefore, Base use might have to be slightly curtained in order to live with this emergency quantity.

(4) The chemical composition of the water from this well is essentially the same as that from Well No. 2 at the Water Treatment Plant; therefore, readjustment of the treatment process probably will not be necessary when switching from Well No. 2 to Well No. 1.

* * * * * * * *

TABLE 1

CHEMICAL ANALYSES OF WATER FROM GALENA AIRPORT

Results in PPM, Analyses by F&M Branch, Testing Section

Sample No.	Date & Time Sampled	Total Solids	Total Iron
TEST WELL NO. W-347 - Adjacent to Alert Hangar - raw water.			
38	3 June 63, 1010	606	28.5
39	3 June 63, 1310	498	9.0
40	3 June 63, 1610	500	8.0
TEST WELL NO. W-348 - Adjacent to Water Treatment Plant - raw water			
41	31 May 63, 0920	1664	64
42	31 May 63, 1240	1340	0.25
43	31 May 63, 1520	1320	0.35
PERMANENT WATER WELL NO. 1 - At Fire Station - raw water.			
44	7 June 63, 1000	776	140.
45	8 June 63, 1000	298	4.40
46	8 June 63, 1600	212	4.68

TABLE 2

SOIL CLASSIFICATION

Depth (ft)	Group Symbol	Classification	Frost Susceptibility
TEST WELL NO. W-345 (Ammo Storage Building)			
35	SP	Gravelly sand	NFS
35-36	"	" "	"
38	"	" "	"
35-39	"	" "	"
39-41	"	" "	"
46	"	" "	"
TEST WELL NO. W-346 (Guard House)			
33-35	GP	Sandy gravel	NFS
53-54	"	" "	"
TEST WELL NO. W-347 (Alert Hangar)			
31-33	SP	Gravelly sand	NFS
31.5	"	Sand	"
32-34	"	Gravelly sand	"
34-35	"	" "	"
TEST WELL NO. W-348 (Water Treatment Building)			
36.5	SP	Gravelly sand	NFS
38	"	" "	"
40	"	" "	"

TABLE 3

PUMP TEST OF TEST WELL NO. W-347
GALENA ALERT HANGAR
GALENA AFS
3 June 1963

Time	Water Level	Pump Pressure	GPM	Remarks
1010 hrs				Started test - water sample #1. taken.
1030 "	4' 1"	20 lbs	12	Some fine sand.
1045 "	4' 1"	10 "	12.44	" " "
1100 "	4' 1"	9 "	12.44	" " "
1115 "	4' 1"	9 "	12.44	" " "
1130 "	4' 1-1/2"	9 "	12.44	" " "
1200 "	4' 1-1/2"	9 "	12.44	" " "
1230 "	4' 2"	9 "	12.44	" " "
1300 "	4' 2"	10 "	12.44	" " "
1310 "	--	--	--	Water sample #2.
1545 "	4' 4"	10 "	12.44	Some fine sand.
1600 "	4' 4"	10 "	12.44	" " "
1610 "	--	--	--	Water Sample #3.

All measurements taken from top of casing 18" stickup.

Static water level 31" from top of casing.

Myers H.C.M. Ejecto Pump, Serial No. 460-62, Century motor type C.S. 3/4 HP, PH 1, cycle 60, RMP 3450, Volt 115/230.

Pump left installed in open by Major Linton's request.

Alfred D Ruff
ALFRED D. RUFF
Churn Driller

TABLE 4

PUMP TEST OF TEST WELL NO. W-348
WATER TREATMENT PLANT
GALENA AFS
31 May 1963

Time	Water Level	GPM	Remarks
0920 hrs			Started pump. Took 2-1 qt samples - some sand. 2 min. & 45 seconds to run over 55 gal barrel.
0930 "	10' 4-3/4"	20.22	
0945 "	10' 6"	20.22	
1000 "	10' 6-1/2"	20.22	
1015 "	10' 6-1/2"	20.22	
1240 "	--	--	Water Sample #2 - little sand.
1400 "	10' 6-1/2"	20.22	
1430 "	10' 6-3/4"	20.22	
1500 "	10' 7"	20.22	Little sand.
1530 "	10' 7-1/2"	20.22	
1700 "	10' 8-3/4"	20.22	Very little sand. Water sample #3 taken at end of test.

Static water level 4' 4" from top of casing. Stickup 2'0".

River dropping could affect our drawdown.

Pump - Fairbanks Morse 1/2 HP submersible, 115 Volt - 3450 RPM.

All measurements taken by Victor Falk, from top of casing.

(Pump left installed with electrodes set in well). Major Linton cautioned to hook up electrodes before using pump.

Alfred D. Ruff

ALFRED D. RUFF
Churn Driller

TABLE 5

PUMP TEST OF PERMANENT WELL NO. 1
FIRE STATION WELL
GALENA AFS
7-10 JUNE 1963

Date & Time		Water Level	GPM	Remarks
7 June 63 -	1000	5' 3" Static		Water green.
	1001	7' 3" Pumping	46	Water sample No. 1
	1100	7' 3"	46	Clear.
	1200	7' 6"	46	"
	1300	7' 9"	46	"
	1400	7' 6"	46	Clear - water sample taken by medical technician.
	1500	7' 6"	46	Clear.
	1800	7' 7"	46	"
	2000	7' 6"	46	"
	2100	7' 9"	46	"
8 June 63 -	0600	7' 10"	46	"
	0700	7' 11"	46	"
	0800	8' 0"	46	"
	0900	8' 3"	46	"
	1000	8' 5"	46	", water sample No. 2.
	1100	8' 2"	46	"
	1200	8' 3"	46	"
	1300	8' 2"	46	"
	1400	8' 2"	46	"
	1500	8' 3"	46	"
	1600	8' 4"	46	", water sample No. 3.
10 June 63 -	0800	--	"Essentially the same quantity".	Run from 1600 hrs 8 June to 0800 hrs 10 June continuously by Base CE forces.

NOTE:

Increase in drawdown is attributed to concurrent fall in Yukon River level.

TABLE 6

CHEMICAL ANALYSES OF YUKON RIVER WATER
AT RAMPART, 1960-61, IN PARTS PER MILLION*

Date	Fe	Dissolved Solids (Calculated)
3 March 1960	.00	85
6 April	.00	160
27-29 May	.12	105
30-31 May - 1-2 June	.10	141
3-9 June	.10	171
10-13 June	None	125
18-27 June	.07	161
1-3, 5-10 July	.10	140
11-12, 14-20 July	.02	154
21-31 July	.02	146
1-10 August	.02	154
11-20 August	.02	158
21-23 August	.02	180
10 October 60	.00	142
9 December	.03	170
21 January 61	.02	161
26 Feb	.07	160
20-26 May	.02	83
27-31 May, 1-3, 5-6 June	.02	99
6 June	.02	97

Date	Fe	Dissolved Solids (Calculated)
10-18 June	.02	105
19, 24-30 June	.02	153
1-8, 10 July	.02	161
11, 15-22 July	.03	137
23-31 July	.05	134
1, 3-7, 10 August	.03	151
11-20 August	.02	139
21-28, 30-31 August	.02	176

* Data for 1960 from U.S.G.S. Bulletin 1720, "Quality and Quantity of Surface Waters of Alaska".

Data for 1961 from State of Alaska publication, "Quality and Quantity of Surface Waters of Alaska".

HEADQUARTERS
ALASKAN AIR COMMAND
UNITED STATES AIR FORCE
APO 942, Seattle, Washington

REPLY TO ATTN OF: ALDEC-3D

13 JUN 1963

SUBJECT: Water Wells (Observation) Galena AFS, Alaska, Project No. GAL 72-3 (Rev 2)

TO: Alaska District Engineer (NAPEN-FM-S)

1. Reference is made to FY 1963 Design Instruction Number MC-1/63-HZ17-A/CE/4, Galena Airport, Alaska, dated 10 August 1962, paragraph "b", which authorizes the construction of observation wells for the purpose of securing information on the quantity and quality of water at various depths.

2. Consideration is being given to reactivate the presently unused well No. 1 in Fire Station Building 1549 to eliminate our presently complete dependence on a single well for main base water supply, i.e., well No. 2 in Water Treatment Building 1578. Well No. 1 has not been used for some considerable time for reason of a reputed but unproven contamination.

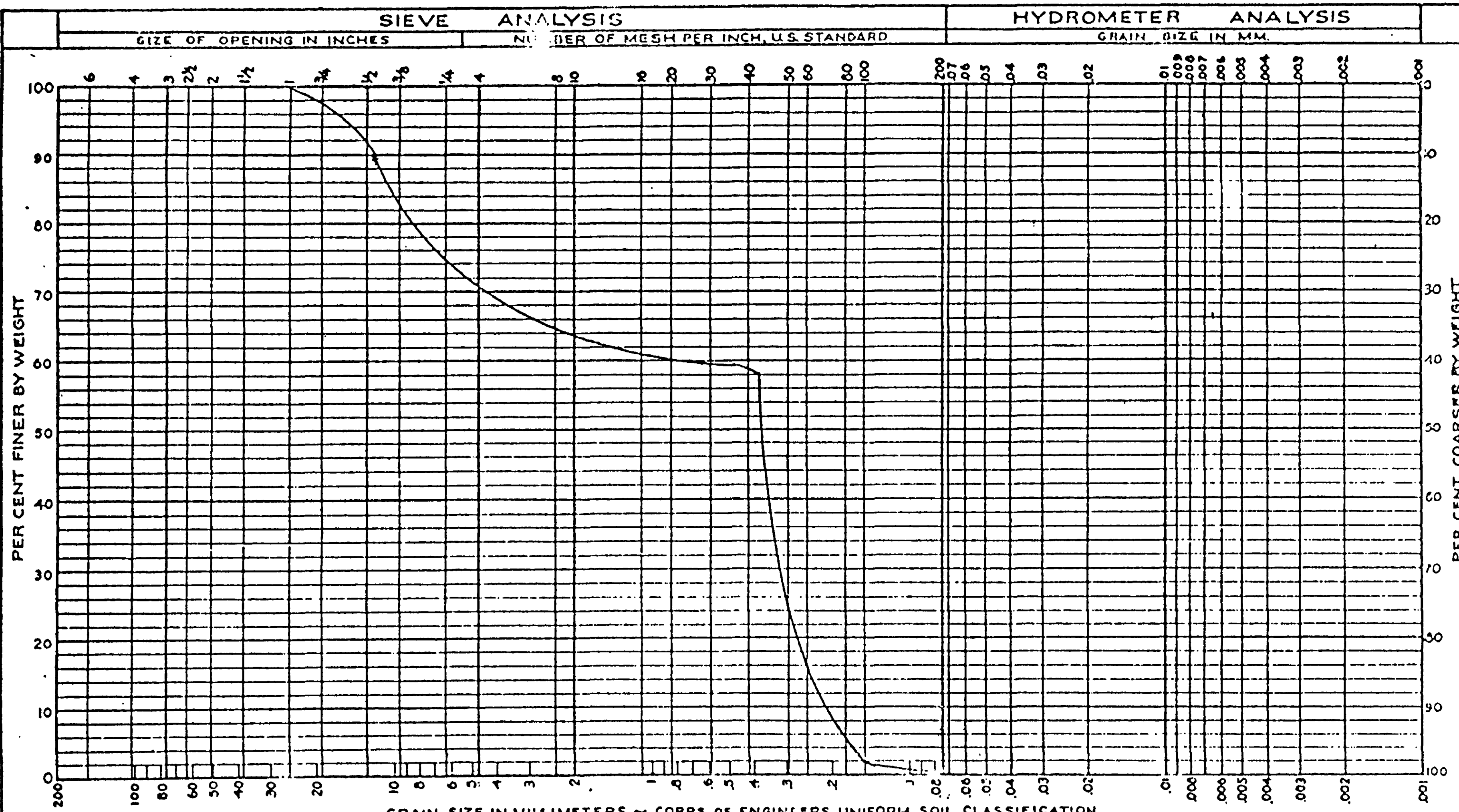
3. Request a seventy-two hour pumping test be performed on this well to prove the type and degree of contamination, and determine whether it can be reactivated. Air Force personnel will make bacterial studies while the pumping test is underway. Water being pumped may be wasted into a nearby drainage ditch so as not to overload the sewage plant during the test.

4. Since you have a well crew at Galena, it would be most advantageous and economical to have the test made at this time. P458-2526 funds remaining from the observation well project may be utilized for this work in the amount of $600. This authorization will not be exceeded without prior approval from this headquarters.

5. Request you proceed with this work as soon as arrangements can be completed.

FOR THE COMMANDER

EDWIN M. EADS
Colonel, USAF
DCS/Civil Engineering



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
42	35'	GRAVELY SAND SP NFS			

PROJECT GALENA AFB WELL # W-315

Sample data Ammo Storage

Submitted by Geology (Patscheck)

Expl. or gp. sample No

W/O No. 92-63

NPD FORM 321 JAN 1951

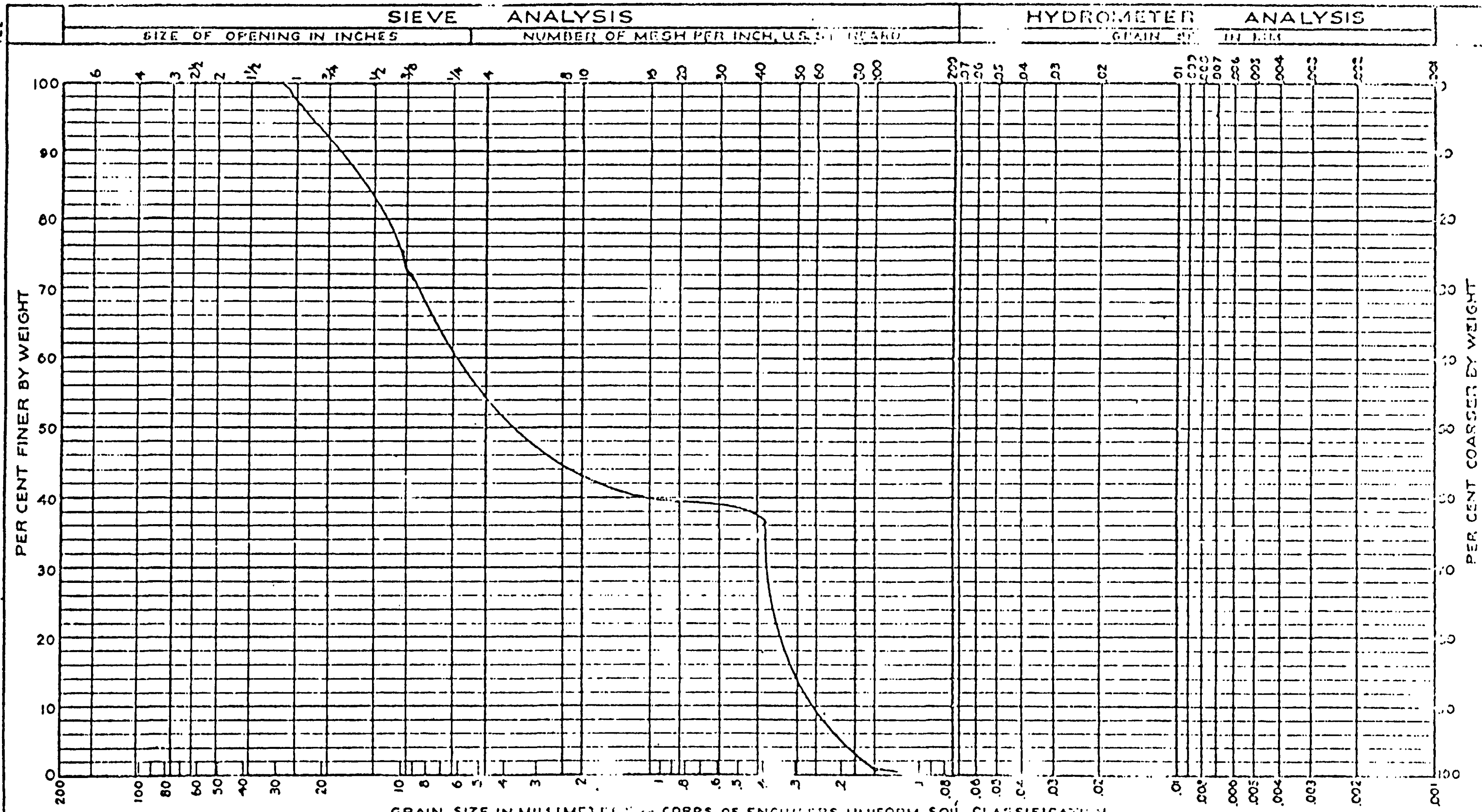
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS
Checked: [signature]

4-29-63 (Date of report)

C H Shaw
Chief, Soil Mechanics Branch



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
#3	35-36	Gravely Sand SP NFS			

PROJECT Galena AFB Well " W-345

Sample data Ammo Storage

Submitted by Geology (Patscheck)

Expl. or gp. sample No.

W/O No. 92-63

(Date of report)

C H Shaw
Chief, Soil Mechanics Branch

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS
Checked: [signature]

4928-61

Expl. or gp. sample No.

W/O No. 92-63

4-24-63
(Date of report)

C H Shaw
Chief, Soil Mechanics Branch

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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Checked: [signature]

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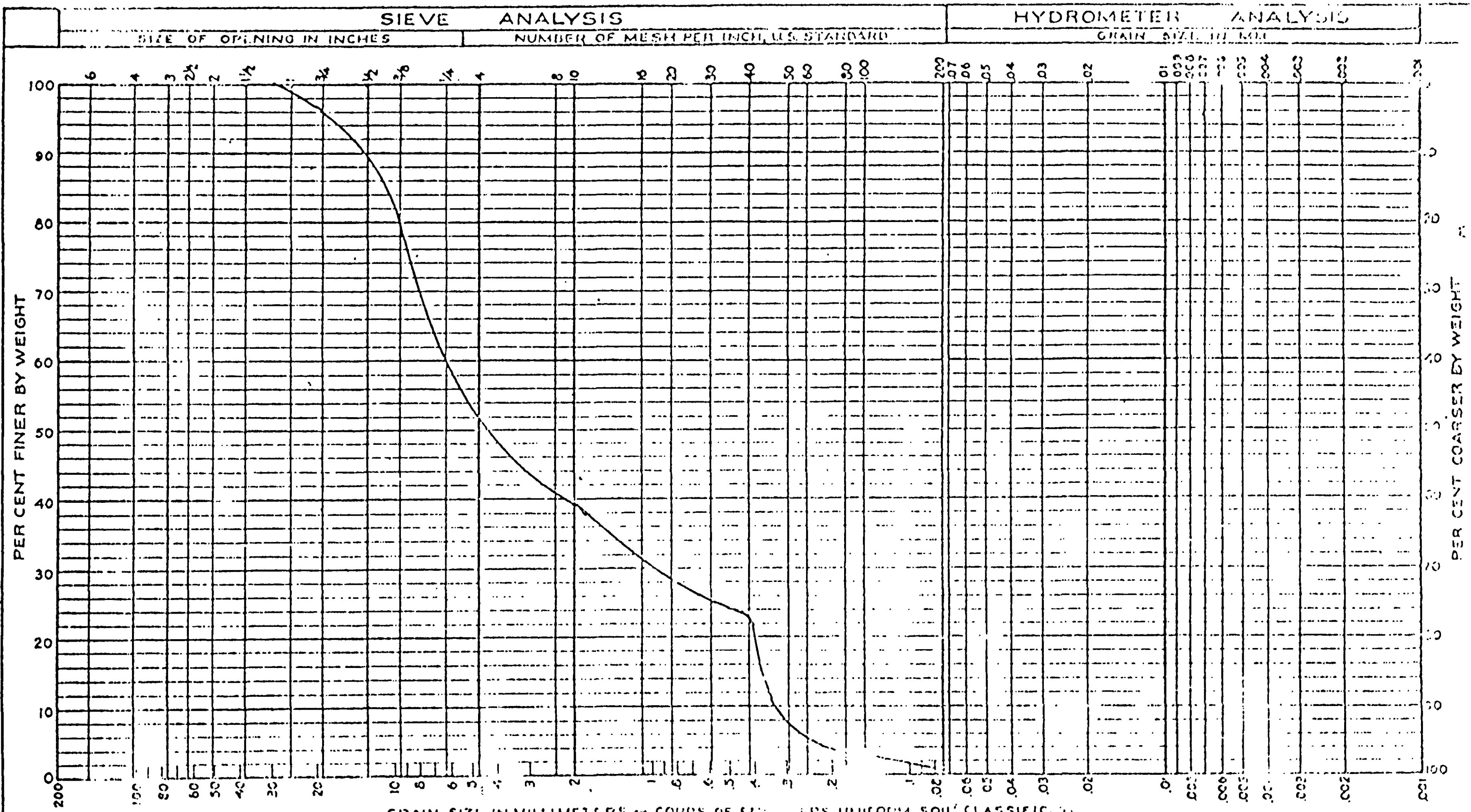


COBBLES	GRAVEL Coarse	GRAVEL Fine	SAND Coarse	SAND Medium	SAND Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI
#4	38-39	GRAVELY SAND SP NES			

PROJECT GALENA AFB WELL # W-345
Sample data AMMO STORAGE
Submitted by Geology (Patschek)
Expl. or gp. sample No
W/O No. 92-63

4-24-63 (Date of report)
C H Shaw — Chief, Soil Mechanics Branch

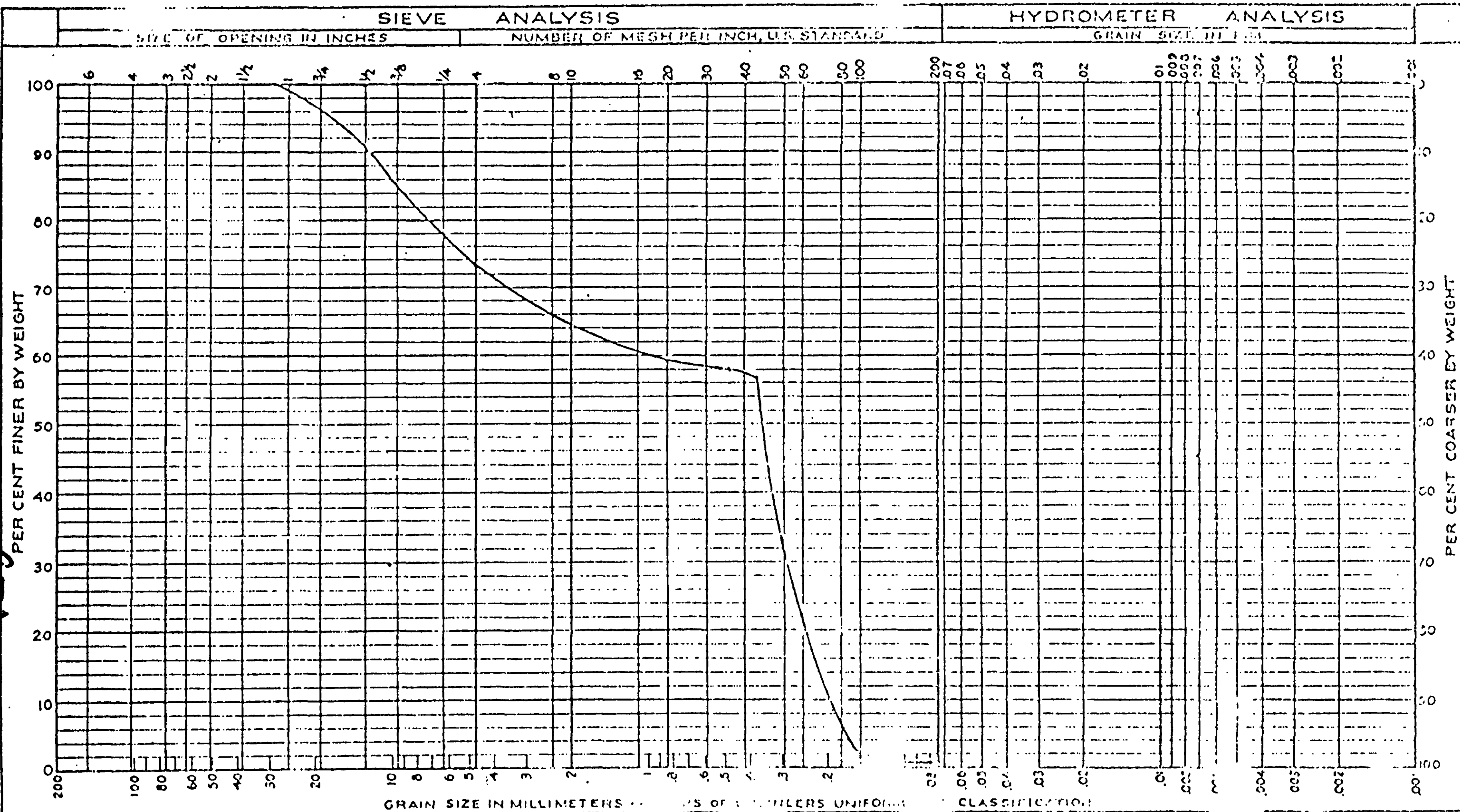
Plotted: CHS
Checked: [illegible]

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

321



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
#5	39-41	GRAVELY SAND SP NFS			

PROJECT GALENA AFB WELL # W-345

Sample data

Submitted by GEOLOGY (Pritscheck)

Expl. or gp. sample No

W/O No. 92-63

4-24-63 (Date of report)

C H Shaw, Chief, Soils Branch

Plotted: CHS

Chkd: [illegible]

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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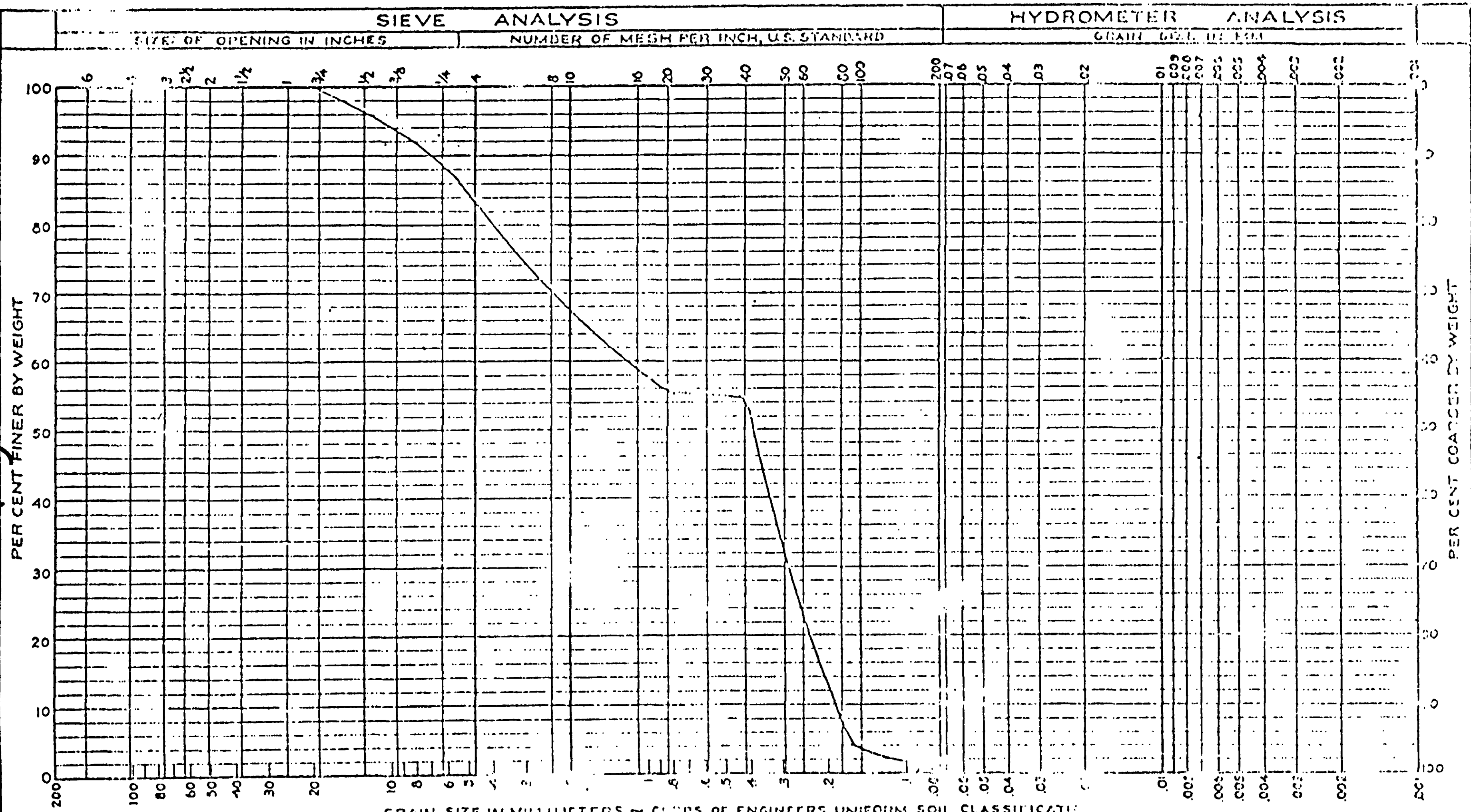


COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
#6	46	GRAVELY SAND SP NFS			

Project: GALENA AFB WELL "W-3-5"
Sample data: AMMO STORAGE
Submitted by: GEOLOGY (PATSCHECK)
Expl. or gp. sample No.
W/O No. 92-63
4-24-63 (Date of report)
C H Shem

NPD FORM 321 JAN 1951

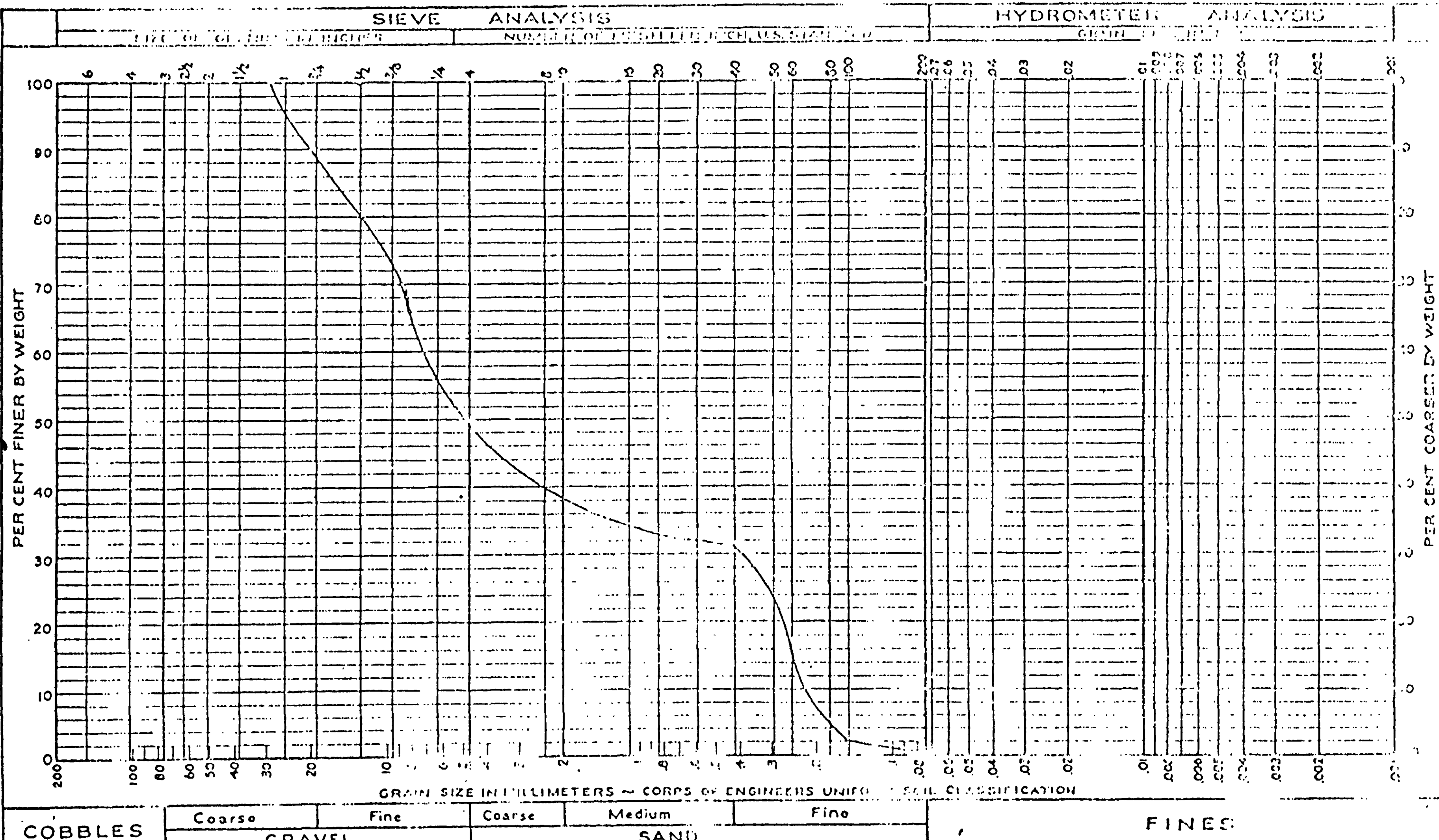
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS
Checked: D. S.

321

(151)



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI
	33-35'	SANDY GRAVEL GP NFS			

PROJECT GALENA [illegible]
Sample data
GUARD HOUSE
Submitted by GEOLOGY (FRISCHKE[illegible])
Expl. or gp. sample No
W/O No. 92-[illegible]

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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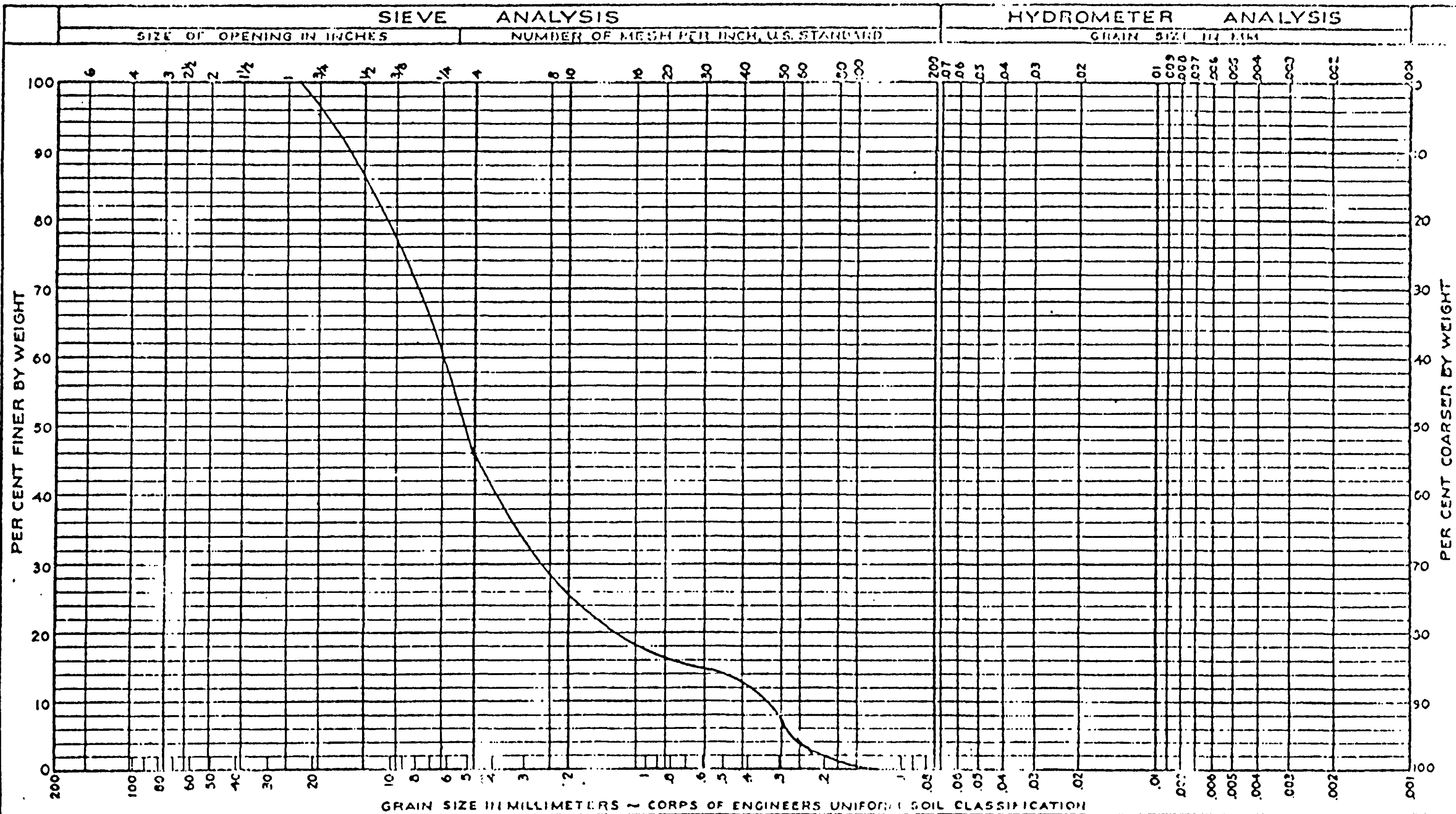
(Date of report)

CHS[illegible]

321

(152)



COBBLES	GRAVEL Coarse	GRAVEL Fine	SAND Coarse	SAND Medium	SAND Fine	FINES

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI
	53-54	SANDY GRAVEL GP NFS			

PROJECT GALENA AFB Well # W-346

Sample data GUARD HOUSE

Submitted by GEOLOGY (Patscheck)

Expl. or gp. sample No

W/O No. 92-63

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS

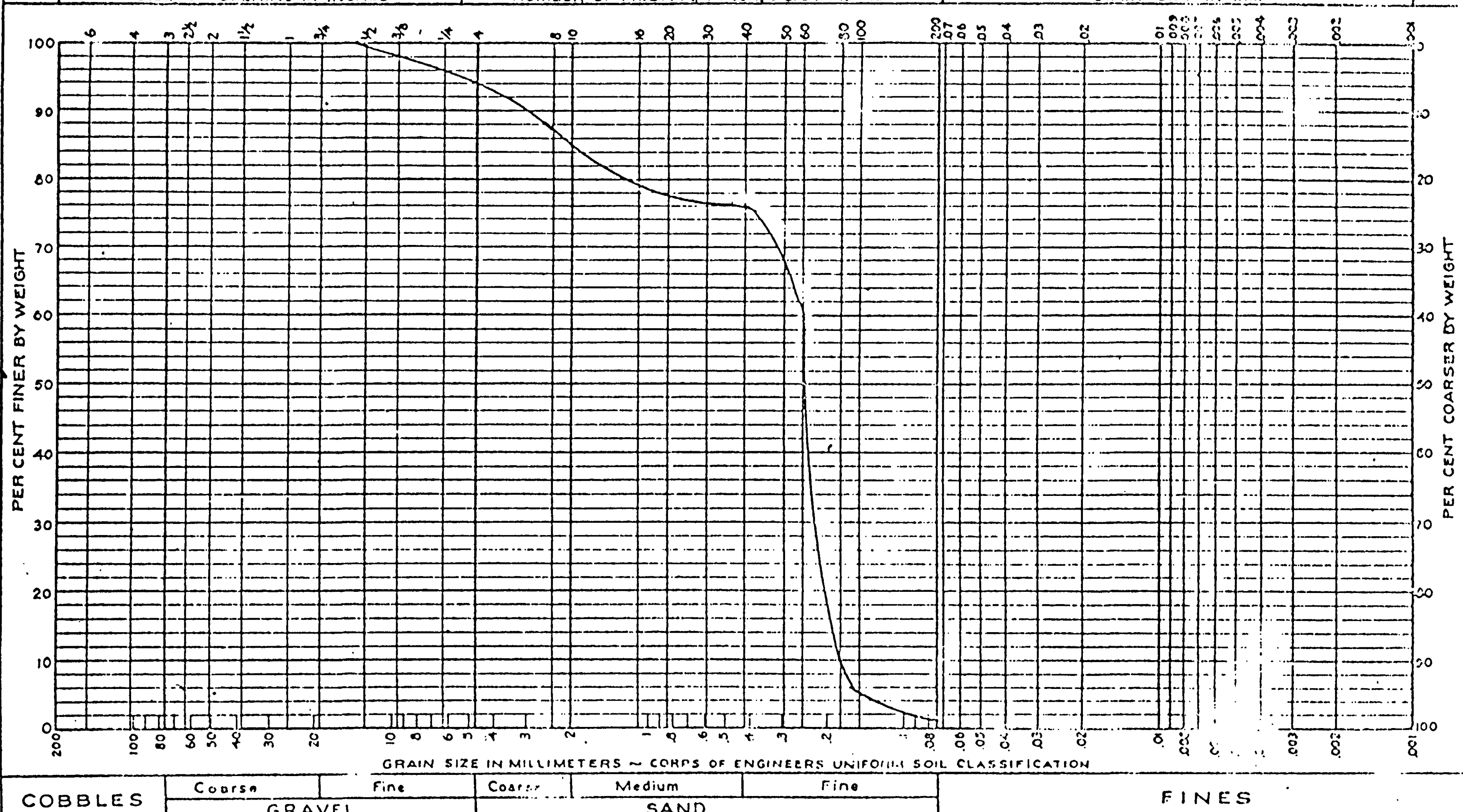
Checked: [signature]

4-24-63 (Date of report)

C H Shaw, Chief, Soil [illegible] Branch

(153)

	SIEVE ANALYSIS		HYDROMETER ANALYSIS
	SIZE OF OPENING IN INCHES	NUMBER OF MESH PER INCH, U.S. STANDARD	GRAIN SIZE IN MM



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI
	31 - 33	GRAVELy SAND SP NES			

PROJECT GALENA AFB WELL # W-347
Sample data ALERT HANGER
Submitted by GEOLOGY (Patscheck)
Expl. or gp. sample No
W/O No. 92 - 63
4-24-63 (Date of report) CH Sh...

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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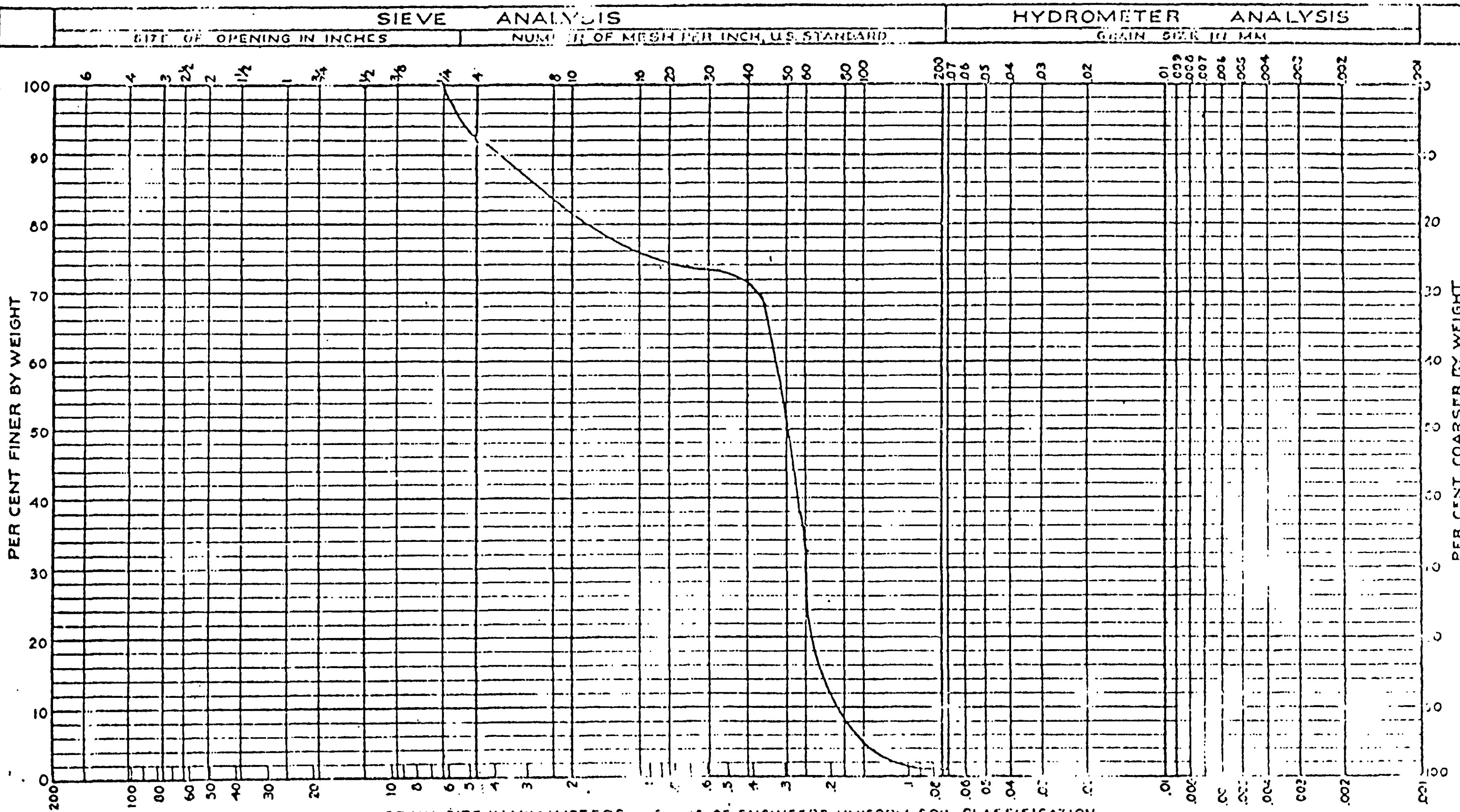
(154)



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
	31.5	SAND SP NFS			

PROJECT Galena AF Well # W-347
Sample data Alert H. Hanger

Submitted by Geology (Patscheck)
Expl. or gp. sample No.
W/O No. 92-63

4-24-63 (Date of report)
CH Shaw, Chief, Soils Section

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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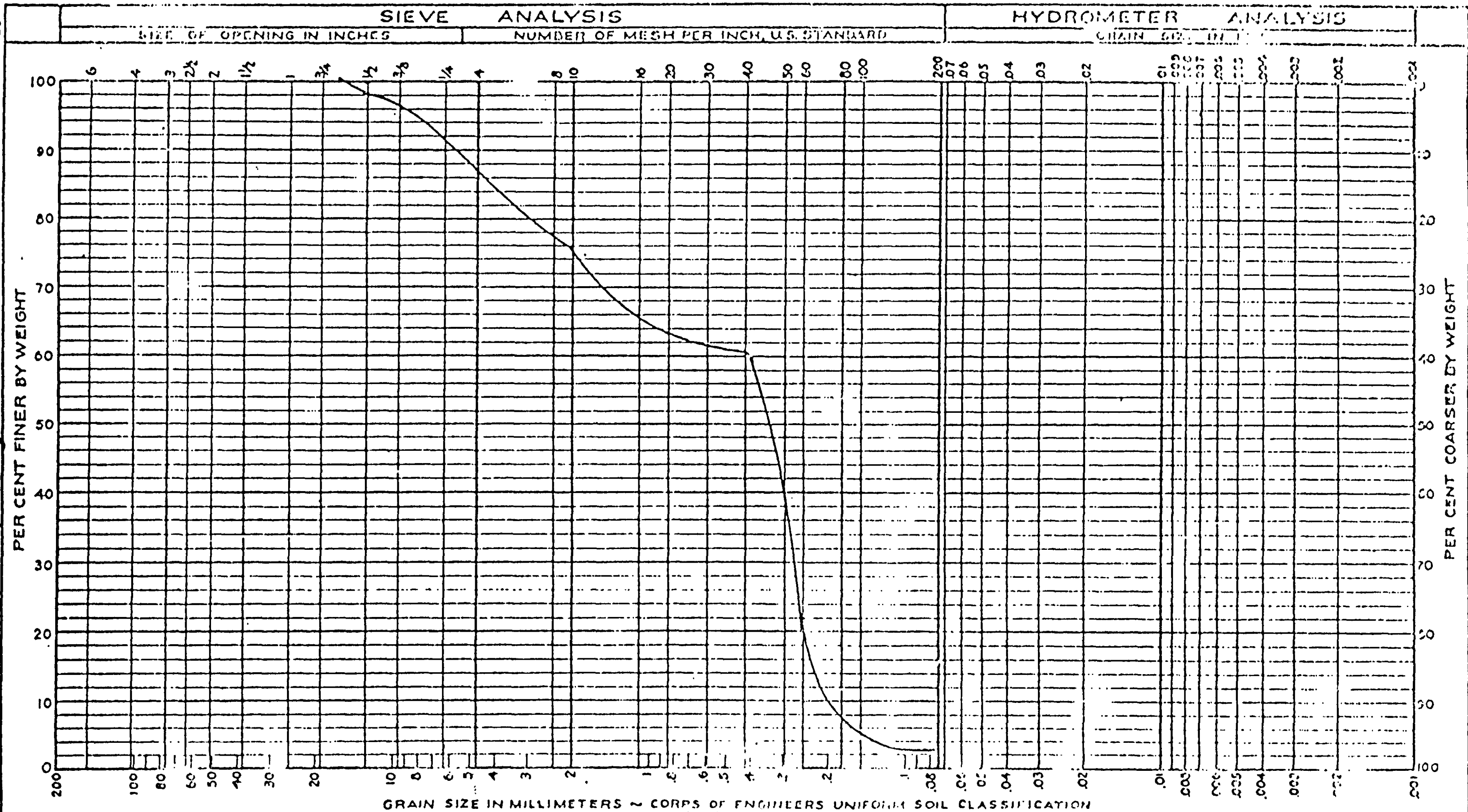

COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	L.L.	P.I.	
	32-34	Gravely Sand SP NFS				

PROJECT Galena AFB Well # W-347
Sample data Alert Hanger
Submitted by Geology (Patscheck)
Expl. or gp. sample No.
W/O No. 92-63
4-24-63
(Date of report)
C H Shaw
Chief, Soil Mechanics Branch

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

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NPD FORM 321
JAN 1951

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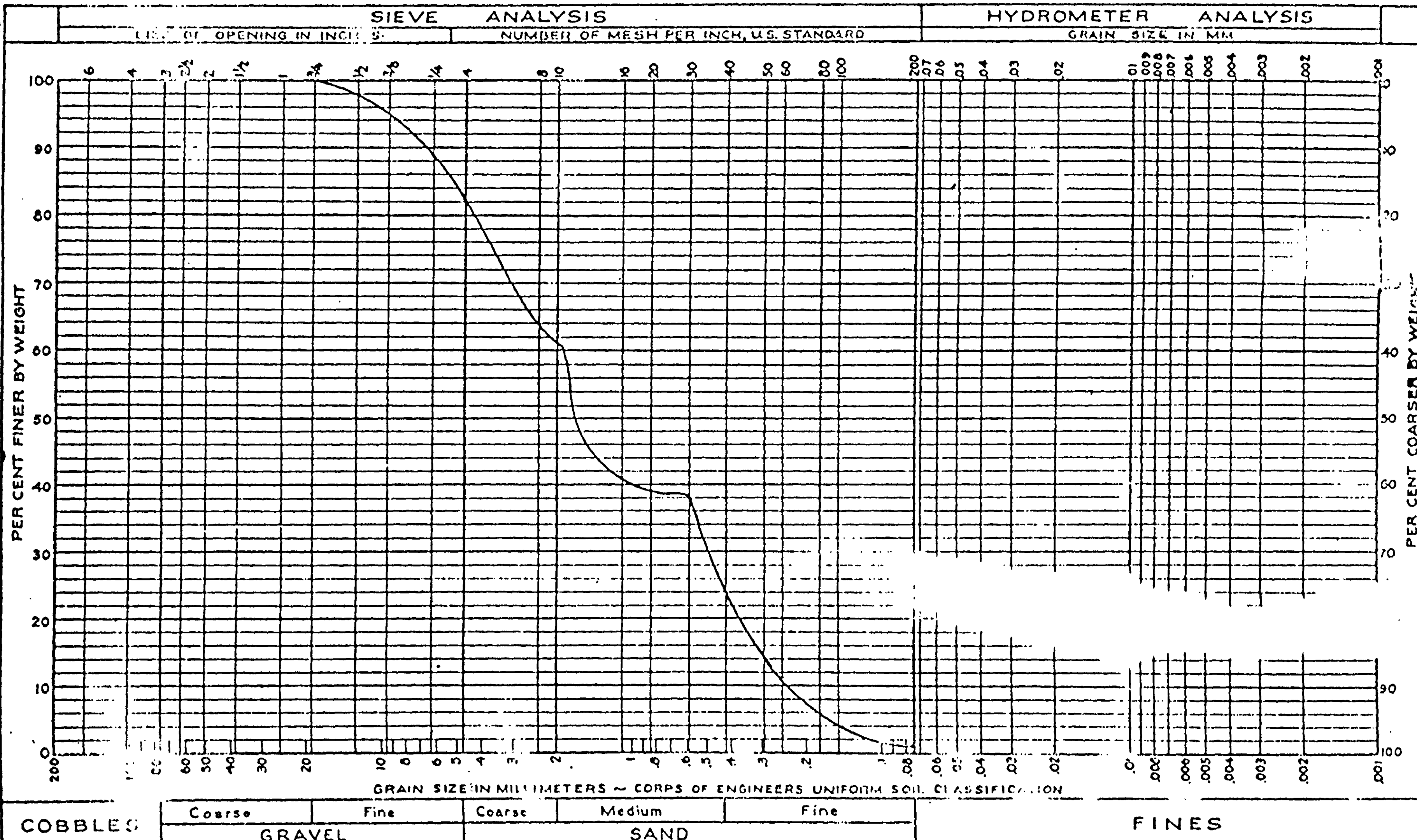
(156)



SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
	34-35	Gravely Sand SP NFS			

PROJECT Galena AFB Well # W-347
Sample data Alert Hanger
Submitted by Geology (Patscheck)
Expl. or gp. sample No.
W/O No. 92-63

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

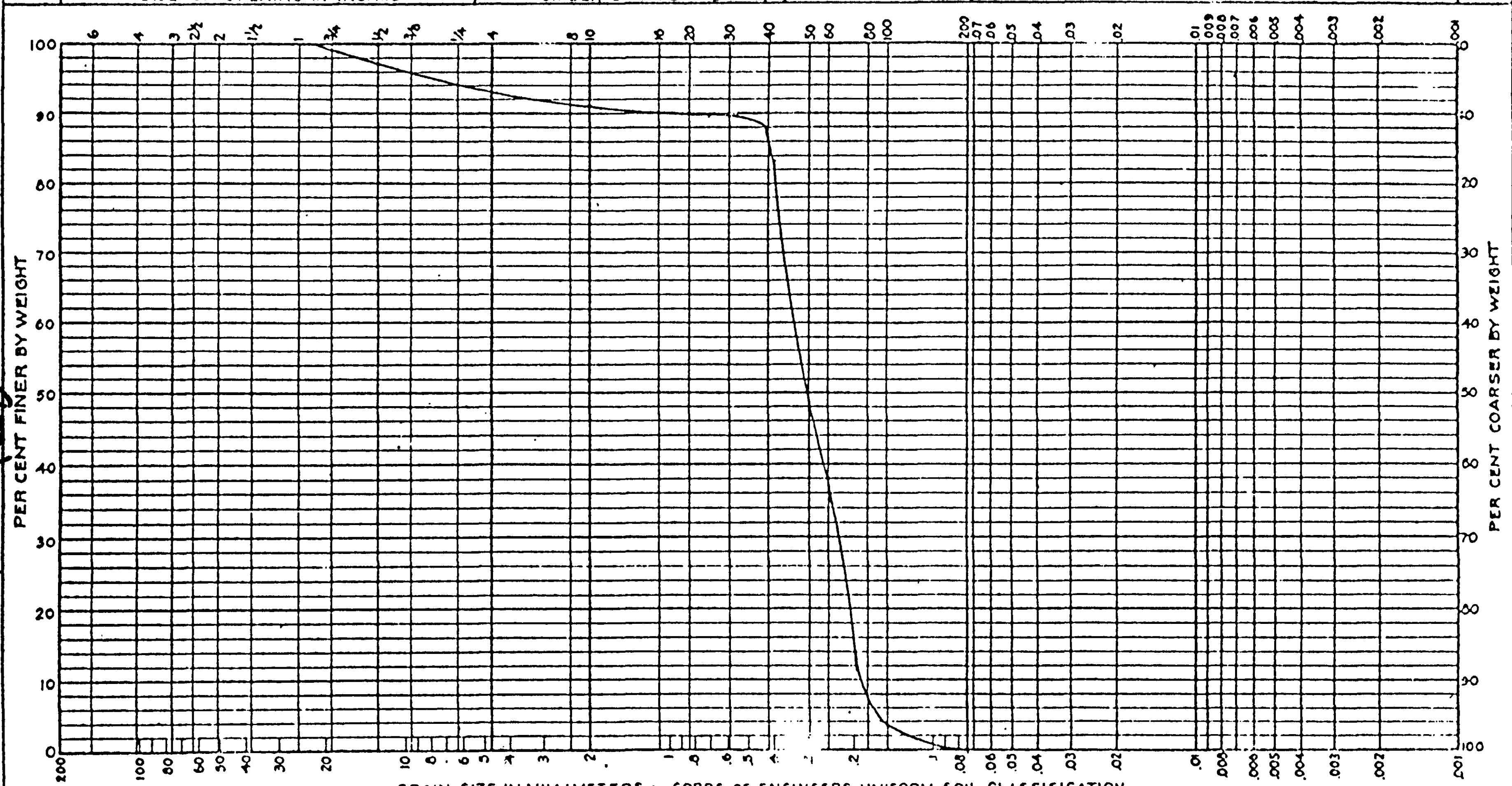
Plotted: C.H.S.
Checked: [illegible]

4-24-63
(Date of report)

C.H. Shaw
Chief, Soil Mechanics [illegible]

321

(157)



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	LL	PI
	36.5	Gravely Sand SP NFS			

PROJECT Galena AFB Well # W-348

Sample data Water Treatment Plant

Submitted by Geology (Pats check)

Expl. or sp. sample No.

W/O No. 92-63

GRADATION CURVES

NPD FORM 321 JAN 1951

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS

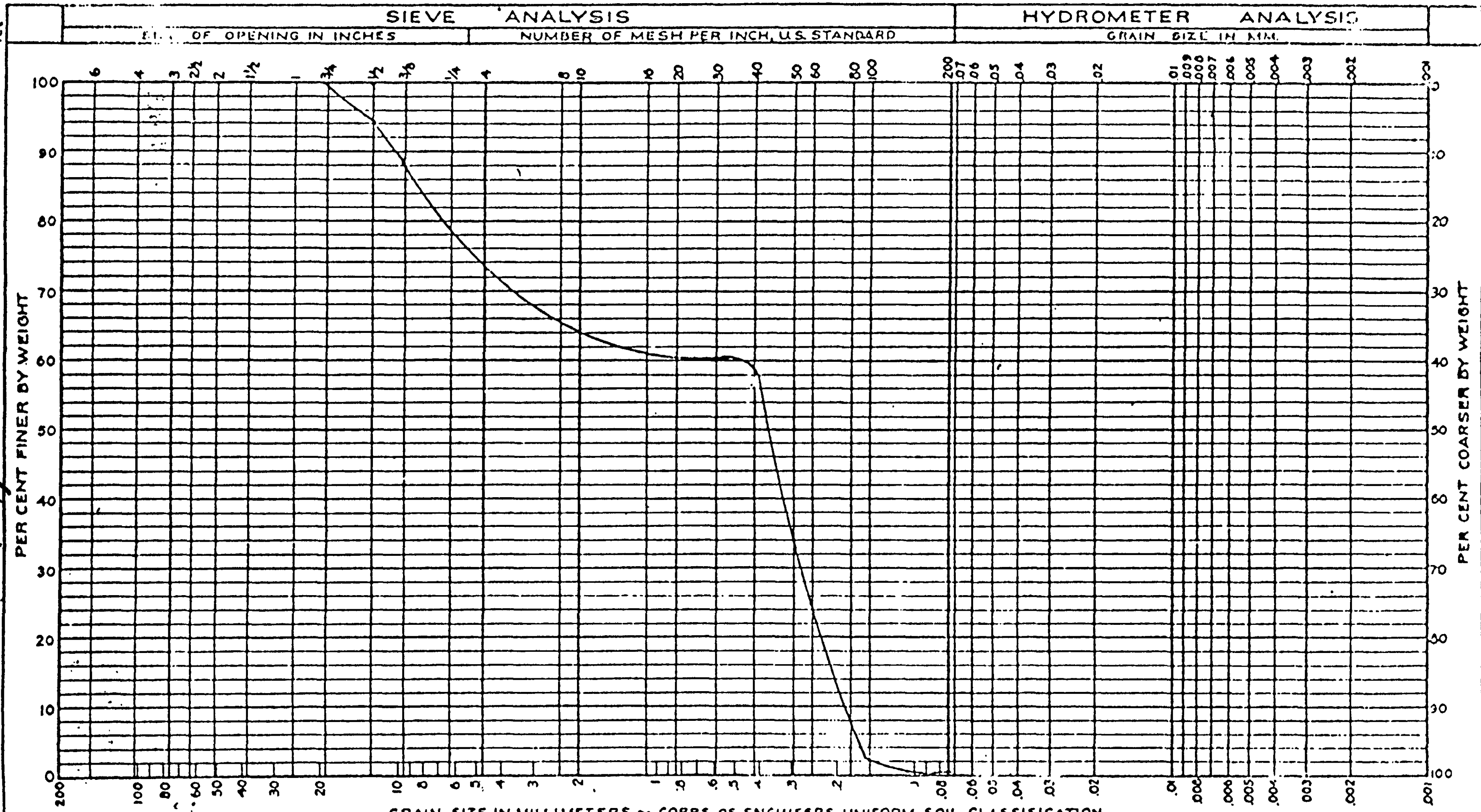
Checked: [illegible]

4-24-63 (Date of report)

C H Shaw, Chief, Soil Mechanics Branch

321

(158)



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT W.C.	LL	PI
	38	GRAVELY SAND SP NFS			

PROJECT GALENA AFB Well # W-348
Sample data WATER TREATMENT PLANT

Submitted by Geology (Patscheck)
Expl. or gp. sample No.
W/O No. 92-63

4-24-63 (Date of report)
C H Shaw
Chief, Soil Mechanics Branch

NPD FORM 321 JAN 1951

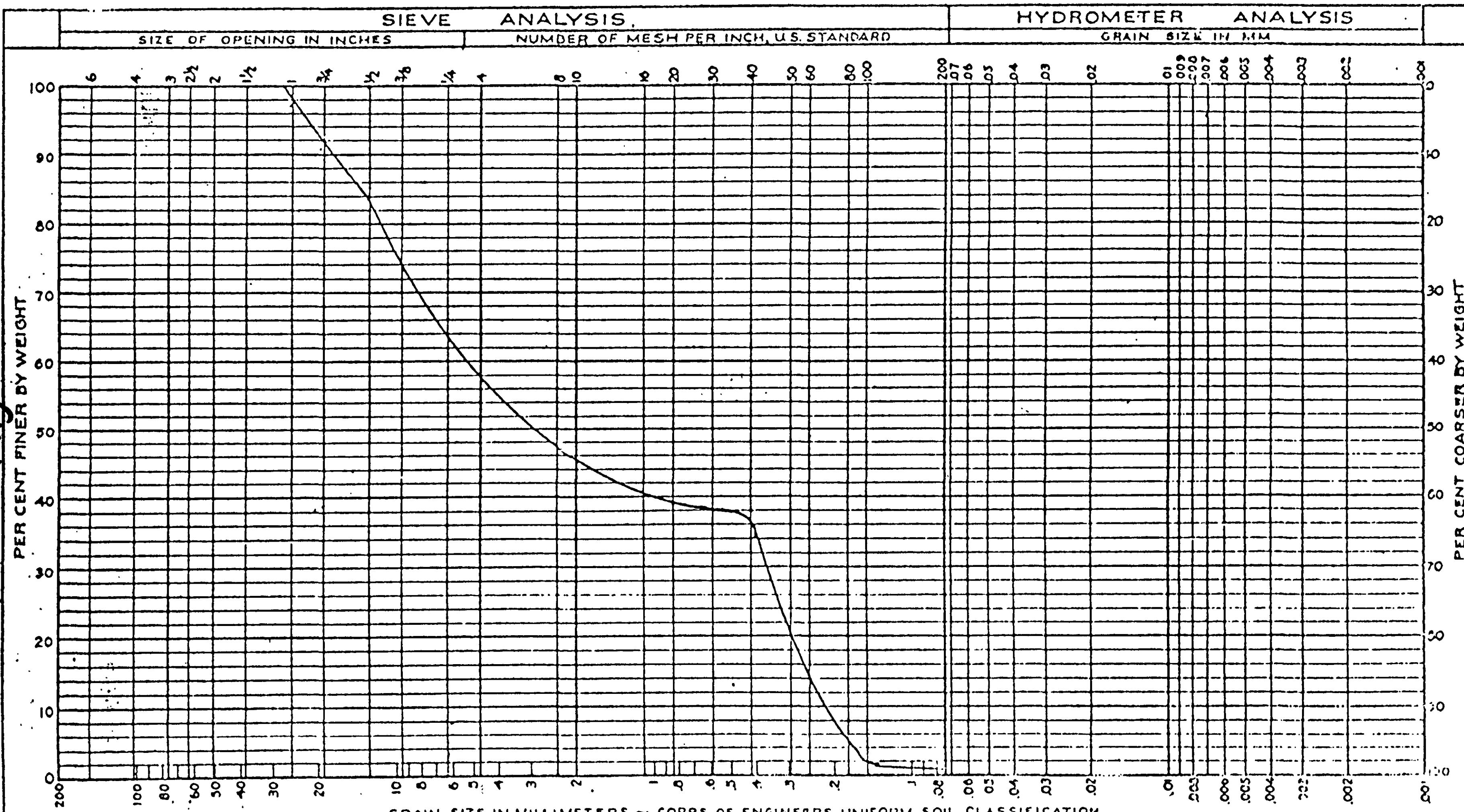
GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS
Checked: [illegible]

321

(159)



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE NO.	DEPTH - FT.	CLASSIFICATION	NAT. W.C.	L.L.	P.I.	
	40	GRAVELY SAND SP NFS				

PROJECT GALENA AFB WELL # W-348
Sample data WATER TREATMENT PLANT
Submitted by GEOLOGY / Patscheck
Expl. or gp. sample No.
W/O No. 92-63
4-24-63 (Date of report)
C H Shaw, Chief, Soils & Chemical Branch

NPD FORM 321 JAN 1951

GRADATION CURVES

CORPS OF ENGINEERS, NORTH PACIFIC DIVISION TESTING LABORATORY, PORTLAND, OREGON

Plotted: CHS
Checked: [illegible]

(160)

APPENDIX 7

U.S. Geological Survey water quality data for the Yukon River at Ruby

and the Yukon River at Galena

Chemical analyses, in parts per million, water year October 1956 to September 1957--Continued

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
YUKON RIVER AT RUBY																		
Apr. 7, 1957.......	28,400	11	0.00	46	8.6	4.4	2.2	180	25	2.0	0.2	0.6	179	150	19	297	7.7	0
July 19............	336,000	7.2	.08	31	7.3	2.5	2.1	108	23	.2	.1	.2	127	107	19	214	7.5	0

30-5648. YUKON RIVER AT RUBY

LOCATION.--Lat 64°44'25", long 155°29'55", at gaging station on left bank at Ruby, 300 feet downstream from Ruby Creek, 2 miles downstream from Melozitna River and 2.2 miles upstream from Ruby Slough.
DRAINAGE AREA.--259,000 square miles, approximately.
RECORDS AVAILABLE.--Chemical analyses: June to September 1966.
Water temperatures: June to September 1966.
EXTREMES, June to September 1966.--Water temperatures: Maximum, 64°F July 24, 26.

Chemical analyses, in parts per million, June to September 1966

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
June 6-17, 1966..	534000	5.8	0.08	24	5.6	1.2	1.1	85	12	0.7	0.3	0.5	93	83	41	165	7.6	5
June 18-30.......	511000	5.3	.12	26	4.9	1.2	1.5	93	15	.7	.1	.5	103	90	14	185	7.3	10
July 1-9.........	369000	6.1	.06	31	5.5	1.6	1.3	106	16	.7	.1	.0	114	100	13	210	7.6	10
July 10-17.......	323000	7.0	.12	31	7.2	1.8	1.9	114	19	.7	.1	.0	125	107	14	220	7.7	10
July 18-31.......	299000	7.3	.21	41	3.8	2.2	2.0	125	24	.0	.2	.8	144	118	15	232	7.2	20
Aug. 1-16........	248000	7.6	.14	43	3.3	2.9	2.2	128	24	.0	.2	.3	146	121	16	251	7.5	20
Aug. 17-31.......	202000	7.7	.04	44	4.6	2.7	1.7	139	24	.7	.1	.0	154	129	15	262	7.6	10
Sept. 1-15.......	177000	7.6	.02	44	3.9	2.6	1.5	134	23	.4	.1	.0	149	126	16	252	7.6	10
Sept. 16-30......	161000	6.3	.00	39	7.9	2.6	1.1	142	27	.7	.2	.2	157	130	14	269	7.6	15

15-5648. YUKON RIVER AT RUBY

LOCATION.--Lat 64°44'25", long 155°29'55", at gaging station on left bank at Ruby, 300 feet downstream from Ruby Creek, 2 miles downstream from Melozitna River and 2.2 miles upstream from Ruby Slough.
DRAINAGE AREA.--259,000 square miles, approximately.
RECORDS AVAILABLE.--Chemical analyses: June 1966 to September 1967.
Water temperatures: June 1966 to September 1967.
EXTREMES, 1966-67.--Water temperatures: Maximum, 64°F June 24, July 11, 13.
EXTREMES, June 1966 to September 1967.--Water temperatures: Maximum, 64°F July 24, 26, 1966, June 24, July 11, 13, 1967.

Chemical analyses, in parts per million, water year October 1966 to September 1967

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color
Oct. 1-15, 1966.....	140000	8.5	0.00	39	8.4	4.1	1.9	140	24	0.4	0.1	1.1	157	131	16	260	7.9	10
Oct. 16-29..........	125000	8.4	.09	38	9.6	3.5	1.4	140	26	.0	.1	2.1	158	134	19	260	7.7	10
May 22-31, 1967.....	415000	4.7	.13	23	4.3	1.9	1.2	78	12	.0	.5	1.4	87	75	11	151	7.4	100
May 25..............	406500	5.1	.31	30	3.8	1.8	1.6	88	20	.7	.3	.2	106	88	16	172	7.3	40
June 1-5............	498000	4.9	.15	25	4.4	19	1.2	83	13	.0	.5	1.0	93	80	12	157	7.6	100
June 6-18...........	666000	4.9	.11	24	4.0	17	2.0	90	16	.4	.1	.7	98	83	9	165	7.4	20
June 19-30..........	506000	6.2	.08	30	5.0	2.3	2.2	100	18	.0	.0	.8	114	96	14	190	7.3	15
July 1-15...........	391000	6.9	.08	33	6.0	3.1	2.4	114	23	.4	.1	1.1	132	108	15	218	7.2	20
July 9..............	390400	6.8	1.86	30	6.2	1.9	.8	106	20	.0	.0	1.4	121	100	13	202	7.7	15
July 16-31..........	373000	6.7	.06	34	5.8	2.6	2.4	120	20	.0	.0	.6	131	108	10	221	7.2	15
Aug. 1-16...........	397000	7.2	.04	41	4.0	2.1	1.5	124	26	2.1	.2	.5	146	119	17	315	7.8	15
Aug. 17.............	564000	7.0	.14	28	5.5	2.1	1.7	99	20	.0	.1	1.5	115	92	11	132	7.5	35
Aug. 17-31..........	553000	7.0	.13	36	1.7	1.5	1.3	74	14	1.4	.2	.4	99	97	36	194	7.5	15
Sept. 1-5...........	371000	7.2	.08	42	.7	1.8	1.4	104	30	1.4	.2	.4	136	108	23	207	7.6	15
Sept. 6-17..........	318000	7.6	.04	40	2.4	2.8	1.4	117	21	.4	.1	.7	135	110	14	206	7.7	15
Sept. 18-27.........	287000	7.9	.04	36	4.4	2.8	1.3	114	24	.0	.1	.6	135	108	15	204	7.7	20
Sept. 28............	247000	7.0	1.00	29	6.6	2.2	.8	98	20	1.4	.0	.8	117	99	19	198	7.8	10
Sept. 28-30.........	257000	8.2	.04	39	4.0	3.1	1.6	120	23	.4	.1	.7	140	113	15	207	7.7	20

15-5648. YUKON RIVER AT RUBY
(International Hydrologic Decade Station)

LOCATION.--Lat 64°44'25", long 155°29'55", at gaging station on left bank at Ruby, 300 feet downstream from Ruby Creek, 2 miles downstream from Melozitna River, and 2.2 miles upstream from Ruby Slough.
DRAINAGE AREA.--259,000 sq mi, approximately.
RECORDS AVAILABLE.--Chemical analyses: June 1966 to September 1968.
Water temperatures: June 1966 to September 1967.
EXTREMES, 1967-68.--Dissolved solids: Minimum, 95 mg/l June 3-17.
Hardness: Minimum, 81 mg/l June 13-17.
Specific conductance: Minimum, 154 micromhos June 16.
EXTREMES, 1966-68.--Dissolved solids (1967-68): Minimum, 95 mg/l June 3-17, 1968.
Hardness (1967-68): Minimum, 81 mg/l June 13-17, 1968.
Specific conductance (1967-68): Minimum, 154 micromhos June 16, 1968.
Water temperatures (1966-67): Maximum, 18°C July 24, 26, 1966, June 24, July 11, 13, 1967.

CHEMICAL ANALYSES IN MILLIGRAMS PER LITER, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DATE	DIS-CHARGE (CFS)	SILICA (SIO2)	TOTAL IRON (FE)	CAL-CIUM (CA)	MAG-NE-SIUM (MG)	SODIUM (NA)	PO-TAS-SIUM (K)	BICAR-BONATE (HCO3)	SULFATE (SO4)
OCT.									
01-05	33	9.2	--	38	6.1	2.9	1.1	130	23
06-14	188	9.0	.07	36	7.1	2.5	1.4	125	19
15-17	159	9.4	.75	39	8.0	5.2	1.9	139	20
JUNE									
02...	48	5.2	.55	27	47	1.5	1.3	93	14
03-17	614	5.5	--	25	4.5	1.5	1.1	87	13
18-27	449	8.0	--	26	5.3	2.0	1.1	92	17
28-30	431	8.2	--	27	5.6	2.2	1.1	95	19
JULY									
01-02	420	8.2	--	27	5.6	2.2	1.1	95	19
08-17	338	8.6	--	31	6.1	2.6	1.4	110	22
18-27	308	6.9	--	35	6.7	2.4	1.7	1	22
28-31	275	7.0	--	34	6.9	2.4	1.7	119	24
AUG.									
01-06	275	7.0	--	34	6.9	2.4	1.7	119	24
07-16	257	7.4	--	34	7.1	2.5	1.8	116	25
18-24	234	8.0	--	34	6.8	2.8	1.9	123	26
25-31	215	8.3	--	36	7.1	3.4	2.0	131	26
SEPT.									
01...	215	8.3	--	36	7.1	3.4	2.0	131	26
02-05	211	8.1	--	37	8.0	3.3	1.7	138	27
06-19	191	8.7	--	34	7.6	3.7	1.6	130	25
20-30	183	8.9	--	32	7.6	3.1	1.4	123	23

DATE	CHLO-RIDE (CL)	FLUO-RIDE (F)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS)	HARD-NESS (CA,MG)	NON-CAR-BONATE HARD-NESS	SPECI-FIC COND-UCTANCE (MICRO-MHOS)	PH	COLOR
OCT.								
01-05	.4	.0	150	120	10	238	8.0	15
06-14	1.1	.0	138	119	17	233	7.7	20
15-17	3.2	.1	156	130	16	264	7.5	15
JUNE								
02...	1.0	.2	102	87	11	173	7.3	90
03-17	1.0	.2	95	81	10	168	7.6	60
18-27	.8	.2	106	87	12	200	7.7	30
28-30	1.0	.2	111	90	12	189	7.6	40
JULY								
01-02	1.0	.2	111	90	12	189	76.0	40
08-17	.9	.3	127	102	12	214	7.6	0
18-27	1.6	.1	136	115	17	227	7.8	1
28-31	1.0	.1	136	114	16	224	7.9	20
AUG.								
01-06	1.0	.1	136	114	16	224	7.9	20
07-16	1.4	.1	136	114	19	221	7.8	20
18-24	.6	.2	141	114	13	240	7.9	20
25-31	1.0	.2	149	119	12	254	7.5	20
SEPT.								
01...	1.0	.2	149	119	12	254	7.5	20
02-05	1.4	.1	155	126	13	262	7.8	10
06-19	1.8	.2	147	121	14	253	7.6	15
20-30	1.0	.1	137	111	10	239	7.5	20

15-5648. YUKON RIVER AT RUBY--Continued

SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C), WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DAY	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.....	--	--	--	--	--	--	--	--	--	188	225	268
2.....	--	--	--	--	--	--	--	--	--	188	229	270
3.....	--	--	--	--	--	--	--	--	165	196	233	281
4.....	--	--	--	--	--	--	--	--	174	192	230	276
5.....	--	--	--	--	--	--	--	--	162	190	230	262
6.....	--	--	--	--	--	--	--	--	167	190	231	245
7.....	--	--	--	--	--	--	--	--	172	195	227	244
8.....	--	--	--	--	--	--	--	--	176	201	226	244
9.....	--	--	--	--	--	--	--	--	166	213	221	244
10.....	--	--	--	--	--	--	--	--	171	203	216	244
11.....	--	--	--	--	--	--	--	--	149	205	216	275
12.....	--	--	--	--	--	--	--	--	162	206	225	245
13.....	--	--	--	--	--	--	--	--	162	217	215	234
14.....	--	--	--	--	--	--	--	--	155	212	214	247
15.....	--	--	--	--	--	--	--	--	164	224	214	243
16.....	--	--	--	--	--	--	--	--	154	218	220	253
17.....	--	--	--	--	--	--	--	--	160	237	--	247
18.....	--	--	--	--	--	--	--	--	166	225	231	244
19.....	--	--	--	--	--	--	--	--	168	225	237	260
20.....	--	--	--	--	--	--	--	--	168	228	235	237
21.....	--	--	--	--	--	--	--	--	178	235	242	236
22.....	--	--	--	--	--	--	--	--	179	225	223	240
23.....	--	--	--	--	--	--	--	--	186	222	243	242
24.....	--	--	--	--	--	--	--	--	185	221	233	238
25.....	--	--	--	--	--	--	--	--	183	223	244	247
26.....	--	--	--	--	--	--	--	--	184	237	242	234
27.....	--	--	--	--	--	--	--	--	185	221	245	244
28.....	--	--	--	--	--	--	--	--	181	229	245	233
29.....	--	--	--	--	--	--	--	--	187	228	253	236
30.....	--	--	--	--	--	--	--	--	184	223	250	229
31.....	--	--	--	--	--	--	--	--	--	225	259	--
AVERAGE	--	--	--	--	--	--	--	--	171	214	231	248

INSTANTANEOUS SUSPENDED SEDIMENT AND PARTICLE SIZE, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968
(METHODS OF ANALYSIS: B, BOTTOM WITHDRAWAL TUBE; C, CHEMICALLY DISPERSED; N, IN NATIVE WATER; P, PIPET; S, SIEVE; V, VISUAL ACCUMULATION TUBE; W, IN DISTILLED WATER)

DATE	TIME	WATER TEMPERATURE (°C)	DISCHARGE (CFS)	CONCENTRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	PARTICLE SIZE: PERCENT FINER THAN THE SIZE (IN MILLIMETERS) INDICATED											METHOD OF ANALYSIS
						.002	.004	.008	.016	.031	.062	.125	.250	.500	1.00	2.00	
MAR 15, 1968	1700	0	30100	56	4600												
JUN 2......	2200	7	501000	665	900000	16	19	30	46	61	78	93	100	--	--	--	VBWC
SEP 19......	1700	--	187000	186	93900												

15-5648. YUKON RIVER AT RUBY
(International Hydrologic Decade Station)

LOCATION.--Lat 64°44'28", long 155°29'22", at gaging station on left bank at Ruby, 300 ft downstream from Ruby Creek, 1.5 miles downstream from Melozitna River, and 2.2 miles upstream from Ruby Slough.
DRAINAGE AREA.--259,000 sq mi, approximately.
PERIOD OF RECORD.--Chemical analyses: June 1966 to September 1969.
Water temperatures: June 1966 to September 1967, August to September 1969.
Sediment records: September 1967 to September 1969 (partial-record station).
EXTREMES, 1968-69.--Dissolved solids: Minimum, 109 mg/l June 8-19.
Hardness: Minimum, 92 mg/l June 8-19.
Specific conductance: Minimum daily, 185 micromhos June 7.
EXTREMES, 1966-69.--Dissolved solids (1967-69): Minimum, 95 mg/l June 3-17, 1968.
Hardness (1967-69): Minimum, 81 mg/l June 13-17, 1968.
Specific conductance (1967-69): Minimum daily, 154 micromhos June 16, 1968.
Water temperatures (1966-67): Maximum, 18°C July 24, 26, 1966, June 24, July 11, 13, 1967.
REMARKS.--Stream frozen over during period October to May.

CHEMICAL ANALYSES, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DATE	MEAN DIS-CHARGE (CFS)	SILICA (SIO2) (MG/L)	TOTAL IRON (FE) (UG/L)	CAL-CIUM (CA) (MG/L)	MAG-NE-SIUM (MG) (MG/L)	SODIUM (NA) (MG/L)	PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	SULFATE (SO4) (MG/L)
OCT.									
01-13	166,000	9.3	--	33	7.7	3.6	1 2	125	24
14-18	144,000	9.0	--	36	8.6	3.2	1.4	138	26
JUN.									
08-19	254,000	7.4	.38	27	6.0	2.5	1.4	94	18
20-30	327,000	7.8	3.9	32	7.2	2.7	1.9	116	20
JUL.									
01-16	224,000	8.6	1.9	36	6.6	3.2	2.0	126	22
17-31	72,000	8.1	9.1	35	6.5	3.0	2.0	120	22
AUG.									
01-04	272,000	8.1	9.1	35	6.5	3.0	2.0	120	22
08-17	331,000	6.1	--	35	5.8	2.9	2.3	124	15
18-27	247,000	7.2	--	32	5.8	2.8	1.2	101	23
28-31	206,000	6.5	.08	33	5.4	3.0	1.2	107	26
SEP.									
01-06	206,000	6.5	.08	33	5.4	3.0	1.2	107	26
07-30	188,000	7.0	--	30	7.8	3.1	1.0	110	22
ANALYSES OF ADDITIONAL SAMPLES									
MAR.									
08...	22,500	10	.07	44	9.6	3.7	2.8	164	26
MAY									
30...	312,000	5.1	.19	26	5.4	1.8	1.6	88	17
JUL.									
04...	239,000	5.7	.03	29	7.8	2.4	2.5	113	20
AUG.									
12...	365,000	5.5	.03	32	6.8	2.3	2.2	111	24
SEP.									
28...	183,000	6.9	.07	29	8.0	2.8	1.0	1040	14

DATE	CHLO-RIDE (CL) (MG/L)	FLUO-RIDE (F) (MG/L)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L)	HARD-NESS (CA,MG) (MG/L)	NON-CAR-BONATE HARD-NESS (MG/L)	SPECI-FIC CONO-UCTANCE (MICRO-MHOS)	PH (UNITS)	COLOR (PLATI-NUM-COBALT UNITS)
OCT.								
01-13	.9	.2	143	114	11	239	7.4	15
14-18	.9	.1	153	126	13	261	7.2	15
JUN.								
08-19	.7	.2	109	92	16	188	7.9	25
20-30	.0	.2	131	110	15	223	8.0	30
JUL.								
01-16	.0	.2	147	118	15	237	8.1	10
17-31	2.5	.2	139	115	17	232	8.1	10
AUG.								
01-04	2.5	.2	139	115	17	232	8.1	10
08-17	.7	.2	130	112	10	228	7.8	30
18-27	.7	.1	129	104	21	214	8.1	30
28-31	.7	.1	130	105	17	217	7.9	30
SEP.								
01-06	.7	.1	130	105	17	217	7.9	30
07-30	.0	.2	126	108	18	215	8.0	20
ANALYSES OF ADDITIONAL SAMPLES								
MAR.								
08...	.4	.4	178	149	15	294	7.5	5
MAY								
30...	1.1	.2	102	88	16	175	7.9	5
JUL.								
04...	.0	.2	126	105	12	215	8.0	--
AUG.								
12...	1.1	.1	129	109	18	223	8.0	30
SEP.								
28...	.4	.1	124	105	19	215	8.0	30

15-5648. YUKON RIVER AT RUBY—Continued

SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C), WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DAY	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBE
1.....	230	—	—	—	—	—	—	—	—	230	226	216
2.....	227	—	—	—	—	—	—	—	—	247	221	219
3.....	233	—	—	—	—	—	—	—	—	230	229	210
4.....	244	—	—	—	—	—	—	—	—	240	217	211
5.....	230	—	—	—	—	—	—	—	—	255	—	210
6.....	237	—	—	—	—	—	—	—	186	248	—	213
7.....	254	—	—	—	—	—	—	—	185	256	—	211
8.....	249	—	—	—	—	249	—	—	186	248	292	213
9.....	240	—	—	—	—	—	—	—	189	240	279	213
10.....	241	—	—	—	—	—	—	—	192	238	228	217
11.....	240	—	—	—	—	—	—	—	190	240	217	219
12.....	240	—	—	—	—	—	—	—	186	238	217	217
13.....	241	—	—	—	—	—	—	—	188	249	230	216
14.....	252	—	—	—	—	—	—	—	190	237	233	216
15.....	258	—	—	—	—	—	—	—	194	241	210	216
16.....	262	—	—	—	—	—	—	—	194	251	200	219
17.....	267	—	—	—	—	—	—	—	198	239	203	217
18.....	265	—	—	—	—	—	—	—	188	239	220	215
19.....	—	—	—	—	—	—	—	—	193	232	221	218
20.....	—	—	—	—	—	—	—	—	204	234	217	220
21.....	—	—	—	—	—	—	—	—	222	229	215	219
22.....	—	—	—	—	—	—	—	—	216	225	215	217
23.....	—	—	—	—	—	—	—	—	218	226	218	216
24.....	—	—	—	—	—	—	—	—	225	226	216	216
25.....	—	—	—	—	—	—	—	—	229	260	218	217
26.....	—	—	—	—	—	—	—	—	234	223	214	218
27.....	—	—	—	—	—	—	—	—	234	222	215	220
28.....	—	—	—	—	—	—	—	—	231	216	218	217
29.....	—	—	—	—	—	—	—	—	231	223	216	217
30.....	—	—	—	—	—	—	—	—	238	219	223	222
31.....	—	—	—	—	—	—	—	—	—	232	217	—
AVERAGE	—	—	—	—	—	—	—	—	206	237	223	216

TEMPERATURE (°C) OF WATER, AUGUST TO SEPTEMBER 1969

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	AVERAGE
AUGUST...	--	--	--	--	--	--	--	12	12	11	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	--
SEPTEMBER	10	12	10	10	10	10	10	10	10	10	11	10	10	10	11	11	11	9	9	9	7	7	7	6	7	5	5	5	6	5	—	9

INSTANTANEOUS SUSPENDED SEDIMENT AND PARTICLE SIZE, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969
(METHODS OF ANALYSIS: B, BOTTOM WITHDRAWAL TUBE; C, CHEMICALLY DISPERSED; N, IN NATIVE WATER; P, PIPET; S, SIEVE; V, VISUAL ACCUMULATION TUBE; W, IN DISTILLED WATER)

DATE	TIME	WATER TEMPERATURE (C)	DISCHARGE (CFS)	CONCENTRATION (MG/L)	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	PARTICLE SIZE: PERCENT FINER THAN THE SIZE (IN MILLIMETERS) INDICATED .002	.004	.008	.016	.031	.062	.125	.250	.500	1.00	2.00	METHOD OF ANALYSIS
MAR 8, 1969	1007	0.0	22100	2	119	--	—	—	--	--	--	—	—	--	—	—	
MAY 30......	1130	12.0	313000	545	461000	5	9	16	28	42	58	81	99	100	—	--	VCBW
JUL 4......	2300	16.0	239000	772	498000	37	50	54	65	70	76	85	95	100	--	--	VCPW
AUG 13......	1100	9.0	366000	867	857000	17	24	35	51	67	77	88	100	--	—	--	VCPW
SEP 28......	1130		184000	132	65600	--	—	--	--	--	38	66	100	--	--	--	VW

15564800 YUKON RIVER AT RUBY
(International Hydrological Decade River Station)

LOCATION.--Lat 64°44'28", long 155°29'22", at gaging station on left bank at Ruby, 300 ft downstream from Ruby Creek, 1.5 miles downstream from Melozitna River, and 2.5 miles upstream from Ruby Slough.

DRAINAGE AREA.--259,000 sq mi, approximately.

PERIOD OF RECORD.--Chemical analyses: June 1966 to September 1970.
Water temperatures: June 1966 to September 1967, August 1969 to September 1970.
Sediment records: September 1967 to September 1970 (partial-record station).

EXTREMES, 1969-70.--Dissolved solids: Maximum, 169 mg/l Mar. 8; minimum, 92 mg/l June 12.
Hardness: Maximum, 140 mg/l Mar. 8; minimum, 80 mg/l June 12.
Specific conductance: Maximum, 280 micromhos Mar. 8; minimum daily, 161 micromhos June 12.
Water temperatures: Maximum, 18°C July 1, 2, 4-6.

EXTREMES, 1966-70: Dissolved solids (1967-70): Maximum, 169 mg/l Mar. 8, 1970; minimum, 87 mg/l May 22-31, 1967.
Hardness (1967-70): Maximum, 140 mg/l Mar. 8, 1970; minimum, 75 mg/l May 22-31, 1967.
Specific conductance (1967-70): Maximum, 315 micromhos Aug. 1-16, 1967; minimum, 154 micromhos May 22-31, 1967.
Water temperatures (1966, 1967, 1970): Maximum, 18°C July 24, 26, 1966, June 24, July 11, 13, 1967, July 1, 2, 4-6, 1970.

REMARKS.--River frozen over during period October to May. Miscellaneous chemical data published for water years 1967-70 and sediment data for water years 1967-70.

CHEMICAL ANALYSES, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DATE	DIS-CHARGE (CFS)	SILICA (SIO2) (MG/L)	TOTAL IRON (FE) (UG/L)	DIS-SOLVED IRON (FE) (UG/L)	CAL-CIUM (CA) (MG/L)	MAG-NE-SIUM (MG) (MG/L)	SODIUM (NA) (MG/L)	PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	SULFATE (SO4) (MG/L)
MAY										
25-31	300C00	7.1	--	20	26	5.3	2.1	1.2	85	18
JUNE										
01-30	362000	7.1	--	20	26	5.3	2.1	1.2	85	18
JULY										
01-02	362C00	7.1	--	20	26	5.3	2.1	1.2	85	18
C3-23	340000	3.1	20	--	26	6.2	2.4	1.5	93	15
24-31	311C00	6.4	50	50	30	7.3	3.2	1.5	110	22
AUG.										
C1-31	311C00	6.4	50	50	30	7.3	3.2	1.5	110	22
SEPT.										
01-21	311000	6.4	50	50	30	7.3	3.2	1.5	110	22
ANALYSES OF ADDITIONAL SAMPLES										
MAR.										
C8...	27200	10	--	50	42	8.6	3.6	2.2	152	23
JUNE										
12...	331000	4.8	--	--	24	4.8	1.8	1.3	78	16
JULY										
12...	317000	7.1	120	--	27	5.7	2.1	1.4	87	21
AUG.										
15...	262000	5.6	--	60	33	6.8	2.2	1.3	110	22
SEPT.										
21...	240000	6.0	--	160	34	7.5	2.7	1.1	114	23

15564800 YUKON RIVER AT RUBY--Continued

CHEMICAL ANALYSES, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970--Continued

DATE	CHLORIDE (CL) (MG/L)	FLUORIDE (F) (MG/L)	NITRATE (NO3) (MG/L)	DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	COLOR (PLATINUM-COBALT UNITS)	TEMPERATURE (DEG C)
MAY										
25-31	1.2	.2	.2	103	86	16	176	7.8	20	--
JUNE										
01-30	1.2	.2	.2	103	86	16	176	7.8	20	--
JULY										
01-02	1.2	.2	.2	103	86	16	176	7.8	20	--
03-23	1.5	.2	1.4	103	91	15	194	7.5	5	--
24-31	.8	.2	.3	126	105	15	219	8.1	10	--
AUG.										
01-31	.8	.2	.3	126	105	15	219	8.1	10	--
SEPT.										
01-21	.8	.2	.3	126	105	15	219	8.1	10	--
ANALYSES OF ADDITIONAL SAMPLES										
MAR.										
08...	1.4	.2	.8	169	140	15	280	8.2	10	.0
JUNE										
12...	.0	.2	.8	92	80	16	161	7.7	75	13.5
JULY										
12...	.1	.1	1.0	108	91	20	184	7.9	50	11.5
AUG.										
15...	.5	.1	.2	126	111	21	217	7.7	10	15.5
SEPT.										
21...	1.0	.1	.4	132	117	24	225	7.6	20	3.0

SPECIFIC CONDUCTANCE (MICROMOHOS AT 25°C), WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.....	225	--	--	--	--	--	--	--	181	178	211	208
2.....	223	--	--	--	--	--	--	--	175	183	211	211
3.....	225	--	--	--	--	--	--	--	165	191	219	209
4.....	229	--	--	--	--	--	--	--	166	190	212	233
5.....	250	--	--	--	--	--	--	--	169	197	208	230
6.....	235	--	--	--	--	--	--	--	159	187	217	236
7.....	--	--	--	--	--	--	--	--	160	186	214	221
8.....	--	--	--	--	--	294	--	--	158	186	215	220
9.....	--	--	--	--	--	--	--	--	163	190	216	220
10.....	--	--	--	--	--	--	--	--	162	186	234	222
11.....	--	--	--	--	--	--	--	--	168	189	237	220
12.....	--	--	--	--	--	--	--	--	164	208	240	222
13.....	--	--	--	--	--	--	--	--	161	188	239	222
14.....	--	--	--	--	--	--	--	--	161	190	218	224
15.....	--	--	--	--	--	--	--	--	167	206	219	224
16.....	--	--	--	--	--	--	--	--	175	190	217	223
17.....	--	--	--	--	--	--	--	--	175	192	215	222
18.....	--	--	--	--	--	--	--	--	181	195	210	234
19.....	--	--	--	--	--	--	--	--	180	203	210	234
20.....	--	--	--	--	--	--	--	--	181	194	217	235
21.....	--	--	--	--	--	--	--	--	182	197	217	228
22.....	--	--	--	--	--	--	--	--	184	195	230	--
23.....	--	--	--	--	--	--	--	--	179	209	228	--
24.....	--	--	--	--	--	--	--	--	174	235	228	--
25.....	--	--	--	--	--	--	--	181	175	212	209	--
26.....	--	--	--	--	--	--	--	183	185	215	205	--
27.....	--	--	--	--	--	--	--	183	186	213	207	--
28.....	--	--	--	--	--	--	--	183	182	211	212	--
29.....	--	--	--	--	--	--	--	185	181	207	206	--
30.....	--	--	--	--	--	--	--	164	179	208	210	--
31.....	--	--	--	--	--	--	--	179	--	209	216	--
AVERAGE	--	--	--	--	--	--	--	--	173	198	218	--

15564800 YUKON RIVER AT RUBY--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971--Continued

DATE	DIS-CHARGE (CFS)	SILICA (SIO2) (MG/L)	TOTAL IRON (FE) (UG/L)	DIS-SOLVED IRON (FE) (UG/L)	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	SODIUM (NA) (MG/L)	PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	SULFATE (SO4) (MG/L)
MAY										
31-31	636800	4.2	--	--	22	4.0	1.9	1.3	78	9.8
JUNE										
01-14	636800	4.2	--	--	22	4.0	1.9	1.3	78	9.8
15-29	433000	5.3	--	--	26	5.1	2.3	1.5	96	13
30-30	324400	5.7	--	--	30	6.1	2.8	1.5	107	19
JULY										
01-17	324400	5.7	--	--	30	6.1	2.8	1.5	107	19
18-31	312500	6.1	--	--	36	6.4	3.2	1.9	126	19
AUG.										
01-28	312500	6.1	--	--	36	6.4	3.2	1.9	126	19
29-31	224400	6.8	--	--	33	7.3	3.7	1.5	117	22
SEP.										
01-29	224400	6.8	--	--	33	7.3	3.7	1.5	117	22
ANALYSES OF ADDITIONAL SAMPLES										
MAR.										
19...	26500	10	--	180	42	9.7	4.0	1.6	154	24
JUNE										
09...	594000	6.1	--	40	22	3.7	1.2	1.1	76	9.6
JULY										
14...	274000	5.6	2700	--	32	6.3	2.3	1.2	106	20
AUG.										
15...	282000	6.4	--	130	36	6.0	2.8	1.9	120	20

DATE	CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	NITRATE (NO3) (MG/L)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L)	HARD-NESS (CA,MG) (MG/L)	NON-CAR-BONATE HARD-NESS (MG/L)	SPECI-FIC COND-UCTANCE (MICRO-MHOS)	PH (UNITS)	COLOR (PLAT-INUM-COBALT UNITS)	TEMP-ERATURE (DEG C)
MAY										
31-31	.5	.3	.7	83	72	8	142	7.6	50	--
JUNE										
01-14	.5	.3	.7	83	72	8	142	7.6	50	--
15-29	.5	.2	.2	101	86	7	179	7.5	20	--
30-30	.5	.1	.1	119	100	12	206	8.1	10	--
JULY										
01-17	.5	.1	.1	119	100	12	206	8.1	10	--
18-31	1.0	.2	.1	136	117	14	238	7.4	40	--
AUG.										
01-28	1.0	.2	.1	136	117	14	238	7.4	40	--
29-31	1.0	.2	.1	134	113	17	232	7.6	10	--
SEP.										
01-29	1.0	.2	.1	134	113	17	232	7.6	10	--
ANALYSES OF ADDITIONAL SAMPLES										
MAR.										
19...	1.0	.1	.6	169	146	20	287	7.8	10	.0
JUNE										
09...	2.0	.2	.4	83	73	11	142	7.6	50	13.0
JULY										
14...	.5	.2	.0	120	106	19	207	7.7	10	--
AUG.										
15...	.5	.2	.1	133	115	17	229	7.7	30	13.0

15564800 YUKON RIVER AT RUBY--Continued

TEMPERATURE (°C) OF WATER, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	8.0	17.0	14.5	13.0
2	---	---	---	---	---	---	---	---	8.0	16.0	14.5	11.5
3	---	---	---	---	---	---	---	---	9.0	16.0	14.0	11.5
4	---	---	---	---	---	---	---	---	9.0	15.5	14.5	11.0
5	---	---	---	---	---	---	---	---	10.0	15.0	15.0	10.0
6	---	---	---	---	---	---	---	---	10.0	15.5	14.5	9.5
7	---	---	---	---	---	---	---	---	11.0	15.5	14.5	9.0
8	---	---	---	---	---	---	---	---	12.0	16.0	14.0	8.5
9	---	---	---	---	---	---	---	---	13.0	17.0	14.0	8.5
10	---	---	---	---	---	---	---	---	14.0	17.0	14.5	8.5
11	---	---	---	---	---	---	---	---	14.0	17.0	14.0	8.5
12	---	---	---	---	---	---	---	---	15.5	17.5	14.5	8.0
13	---	---	---	---	---	---	---	---	15.5	16.5	15.5	8.0
14	---	---	---	---	---	---	---	---	14.0	15.5	15.0	8.0
15	---	---	---	---	---	---	---	---	14.5	15.5	15.0	7.5
16	---	---	---	---	---	---	---	---	13.0	15.0	14.0	7.0
17	---	---	---	---	---	---	---	---	13.0	15.5	14.0	7.0
18	---	---	---	---	---	---	---	---	13.0	16.5	14.0	7.0
19	---	---	---	---	---	---	---	---	14.0	16.5	14.0	6.5
20	---	---	---	---	---	---	---	---	15.0	16.5	12.0	6.0
21	---	---	---	---	---	---	---	---	16.0	16.5	13.0	7.0
22	---	---	---	---	---	---	---	---	17.0	16.5	---	7.0
23	---	---	---	---	---	---	---	---	17.0	17.0	12.5	7.0
24	---	---	---	---	---	---	---	---	17.5	17.0	12.5	7.0
25	---	---	---	---	---	---	---	---	18.0	17.0	12.0	6.0
26	---	---	---	---	---	---	---	---	18.5	16.5	12.0	5.5
27	---	---	---	---	---	---	---	---	18.5	17.0	13.0	5.0
28	---	---	---	---	---	---	---	---	18.5	16.0	13.0	4.5
29	---	---	---	---	---	---	---	---	17.5	---	13.0	4.5
30	---	---	---	---	---	---	---	---	---	16.0	13.0	5.0
31	---	---	---	---	---	---	---	8.0	---	15.5	13.0	---
MONTH	---	---	---	---	---	---	---	---	14.0	16.5	14.0	8.0

SUSPENDED SEDIMENT ANALYSES, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TIME	TEMPERATURE (DEG C)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	DISCHARGE (CFS)	SUSPENDED SEDIMENT (MG/L)	SUSPENDED SEDIMENT DISCHARGE (T/DAY)	SUS. SED. FALL DIAM. % FINER THAN .002 MM
MAR. 19...	1915	.0	300	---	26500	16	1150	--
JUNE 09...	1815	13.0	142	60	594000	518	831000	11
AUG. 15...	1640	15.5	229	95	282000	---	---	---

DATE	SUS. SED. FALL DIAM. % FINER THAN .004 MM	SUS. SED. FALL DIAM. % FINER THAN .008 MM	SUS. SED. FALL DIAM. % FINER THAN .016 MM	SUS. SED. FALL DIAM. % FINER THAN .031 MM	SUS. SED. FALL DIAM. % FINER THAN .062 MM	SUS. SED. FALL DIAM. % FINER THAN .125 MM	SUS. SED. FALL DIAM. % FINER THAN .250 MM	SUS. SED. FALL DIAM. % FINER THAN .500 MM
MAR. 19...	---	---	---	---	---	---	---	---
JUNE 09...	18	22	32	47	68	87	99	100
AUG. 15...	---	---	--	---	---	---	---	--

Chemical analyses, in parts per million, water years October 1953 to September 1956--Continued

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Noncarbonate			
YUKON RIVER BELOW TOZITNA RIVER NEAR TANANA																		
July 19, 1956		5.7	0.00	34	6.0	2.1	1.3	106	22	0.0	0.0	0.2	123	110	23	217	7.5	15