Overview of Environmental and Hydrogeologic Conditions at Fort Yukon, Alaska

By Allan S. Nakanishi and Joseph M. Dorava

U.S. GEOLOGICAL SURVEY

Open-File Report 94-526

Prepared in cooperation with the

FEDERAL AVIATION ADMINISTRATION

U.S. DEPARTMENT OF THE INTERIOR

MARCH 3, 1849

Anchorage, Alaska
1994

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
4230 University Drive, Suite 201
Anchorage, AK 99508-4664

Copies of this report may be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Box 25286, MS 517
Federal Center
Denver, CO 80225-0425

CONTENTS

Abstract 1
Introduction 1
Background 1
  Location 1
  History and socioeconomics 2
Physical setting 2
  Climate 2
  Vegetation 6
  Bedrock geology 6
  Surficial geology and soils 6
Hydrology 7
  Surface water 7
  Floods 8
  Ice-jam floods 8
  Flood-protection measures 9
  Ground water 10
  Ground-water and surface-water interaction 10
  Simulation of ground-water movement 11
Drinking water 15
  Present drinking-water supplies 15
  Quality of present supplies 15
  Alternative drinking-water sources 15
  Quality of alternative sources 16
Summary 16
References cited 17

Appendix 1. Data, assumptions, justifications, and data sources used in the MODFLOW packages A-1
Appendix 2. Example output file of the U.S. Geological Survey Modular Finite-Difference Ground-Water Model A-2
Appendix 3. Public Health Service well driller's logs, aquifer test data, and ground-water quality for Fort Yukon, Alaska A-3
Appendix 4. U.S. Geological Survey well drillers' logs, aquifer test data, and ground-water quality for Fort Yukon, Alaska A-4
Appendix 5. Alaska Department of Environmental Conservation ground-water quality data from the public water supply system at Fort Yukon A-5
Appendix 6. U.S. Geological Survey water-quality data for the Yukon River at Rampart... A-6

FIGURES

1. Map showing location of Fort Yukon.. 2
2. Map showing village of Fort Yukon and location of FAA facilities 4
3. Hydrograph of mean discharge for the Yukon River at Rampart, water years 1956-66 11
4. Map showing water table contours and estimated shallow ground-water flow direction with low lakebed conductance.................................. 13
5. Map showing water table contours and estimated shallow ground-water flow direction with high lakebed conductance 14

TABLES

1. Mean monthly temperature, precipitation and snowfall for the combined periods, 1922-33 and 1935-87, Fort Yukon Alaska.......................... 5
2. Peak discharges of the Yukon River near Fort Yukon for various recurrence intervals 8

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	**By**	**To obtain**
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
liter per second (L/s)	15.85	gallon per minute
liter per day (L/d)	0.2642	gallon per day
cubic meter per second (m^3/s)	35.31	cubic foot per second
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.

Other abbreviation used in this report:

mg/L, milligram per liter

Overview of Environmental and Hydrogeologic Conditions Fort Yukon, Alaska

By Allan S. Nakanishi and Joseph M. Dorava

Abstract

The village of Fort Yukon along the Yukon River in east-central Alaska has long cold winters and short summers. The Federal Aviation Administration operates airway support facilities in Fort Yukon and is evaluating the severity of environmental contamination and options for remediation of such contamination at their facilities. Fort Yukon 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 from local surface-water bodies or from presently unidentified confined aquifers.

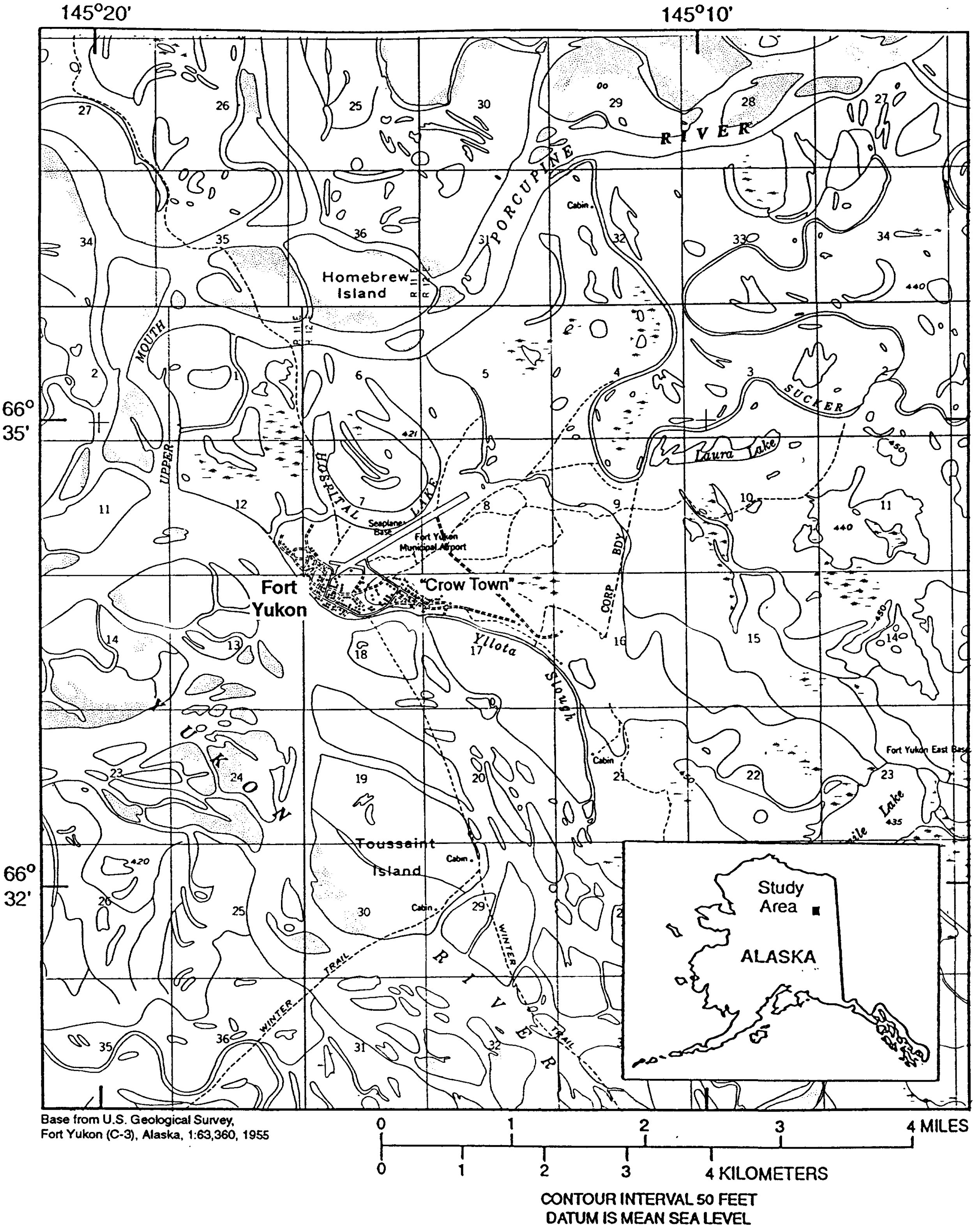
INTRODUCTION

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 (USGS), in cooperation with the FAA, and provides such information for the FAA facility and nearby areas at Fort Yukon, Alaska. Also presented in this report is a description of the history, socioeconomics, and physical setting of the Fort Yukon area

BACKGROUND

Location

Fort Yukon is located in the eastern interior of Alaska near latitude 66°34'10" N. and longitude 145°14'52" W. Fort Yukon (fig. 1) lies within the Yukon Flats National Wildlife Refuge at the confluence of the Yukon and Porcupine Rivers, 13 km north of the Arctic Circle, and approximately 380 km northeast of the city of Fairbanks. Fort Yukon is the largest community in the area, and its airport, a 1,770 m gravel airstrip north of the village, is used by all area residents for year-round transportation.



Base from U.S. Geological Survey,
Fort Yukon (C-3), Alaska, 1:63,360, 1955

Figure 1. Location of Fort Yukon.

History and Socioeconomics

Fort Yukon is the center of the territory that is the historical home of the Gwich'in Athabaskan Indian people. The village of Fort Yukon was founded in 1847 as an outpost by Canadians in what was then Russian territory. It later became an important trade center for the Indians (Darbyshire and Associates, 1990). The growth of the non-Native population in the region has been motivated by the abundance of natural resources such as, trapping, mineral exploration, and mining (Alaska Transportation Consultants, 1983).

Between 1950 and 1980, the Fort Yukon population varied from 446 to 701 persons (Darbyshire and Associates, 1990). According to U.S. Bureau of Census, the 1990 population was 580, of which approximately 85 percent were American Indian or Eskimo (Alaska Department of Community and Regional Affairs, 1993). In August 1943, the Fort Yukon Airport was established (Alaska Transportation Consultants, 1983) and in 1954 the Fort Yukon Air Force Station (AFS) was established (Woodward-Clyde Consultants, 1989). The Fort Yukon AFS is still in existence, although activity has been reduced to a minimal level (Alaska Transportation Consultants, 1983). Fort Yukon was incorporated as a second-class city in 1959 and provides municipal services including public safety and fire protection, public works, water, and museum services. The only municipally owned utility is the water service. Fort Yukon is accessible only by air and water transportation. Most goods and people are transported by air, while river barges and boats provide additional service during the summer months. Barges are limited to a few trips each season when the Yukon River is free of ice (Darbyshire and Associates, 1990).

The Fort Yukon economy is highly dependent on village, state, and Federal agencies and Native corporation employment, but the community has a higher proportion of private sector employment than most villages in the region (Darbyshire and Associates, 1990). Fort Yukon residents have strong cultural traditions which place a high value on subsisting from the land.

The FAA facilities at Fort Yukon include navigational aids and living quarters concentrated around the airport (fig. 2). The FAA facilities are described in detail in a report by Ecology and Environment (1992) and are maintained by personnel stationed in Fairbanks.

PHYSICAL SETTING

Climate

The continental climate of Fort Yukon is characterized by low precipitation, low cloudiness, low humidity, large diurnal and annual temperature variations, and light surface winds (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 -6.4 ^{o}C but temperatures range from a July mean maximum of 22.3 ^{o}C to a January mean minimum of about -33.1 ^{o}C. Mean annual precipitation is about 168 mm; approximately 1,070 mm of snow falls annually (Leslie, 1989). Most rainfall occurs in July and August. Mean monthly temperature, precipitation, and snowfall data are summarized in table 1.

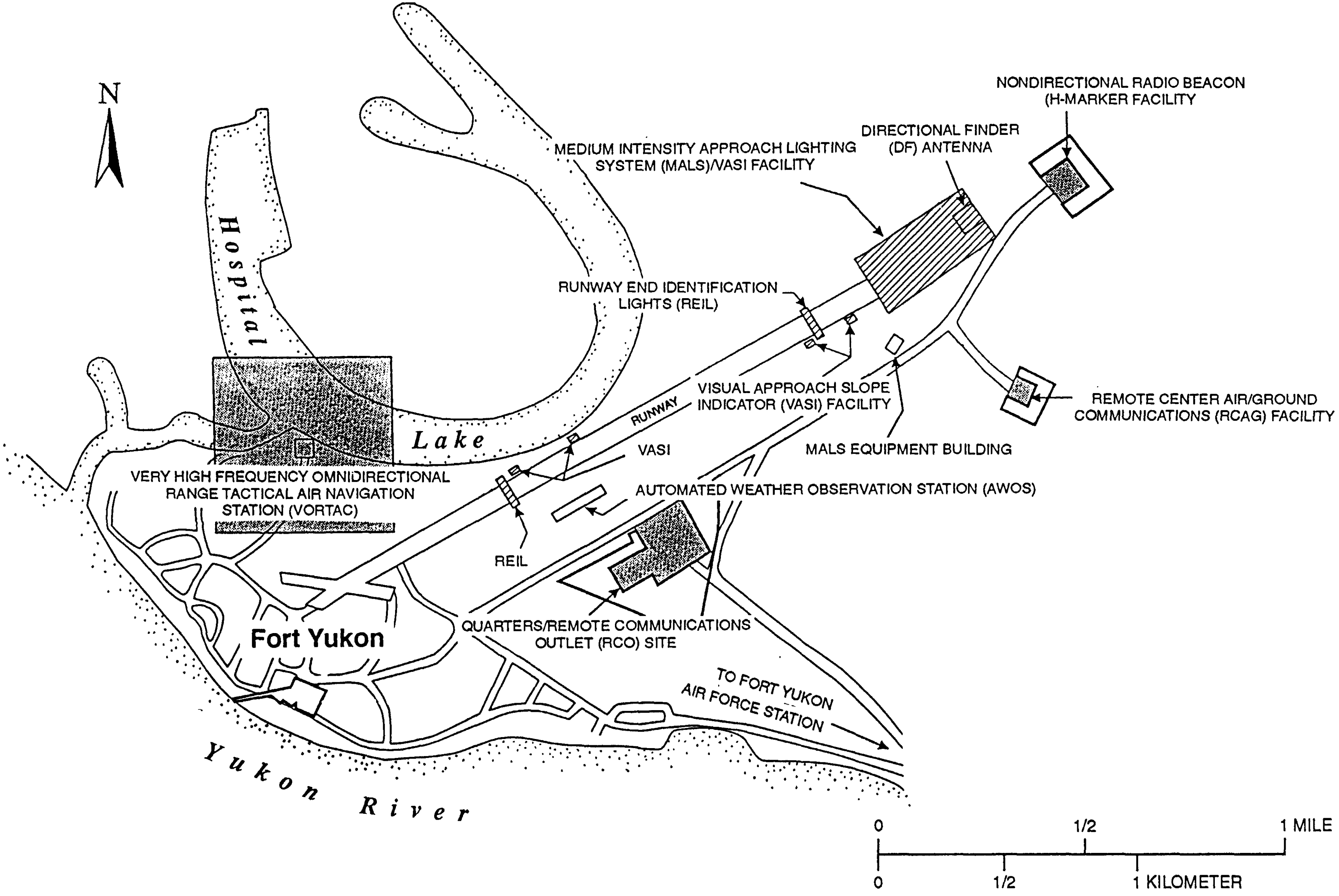


Figure 2. Village of Fort Yukon and location of Federal Aviation Administration (FAA) facilities (modified from Ecology and Environment Inc., 1992).

Table 1. Mean monthly temperature, precipitation, and snowfall for the combined periods 1922-33 and 1935-87, Fort Yukon
[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	-23.4	-20.3	-10.1	1.2	13.2	21.3	22.3	18.7	10.3	-2.4	-16.2	-23.9	-0.8
	(Record maximum 36.1°C, July 1929)												
Mean minimum	-33.1	-31.5	-24.3	-13.3	-0.1	8.8	10.4	6.9	0.0	-10.4	-24.7	-32.7	-12.0
	(Record minimum -57.2 °C, December 1935)												
Mean	-28.1	-25.9	-17.2	-6.1	6.6	15.1	16.4	12.8	5.2	-6.4	-20.4	-28.3	-6.4
Precipitation (mm of moisture)	10.7	9.1	6.6	4.8	7.9	17.8	24.1	30.7	20.6	15.2	10.4	9.9	167.9
Snowfall (mm)	170.2	144.8	114.3	55.9	17.8	0.0	0.0	0.0	43.2	182.9	182.9	154.9	1069.3

Vegetation

Viereck and Little, (1972) describe the vegetation north of the Arctic Circle near Fort Yukon as consisting of closed spruce-hardwood along the rivers and widespread open, low-growing spruce. Closed spruce-hardwood forests consist of white and black spruce, paper birch, aspen, and balsam poplar located on moderate to well-drained sites. Open, low-growing spruce forests consist primarily of black spruce with sporadic stands of paper birch, and willows with some locally interspersed treeless bogs.

Near the Fort Yukon airport, the land cover is generally treeless to the northeast and southwest. The small stands of black spruce that are visible on aerial photographs taken in springtime are concentrated along the shoreline of Hospital Lake and the banks of the Yukon River.

Bedrock Geology

The nearest outcrops of bedrock are in the mountains and hills surrounding the Yukon Flats area, which is a broad lowland encompassing the large bend in the Yukon River near Fort Yukon. The Yukon Flats area drains the Porcupine Plateau to the northeast, the Kokrine-Hodzana Highlands to the northwest, and the Yukon-Tanana Upland to the south (Wahrhaftig, 1965). A well-exposed belt of metamorphic rocks lies to the north of the Yukon Flats. It consists of quartz-biotite schist containing some small, localized outcrops of coarse, crystalline limestone. The schist is cut by granite porphyry and gneissoid porphyritic rocks of granitic and dioritic composition. The age of the metamorphic rocks is early Paleozoic or possibly Precambrian (Williams, 1962; Wahrhaftig, 1965).

The bedrock of the marginal upland and parts of the surrounding highland is a complex group of sedimentary, volcanic, and associated intrusive igneous rocks. Shale, chert, quartzite, and minor amounts of crystalline limestone, chlorite schist, and schistose conglomerate are present. These rocks are intruded by dikes and sills, and small bodies of igneous rocks that range from gabbro, diorite, and diabase to quartz diorite and granite (Williams, 1962). Continental sedimentary rocks occur in the highland regions that border the Yukon Flats district, and occur locally in the marginal upland bordering the Yukon Flats. The deposits consist of folded soft shale and lignitic coal (Williams, 1962).

The village of Fort Yukon is situated near the center of the Yukon Flats area on thick alluvial deposits overlying bedrock. The depth to bedrock and its thickness are currently unknown: at Fort Yukon a well was drilled to a depth of 134 m without reaching bedrock (Williams, 1962). In mid-June 1994, a USGS global change drilling project bored to a depth of more than 380 m at Fort Yukon and found no bedrock (Thomas A. Ager, USGS, oral commun., 1994). Preliminary drill logs from this project do not indicate the depth of the aquifer or the depth to bedrock.

Surficial Geology and Soils

Early studies done on the surficial geology and soils of Yukon Flats area include a reconnaissance level engineering geology study by Weber and Péwé (1961), a reconnaissance level geology study by Williams (1962), a soil temperature investigation by the U.S. Army Cold Regions Research and Engineering Laboratory (1962), and a statewide soil classification by Rieger and others (1979).

The Yukon Flats, where Fort Yukon is situated, consists of marshy lake-dotted flats rising from 90 m in elevation on the west to elevations ranging from 180 to 270 m on the north and east. Cliff-forming silt and gravel-covered marginal terraces rise 45 to 180 m in height above the flats and slope gradually upward to elevations of about 450 m, where they merge with the base of surrounding uplands and mountains. The marginal terraces are capped with gravel on which rests a layer of wind-borne silt.

According to Williams (1962), flood-plain and low terrace alluvium consists of well-stratified layers and lenses of coarse to fine well-sorted gravel and minor amounts of sand and silt, mantled by as much as 8 m of well-stratified layers and lenses of silt, sand and organic matter. The thickness of alluvium at Fort Yukon is about 30 m.

Eolian sand deposits consist of massive well-sorted homogeneous sand and silty sand ranging from 2 to 20 m in thickness (Williams, 1962). Permafrost is generally present with sporadic ground-ice masses.

Alluvial-fan and related terrace deposits consist of well-stratified layers and lenses of well-sorted coarse to fine-grained gravel containing minor amounts of sand and silt and a few layers or lenses of organic material. This alluvium is predominantly pebble to boulder gravel deposited by the Yukon River and its larger tributaries. Gravelly deposits are mantled by silt, sand, and organic material as thick as 8 m (Williams, 1962). The total thickness of this deposit is not known, but is estimated to exceed 30 m.

According to Ferrians (1965), Fort Yukon lies within a region of discontinuous permafrost. However, because the region is so far north and near the border of the continuous permafrost zone, permafrost probably underlies most of the area. Exceptions are under rivers, recently abandoned meander belts, and large thaw lakes. A U.S. Army Cold Regions Research and Engineering Laboratory (1962) study of ground temperatures at Fort Yukon showed that the maximum seasonal depth of thaw was about 2.4 m, below which the temperature remained below freezing. Ground-ice masses form wedges 0.5 to 1 m thick in a polygonal network and are found in local areas where the silt mantle is greater than 2.5 m thick (Williams, 1962).

HYDROLOGY

Surface Water

The Yukon Flats area is drained by the Yukon River, which is Alaska's largest river and the fifth largest river in North America in terms of drainage area and runoff (Feulner and others, 1971). The Porcupine River enters the Yukon River less than 3 km downstream from the airport (fig. 1). Most other tributaries to these rivers drain surrounding uplands and mountains, and have meandering courses through the flats. Thaw lakes are abundant throughout the flats and are common on the marginal terraces. Runoff rates are very low and the chemical quality of surface waters is generally good (Woodward-Clyde Consultants, 1989).

Surface-water bodies within a 4-km radius of Fort Yukon include the Yukon River, Porcupine River, Hospital Lake, Yllota Slough, and Laura Lake (fig. 1). Hospital Lake to the northwest of the runway is used as a float plane base and for recreational boating, fishing and waterfowl hunting. The lake is directly connected to the Yukon River by a 0.7 km long outlet.

Floods

Most of the Fort Yukon townsite is subject to flooding except the southeastern part, called "Crow Town," which sits on a low ridge (fig. 1). Flooding usually results from ice jams along the Yukon River in the vicinity of Fort Yukon or on the Porcupine River near its mouth. Flooding caused by rainfall has not been recorded in recent history (U.S. Army Corps of Engineers, 1992).

Food frequency for rainfall floods on the Yukon River near Fort Yukon can be obtained using a graph of discharge to drainage area for the Yukon River developed by Jones and Fahl (1994, fig. 10). Downstream from the mouth of the Porcupine River, the Yukon River has a drainage area of about 471,900 km ^{2} and upstream from the mouth of the Porcupine River, the drainage area is about 326,800 km^2. For these two sites, the discharge is given for various recurrence intervals in table 2. The flood frequency curves of Jones and Fahl apply only to floods generated from rain and snowmelt runoff and are not applicable to ice-jam floods, the primary source of flooding at Fort Yukon.

Table 2. Peak discharges of the Yukon River near Fort Yukon for various recurrence intervals

[Discharge is in cubic meters per second]

Site location relative to mouth of Porcupine River	Recurrence interval						
	2 years	5 years	10 years	25 years	50 years	100 years	500 years
Upstream	8,900	11,000	12,500	14,400	15,900	17,400	21,200
Downstream	12,600	15,000	16,700	18,700	20,700	22,400	26,500

The U.S. Army Corps of Engineers (1992) reported that the discharge value for the 100-year flood is approximately 20 percent higher than that computed using that of Jones and Fahl (1994). The Corps of Engineers, however, used a less rigorous evaluation of flood frequency that computed a more conservative estimate of discharge used in their evaluation of flood protection measures. The difference in discharge values is reduced to about 12 percent when a comparison is made between the 10-year floods.

Ice-Jam Floods

Historically, flooding within the village of Fort Yukon occurs in mid-May during the breakup of the Yukon River. Flood hazards for Fort Yukon are considered high by the U.S. Army Corps of Engineers (1993). Approximately 100 houses are within the 100-year flood zone. The airport has a flood hazard rating of very high. The primary cause of flooding at Fort Yukon is backwater from ice jams. Previous major floods occurred in 1949, 1972, 1982, and 1989. In 1949, flood waters were over 2 m deep on Main Street (U.S. Army Corps of Engineers, 1993).

Flooding at Fort Yukon not only damages structures and roads, but also causes contaminants on the surface of the land to mobilize and move into inadequately sealed wells. Even for wells that are effectively sealed, flood water may move contaminants into previously uncontaminated surfaces, where the contaminants can then infiltrate into the aquifer.

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.

The inhabitants of Fort Yukon relocated to higher ground, Crow Town, because of extensive flooding of the original townsite in the first half of this century (Federal Emergency Management Agency, 1980). The most damaging flood in recent times occurred in 1949 as a result of ice jams on the Porcupine River (U.S. Army Corps of Engineers, 1969 and 1992). About one-third of the buildings in the village were destroyed, and the remaining two-thirds of the buildings were severely damaged by the crushing effect of the ice rafts carried into the village by floodwaters (U.S. Army Corps of Engineers, 1992). Erosion caused by the swiftly moving water and scouring effects of the ice can cause considerable damage to structures bordering the riverbanks (Alaska Transportation Consultants, 1983).

An evaluation of flood frequency and stage probabilities includes a peak annual stage frequency curve that can be used to determine river stage for both ice-jam and open-water floods (U.S. Army Corps of Engineers, 1992, fig. 2). Their flood frequency curves include the effects of ice-jam floods and indicate that a 100-year-flood resulting from an ice jam would have a stage of about 132.6 m, which is more than 1.5 m higher than an open-water 100-year-flood. This relation of increased stage for ice-jam floods relative to open-water floods is similar for all recurrence intervals but not always with the same difference. For example, a 10-year ice-jam flood would have a stage about 1 m higher than a 10-year rainfall flood.

Flood Protection Measures

Several flood-protection measures were built, attempted, or designed at Fort Yukon: a slough closure dike was built in 1967, ice sanding or dusting was done in 1968 and 1969 to speed ice melt, and a ring-dike was designed in 1992 to protect the village.

In 1967, the State of Alaska completed a slough closure dike to alleviate an erosion problem along the south side of village (U.S. Army Corps of Engineers 1969, 1987, 1993; and Federal Emergency Management Agency, 1980). The planned protective life of the project was 5 years, enough time for river bars to form and divert flow from the slough to the main channel. (U.S. Army Corps of Engineers, 1969, 1992)

The U.S. Army Corps of Engineers (1969) conducted a research project called "Operation Dusty" in an attempt to increase ice-melt rates and reduce the frequency of ice jams in historical jam areas by using large-scale river ice-dusting operations. The dusting operation involved the aerial spraying or dusting of the river ice with a thin layer of dark sand which would then increase the ice-melt rate by increasing the solar absorption of the ice. A strip of ice was dusted in April 1968 and again in April 1969 on the Yukon River near Fort Yukon as a measure to prevent the development of an ice jam. No serious ice jam or flooding problems occurred in either 1968 or 1969.

The U.S. Army Corps of Engineers (1992) described a design for a floodwater protection dike for the village of Fort Yukon. Hydrologic studies determined that an earthfill ring levee, 2,210 m in length and 2 to 2.5 m in height, could be constructed to protect two-thirds of the village from the 100-year-flood. The levee would tie into the higher ground at Crow Town, on the southeastern side of the village. It was determined that the levee would provide protection against the 100-year-flood at a benefit/cost ratio of 1.3 and a capital cost of about $4.25 million.

Ground Water

Ground-water recharge to the Fort Yukon area occurs from precipitation, infiltration, and normal ground-water movement from areas near the slopes of the surrounding highlands. Ground-water discharge takes place into local surface-water streams and sloughs which drain into the Yukon River. Flow paths for ground-water movement are influenced by impermeable lenses or layers of permafrost acting as a barrier to horizontal and vertical movement of the ground water. The areawide variability in the presence of permafrost accounts for the local occurrence of sub-, intra-, and supra-permafrost ground water. Previous studies done 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. Most of the wells in villages on the Yukon River 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 (Williams, 1970). In general, ground water flows toward the Yukon River and then northwestward in the direction of the flow of the river (Woodward-Clyde Consultants, 1989; Ecology and Environment, 1992). The depth to water from the ground surface is approximately 3 to 3.5 m, based on drill log data for the Fort Yukon municipal well and on data from a site contamination study by Woodward-Clyde Consultants (1989).

Ground-Water and Surface-Water Interaction

Adjacent to the river, shallow ground-water can flow into and out of the riverbanks depending on the elevation of water in the river relative to the water table. Seasonally, the Yukon River at Fort Yukon fluctuates from a maximum discharge in late May or early June to a minimum flow in late April or early May. The discharge of the Yukon River at Fort Yukon is probably similar to the reported discharge at a USGS gaging station on the Yukon River at Rampart (fig. 3) (U.S. Geological Survey, 1957-76). The Rampart gaging station, 250 km downstream from Fort Yukon, has a drainage area of about 516,400 km^2, which is 9 percent larger than that at Fort Yukon The river also rises during late-summer rainstorms. The water table generally rises and falls in response to these river fluctuations. The water table fluctuations, however, are 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 Fort Yukon. Because the airport facilities and village utilities are adjacent to the river, bank storage effects could have a significant impact on ground-water flow in the Fort Yukon area.

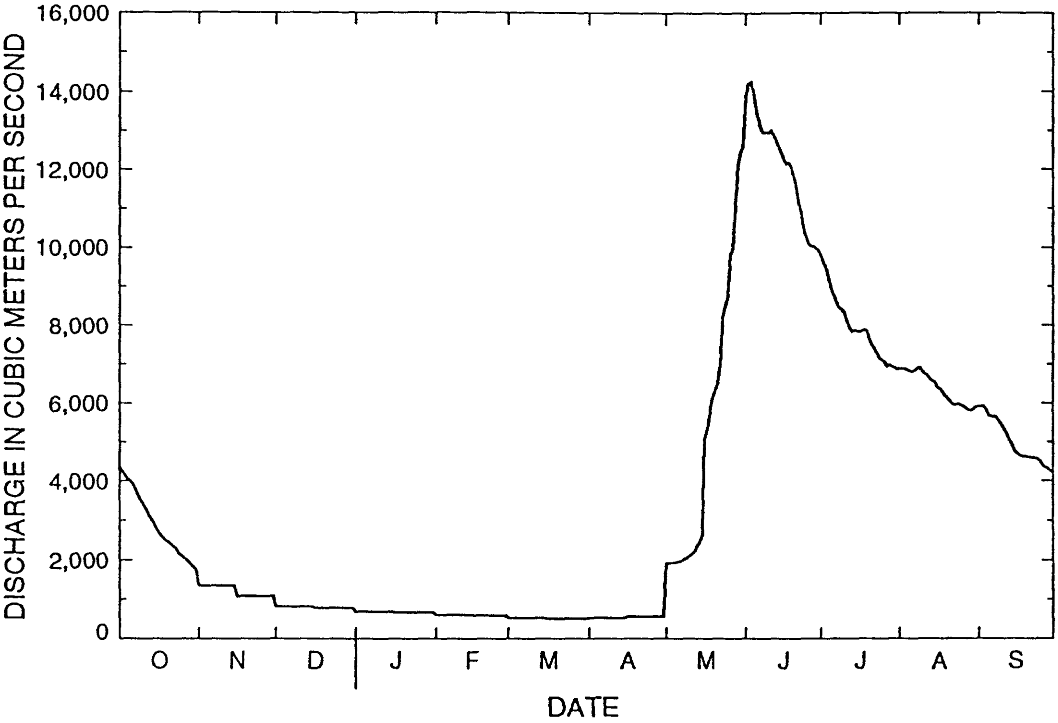


Figure 3. Mean discharge for the Yukon River at Rampart, water years 1956-66.

Continuous records of water-table elevation are not available for Fort Yukon. A further study of seasonal changes in water table and river stage would be required to determine the extent of ground-water/surface-water interaction at Fort Yukon. The variations in river stage at Fort Yukon will generally follow the pattern of the discharge hydrograph for the Yukon River at Rampart (fig. 3).

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, river bank, or other similar feature, and may be natural or artificially induced (such as a pumped well). In cases where there are 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 Fort Yukon 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 Fort Yukon area. Two ground-water flow simulations were used to identify features having the greatest influence on ground-water flow direction.

The westward-sloping surfaces of the Yukon and Porcupine Rivers are important factors in establishing the general westward direction of ground-water flow. The water table is strongly influenced by the surface-water gradients of the rivers, which were measured by the U.S. Army Corps of Engineers (1981). The hydraulic continuity of the alluvium away from the river is expected to have a profound influence on the directions of ground-water flow. Little information however, is available on the presence of permafrost in the area, north and east of the village. 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 ground-water model assumes that permafrost is not a barrier to ground-water flow. Although permafrost has a significant influence on ground-water flow, continuous permafrost was not assumed in the model because the existing data on subsurface conditions at Fort Yukon are inadequate to define the presence and continuity of permafrost. A ground-water model that assumes continuous permafrost conditions would resemble a narrow "strip-aquifer" along the riverbanks with ground-water flow that is parallel to the flow of the rivers.

Both simulations of ground-water movement indicate that shallow ground water flows to the northwest towards Hospital Lake and the lake outlet. Ground water infiltrates upward through the lakebed and eventually flows through the Hospital Lake outlet and into the Yukon River. The aquifer transmits water to Hospital Lake at a rate which is dependent on the vertical hydraulic conductance of the lakebed. Higher lakebed conductance increases the quantity of water transmitted from the aquifer to Hospital Lake, resulting in an increase of the influence of the lake on ground-water flow direction.

Calibration of the ground-water model was not attempted. Calibration is a procedure where differences between observed and simulated head values are minimized so that the model will replicate the behavior of aquifer(s) during steady-state conditions. Because specific information on aquifer characteristics for the site was limited and the available data are confined to a small area relative to the model grid, meaningful model calibration is not possible.

Two model simulations, each using different assumptions of the conductance of the lakebed, illustrate the importance of the hydraulic connection between Hospital Lake and the aquifer: the effects of an assumed lower value of lakebed conductance (fig. 4) and those of a higher conductance (fig. 5). Without field data, shallow ground-water flow directions can not be ascertained exactly, but can only be described generally on the basis of assumed boundary conditions.

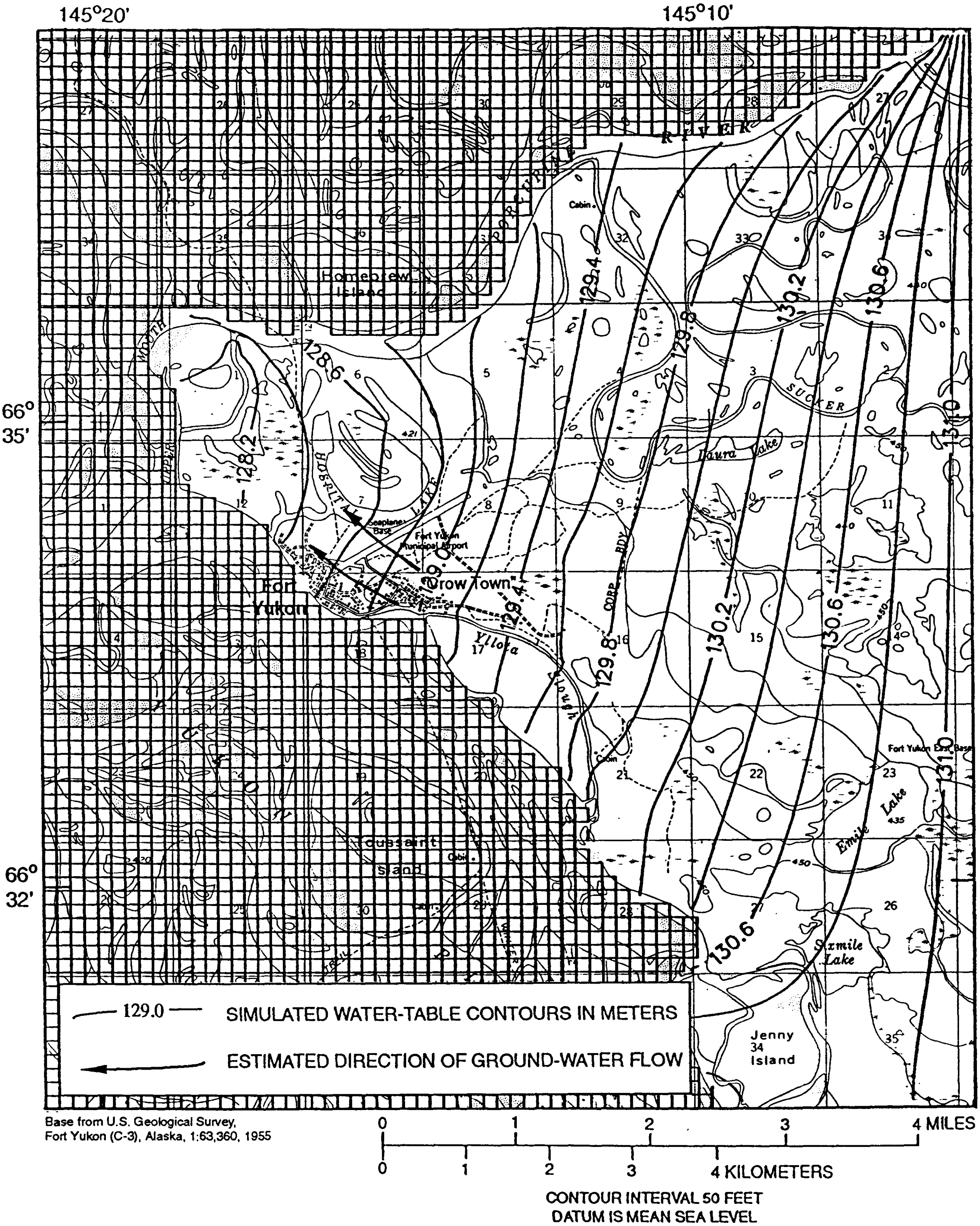


Figure 4. Simulated water-table contours and estimated flow direction of shallow ground water with low lakebed conductance in the Fort Yukon area.

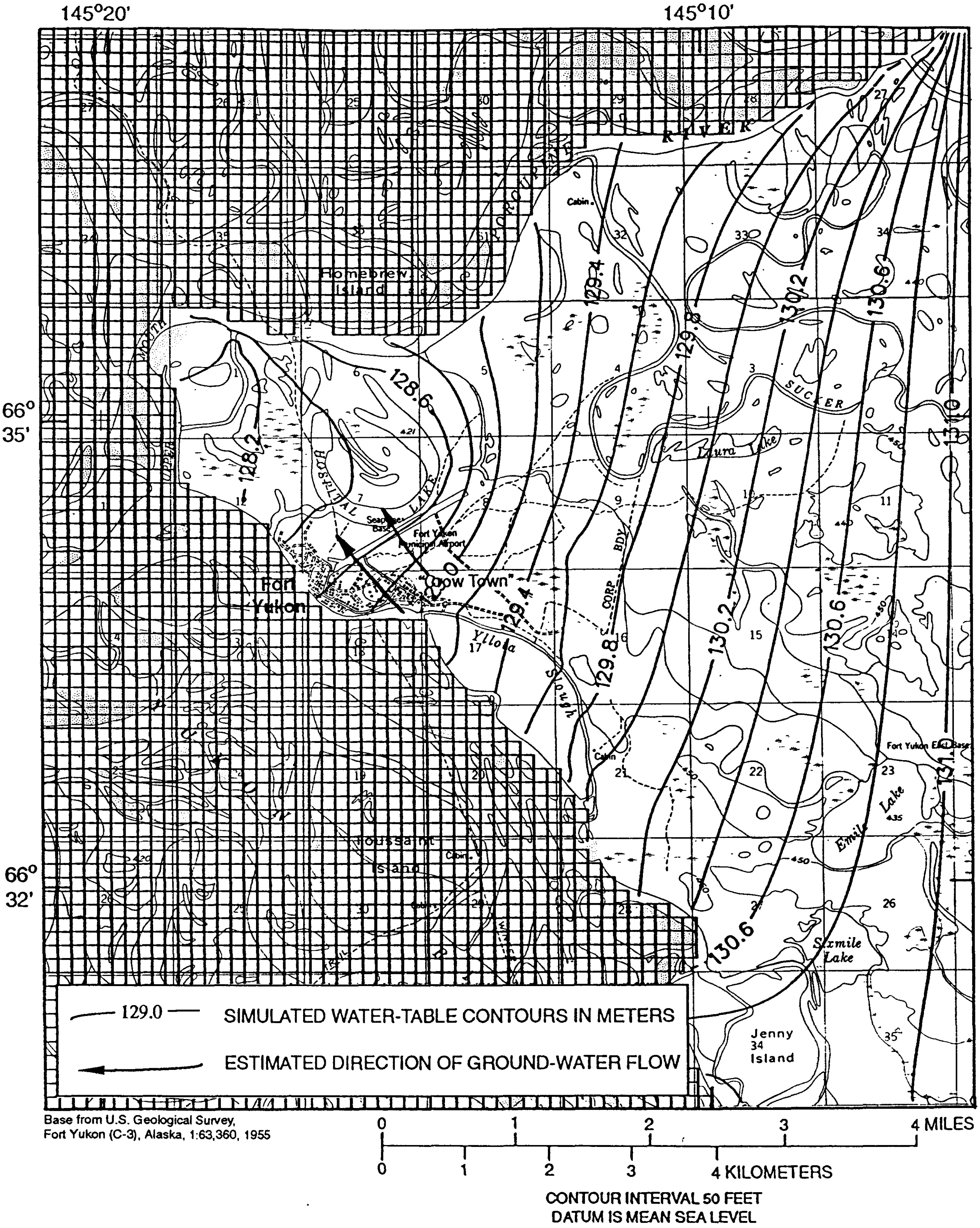


Figure 5. Simulated water-table contours and estimated flow direction of shallow ground water with high lakebed conductance in the Fort Yukon area.

DRINKING WATER

Present Drinking-Water Supplies

The village of Fort Yukon operates and maintains public sewage collection and water distribution systems, which service nearly all area residents. The water obtained by Fort Yukon for its drinking-water supply comes from shallow wells. Two shallow wells, drilled to a depth of approximately 10 m into unfrozen alluvium along the riverbanks, receive water mainly by infiltration from the Yukon River (Ecology and Environment, 1992; appendix 3). These wells are located at the southeast end of the village near the riverbank. Water from the wells is piped about 70 m to a pumphouse through an above-ground, insulated utilidor. The water is chemically treated, filtered, and stored in above-ground steel storage tanks. Most of the houses in Fort Yukon are connected to a piped water distribution system that has about 200 service connections. Houses not connected to the village water system haul water from a central watering point, such as the washeteria in the Fort Yukon Community Center (Darbyshire and Associates, 1990). The Fort Yukon AFS is not on the village water system and obtains its water supply from a single shallow well drilled to a depth of 11.5 m (Ecology and Environment, 1992).

Water-use withdrawals were estimated for Fort Yukon using the 1990 population of 580. The village water system supplied an estimated 120 L/d per person for domestic and commercial users (Solley and others, 1993). This compares with an average water use per person of 1,950 L/d estimated for all uses for the entire State of Alaska in 1990.

Quality of Present Supplies

Records on the water quality in the Fort Yukon area are available from the U.S. Public Health Service for the periods 1975-80 (appendix 3), from the USGS for the periods 1968-73 (appendix 4) and from the Alaska Department of Environmental Conservation for the periods 1980-94 (appendix 5). Analyses of untreated water samples taken from the village drinking water supply had an average hardness as $CaCO_3$ of 147 mg/L and an average iron content of 2.3 mg/L. Hardness may create scale in plumbing and boilers but is of little health concern. The iron content is higher than the 0.30 mg/L secondary maximum contaminant level (SMCL) regulations set by the U.S. Environmental Protection Agency (1993) for drinking water, but does not prohibit this water from being used for drinking.

Alternative Drinking-Water Sources

The FAA requested information on alternative drinking-water sources that could be used if the present drinking-water source became contaminated. The aquifer system at Fort Yukon has not been mapped in sufficient detail to define individual aquifers and confining layers. It is possible that a permafrost confining layer is sufficiently impermeable to protect deep ground water from contamination by the shallow aquifer. Uncertainty about the area-wide permeability of the permafrost prohibits the conclusion that subpermafrost water is an alternative supply to the shallow aquifer.

The Yukon River is Fort Yukon's greatest alternative water source, whether water is obtained from it indirectly though infiltration wells or directly by intake systems at the riverbanks. Infiltration wells use the riverbank itself to filter out much of the sediment in the river water. Water taken directly from the Yukon River would require a filtering system for sediment removal. A direct intake system is also susceptible to damage from bank erosion and moving ice masses.

Another possible source of water could be from local lakes such as Hospital Lake. The lake does not completely freeze in the winter and could be a viable source of water. Other surface-water bodies in the Fort Yukon area are not considered reasonable alternatives to ground-water as a drinking water source because of their distance to the population or their inadequate size. Many sloughs and lakes near Fort Yukon are too shallow and freeze completely in the winter.

Quality of Alternative Sources

The chemical quality of the surface-water bodies in the area is good. Summer river flows, which tend to be much greater than winter flows, commonly contain high concentrations of sediments. These fine-grained sediments must be removed by a water-treatment system if these sources are used for drinking water (Smith, 1986).

Lakes may be a good source of water depending on the size of the lake and the severity of the climate (Smith, 1986). For small, shallow lakes during the winter, impurities such as salts and dissolved organics concentrate in the water as ice is formed. Water that may be potable in the summer may exceed drinking-water standards in the winter. A report by Alaska Transportation Consultants (1983) suggested that Hospital Lake may be contaminated from air-fuel spills from float-planes and seepage from septic waste. However, water-quality data for Hospital Lake are not available.

In 1980, the Alaska Department of Environmental Conservation sampled water from the Yukon River at Fort Yukon (appendix 3). Analysis of this sample showed that the water quality was within Federal drinking-water regulations. A greater amount of water-quality information is available for the Yukon River at Rampart. The Rampart water-quality data, however, were typically obtained from samples collected during the open-water period from late March to late September, and do not include samples for the winter period. Iron concentration at Rampart is typically below the 0.30 mg/L SMCL (appendix 6). Hardness as $CaCO_3$ ranged from a low of 62 mg/L to a high of 162 mg/L and averages about 114 mg/L. Sediment concentrations had a maximum of 420 mg/L and minimum of 2 mg/L and averaged about 182 mg/L.

SUMMARY

Fort Yukon serves as the transportation, government, and commercial center for the Yukon Flats region. Its remote location makes it dependent 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, and high water from flooding may move surface contaminants into previously uncontaminated areas or directly into inadequately sealed wells. Fort Yukon currently obtains its water supply from shallow infiltration wells located near the banks of the Yukon River. A deep subpermafrost well may be an alternative water supply, but no definition of the extent of existing aquifers is currently available. Surface- water bodies, such as Hospital Lake or the Yukon River, are available alternative drinking-water sources if acquisition, distribution, and treatment systems are developed.

REFERENCES CITED

Alaska Department of Community and Regional Affairs, 1993, Alaska Department of Community and Regional Affairs database, Fort Yukon, Alaska: Alaska Department of Community and Regional Affairs, Research and Analysis Section, Municipal and Regional Assistance Division, Juneau, Alaska, 11 p.

Alaska Transportation Consultants, Inc., 1983, Airport development & land use plans, Fort Yukon Airport: Anchorage, Alaska, variously paged.

Beltaos, Spyridon, 1990, Breakup jams, *in* Ryan, R.L., and Crissman, R.D., eds., Cold regions hydrology and hydraulics: American Society of Civil Engineers Monograph, p. 485-510.

Cederstrom, D.J., Johnston, P.M., Subitzky, S., 1953, Occurrence and development of ground-water in permafrost regions: U.S. Geological Survey Circular 275, 30 p.

Darbyshire and Associates, 1990, Fort Yukon: Alaska Department of Community and Regional Affairs Community Map--Fort Yukon, 1 sheet.

Ecology and Environment, Inc., 1992, Environmental compliance investigation report, Fort Yukon FAA station Fort Yukon, Alaska: Anchorage [Draft report available from Federal Aviation Administration, Alaskan Region], variously paged.

Federal Emergency Management Agency, 1980, Flood insurance study, Fort Yukon, Alaska: U.S. Army Corps of Engineers, Alaska District, 13 p.

Ferrians, O.J. Jr., 1965, Permafrost map of Alaska: U.S. Geological Survey Map Miscellaneous Geologic Investigations Map I-445, 1 sheet (reprinted 1981).

Feulner, A.J., Childers, J.M., and Norman, V.W., 1971, Water resources of Alaska: U.S. Geological Survey Open-File Report 1971, 60 p.

Fountain, A.G., 1984, Yukon River breakup--The 82-year record: The Northern Engineer, v. 16, no. 1. p. 20-24.

Fountain, A.G., and Vaughn, B.H., 1984, Yukon River ice--Freeze up data (1883-1975): U.S. Geological Survey Open-File Report 84-601, 51 p.

Hartman, C.W., and Johnson, P.R., 1984, Environmental atlas of Alaska: University of Alaska Fairbanks, Institute of Water Resources/Engineering Experiment Station, 95 p.

Hopkins, D.M., Karlstrom, T.N.V., and others, 1955, Permafrost and ground water in Alaska: U.S. Geological Survey Professional Paper 264-F, p. 113-146.

Jones, S.H., and Fahl, C.B., 1994, Magnitude and frequency of floods in Alaska and conterminous basins of Canada: U.S. Geological Survey Water Resources Investigations Report 93-4179, 122 p.

Leslie, L.D., 1989, Alaska climate summaries (2d ed.): University of Alaska Anchorage, Arctic Environmental Information and Data Center, Alaska Climate Center Technical Note 5.

Linsley, R.K., Kohler, M.A., and Paulhus, J.L., 1982, Hydrology for engineers (3d ed.):New York, McGraw Hill Book Company, 508 p.

McDonald M.G., and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A1, 576 p.

Rieger, Samuel, Schoephorster, D.B., and Furbush, C.E., 1979, Exploratory soil survey of Alaska: Soil Conservation Service report, 213 p.

Smith, D.W., 1986, Cold climate utilities manual: Canadian Society for Civil Engineering, variously paged.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.

U.S. Army Cold Regions Research and Engineering Laboratory, 1962, Ground temperature observations--Fort Yukon, Alaska: U.S. Army Cold Regions Research and Engineering Laboratory Technical Report 100, 14 p.

U.S. Army Corps of Engineers, 1969, Yukon River flood control, Fort Yukon, Alaska: U.S. Army Corps of Engineers, Alaska District, Copy No. 23, 20 p.

_____1987, Interim water resources study, Yukon and Kuskokwim Rivers, Alaska: U.S. Army Corps of Engineers, Alaska District, 104 p.

_____1992, Section 205 reconnaissance report for flood damage reduction, Fort Yukon, Alaska: U.S. Army Corps of Engineers, Alaska District, 28 p.

_____1993, Alaskan communities flood hazard data: U.S. Army Corps of Engineers, Alaska District, 335 p.

U.S. Environmental Protection Agency, 1993, Drinking water regulations and health advisories: U.S. Environmental Protection Agency report, 11 p.

U.S. Geological Survey, 1957-62, Quantity and quality of surface waters of Alaska. Annual reports as follows: water years 1954-56, Water-Supply Paper 1486; water year 1957, Water-Supply Paper 1500; water year 1958, Water-Supply Paper 1570; water year 1959, Water-Supply Paper 1640; and water year 1960, Water-Supply Paper 1720.

_____1971, Surface-water supply of the United States, 1961-65, Part 15, Alaska: U.S. Geological Survey Water-Supply Paper 1936.

_____1976, Surface-water supply of the United States, 1966-70, Part 15, Alaska: U.S. Geological Survey Water-Supply Paper 2136.

Viereck, L.A., and Little, E.L. Jr., 1972, Alaska trees and shrubs: U.S. Department of Agriculture Handbook No. 410, 265 p.

Wahrhaftig, Clyde, 1965, Physiographic divisions of Alaska: U.S. Geological Survey Professional Paper 482, 52 p.

Weber, F.R., and Péwé, T.L., 1961, Engineering geology problems in the Yukon-Porcupine Lowland, Alaska: U.S. Geological Survey Professional Paper 424-D, p. D-371 to D-373.

Williams, J.R., 1962, Geologic reconnaissance of the Yukon-Flats District, Alaska: U.S. Geological Survey Bulletin 1111-H, p. 289-331, 1 map sheet.

_____1970, Ground water in permafrost regions of Alaska: U.S. Geological Survey Professional Paper 696, 83 p.

Williams, J.R., and Waller, R.M., 1963, Occurrence of ground water in the permafrost regions of Alaska: Purdue University, Indiana, International Conference on Permafrost, 19 p.

Woodward-Clyde Consultants, 1989, Installation restoration program, Phase II--Confirmation/quantification, Stage 1, Campion, Fort Yukon, Galena, Indian Mountain, Murphy Dome, Cold Bay, Sparrevohn Air Force Stations, Alaska [final report]: Anchorage, Alaska, variously paged.

APPENDIX 1

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

Ground Water at Fort Yukon, Alaska - Modflow Notes

BAS Package

Packages Used: BAS, BCF, OC, PCG2, RCH, RIV
Single-layer, Steady state model
Grid size:70 columns x 80 rows
IBOUND: All cells west of river cells set at no-flow (0)
all cells at column 70 set at constant head (-1)
all others set at variable head (1)
Anisotropy: 1.00

BCF Package

Layer thickness: 200 ft (230 ft above MSL)
DELR: 528 ft (0.1 mile)
DELC: 528 ft
Hydraulic Conductivity (K) along Rows and Columns: 80 ft/day

RCH Package

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

RIV Package

Number of River Reaches (cells): 210

Yukon River
Slope: 0.00032, obtained from U.S. Army Corps of Engineers (COE) (1981).
Lowest River Stage: 420 ft, estimated from USGS Fort Yukon C-3 !:63,360 map (r34, c11).
Profile extrapolated above and below the original COE (1981) study area
River Conductance: 5.600E+06 ft^2/day (K = 20 ft/day = 7.1E-03 cm/s)
Reach Length (L): 528 ft, based on unit cell size
Reach Width (W): 528 ft, based on unit cell size
Reach riverbed depth (D):1 ft
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 70 ft lower than river stage height

Porcupine River
Slope: 0.00017, obtained from U.S. Army Corps of Engineers (COE) (1981).
Lowest River Stage: 420 ft, estimated from 1" to mile USGS topo, (r34, c11).
Profile was extended by extrapolating the slope above and below COE (1981) study area
River Conductance: 5.600E+06 ft^2/day (K = 20 ft/day = 7.1E-03 cm/s)
Reach Length (L): 528 ft, based on unit cell size

Reach Width (W): 528 ft, based on unit cell size
Reach riverbed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 40 ft lower than river stage height

Yllata Slough
Slope: 0.00032, obtained from U.S. Army Corps of Engineers (1981).
River Conductance: 1.800E+06 ft^2/day (K = 20 ft/day = 7.1E-03 cm/s)
Reach Length (L): 528 ft, based on unit cell size
Reach Width (W): 175 ft, estimated from air photos and USGS Fort Yukon C-3 1:63,360
Reach riverbed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 15 ft lower than river stage height

Northwest Slough
Slope: 0.00017, obtained from FEMA Report by the Corps of Engineers (1981).
River Conductance: 5.600E+06 ft^2/day (K = 20 ft/day = 7.1E-03 cm/s)
Reach Length (L): 528 ft, based on unit cell size
Reach Width (W): 175 ft, estimated from air phots and USGS Fort Yukon C-3 1:63,360
Reach riverbed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 15 ft lower than river stage height

Hospital Lake
Slope: 0.00
Stage: 421.2 ft, estimated from river stage at drainage point.
Conductance:
model run #1: 5.600E+04 ft^2/day (K = 0.20 ft/day = 7.1E-05 cm/s)
model run #2: 5.600E+05 ft^2/day (K = 2.00 ft/day = 7.1E-04 cm/s)
Reach Length (L): 528 ft, based on unit cell size
Reach Width (W): 528 ft, based on unit cell size
Reach riverbed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 25 ft lower than stage height

Hospital Lake Drainage
Slope: 0.00
Lowest River Stage: 421.2 ft, estimated from river stage at drainage point.
Profile extrapolated based on slope above and below the original COE (1981) study area
River Conductance: 5.600E+06 ft^2/day (K = 20 ft/day = 7.1E-03 cm/s)
Reach Length (L): 528 ft, based on unit cell size
Reach Width (W): 528 ft, based on unit cell size
Reach riverbed depth (D):1 ft, estimated
Conductivity Equation: (LW/D)K
Bottom elevation is estimated to be 15 ft lower than river stage height

APPENDIX 2

Example output file of the U.S. Geological Survey

Modular Finite-Difference Ground-Water Model

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

TWO DIMENSIONAL MODEL OF GROUND-WATER FLOW AT FORT YUKON                  1 layer, 80 rows, 70 columns, 0.1 mile grid
   1 LAYERS         80 ROWS         70 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  0  0  0  0 42 39  0  0  0  0  0  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
   50554 ELEMENTS IN X ARRAY ARE USED BY BAS
   50554 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
   11201 ELEMENTS IN X ARRAY ARE USED BY BCF
   61755 ELEMENTS OF X ARRAY USED OUT OF  350000

RIV1 -- RIVER PACKAGE, VERSION 1, 9/1/87 INPUT READ FROM UNIT 34
MAXIMUM OF  210 RIVER NODES
CELL-BY-CELL FLOWS WILL BE RECORDED ON UNIT 21
    1260 ELEMENTS IN X ARRAY ARE USED FOR RIVERS
   63015 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
  26400 ELEMENTS IN X ARRAY ARE USED BY PCG
  89415 ELEMENTS OF X ARRAY USED OUT OF 350000

TWO DIMENSIONAL MODEL OF GROUND-WATER FLOW AT FORT YUKON                  1 layer, 80 rows, 70 columns, 0.1 mile grid


                         BOUNDARY ARRAY FOR LAYER  1 WILL BE READ ON UNIT 61 USING FORMAT:  (70I2)
                    ----------------------------------------------------------------------------------------------

         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         36         37         38         39         40
        41         42         43         44         45         46         47         48         49         50
        51         52         53         54         55         56         57         58         59         60
        61         62         63         64         65         66         67         68         69         70
.............................................................................................................................

  1          0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          1          1         -1

  2          0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          1          1          1          1         -1

  3          0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          1          1          1          1          1          1         -1

  4          0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          1          1          1          1          1          1          1         -1

  5          0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          0          0
             0          0          0          0          0          0          0          0          1          1
             1          1          1          1          1          1          1          1          1         -1
```

6	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	1	1
	1	1	1	1	1	1	1	1	1	-1
7	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	-1
8	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	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
9	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	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	-1
10	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	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	1	-1
11	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	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	1	1	-1
12	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	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	1	1	1	-1
13	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	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	1	1	1	1	-1
14	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	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	1	1	1	1	-1
15	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	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	1	1	1	1	1	-1
16	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	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	1	1	1	1	1	-1
17	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	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	1	1	1	1	1	.1	-1
18	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	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    1    1    1    1    1    1   -1

19       0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    0    0    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    1    1    1    1    1    1   -1

20       0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    0    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    1    1    1    1    1    1    1   -1

21       0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    0    0    0    0
         0    0    0    0    0    0    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    1    1    1    1    1    1    1    1   -1

22       0    0    0    0    0    0    0    0    0    1
         1    1    1    1    0    0    0    0    0    0
         0    0    0    0    0    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
         1    1    1    1    1    1    1    1    1   -1

23       0    0    0    0    0    0    0    0    1    1
         1    1    1    1    1    1    1    0    0    1
         1    1    0    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    1    1
         1    1    1    1    1    1    1    1    1   -1

24       0    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    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

25       0    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    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

26       0    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    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

27       0    0    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    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

28       0    0    0    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    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

29       0    0    0    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    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

30       0    0    0    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    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
31        0     0     0     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     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
32        0     0     0     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     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
33        0     0     0     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     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
34        0     0     0     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     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
35        0     0     0     0     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     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
36        0     0     0     0     0     0     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     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
37        0     0     0     0     0     0     0     0     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     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
38        0     0     0     0     0     0     0     0     0     0
          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     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
39        0     0     0     0     0     0     0     0     0     0
          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     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
40        0     0     0     0     0     0     0     0     0     0
          0     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     1     1     1     1
          1     1     1     1     1     1     1     1     1     1
          1     1     1     1     1     1     1     1     1    -1
41        0     0     0     0     0     0     0     0     0     0
          0     0     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     1     1     1
          1     1     1     1     1     1     1     1     1     1
          1     1     1     1     1     1     1     1     1    -1
42        0     0     0     0     0     0     0     0     0     0
          0     0     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     1     1     1
          1     1     1     1     1     1     1     1     1     1
          1     1     1     1     1     1     1     1     1    -1
43        0     0     0     0     0     0     0     0     0     0
```

```
         0     0     0     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     1     1
         1     1     1     1     1     1     1     1     1     1
         1     1     1     1     1     1     1     1     1    -1

44       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     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     1
         1     1     1     1     1     1     1     1     1     1
         1     1     1     1     1     1     1     1     1    -1

45       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     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     1     1     1
         1     1     1     1     1     1     1     1     1    -1

46       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     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     1     1     1
         1     1     1     1     1     1     1     1     1    -1

47       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     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     1     1
         1     1     1     1     1     1     1     1     1    -1

48       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     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     1     1
         1     1     1     1     1     1     1     1     1    -1

49       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     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     1
         1     1     1     1     1     1     1     1     1    -1

50       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     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
         1     1     1     1     1     1     1     1     1    -1

51       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     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     1     1     1     1     1     1     1    -1

52       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     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     1     1     1     1     1     1     1    -1

53       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     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     1     1     1     1     1     1    -1

54       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     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     1     1     1     1     1    -1

55       0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         0     0     0     0     0     0     0     0     0     0
         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	1	1	1	1	-1
56	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	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	1	1	-1
57	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	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	1	1	-1
58	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	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	1	-1
59	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	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	-1
60	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	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	1	-1
61	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	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	1	-1
62	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	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	-1
63	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	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
64	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	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
65	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	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
66	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	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
67	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	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

68	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 -1
69	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 -1
70	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
71	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
72	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
73	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
74	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
75	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
76	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
77	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 1	0 0 0 0 1 1 -1
78	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 -1
79	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 0 1 1	0 0 0 0 1 1 -1
80	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0

```
                0         0         0         0         0         0         0         0         0         0
                0         0         0         0         0         0         0         0         0         0
                0         0         0         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

 AQUIFER HEAD WILL BE SET TO  999.00     AT ALL NO-FLOW NODES (IBOUND=0).



                                         INITIAL HEAD FOR LAYER  1 WILL BE READ ON UNIT 64 USING FORMAT:  (15F6.1)
                              ------------------------------------------------------------------------------------

            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         36         37         38         39         40
           41         42         43         44         45         46         47         48         49         50
           51         52         53         54         55         56         57         58         59         60
           61         62         63         64         65         66         67         68         69         70
 ..........................................................................................................

   1    430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0

 80   430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0
        430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0      430.0

 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
                              -----------------------------------------------------------------------

   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00



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

   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
   528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00     528.00
                                                       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


210 RIVER REACHES

        LAYER      ROW      COL     STAGE     CONDUCTANCE   BOTTOM ELEVATION   RIVER REACH
        ------------------------------------------------------------------------------------
           1        1       68     426.6      0.5600E+07          386.6             1
           1        2       67     426.6      0.5600E+07          386.6             2
           1        2       66     426.5      0.5600E+07          386.5             3
           1        3       65     426.4      0.5600E+07          386.4             4
           1        3       64     426.3      0.5600E+07          386.3             5
           1        4       63     426.2      0.5600E+07          386.2             6
           1        5       62     426.1      0.5600E+07          386.1             7
           1        5       61     426.0      0.5600E+07          386.0             8
           1        5       60     425.9      0.5600E+07          385.9             9
           1        5       59     425.8      0.5600E+07          385.8            10
           1        6       58     425.7      0.5600E+07          385.7            11
           1        7       57     425.7      0.5600E+07          385.7            12
           1        7       56     425.6      0.5600E+07          385.6            13
           1        8       55     425.5      0.5600E+07          385.5            14
           1        8       54     425.4      0.5600E+07          385.4            15
           1        8       53     425.3      0.5600E+07          385.3            16
           1        9       52     425.2      0.5600E+07          385.2            17
           1        9       51     425.1      0.5600E+07          385.1            18
           1        9       50     425.0      0.5600E+07          385.0            19
           1        9       49     424.9      0.5600E+07          384.9            20
           1        9       48     424.8      0.5600E+07          384.8            21
           1        9       47     424.8      0.5600E+07          384.8            22
           1        9       46     424.7      0.5600E+07          384.7            23
           1        9       45     424.6      0.5600E+07          384.6            24
           1        9       44     424.5      0.5600E+07          384.5            25
           1        9       43     424.4      0.5600E+07          384.4            26
           1        9       42     424.3      0.5600E+07          384.3            27
           1       10       41     424.2      0.5600E+07          384.2            28
           1       11       40     424.1      0.5600E+07          384.1            29
           1       12       39     424.0      0.5600E+07          384.0            30
           1       13       38     423.9      0.5600E+07          383.9            31
           1       14       38     423.9      0.5600E+07          383.9            32
           1       15       37     423.8      0.5600E+07          383.8            33
           1       16       37     423.7      0.5600E+07          383.7            34
           1       17       36     423.6      0.5600E+07          383.6            35
           1       18       36     423.5      0.5600E+07          383.5            36
           1       19       36     423.4      0.5600E+07          383.4            37
           1       20       35     423.3      0.5600E+07          383.3            38
           1       21       34     423.2      0.5600E+07          383.2            39
           1       22       33     423.1      0.5600E+07          383.1            40
           1       23       32     423.1      0.5600E+07          383.1            41
           1       23       31     423.0      0.5600E+07          383.0            42
           1       24       30     422.9      0.5600E+07          382.9            43
           1       24       29     422.8      0.5600E+07          382.8            44
           1       24       28     422.7      0.5600E+07          382.7            45
           1       24       27     422.6      0.5600E+07          382.6            46
           1       24       26     422.5      0.5600E+07          382.5            47
           1       24       25     422.4      0.5600E+07          382.4            48
           1       24       24     422.3      0.5600E+07          382.3            49
           1       24       23     422.2      0.5600E+07          382.2            50
           1       23       22     422.2      0.5600E+07          382.2            51
           1       23       21     422.1      0.5600E+07          382.1            52
           1       23       20     422.0      0.5600E+07          382.0            53
           1       24       19     421.9      0.5600E+07          381.9            54
           1       24       18     421.8      0.5600E+07          381.8            55
           1       23       17     421.7      0.5600E+07          381.7            56
           1       23       16     421.6      0.5600E+07          381.6            57
           1       23       15     421.5      0.5600E+07          381.5            58
           1       22       14     421.4      0.5600E+07          381.4            59
           1       22       13     421.3      0.5600E+07          381.3            60
           1       22       12     421.3      0.5600E+07          381.3            61
           1       22       11     421.2      0.5600E+07          381.2            62
           1       22       10     421.1      0.5600E+07          381.1            63
           1       23        9     421.0      0.5600E+07          381.0            64
           1       24        9     420.9      0.5600E+07          380.9            65
           1       25        9     420.8      0.5600E+07          380.8            66
           1       26        9     420.7      0.5600E+07          380.7            67
           1       27       10     420.6      0.5600E+07          380.6            68
           1       28       11     420.5      0.5600E+07          380.5            69
           1       29       11     420.4      0.5600E+07          380.4            70
           1       30       11     420.4      0.5600E+07          380.4            71
           1       31       11     420.3      0.5600E+07          380.3            72
           1       32       11     420.2      0.5600E+07          380.2            73
           1       33       11     420.1      0.5600E+07          380.1            74
           1       34       11     420.0      0.5600E+07          380.0            75
           1       35       12     420.0      0.5600E+07          350.6            76
           1       35       13     420.2      0.5600E+07          350.7            77
           1       36       14     420.3      0.5600E+07          350.7            78
           1       36       15     420.5      0.5600E+07          350.8            79
           1       37       16     420.7      0.5600E+07          350.9            80
           1       37       17     420.8      0.5600E+07          350.9            81
           1       38       18     421.0      0.5600E+07          351.0            82
           1       39       18     421.2      0.5600E+07          351.2            83
           1       40       19     421.4      0.5600E+07          351.4            84
           1       41       20     421.5      0.5600E+07          351.5            85
           1       42       20     421.7      0.5600E+07          351.7            86
           1       43       21     421.9      0.5600E+07          351.9            87
```

```
1        44       22      422.0          0.5600E+07            352.0             88
1        44       23      422.2          0.5600E+07            352.2             89
1        44       24      422.4          0.5600E+07            352.4             90
1        44       25      422.5          0.5600E+07            352.5             91
1        44       26      422.7          0.5600E+07            352.7             92
1        44       27      422.9          0.5600E+07            352.9             93
1        44       28      423.0          0.5600E+07            353.0             94
1        44       29      423.2          0.5600E+07            353.2             95
1        45       30      423.4          0.5600E+07            353.4             96
1        46       30      423.5          0.5600E+07            353.5             97
1        47       31      423.7          0.5600E+07            353.7             98
1        48       31      423.9          0.5600E+07            353.9             99
1        49       32      424.1          0.5600E+07            354.1            100
1        50       33      424.2          0.5600E+07            354.2            101
1        50       34      424.4          0.5600E+07            354.4            102
1        50       35      424.6          0.5600E+07            354.6            103
1        51       35      424.7          0.5600E+07            354.7            104
1        52       35      424.9          0.5600E+07            354.9            105
1        53       36      425.1          0.5600E+07            355.1            106
1        54       37      425.2          0.5600E+07            355.2            107
1        55       38      425.4          0.5600E+07            355.4            108
1        55       39      425.6          0.5600E+07            355.6            109
1        56       40      425.7          0.5600E+07            355.7            110
1        57       40      425.9          0.5600E+07            355.9            111
1        58       41      426.1          0.5600E+07            356.1            112
1        60       41      426.3          0.5600E+07            356.3            113
1        61       41      426.4          0.5600E+07            356.4            114
1        62       42      426.6          0.5600E+07            356.6            115
1        63       43      426.8          0.5600E+07            356.8            116
1        64       44      426.9          0.5600E+07            356.9            117
1        65       45      427.1          0.5600E+07            357.1            118
1        65       46      427.3          0.5600E+07            357.3            119
1        65       47      427.4          0.5600E+07            357.4            120
1        66       48      427.6          0.5600E+07            357.6            121
1        66       49      427.8          0.5600E+07            357.8            122
1        67       50      427.9          0.5600E+07            357.9            123
1        68       50      428.1          0.5600E+07            358.1            124
1        69       50      428.3          0.5600E+07            358.3            125
1        70       49      428.4          0.5600E+07            358.4            126
1        71       48      428.6          0.5600E+07            358.6            127
1        72       47      428.8          0.5600E+07            358.8            128
1        73       47      429.0          0.5600E+07            359.0            129
1        74       48      429.1          0.5600E+07            359.1            130
1        75       48      429.3          0.5600E+07            359.3            131
1        76       49      429.5          0.5600E+07            359.5            132
1        77       49      429.6          0.5600E+07            359.6            133
1        78       50      429.8          0.5600E+07            359.8            134
1        79       50      430.0          0.5600E+07            360.0            135
1        80       51      430.1          0.5600E+07            360.1            136
1        59       42      427.1          0.1800E+07            412.1            137
1        58       42      426.9          0.1800E+07            411.9            138
1        57       42      426.8          0.1800E+07            411.8            139
1        56       42      426.6          0.1800E+07            411.6            140
1        55       42      426.4          0.1800E+07            411.4            141
1        54       42      426.3          0.1800E+07            411.3            142
1        53       42      426.1          0.1800E+07            411.1            143
1        52       41      425.9          0.1800E+07            410.9            144
1        51       41      425.7          0.1800E+07            410.7            145
1        40       41      425.6          0.1800E+07            410.6            146
1        49       41      425.4          0.1800E+07            410.4            147
1        48       40      425.2          0.1800E+07            410.2            148
1        47       39      425.1          0.1800E+07            410.1            149
1        46       38      424.9          0.1800E+07            409.9            150
1        46       37      424.7          0.1800E+07            409.7            151
1        45       36      424.6          0.1800E+07            409.6            152
1        45       35      424.4          0.1800E+07            409.4            153
1        45       34      424.2          0.1800E+07            409.2            154
1        44       33      424.1          0.1800E+07            409.1            155
1        44       32      423.9          0.1800E+07            408.9            156
1        44       31      423.7          0.1800E+07            408.7            157
1        44       30      423.5          0.1800E+07            408.5            158
1        27       26      421.2          0.5600E+05            396.2            159
1        28       27      421.2          0.5600E+05            396.2            160
1        29       22      421.2          0.5600E+05            396.2            161
1        29       25      421.2          0.5600E+05            396.2            162
1        29       27      421.2          0.5600E+05            396.2            163
1        29       28      421.2          0.5600E+05            396.2            164
1        30       22      421.2          0.5600E+05            396.2            165
1        30       26      421.2          0.5600E+05            396.2            166
1        30       27      421.2          0.5600E+05            396.2            167
1        30       28      421.2          0.5600E+05            396.2            168
1        30       29      421.2          0.5600E+05            396.2            169
1        31       22      421.2          0.5600E+05            396.2            170
1        31       28      421.2          0.5600E+05            396.2            171
1        31       29      421.2          0.5600E+05            396.2            172
1        31       30      421.2          0.5600E+05            396.2            173
1        32       22      421.2          0.5600E+05            396.2            174
1        32       30      421.2          0.5600E+05            396.2            175
1        33       22      421.2          0.5600E+05            396.2            176
1        33       30      421.2          0.5600E+05            396.2            177
1        33       31      421.2          0.5600E+05            396.2            178
1        34       22      421.2          0.5600E+05            396.2            179
1        34       23      421.2          0.5600E+05            396.2            180
1        34       30      421.2          0.5600E+05            396.2            181
1        35       22      421.2          0.5600E+05            396.2            182
1        35       23      421.2          0.5600E+05            396.2            183
1        35       29      421.2          0.5600E+05            396.2            184
1        35       30      421.2          0.5600E+05            396.2            185
1        36       23      421.2          0.5600E+05            396.2            186
```

```
                  1       36      24     421.2        0.5600E+05          396.2           187
                  1       36      25     421.2        0.5600E+05          396.2           188
                  1       36      26     421.2        0.5600E+05          396.2           189
                  1       36      27     421.2        0.5600E+05          396.2           190
                  1       36      28     421.2        0.5600E+05          396.2           191
                  1       36      29     421.2        0.5600E+05          396.2           192
                  1       37      25     421.2        0.5600E+05          396.2           193
                  1       37      25     421.2        0.5600E+05          396.2           194
                  1       37      25     421.2        0.5600E+05          396.2           195
                  1       35      19     421.2        0.2800E+05          406.2           196
                  1       36      19     421.2        0.2800E+05          406.2           197
                  1       36      20     421.2        0.2800E+05          406.2           198
                  1       36      21     421.2        0.2800E+05          406.2           199
                  1       36      22     421.2        0.2800E+05          406.2           200
                  1       37      18     421.2        0.2800E+05          406.2           201
                  1       24      15     420.4        0.1800E+07          405.4           202
                  1       25      15     420.4        0.1800E+07          405.4           203
                  1       26      16     420.4        0.1800E+07          405.4           204
                  1       27      16     420.3        0.1800E+07          405.3           205
                  1       28      16     420.3        0.1800E+07          405.3           206
                  1       29      15     420.3        0.1800E+07          405.3           207
                  1       30      14     420.2        0.1800E+07          405.2           208
                  1       30      13     420.2        0.1800E+07          405.2           209
                  1       30      12     420.1        0.1800E+07          405.1           210

    5 CALLS TO PCG ROUTINE FOR TIME STEP   1 IN STRESS PERIOD  1
   33 TOTAL ITERATIONS

MAXIMUM HEAD CHANGE FOR EACH ITERATION:

    HEAD CHANGE  LAYER,ROW,COL    HEAD CHANGE  LAYER,ROW,COL    HEAD CHANGE  LAYER,ROW,COL    HEAD CHANGE  LAYER,ROW,COL
-----------------------------------------------------------------------------------------------------------------------
      -9.998     (  1, 34, 11)     0.7831     (  1, 79, 64)     0.2435     (  1, 52, 56)     0.1387     (  1, 42, 58)
     0.5073E-01 (  1, 37, 62)   -0.2774E-01 (  1, 24, 47)   -0.1529E-01 (  1, 80, 66)   -0.9997E-02 (  1, 63, 56)
     0.4784E-02 (  1, 64, 58)   -0.2537E-02 (  1, 34, 63)    0.7308E-02 (  1, 41, 52)    0.5763E-02 (  1, 35, 55)
     0.2310E-02 (  1, 22, 58)   -0.1002E-02 (  1, 47, 59)   -0.6764E-03 (  1, 31, 61)   -0.2269E-03 (  1, 22, 64)
    -0.1532E-03 (  1, 17, 65)   -0.8548E-04 (  1, 15, 65)   -0.4560E-04 (  1, 12, 66)    0.2145E-04 (  1, 76, 61)
    -0.8398E-05 (  1, 35, 58)   -0.6224E-05 (  1, 27, 58)   -0.3689E-05 (  1, 20, 62)   -0.2370E-05 (  1, 11, 65)
    -0.1501E-05 (  1, 36, 52)   -0.7764E-06 (  1, 16, 64)   -0.3898E-06 (  1, 20, 62)    0.1645E-06 (  1, 10, 66)
    -0.1722E-06 (  1, 32, 52)   -0.6593E-07 (  1, 49, 59)    0.4485E-07 (  1, 30, 59)    0.4747E-07 (  1, 36, 57)
    -0.1534E-07 (  1, 39, 59)


MAXIMUM RESIDUAL FOR EACH ITERATION:

     RESIDUAL    LAYER,ROW,COL     RESIDUAL    LAYER,ROW,COL     RESIDUAL    LAYER,ROW,COL     RESIDUAL    LAYER,ROW,COL
-----------------------------------------------------------------------------------------------------------------------
      0.2121E+05 (  1, 40, 41)      9400.     (  1, 40, 41)     -5311.     (  1,  2, 69)      3429.     (  1, 23, 15)
       2207.     (  1, 24, 18)      1460.     (  1, 24, 18)      881.4     (  1, 24, 18)      518.2     (  1, 24, 18)
       293.5     (  1, 24, 18)      174.8     (  1, 24, 18)      982.7     (  1, 24, 15)      560.9     (  1, 24, 15)
       330.5     (  1, 24, 15)      164.7     (  1, 24, 15)      76.87     (  1, 24, 15)      41.97     (  1, 24, 15)
       23.80     (  1, 24, 15)      13.28     (  1, 24, 15)      6.353     (  1, 24, 15)      2.991     (  1, 24, 15)
       2.569     (  1, 24, 15)      1.661     (  1, 24, 15)     0.9411     (  1, 24, 15)     0.5373     (  1, 24, 15)
      0.3130     (  1, 24, 15)     0.1519     (  1, 24, 15)     0.7781E-01 (  1, 24, 15)     0.4247E-01 (  1, 24, 15)
      0.2141E-01 (  1, 24, 15)     0.1247E-01 (  1, 24, 15)     0.1021E-01 (  1, 24, 15)     0.6238E-02 (  1, 24, 15)
      0.5390E-02 (  1, 24, 15)


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    DRAWDOWN  HEAD  DRAWDOWN
PRINTOUT  PRINTOUT  SAVE    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
"   RIVER LEAKAGE" BUDGET VALUES WILL BE SAVED ON UNIT 21 AT END OF TIME STEP  1, STRESS PERIOD  1

                       HEAD IN LAYER  1 AT END OF TIME STEP  1 IN STRESS PERIOD  1
           ---------------------------------------------------------------------

            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      36      37      38      39      40      41      42      43      44      45
           46      47      48      49      50      51      52      53      54      55      56      57      58      59      60
           61      62      63      64      65      66      67      68      69      70
.............................................................................................................................

   1    999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   426.6   428.5   430.0

   2    999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   426.5   426.6   427.5   428.7   430.0

   3    999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
        999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
```

```
     999.0  999.0  999.0  426.3  426.4  426.9  427.3  428.1  429.0  430.0

 4   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  426.2  426.5  426.9  427.3  427.8  428.4  429.2  430.0

 5   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.8  425.9
     426.0  426.1  426.5  426.8  427.2  427.6  428.1  428.7  429.3  430.0

 6   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.7  425.9  426.1
     426.3  426.5  426.8  427.1  427.5  427.9  428.3  428.9  429.4  430.0

 7   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.6  425.7  425.9  426.1  426.3
     426.5  426.7  427.0  427.3  427.7  428.1  428.5  429.0  429.5  430.0

 8   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.3  425.4  425.5  425.7  425.9  426.1  426.3  426.5
     426.7  426.9  427.2  427.5  427.9  428.3  428.7  429.1  429.5  430.0

 9   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  424.3  424.4  424.5  424.6
     424.7  424.8  424.8  424.9  425.0  425.1  425.2  425.4  425.5  425.7  425.9  426.0  426.2  426.4  426.6
     426.9  427.1  427.4  427.7  428.0  428.4  428.8  429.2  429.6  430.0

10   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  424.2  424.3  424.4  424.5  424.6
     424.7  424.8  424.9  425.0  425.1  425.2  425.3  425.5  425.7  425.8  426.0  426.2  426.4  426.6  426.8
     427.0  427.3  427.6  427.9  428.2  428.5  428.9  429.2  429.6  430.0

11   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  424.1  424.2  424.3  424.4  424.6  424.7
     424.8  424.9  425.0  425.1  425.2  425.3  425.5  425.6  425.8  425.9  426.1  426.3  426.5  426.7  426.9
     427.2  427.4  427.7  428.0  428.3  428.6  428.9  429.3  429.6  430.0

12   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  424.0  424.1  424.2  424.4  424.5  424.6  424.7
     424.8  424.9  425.1  425.2  425.3  425.4  425.6  425.7  425.9  426.1  426.2  426.4  426.6  426.8  427.1
     427.3  427.6  427.8  428.1  428.4  428.7  429.0  429.3  429.7  430.0

13   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  423.9  424.0  424.1  424.3  424.4  424.5  424.6  424.7
     424.9  425.0  425.1  425.2  425.4  425.5  425.7  425.8  426.0  426.2  426.4  426.5  426.7  427.0  427.2
     427.4  427.7  427.9  428.2  428.5  428.8  429.1  429.4  429.7  430.0

14   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  423.9  424.0  424.1  424.3  424.4  424.5  424.7  424.8
     424.9  425.0  425.2  425.3  425.5  425.6  425.8  425.9  426.1  426.3  426.5  426.6  426.8  427.1  427.3
     427.5  427.8  428.0  428.3  428.5  428.8  429.1  429.4  429.7  430.0

15   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  423.8  423.9  424.0  424.1  424.3  424.4  424.5  424.7  424.8
     425.0  425.1  425.2  425.4  425.5  425.7  425.8  426.0  426.2  426.4  426.5  426.7  426.9  427.2  427.4
     427.6  427.8  428.1  428.3  428.6  428.9  429.1  429.4  429.7  430.0

16   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  423.7  423.9  424.0  424.2  424.3  424.4  424.6  424.7  424.9
     425.0  425.1  425.3  425.4  425.6  425.8  425.9  426.1  426.3  426.4  426.6  426.8  427.0  427.2  427.5
     427.7  427.9  428.2  428.4  428.7  428.9  429.2  429.5  429.7  430.0

17   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  423.6  423.7  423.9  424.0  424.2  424.3  424.5  424.6  424.7  424.9
     425.0  425.2  425.3  425.5  425.7  425.8  426.0  426.2  426.3  426.5  426.7  426.9  427.1  427.3  427.5
     427.8  428.0  428.2  428.5  428.7  429.0  429.2  429.5  429.7  430.0

18   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  423.5  423.7  423.8  424.0  424.2  424.3  424.5  424.6  424.8  424.9
     425.1  425.2  425.4  425.6  425.7  425.9  426.1  426.2  426.4  426.6  426.8  427.0  427.2  427.4  427.6
     427.8  428.0  428.3  428.5  428.7  429.0  429.2  429.5  429.7  430.0

19   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
     999.0  999.0  999.0  999.0  999.0  423.4  423.6  423.8  424.0  424.2  424.3  424.5  424.6  424.8  425.0
     425.1  425.3  425.4  425.6  425.8  425.9  426.1  426.3  426.5  426.7  426.8  427.0  427.2  427.4  427.7
     427.9  428.1  428.3  428.5  428.8  429.0  429.3  429.5  429.8  430.0

20   999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
```

```
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  423.3  423.5  423.7  423.8  424.0  424.2  424.3  424.5  424.7  424.8  425.0
      425.2  425.3  425.5  425.7  425.8  426.0  426.2  426.4  426.5  426.7  426.9  427.1  427.3  427.5  427.7
      427.9  428.1  428.4  428.6  428.8  429.1  429.3  429.5  429.8  430.0

21    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  423.2  423.3  423.5  423.7  423.8  424.0  424.2  424.4  424.5  424.7  424.9  425.0
      425.2  425.4  425.5  425.7  425.9  426.1  426.2  426.4  426.6  426.8  427.0  427.2  427.4  427.6  427.8
      428.0  428.2  428.4  428.6  428.8  429.1  429.3  429.5  429.8  430.0

22    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  421.1  421.2  421.3  421.3  421.4  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  423.1  423.2  423.4  423.5  423.7  423.9  424.0  424.2  424.4  424.6  424.7  424.9  425.1
      425.2  425.4  425.6  425.8  425.9  426.1  426.3  426.5  426.6  426.8  427.0  427.2  427.4  427.6  427.8
      428.0  428.2  428.4  428.7  428.9  429.1  429.3  429.5  429.8  430.0

23    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  421.0  421.0  421.1  421.1  421.1  421.2  421.5
      421.6  421.7  999.0  999.0  422.0  422.1  422.2  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      423.0  423.1  423.1  423.2  423.4  423.5  423.7  423.9  424.0  424.2  424.4  424.6  424.7  424.9  425.1
      425.3  425.4  425.6  425.8  426.0  426.1  426.3  426.5  426.7  426.9  427.1  427.3  427.5  427.7  427.9
      428.1  428.3  428.5  428.7  428.9  429.1  429.3  429.6  429.8  430.0

24    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.9  420.9  420.9  420.9  420.9  420.8  420.4
      421.0  421.4  421.8  421.9  421.9  422.0  422.1  422.2  422.3  422.4  422.5  422.6  422.7  422.8  422.9
      422.9  423.0  423.1  423.2  423.4  423.5  423.7  423.9  424.1  424.2  424.4  424.6  424.8  425.0  425.1
      425.3  425.5  425.7  425.8  426.0  426.2  426.4  426.6  426.7  426.9  427.1  427.3  427.5  427.7  427.9
      428.1  428.3  428.5  428.7  428.9  429.1  429.4  429.6  429.8  430.0

25    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.8  420.8  420.8  420.8  420.7  420.6  420.4
      420.7  421.1  421.4  421.6  421.7  421.8  421.9  422.0  422.1  422.2  422.2  422.3  422.5  422.6  422.7
      422.8  422.9  423.0  423.2  423.4  423.5  423.7  423.9  424.1  424.3  424.4  424.6  424.8  425.0  425.2
      425.3  425.5  425.7  425.9  426.1  426.2  426.4  426.6  426.8  427.0  427.2  427.4  427.5  427.7  427.9
      428.1  428.3  428.5  428.7  428.9  429.2  429.4  429.6  429.8  430.0

26    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.7  420.7  420.7  420.6  420.6  420.5  420.4
      420.4  420.8  421.1  421.3  421.5  421.6  421.7  421.8  421.9  421.9  421.9  422.1  422.2  422.4  422.5
      422.7  422.8  423.0  423.1  423.3  423.5  423.7  423.9  424.1  424.3  424.5  424.6  424.8  425.0  425.2
      425.4  425.6  425.7  425.9  426.1  426.3  426.5  426.6  426.8  427.0  427.2  427.4  427.6  427.8  428.0
      428.2  428.4  428.6  428.8  429.0  429.2  429.4  429.6  429.8  430.0

27    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.6  420.6  420.5  420.5  420.4  420.4
      420.3  420.7  421.0  421.2  421.3  421.4  421.5  421.6  421.7  421.7  421.6  421.8  421.9  422.1  422.3
      422.5  422.7  422.9  423.1  423.3  423.5  423.7  423.9  424.1  424.3  424.5  424.7  424.9  425.0  425.2
      425.4  425.6  425.8  426.0  426.1  426.3  426.5  426.7  426.9  427.1  427.2  427.4  427.6  427.8  428.0
      428.2  428.4  428.6  428.8  429.0  429.2  429.4  429.6  429.8  430.0

28    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.5  420.4  420.4  420.4  420.3
      420.3  420.6  420.9  421.1  421.2  421.3  421.4  421.5  421.5  421.5  421.5  421.5  421.7  421.9  422.1
      422.4  422.6  422.8  423.0  423.3  423.5  423.7  423.9  424.1  424.3  424.5  424.7  424.9  425.1  425.3
      425.5  425.6  425.8  426.0  426.2  426.4  426.5  426.7  426.9  427.1  427.3  427.5  427.7  427.8  428.0
      428.2  428.4  428.6  428.8  429.0  429.2  429.4  429.6  429.8  430.0

29    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.4  420.3  420.3  420.3  420.3
      420.4  420.6  420.8  421.0  421.1  421.2  421.3  421.3  421.4  421.3  421.4  421.3  421.4  421.7  421.9
      422.2  422.5  422.7  423.0  423.2  423.5  423.7  423.9  424.1  424.3  424.5  424.7  424.9  425.1  425.3
      425.5  425.7  425.9  426.0  426.2  426.4  426.6  426.8  427.0  427.1  427.3  427.5  427.7  427.9  428.1
      428.3  428.4  428.6  428.8  429.0  429.2  429.4  429.6  429.8  430.0

30    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.4  420.1  420.2  420.2  420.4
      420.5  420.7  420.8  420.9  421.1  421.2  421.2  421.3  421.3  421.3  421.3  421.3  421.3  421.4  421.7
      422.0  422.4  422.7  422.9  423.2  423.4  423.7  423.9  424.1  424.4  424.6  424.8  425.0  425.2  425.3
      425.5  425.7  425.9  426.1  426.3  426.4  426.6  426.8  427.0  427.2  427.4  427.5  427.7  427.9  428.1
      428.3  428.5  428.7  428.8  429.0  429.2  429.4  429.6  429.8  430.0

31    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.3  420.2  420.2  420.3  420.4
      420.5  420.7  420.8  420.9  421.0  421.1  421.2  421.2  421.3  421.3  421.3  421.3  421.3  421.3  421.5
      421.9  422.3  422.6  422.9  423.2  423.4  423.7  423.9  424.2  424.4  424.6  424.8  425.0  425.2  425.4
      425.6  425.8  425.9  426.1  426.3  426.5  426.7  426.8  427.0  427.2  427.4  427.6  427.8  427.9  428.1
      428.3  428.5  428.7  428.9  429.1  429.2  429.4  429.6  429.8  430.0

32    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.2  420.2  420.3  420.3  420.4
      420.6  420.7  420.8  420.9  421.0  421.1  421.2  421.2  421.3  421.3  421.3  421.3  421.3  421.4  421.4
      421.8  422.2  422.6  422.9  423.2  423.5  423.7  424.0  424.2  424.4  424.6  424.8  425.0  425.2  425.4
      425.6  425.8  426.0  426.2  426.3  426.5  426.7  426.9  427.1  427.2  427.4  427.6  427.8  428.0  428.1
      428.3  428.5  428.7  428.9  429.1  429.3  429.4  429.6  429.8  430.0

33    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.1  420.2  420.2  420.3  420.5
      420.6  420.7  420.8  420.9  421.0  421.1  421.2  421.2  421.2  421.3  421.3  421.3  421.4  421.4  421.4
      421.6  422.2  422.6  422.9  423.2  423.5  423.8  424.0  424.2  424.5  424.7  424.9  425.1  425.3  425.5
      425.7  425.9  426.0  426.2  426.4  426.6  426.7  426.9  427.1  427.3  427.5  427.6  427.8  428.0  428.2
      428.4  428.5  428.7  428.9  429.1  429.3  429.4  429.6  429.8  430.0

34    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.0  420.1  420.2  420.3  420.5
      420.6  420.7  420.9  421.0  421.1  421.1  421.2  421.2  421.2  421.3  421.3  421.3  421.4  421.4  421.5
      421.8  422.2  422.6  423.0  423.3  423.6  423.8  424.1  424.3  424.5  424.8  425.0  425.2  425.3  425.5
      425.7  425.9  426.1  426.3  426.4  426.6  426.8  427.0  427.1  427.3  427.5  427.7  427.8  428.0  428.2
      428.4  428.6  428.7  428.9  429.1  429.3  429.5  429.6  429.8  430.0

35    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.0  420.2  420.3  420.5
      420.6  420.8  420.9  421.0  421.1  421.2  421.2  421.2  421.3  421.3  421.3  421.3  421.4  421.4  421.6
      422.0  422.4  422.7  423.0  423.3  423.6  423.9  424.1  424.4  424.6  424.8  425.0  425.2  425.4  425.6
      425.8  426.0  426.1  426.3  426.5  426.7  426.8  427.0  427.2  427.3  427.5  427.7  427.9  428.0  428.2
      428.4  428.6  428.8  428.9  429.1  429.3  429.5  429.6  429.8  430.0

36    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  420.3  420.5
      420.7  420.8  420.9  421.1  421.2  421.2  421.2  421.3  421.3  421.3  421.3  421.4  421.4  421.5  421.8
      422.2  422.5  422.8  423.1  423.4  423.7  424.0  424.2  424.5  424.7  424.9  425.1  425.3  425.5  425.7
      425.8  426.0  426.2  426.3  426.5  426.7  426.9  427.0  427.2  427.4  427.6  427.7  427.9  428.1  428.3
```

```
       428.4  428.6  428.8  428.9  429.1  429.3  429.5  429.6  429.8  430.0

37     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       420.7  420.8  421.0  421.1  421.2  421.3  421.3  421.4  421.4  421.3  421.5  421.6  421.7  421.9  422.1
       422.4  422.7  423.0  423.3  423.5  423.8  424.1  424.3  424.5  424.8  425.0  425.2  425.4  425.5  425.7
       425.9  426.1  426.2  426.4  426.6  426.7  426.9  427.1  427.2  427.4  427.6  427.8  427.9  428.1  428.3
       428.4  428.6  428.8  429.0  429.1  429.3  429.5  429.7  429.8  430.0

38     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  421.0  421.2  421.3  421.4  421.4  421.5  421.5  421.6  421.7  421.8  422.0  422.1  422.4
       422.6  422.9  423.1  423.4  423.7  423.9  424.2  424.4  424.7  424.9  425.1  425.3  425.5  425.6  425.8
       425.9  426.1  426.3  426.4  426.6  426.8  426.9  427.1  427.3  427.5  427.6  427.8  428.0  428.1  428.3
       428.5  428.6  428.8  429.0  429.1  429.3  429.5  429.7  429.8  430.0

39     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  421.2  421.3  421.4  421.5  421.5  421.6  421.7  421.8  421.9  422.0  422.2  422.4  422.6
       422.8  423.0  423.3  423.5  423.8  424.0  424.3  424.5  424.8  425.0  425.3  425.4  425.5  425.7  425.8
       426.0  426.2  426.3  426.5  426.7  426.8  427.0  427.2  427.3  427.5  427.7  427.8  428.0  428.2  428.3
       428.5  428.7  428.8  429.0  429.2  429.3  429.5  429.7  429.8  430.0

40     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  421.4  421.5  421.6  421.6  421.7  421.8  422.0  422.1  422.2  422.4  422.6  422.8
       423.0  423.2  423.4  423.7  423.9  424.1  424.4  424.6  424.9  425.2  425.6  425.5  425.6  425.7  425.9
       426.0  426.2  426.4  426.5  426.7  426.9  427.0  427.2  427.4  427.5  427.7  427.9  428.0  428.2  428.3
       428.5  428.7  428.8  429.0  429.2  429.3  429.5  429.7  429.8  430.0

41     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  421.5  421.6  421.8  421.9  422.0  422.1  422.3  422.4  422.6  422.8  423.0
       423.2  423.4  423.6  423.8  424.0  424.2  424.4  424.7  424.9  425.2  425.4  425.5  425.7  425.8  425.9
       426.1  426.3  426.4  426.6  426.7  426.9  427.1  427.2  427.4  427.6  427.7  427.9  428.0  428.2  428.4
       428.5  428.7  428.9  429.0  429.2  429.3  429.5  429.7  429.8  430.0

42     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  421.7  421.8  421.9  422.0  422.1  422.3  422.4  422.6  422.7  422.9  423.1
       423.3  423.5  423.7  423.9  424.1  424.3  424.5  424.7  424.9  425.2  425.4  425.5  425.7  425.8  426.0
       426.1  426.3  426.5  426.6  426.8  426.9  427.1  427.3  427.4  427.6  427.8  427.9  428.1  428.2  428.4
       428.6  428.7  428.9  429.0  429.2  429.4  429.5  429.7  429.8  430.0

43     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  421.9  422.0  422.1  422.3  422.4  422.6  422.7  422.9  423.1  423.3
       423.5  423.7  423.9  424.1  424.2  424.4  424.6  424.8  425.0  425.2  425.4  425.5  425.7  425.9  426.0
       426.2  426.3  426.5  426.7  426.8  427.0  427.1  427.3  427.5  427.6  427.8  427.9  428.1  428.3  428.4
       428.6  428.7  428.9  429.1  429.2  429.4  429.5  429.7  429.8  430.0

44     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  422.0  422.2  422.4  422.5  422.7  422.9  423.0  423.2  423.5
       423.7  423.9  424.1  424.2  424.3  424.5  424.7  424.8  425.0  425.2  425.4  425.5  425.7  425.9  426.1
       426.2  426.4  426.5  426.7  426.9  427.0  427.2  427.3  427.5  427.7  427.8  428.0  428.1  428.3  428.4
       428.6  428.8  428.9  429.1  429.2  429.4  429.5  429.7  429.8  430.0

45     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  423.4
       423.7  423.9  424.1  424.2  424.4  424.6  424.7  424.9  425.0  425.2  425.4  425.6  425.7  425.9  426.1
       426.3  426.4  426.6  426.7  426.9  427.1  427.2  427.4  427.5  427.7  427.8  428.0  428.2  428.3  428.5
       428.6  428.8  428.9  429.1  429.2  429.4  429.5  429.7  429.8  430.0

46     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  423.5
       423.7  423.9  424.1  424.3  424.4  424.6  424.7  424.9  425.1  425.2  425.4  425.6  425.8  426.0  426.1
       426.3  426.5  426.6  426.8  426.9  427.1  427.3  427.4  427.6  427.7  427.9  428.0  428.2  428.3  428.5
       428.6  428.8  428.9  429.1  429.2  429.4  429.5  429.7  429.8  430.0

47     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       423.7  423.9  424.1  424.3  424.5  424.6  424.8  424.9  425.1  425.2  425.4  425.6  425.8  426.0  426.2
       426.3  426.5  426.7  426.8  427.0  427.1  427.3  427.5  427.6  427.8  427.9  428.1  428.2  428.4  428.5
       428.7  428.8  429.0  429.1  429.3  429.4  429.6  429.7  429.9  430.0

48     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       423.9  424.0  424.2  424.3  424.5  424.7  424.8  425.0  425.1  425.2  425.4  425.6  425.8  426.0  426.2
       426.4  426.6  426.7  426.9  427.0  427.2  427.3  427.5  427.6  427.8  427.9  428.1  428.2  428.4  428.5
       428.7  428.8  429.0  429.1  429.3  429.4  429.6  429.7  429.9  430.0

49     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  424.1  424.2  424.4  424.6  424.7  424.9  425.0  425.2  425.3  425.4  425.7  425.9  426.1  426.3
       426.5  426.6  426.8  426.9  427.1  427.2  427.4  427.5  427.7  427.8  428.0  428.1  428.3  428.4  428.6
       428.7  428.9  429.0  429.1  429.3  429.4  429.6  429.7  429.9  430.0

50     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  424.2  424.4  424.6  424.8  425.0  425.1  425.3  425.4  425.6  425.8  426.0  426.2  426.3
       426.5  426.7  426.8  427.0  427.1  427.3  427.4  427.6  427.7  427.9  428.0  428.2  428.3  428.4  428.6
       428.7  428.9  429.0  429.2  429.3  429.4  429.6  429.7  429.9  430.0

51     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  424.7  424.9  425.0  425.2  425.4  425.5  425.7  425.9  426.1  426.3  426.4
       426.6  426.7  426.9  427.0  427.2  427.3  427.5  427.6  427.8  427.9  428.1  428.2  428.3  428.5  428.6
       428.8  428.9  429.0  429.2  429.3  429.4  429.6  429.7  429.9  430.0

52     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
       999.0  999.0  999.0  999.0  424.9  425.0  425.1  425.3  425.5  425.7  425.9  426.0  426.2  426.3  426.5
       426.7  426.8  427.0  427.1  427.2  427.4  427.5  427.7  427.8  427.9  428.1  428.2  428.4  428.5  428.6
       428.8  428.9  429.1  429.2  429.3  429.5  429.6  429.7  429.9  430.0

53     999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
```

```
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  425.1  425.2  425.3  425.5  425.7  425.9  426.1  426.3  426.4  426.6
      426.7  426.9  427.0  427.2  427.3  427.4  427.6  427.7  427.8  428.0  428.1  428.3  428.4  428.5  428.7
      428.8  428.9  429.1  429.2  429.3  429.5  429.6  429.7  429.9  430.0

54    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  425.2  425.4  425.6  425.8  426.0  426.3  426.4  426.5  426.7
      426.8  426.9  427.1  427.2  427.3  427.5  427.6  427.8  427.9  428.0  428.2  428.3  428.4  428.6  428.7
      428.8  429.0  429.1  429.2  429.4  429.5  429.6  429.7  429.9  430.0

55    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.4  425.6  425.8  426.1  426.4  426.5  426.7  426.8
      426.9  427.0  427.1  427.3  427.4  427.5  427.7  427.8  427.9  428.1  428.2  428.3  428.5  428.6  428.7
      428.9  429.0  429.1  429.2  429.4  429.5  429.6  429.7  429.9  430.0

56    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.7  426.2  426.6  426.7  426.8  426.9
      427.0  427.1  427.2  427.3  427.5  427.6  427.7  427.8  428.0  428.1  428.2  428.4  428.5  428.6  428.8
      428.9  429.0  429.1  429.3  429.4  429.5  429.6  429.8  429.9  430.0

57    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  425.9  426.2  426.8  426.8  426.9  426.9
      427.0  427.1  427.3  427.4  427.5  427.6  427.8  427.9  428.0  428.1  428.3  428.4  428.5  428.7  428.8
      428.9  429.0  429.2  429.3  429.4  429.5  429.6  429.8  429.9  430.0

58    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.1  426.9  426.9  426.9  427.0
      427.1  427.2  427.3  427.4  427.6  427.7  427.8  427.9  428.1  428.2  428.3  428.4  428.6  428.7  428.8
      428.9  429.1  429.2  429.3  429.4  429.5  429.6  429.8  429.9  430.0

59    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  427.1  426.9  427.0  427.0
      427.1  427.2  427.4  427.5  427.6  427.7  427.9  428.0  428.1  428.2  428.4  428.5  428.6  428.7  428.8
      429.0  429.1  429.2  429.3  429.4  429.5  429.7  429.8  429.9  430.0

60    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.3  426.7  426.9  427.0  427.0
      427.2  427.3  427.4  427.5  427.6  427.8  427.9  428.0  428.1  428.3  428.4  428.5  428.6  428.8  428.9
      429.0  429.1  429.2  429.3  429.4  429.6  429.7  429.8  429.9  430.0

61    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.4  426.6  426.8  426.9  427.1
      427.2  427.3  427.4  427.6  427.7  427.8  427.9  428.1  428.2  428.3  428.4  428.6  428.7  428.8  428.9
      429.0  429.1  429.2  429.4  429.5  429.6  429.7  429.8  429.9  430.0

62    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.6  426.8  426.9  427.1
      427.2  427.3  427.5  427.6  427.7  427.9  428.0  428.1  428.2  428.4  428.5  428.6  428.7  428.8  428.9
      429.0  429.2  429.3  429.4  429.5  429.6  429.7  429.8  429.9  430.0

63    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.8  426.9  427.1
      427.2  427.4  427.5  427.6  427.8  427.9  428.0  428.2  428.3  428.4  428.5  428.6  428.8  428.9  429.0
      429.1  429.2  429.3  429.4  429.5  429.6  429.7  429.8  429.9  430.0

64    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  426.9  427.1
      427.2  427.4  427.5  427.7  427.8  428.0  428.1  428.2  428.3  428.5  428.6  428.7  428.8  428.9  429.0
      429.1  429.2  429.3  429.4  429.5  429.6  429.7  429.8  429.9  430.0

65    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  427.1
      427.3  427.4  427.6  427.7  427.9  428.0  428.1  428.3  428.4  428.5  428.6  428.7  428.8  429.0  429.1
      429.1  429.2  429.3  429.4  429.5  429.6  429.7  429.8  429.9  430.0

66    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  427.6  427.8  427.9  428.1  428.2  428.3  428.5  428.6  428.7  428.8  428.9  429.0  429.1
      429.2  429.3  429.4  429.5  429.5  429.6  429.7  429.8  429.9  430.0

67    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  427.9  428.1  428.3  428.4  428.5  428.7  428.8  428.9  429.0  429.0  429.1
      429.2  429.3  429.4  429.5  429.6  429.7  429.7  429.8  429.9  430.0

68    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  428.1  428.3  428.4  428.5  428.6  428.7  428.8  428.9  429.0  429.1  429.2
      429.3  429.3  429.4  429.5  429.6  429.7  429.8  429.8  429.9  430.0

69    999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0  999.0
      999.0  999.0  999.0  999.0  428.3  428.4  428.5  428.6  428.7  428.8  428.9  429.0  429.1  429.1  429.2
```

```
         429.3   429.4   429.5   429.5   429.6   429.7   429.8   429.8   429.9   430.0

  70     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   428.4   428.5   428.6   428.7   428.7   428.8   428.9   429.0   429.0   429.1   429.2   429.3
         429.3   429.4   429.5   429.6   429.6   429.7   429.8   429.9   429.9   430.0

  71     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   428.6   428.6   428.7   428.7   428.8   428.9   428.9   429.0   429.1   429.1   429.2   429.2   429.3
         429.4   429.4   429.5   429.6   429.6   429.7   429.8   429.9   429.9   430.0

  72     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   428.8   428.8   428.8   428.8   428.9   428.9   429.0   429.0   429.1   429.1   429.2   429.2   429.3   429.4
         429.4   429.5   429.5   429.6   429.7   429.7   429.8   429.9   429.9   430.0

  73     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   429.0   429.0   429.0   429.0   429.0   429.1   429.1   429.1   429.2   429.2   429.2   429.3   429.3   429.4
         429.4   429.5   429.6   429.6   429.7   429.7   429.8   429.9   429.9   430.0

  74     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   429.1   429.1   429.2   429.2   429.2   429.2   429.2   429.2   429.3   429.3   429.3   429.4   429.4
         429.5   429.5   429.6   429.6   429.7   429.8   429.8   429.9   429.9   430.0

  75     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   429.3   429.3   429.3   429.3   429.3   429.3   429.3   429.3   429.3   429.4   429.4   429.4   429.5
         429.5   429.6   429.6   429.7   429.7   429.8   429.8   429.9   429.9   430.0

  76     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   429.5   429.5   429.4   429.4   429.4   429.4   429.4   429.4   429.4   429.4   429.5   429.5
         429.5   429.6   429.6   429.7   429.7   429.8   429.8   429.9   429.9   430.0

  77     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   429.6   429.6   429.6   429.6   429.5   429.5   429.5   429.5   429.5   429.5   429.5   429.5
         429.6   429.6   429.6   429.7   429.7   429.8   429.8   429.9   429.9   430.0

  78     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   429.8   429.7   429.7   429.6   429.6   429.5   429.5   429.5   429.5   429.5   429.5
         429.6   429.6   429.7   429.7   429.7   429.8   429.8   429.9   429.9   430.0

  79     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   430.0   429.9   429.8   429.7   429.6   429.6   429.5   429.5   429.5   429.5   429.6
         429.6   429.6   429.7   429.7   429.7   429.8   429.8   429.9   429.9   430.0

  80     999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
         999.0   999.0   999.0   999.0   999.0   430.1   429.9   429.7   429.6   429.6   429.6   429.5   429.5   429.6   429.6
         429.6   429.6   429.7   429.7   429.7   429.8   429.8   429.9   429.9   430.0

HEAD WILL BE SAVED ON UNIT 20 AT END OF TIME STEP  1, STRESS PERIOD  1


                             VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD  1
                             ----------------------------------------------------------------------------

                CUMULATIVE VOLUMES       L**3                                RATES FOR THIS TIME STEP       L**3/T
                ------------------                                           ------------------------

                      IN:                                                           IN:
                      ---                                                           ---
                        STORAGE =   0.00000E+00                                       STORAGE =   0.00000E+00
                  CONSTANT HEAD =   0.76188E+06                                 CONSTANT HEAD =   0.76188E+06
                 RIVER LEAKAGE =   0.65119E+06                                  RIVER LEAKAGE =   0.65119E+06

                       TOTAL IN =   0.14131E+07                                      TOTAL IN =   0.14131E+07

                     OUT:                                                          OUT:
                     ----                                                          ----
                        STORAGE =   0.00000E+00                                       STORAGE =   0.00000E+00
                  CONSTANT HEAD =   0.00000E+00                                 CONSTANT HEAD =   0.00000E+00
                  RIVER LEAKAGE =   0.14132E+07                                 RIVER LEAKAGE =   0.14132E+07

                      TOTAL OUT =   0.14132E+07                                     TOTAL OUT =   0.14132E+07

                       IN - OUT =   -133.38                                          IN - OUT =   -133.38

             PERCENT DISCREPANCY =              -0.01                      PERCENT DISCREPANCY =              -0.01
```

```
             TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                                  SECONDS        MINUTES         HOURS           DAYS          YEARS
                              -----------------------------------------------------------------------
         TIME STEP LENGTH         86400.0        1440.00        24.0000        1.00000     0.273785E-02
       STRESS PERIOD TIME         86400.0        1440.00        24.0000        1.00000     0.273785E-02
    TOTAL SIMULATION TIME         86400.0        1440.00        24.0000        1.0000u     0.273785E-02
```

APPENDIX 3

Selected well drillers' logs, aquifer test data,

and ground-water quality data for Fort Yukon, Alaska

from U.S. Public Health Service village files

SUBSURFACE SOIL INVESTIGATION
FOR
U.S. PUBLIC HEALTH SERVICE
SEWER LAGOON LOCATION
FT. YUKON, ALASKA

R&M CONSULTANTS, INC.

R & M CONSULTANTS, INC.
ANCHORAGE
FAIRBANKS
JUNEAU
249 EAST 51ST AVENUE • P.O. BOX 6087 • ANCHORAGE, ALASKA 99503 • TELEPHONE 907-279-0483 • TELEX 090-35419

March 31, 1976 R & M No. 612508

Mr. Charles P. Cummiskey
U. S. Public Health Service
P. O. Box 7-741
Anchorage, Alaska 99510

Re: Soil Investigation: Sites 2, 3, and 4, Sewer Lagoon Location
Public Law 86-721 Project, Ft. Yukon, Alaska

Dear Mr. Cummiskey:

We are submitting herewith four copies of the results of test borings drilled at the subject sites. The work has been performed in accordance with your letter of March 4, 1976. Your reference number for the project was given as A-PC (243-76-0168).

Also included with this letter are two location diagrams which present the locations of the test holes.

Should you have any questions with regard to the enclosed information, please do not hesitate to contact us.

Very truly yours,

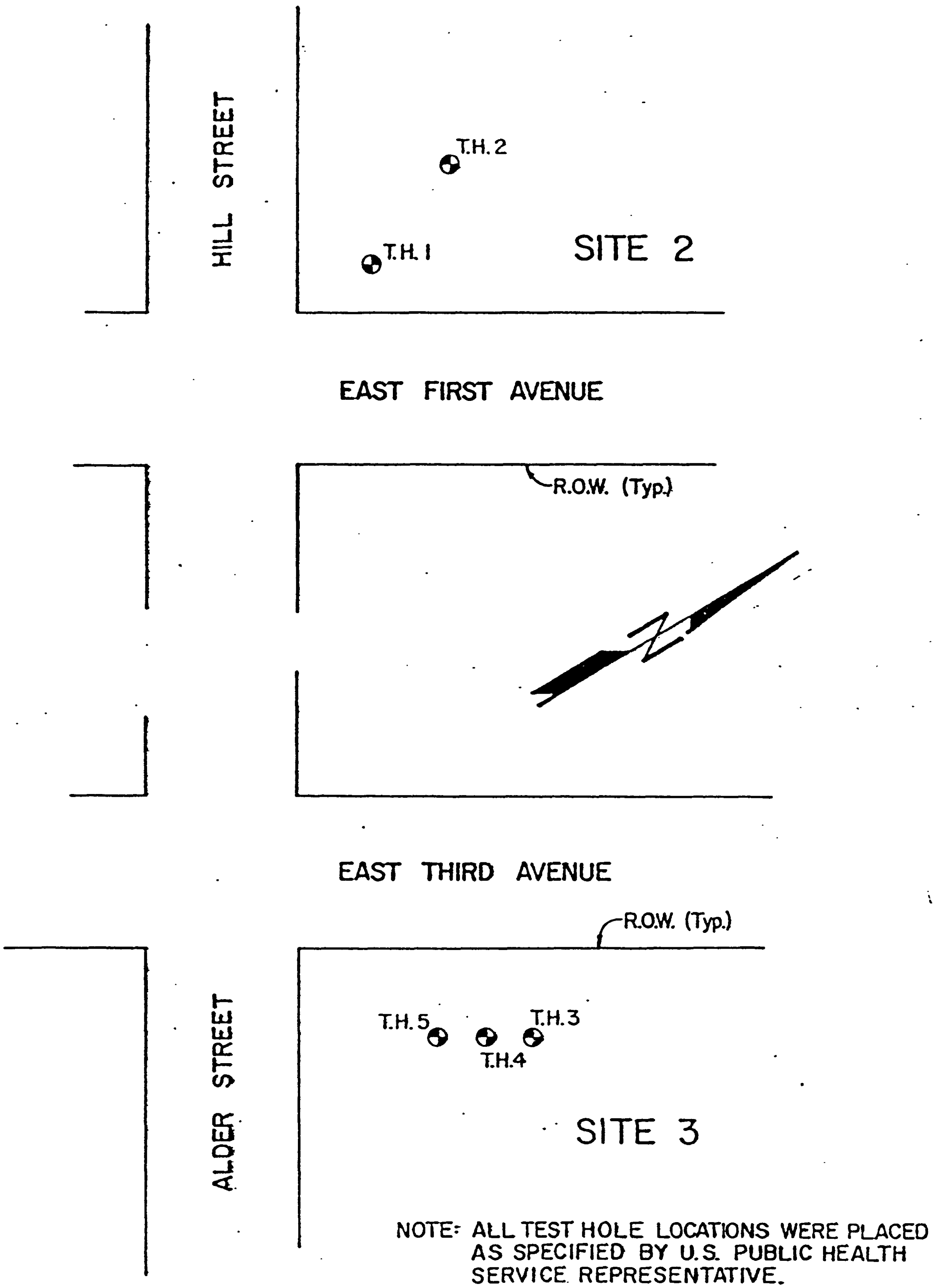
R & M CONSULTANTS, INC.

James W. Rooney

James W. Rooney
Vice President

JWR/DM/tk

Enclosures



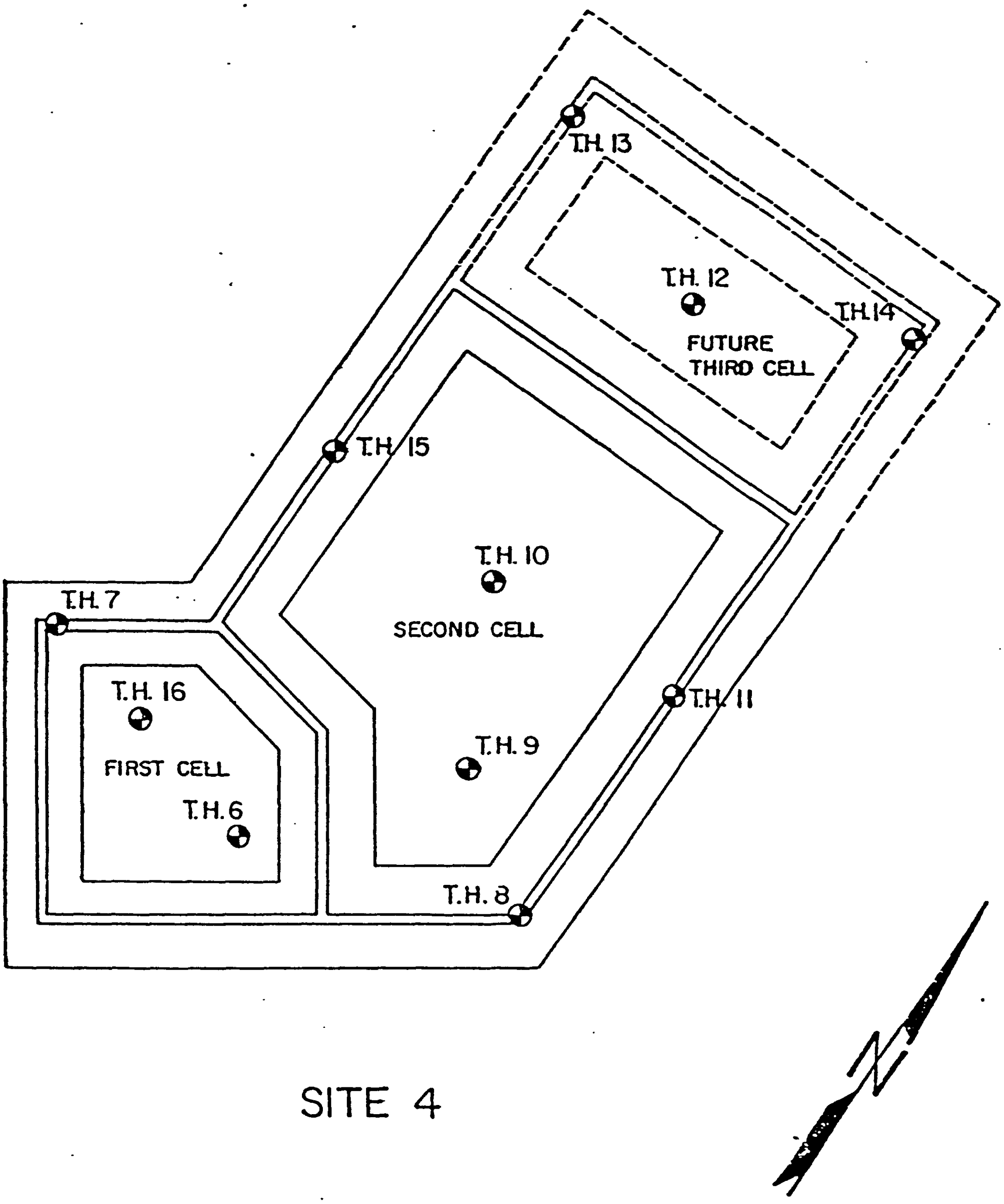
NOTE: ALL TEST HOLE LOCATIONS WERE PLACED AS SPECIFIED BY U.S. PUBLIC HEALTH SERVICE REPRESENTATIVE.

R & M CONSULTANTS, INC.

BORING LOCATIONS

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(43)



SITE 4

NOTE: ALL TEST HOLE LOCATIONS WERE PLACED AS SPECIFIED BY U.S. PUBLIC HEALTH SERVICE REPRESENTATIVE.

R&M CONSULTANTS, INC.

BORING LOCATIONS

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(44)

DATE	3-22-76	SCALE	1"=200'±	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	A-02

SOILS
CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION: Identification and classification of the soil is accomplished in accordance with the Unified Soil Classification System. Normally, the grain size distribution determines classification of the soil. The soil is defined according to major and minor constituents with the minor elements serving as modifiers of the major elements. For cohesive soils, the clay becomes the principal noun with the other major soil constituents used as modifier; i.e. silty clay, when the clay particles are such that the clay dominates soil properties. Minor soil constituents may be added to the classification breakdown in accordance with the particle size proportion listed below; i.e. sandy silt w/some gravel, trace clay.

no call - 0 - 3% trace - 3 - 12% some - 13 - 30%

SOIL CONSISTENCY - CRITERIA: Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e. fissure systems, shrinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

	Cohesionless	
	N*(blows/ft)	Relative Density
Loose	0 - 10	0 to 40%
Medium Dense	10 - 30	40 to 70%
Dense	30 - 60	70 to 90%
Very Dense	- 60	90 to 100%

*Standard Penetration "N": Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch OD split-spoon except where noted.

	Cohesive
	T - (tsf)
Very Soft	0 - 0.25
Soft	0.25 - 0.5
Stiff	0.5 - 1.0
Firm	1.0 - 2.0
Very Firm	2.0 - 4.0
Hard	- 4.0

DRILLING SYMBOLS

WO: Wash Out
WL: Water Level
WCI: Wet Cave In
DCI: Dry Cave In
WS: While Sampling
WD: While Drilling
BCR: Before Casing Removal
ACR: After Casing Removal
AB: After Boring
TD: Total Depth

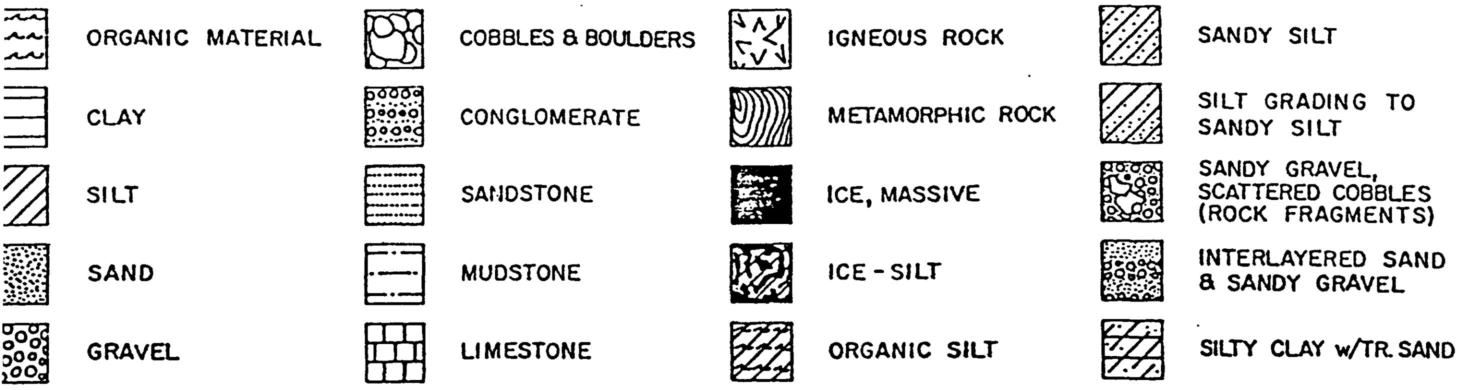
Note: Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious unfrozen soils, the indicated elevations are considered to represent actual ground water conditions. In impervious and frozen soils, accurate determinations of ground water elevations cannot be obtained within a limited period of observation and other evidence on ground water elevations and conditions are required.

R & M CONSULTANTS, INC.

GENERAL NOTES

DATE	3-1-72	SCALE	N/A	DWN BY	LDS	CHKD BY	GLB	PROJ. NO. GENERAL	DWG NO.	B-01

STANDARD SYMBOLS



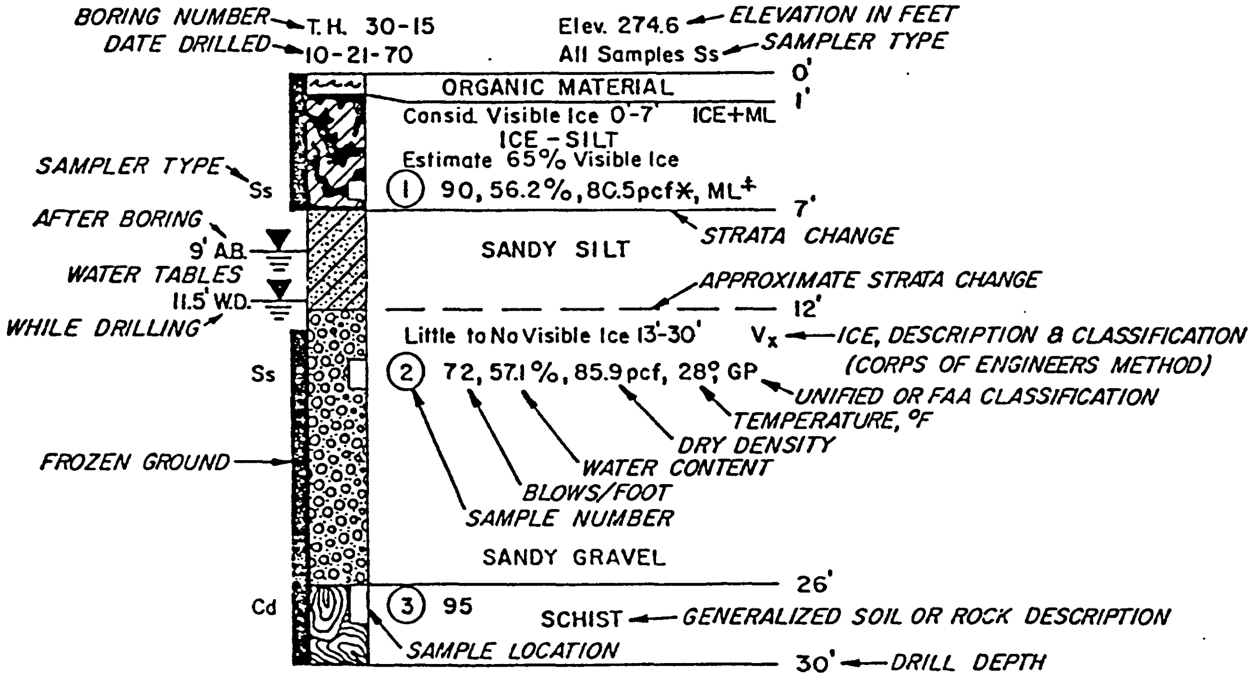
SAMPLER TYPE SYMBOLS

t . . . . . 1.4" SPLIT SPOON WITH 47# HAMMER
s . . . . . 1.4" SPLIT SPOON WITH 140# HAMMER
l . . . . . 2.5" SPLIT SPOON WITH 140# HAMMER
h . . . . . 2.5" SPLIT SPOON WITH 340# HAMMER
x . . . . . 2.0" SPLIT SPOON WITH 140# HAMMER
z . . . . . 1.4" SPLIT SPOON WITH 340# HAMMER
p . . . . . 2.5" SPLIT SPOON, PUSHED
s . . . . . 1.4" SPLIT SPOON DRIVEN WITH AIR HAMMER
l . . . . . 2.5" SPLIT SPOON DRIVEN WITH AIR HAMMER

Ts . . . . SHELBY TUBE
Tm . . . . MODIFIED SHELBY TUBE
Pb . . . . PITCHER BARREL
Cs . . . . CORE BARREL WITH SINGLE TUBE
Cd . . . . CORE BARREL WITH DOUBLE TUBE
Bs . . . . BULK SAMPLE
A. . . . . AUGER SAMPLE
G. . . . . GRAB SAMPLE

OTE: SAMPLER TYPES ARE EITHER NOTED ABOVE THE BORING LOG OR ADJACENT TO IT AT THE RESPECTIVE SAMPLE DEPTH.

TYPICAL BORING LOG



* WEIGHTED AVERAGE
+ ADDITIONAL DATA AVAILABLE ON SUPPLEMENTAL LAB SHEETS

R & M CONSULTANTS, INC.

(46)

EXPLANATION OF SELECTED SYMBOLS

TE	2-16-72	SCALE	NONE	DWN BY	LDS	CHKD BY	GLB	PROJ. NO.	GENERAL	DWG NO.	B-02

EXPLANATION OF ICE SYMBOLS

Percentage of visible ice has been grouped for the purpose of designating the amount of soil ice content. These groups have arbitrarily been set out as follows:

0%	No Visible Ice
1% - 10%	Little Visible Ice
11% - 20%	Occasional Visible Ice
21% - 35%	Some Visible Ice
>35%	Considerable Visible Ice

The ice description system is based on that presented by K. A. Linell, and C. W. Kaplar (1966). In this system, which is an extension of the Unified Soil Classification System, the amount and physical characteristics of the soil ice are accounted for. The following table is a brief summary of the salient points of their classification system as modified to meet the needs of this study.

ICE DESCRIPTIONS

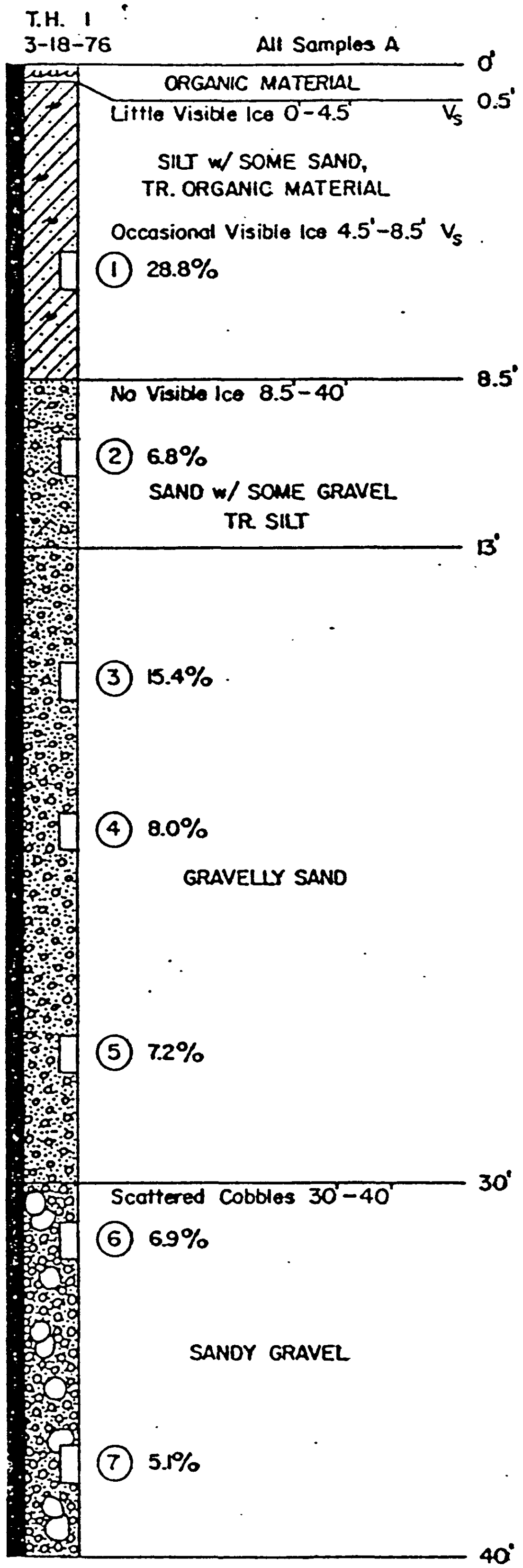
<table>
<tr><th rowspan="2">GROUP SYMBOL</th><th rowspan="2">ICE VISIBILITY & CONTENT</th><th colspan="4">SUBGROUP</th></tr>
<tr><th colspan="2">DESCRIPTION</th><th colspan="2">SYMBOL</th></tr>
<tr><td rowspan="3">N</td><td rowspan="3">Ice not visible</td><td colspan="2">Poorly bonded or friable</td><td colspan="2">N_f</td></tr>
<tr><td rowspan="2">Well-bonded</td><td>No excess ice</td><td rowspan="2">N_b</td><td>N_{bn}</td></tr>
<tr><td>Excess ice</td><td>N_{be}</td></tr>
<tr><td rowspan="4">V</td><td rowspan="4">Ice visible, <50%</td><td colspan="2">Individual ice crystals or inclusions</td><td colspan="2">V_x</td></tr>
<tr><td colspan="2">Ice coatings on particles</td><td colspan="2">V_c</td></tr>
<tr><td colspan="2">Random or irregularly oriented ice formations</td><td colspan="2">V_r</td></tr>
<tr><td colspan="2">Stratified or distinctly oriented ice formations</td><td colspan="2">V_s</td></tr>
<tr><td rowspan="2">ICE</td><td>Ice visible, >50%</td><td colspan="2">Ice with soil inclusions</td><td colspan="2">ICE + soil type</td></tr>
<tr><td>Individual layer >6" thick *</td><td colspan="2">Ice without soil inclusions</td><td colspan="2">ICE</td></tr>
</table>

* In some cases where the soil is ice poor a thin ice layer may be called out by special notation on the log, i.e. 2" ice lens at 7'.

R & M CONSULTANTS, INC.

EXPLANATION OF ICE SYMBOLS

DATE	3-1-72	SCALE	N/A	DWN BY	LDS	CHKD BY	GLB	PROJ. NO.	GENERAL	DWG NO.	B-03



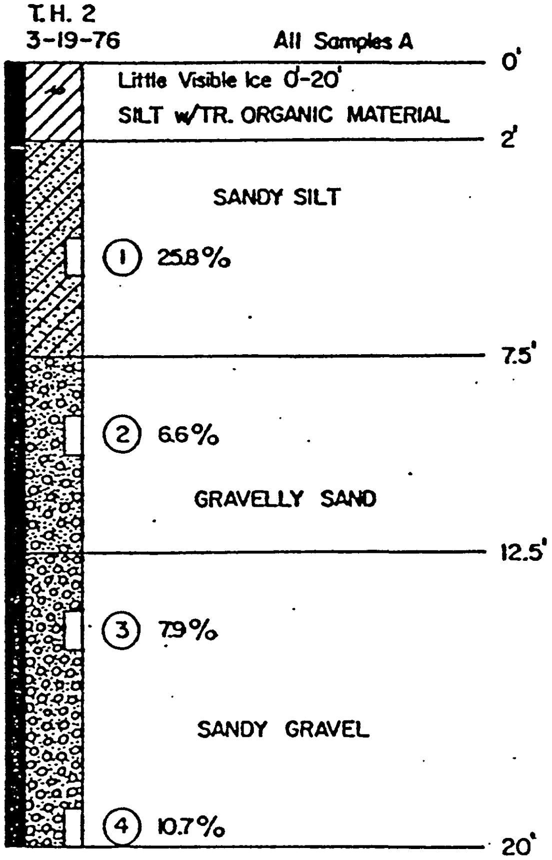
R&M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(48)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-04

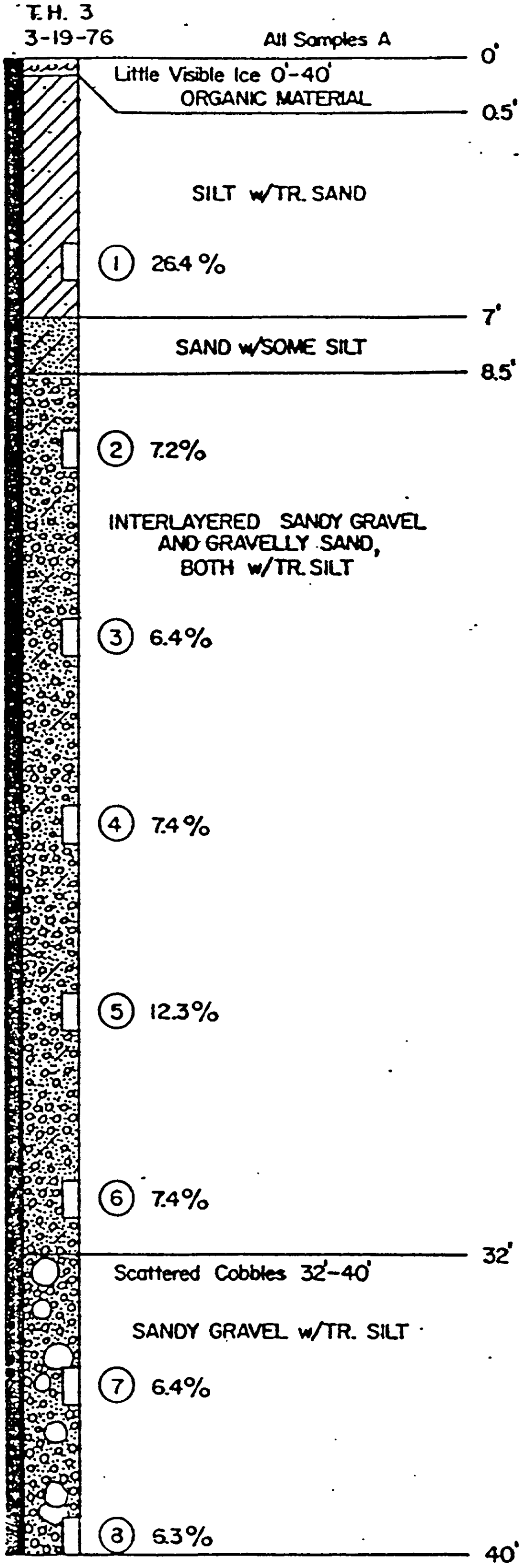


R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612503	DWG NO.	B-05



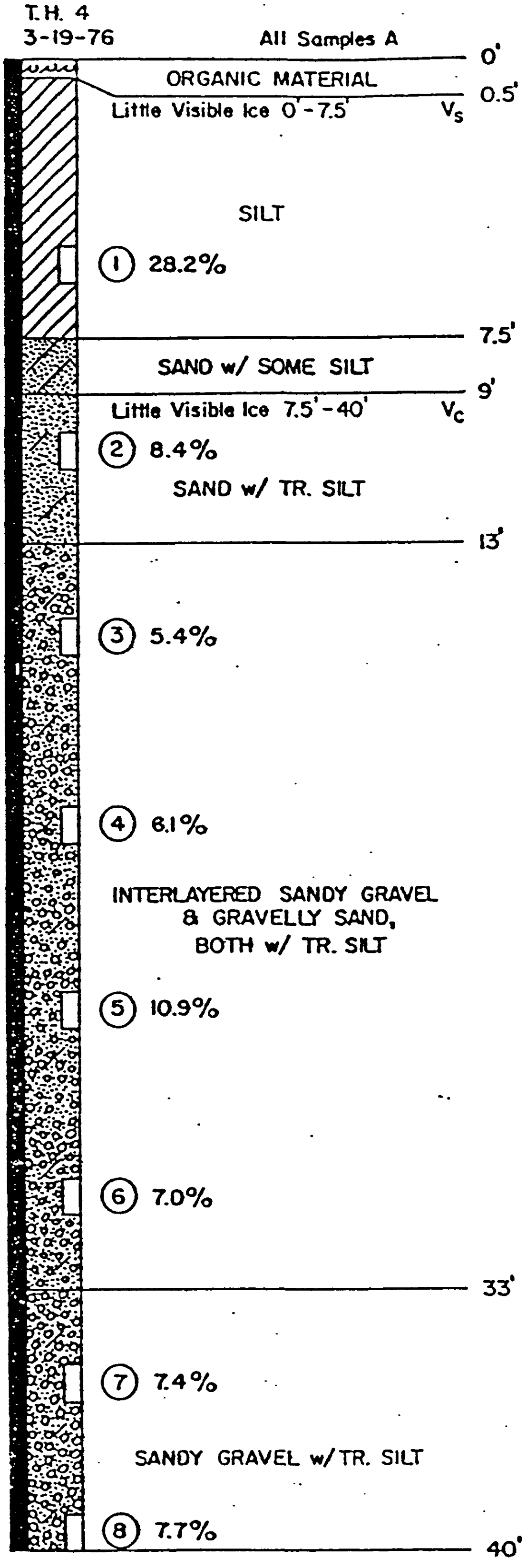
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION-SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(50)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-06



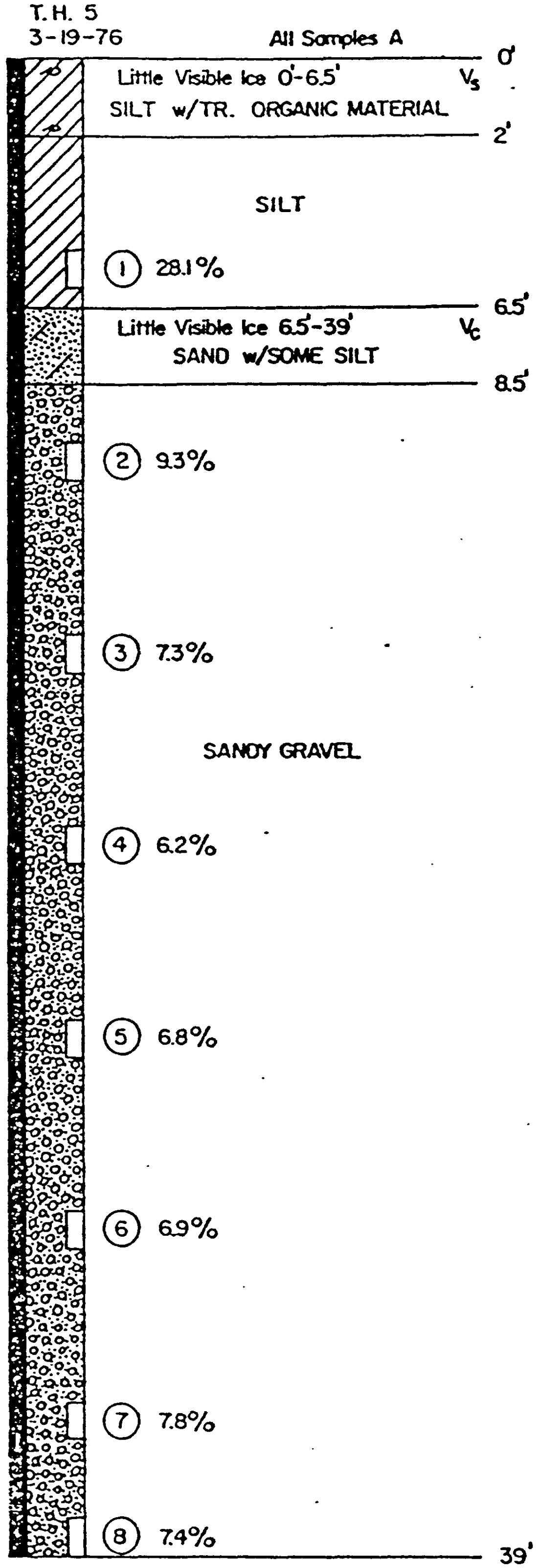
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(51)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO	612508	DWG NO	B-07



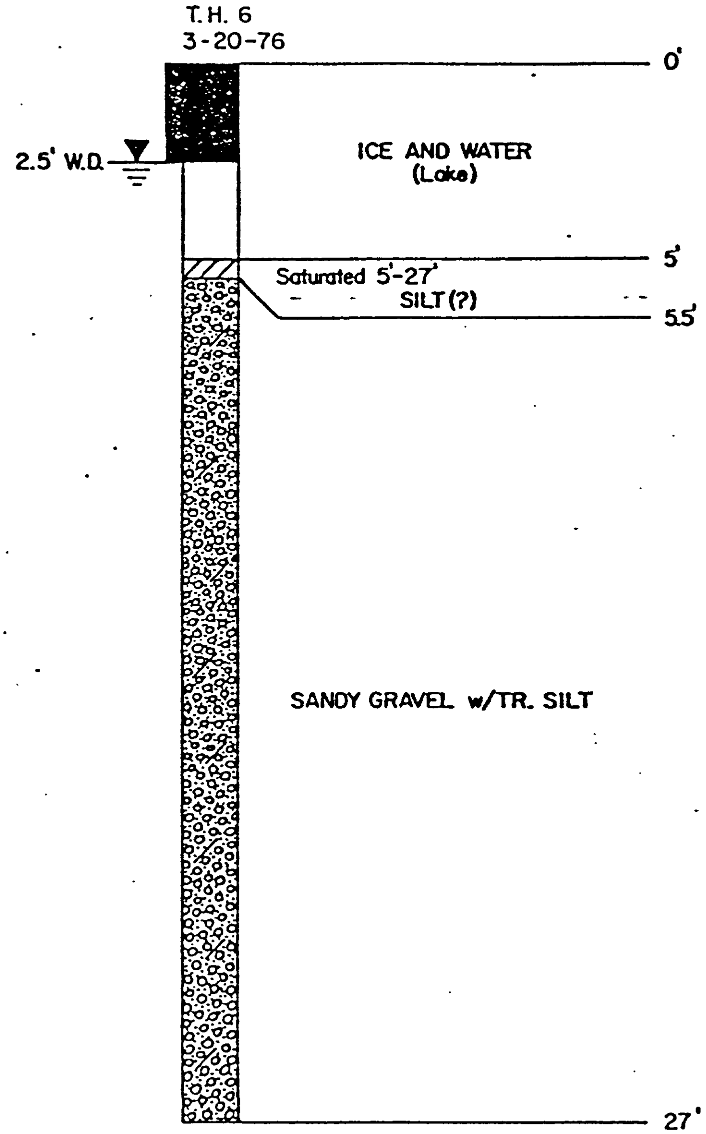
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(52)

DATE	3-22-76	SCALE	1"=3'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO	B-08



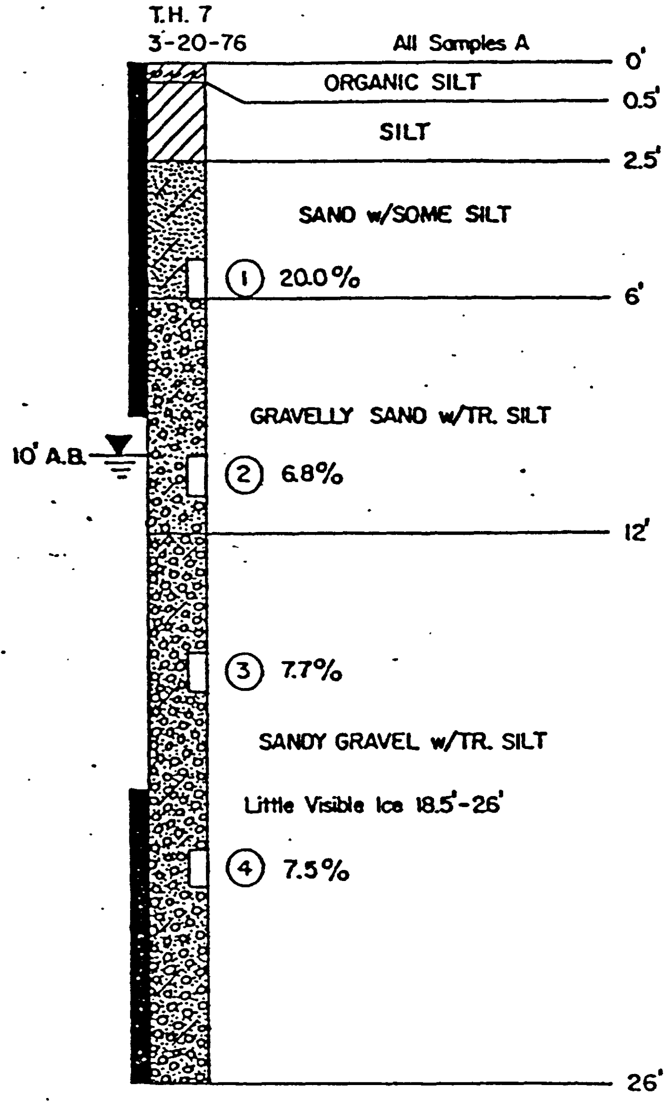
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(53)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-09



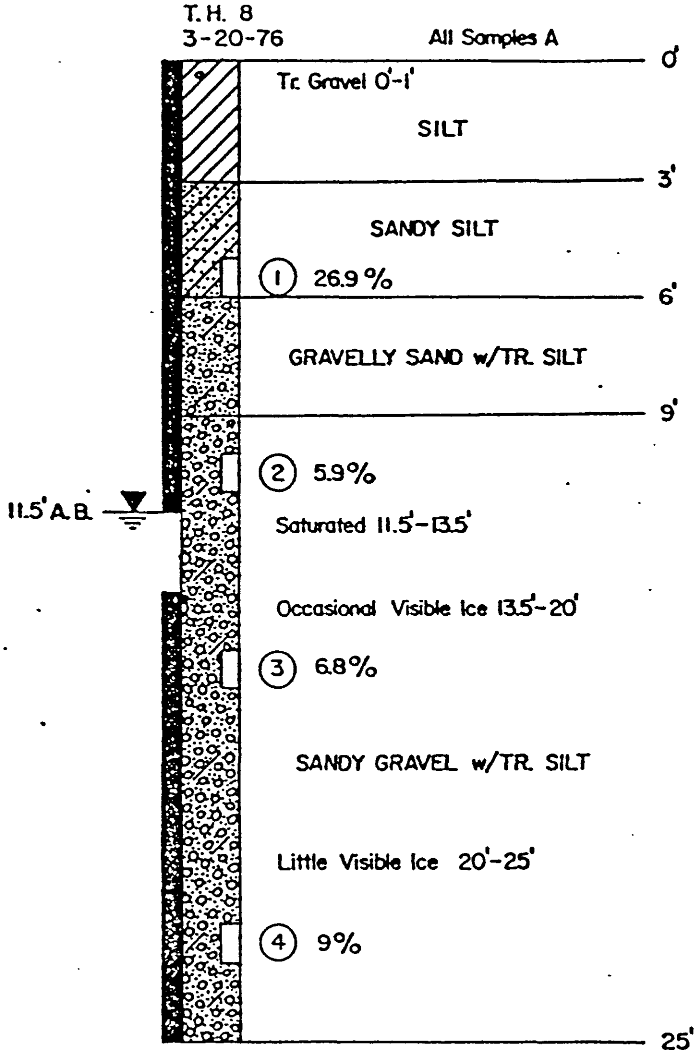
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION-SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(54)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-10



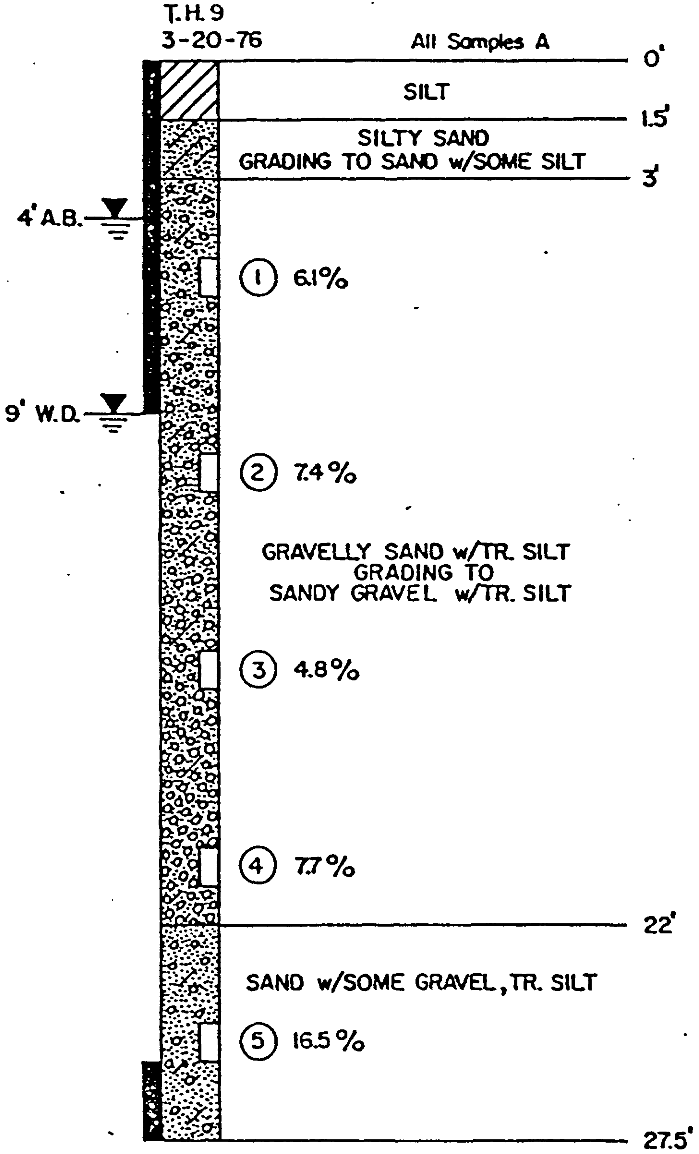
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(55)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO	B-11



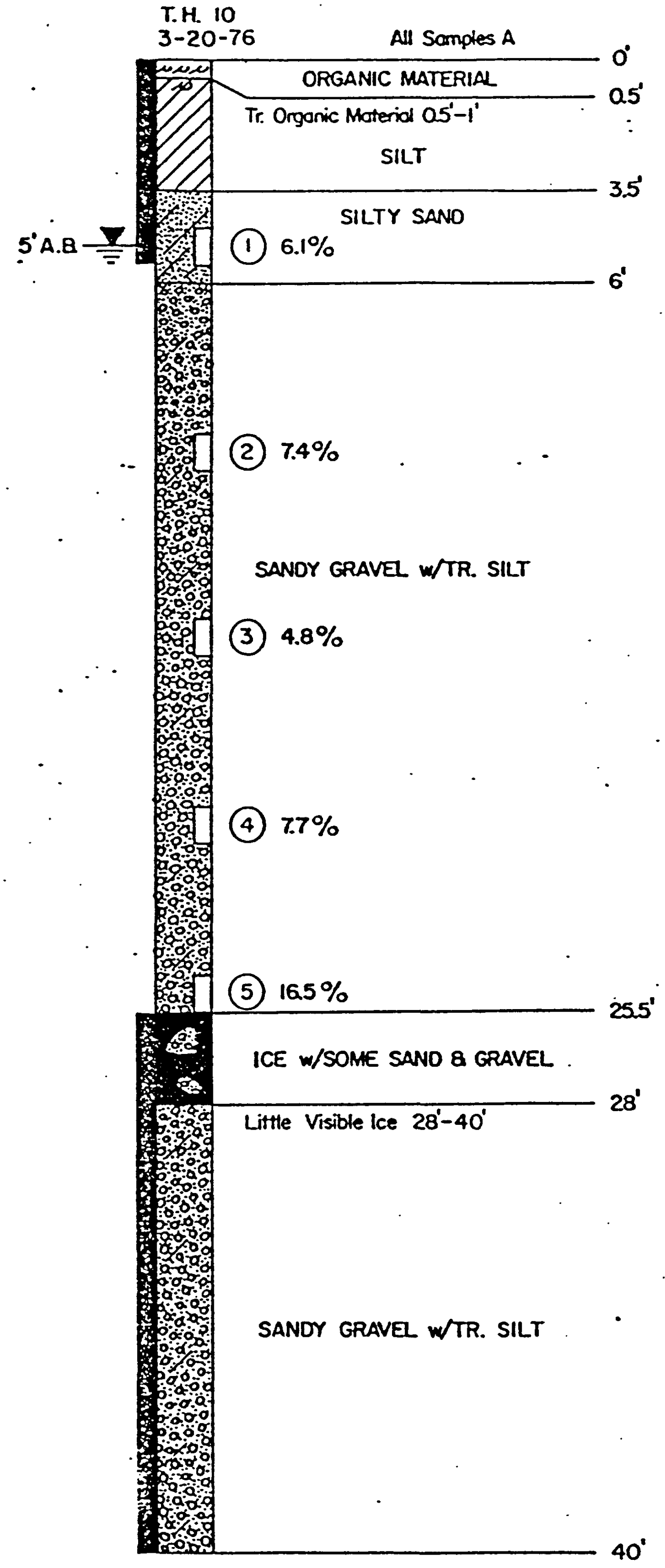
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(56)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-12



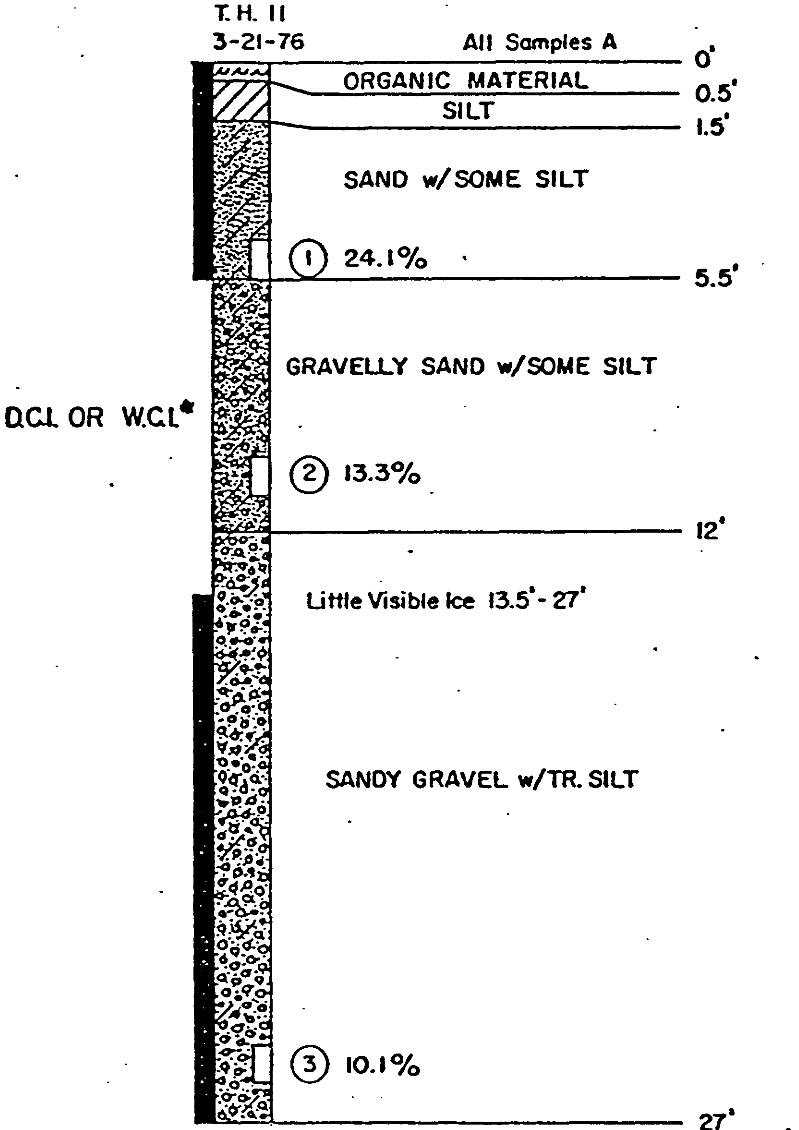
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(57)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO	B-13



* DRY CAVE-IN OR WET CAVE-IN AT APPROX. 6.5'
COULD NOT IDENTIFY WATER TABLE
CONDITION DUE TO CAVE-IN

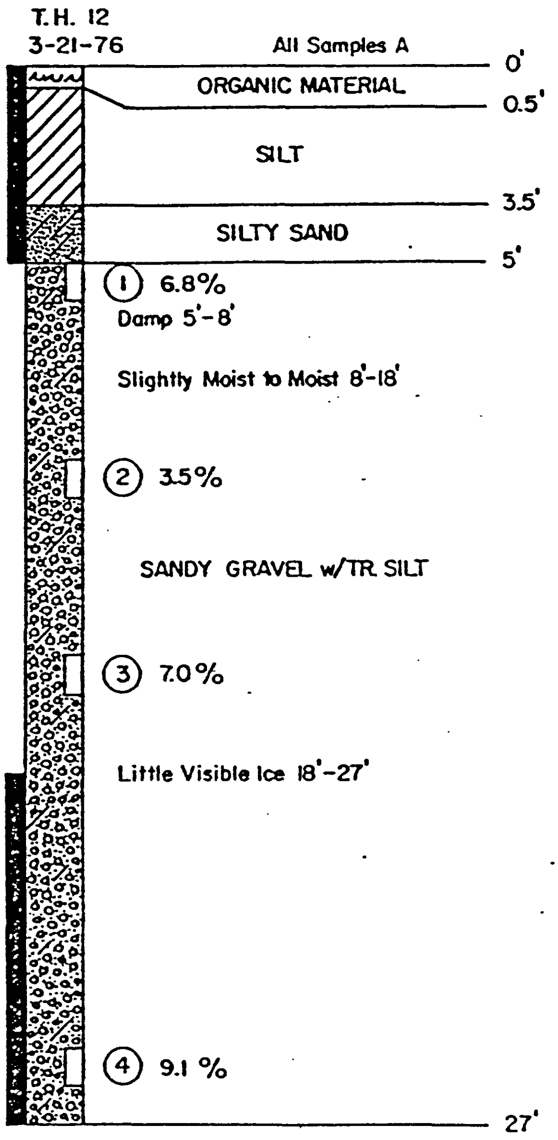
R&M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION-SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(58)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-14



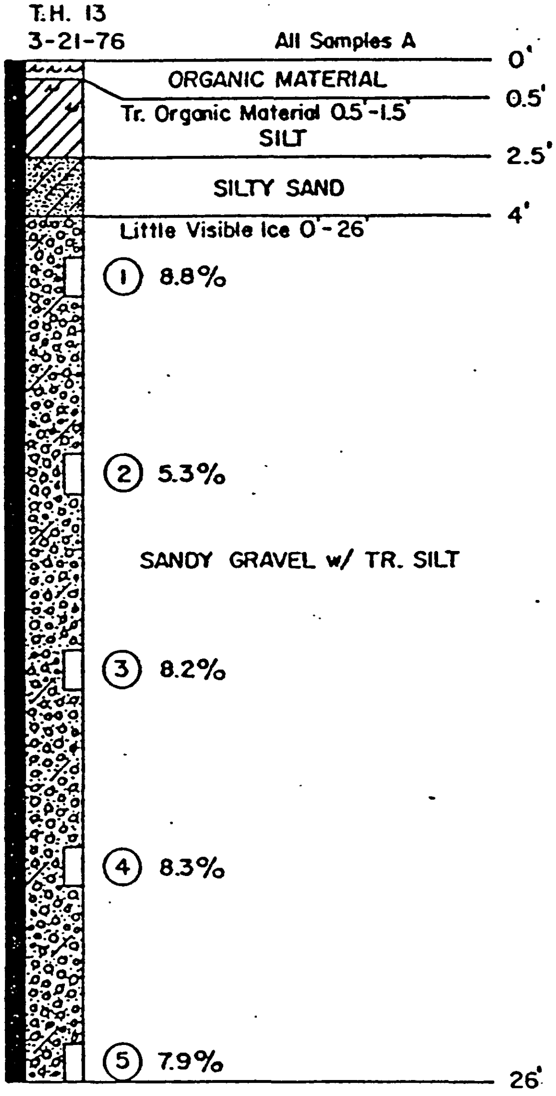
R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(59)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-15



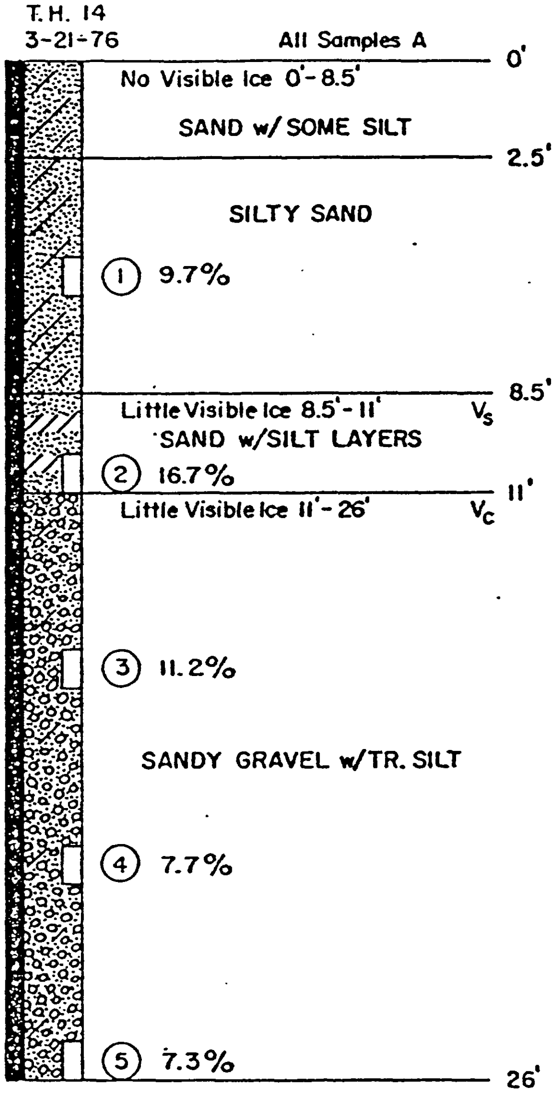
R&M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(60)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO	B-16



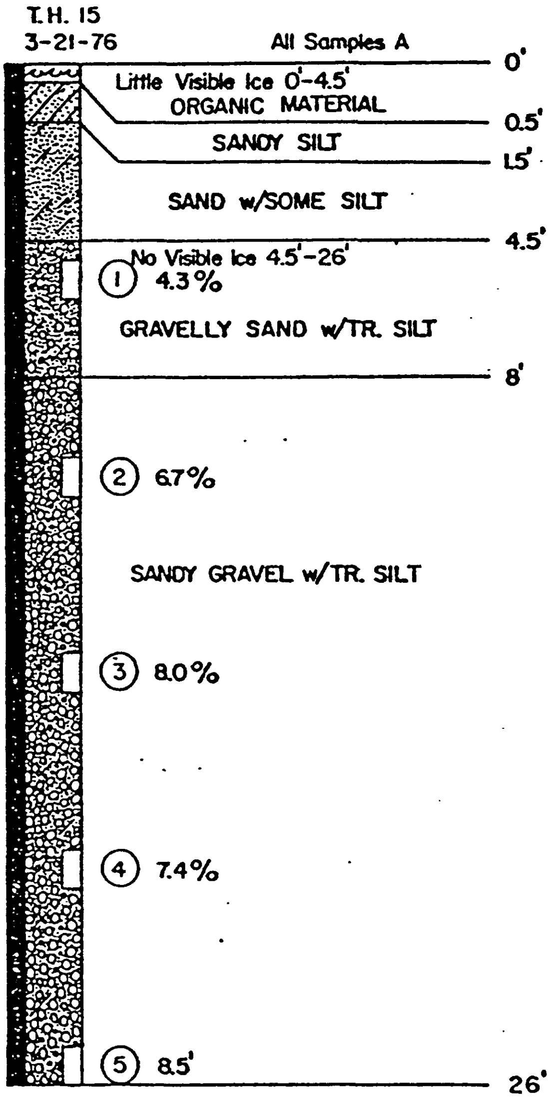
R&M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION-SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(61)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ. NO.	612508	DWG NO.	B-17

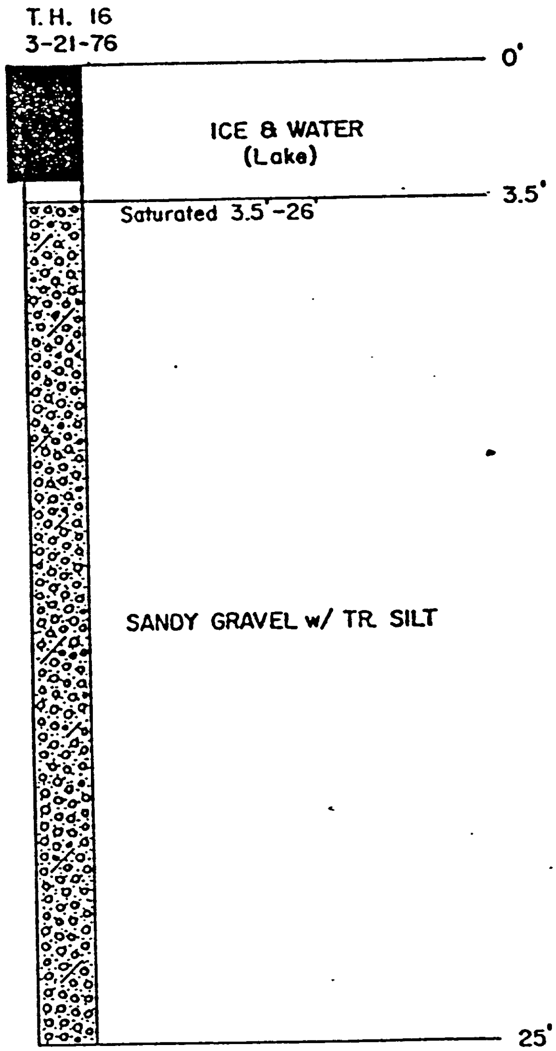


R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION - SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ NO	612508	DWG NO	B-18



R & M CONSULTANTS, INC.

BORING LOG

SOIL INVESTIGATION-SEWER LAGOON LOCATION
PUBLIC LAW 86-121 PROJECT
FT. YUKON, ALASKA

(63)

DATE	3-22-76	SCALE	1"=5'	DWN BY	LDS	CHKD BY	JF	PROJ NO.	612508	DWG NO.	B-19

PROJECT NO. 612508 (616508)
PROJECT NAME Public Health Service Ft. Yukon PL-86-121

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE March 25, 1976
PARTY NO.
PAGE NO. 1

LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLAS
	1	1	5-6								100	76									28.8	
		2	10-11			100	99	96	79	68	60	10									6.8	
		3	16-17																		15.4	
		4	20-21																		8.0	
		5	26-27																		7.2	
		6	31-32																		6.9	
		7	37-38																		5.1	
	2	1	4.5-5.5																		25.8	
		2	9-10																		6.6	
		3	14-15																		7.9	
		4	19-20																		10.7	

REMARKS:

NOTE: SIEVE ANALYSIS = PERCENT PASS

Wei-Jen Lin
APPROVED

PROJECT NO. 612508 (616508)

PROJECT NAME Public Health Service
Ft. Yukon PL-36-121

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE March 25, 1976

PARTY NO. ______ PAGE NO. 2

LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLASS
	3	1	5-6								100	95									26.4	
		2	10-11																		7.2	
		3	15-16	100	99	89	78	67	44	31	25	5									6.4	
		4	20-21																		7.4	
		5	25-26																		12.3	
		6	30-31																		7.4	
		7	35-36																		6.4	
		8	39-40																		6.3	
(65)																						
	4	1	5-6																		28.2	
		2	10-11																		8.4	
		3	15-16																		5.4	
		4	20-21																		6.1	
		5	25-26																		10.5	
		6	30-31																		7.0	
		7	35-36																		7.4	
		8	39-40																		7.7	

REMARKS: ______

NOTE: SIEVE ANALYSIS = PERCENT PASSIN

APPROVED Wai-Jen Lin

PROJECT NO. 612508 (616508)

PROJECT NAME Public Health Service Ft. Yukon PL-86-121

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE March 25, 1976

PARTY NO. ______ PAGE NO. 3

LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLAS
	5	1	5-6																		28.1	
		2	10-11																		9.3	
		3	15-16																		7.3	
		4	20-21																		6.2	
		5	25-26																		6.8	
		6	30-31																		6.9	
		7	35-36																		7.8	
		8	38-39																		7.4	
(66)																						
	7	1	5-6																		20.0	
		2	10-11																		6.8	
		3	15-16																		7.7	
		4	20-21																		7.5	
	8	1	5-6																		26.9	
		2	10-11																		5.9	
		3	15-16																		6.8	
		4	22-23																		9.0	

REMARKS: ______

NOTE: SIEVE ANALYSIS = PERCENT PASS

Wei-Jen Lin

APPROVED

PROJECT NO. 612508 (616508)
PROJECT NAME Public Health Service Ft. Yukon PL-86-121

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE March 25, 1976
PARTY NO.
PAGE NO. 4

LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLA
	9	1	5-6																		6.1	
		2	10-11																		7.4	
		3	15-16																		4.8	
		4	20-21																		7.7	
		5	24.5-25.5																		16.5	
(67)	10	1	4.5-5.5						100	99	99	37									19.9	
		2	10-11																		11.9	
		3	15-16	100	98	88	76	61	39	30	26	3									8.4	
		4	20-21																		7.0	
		5	24.5-25.5																		5.5	
	11	1	4.5-5.5																		24.1	
		2	10-11																		13.3	
		3	25-26																		10.1	
	12	1	5-6																		6.8	
		2	10-11																		3.5	
		3	15-16																		7.0	
		4	25-26																		9.1	

REMARKS:

NOTE: SIEVE ANALYSIS = PERCENT PAS

Wei-Jen Lin
APPROVED

PROJECT NO. 612508 (616508)

PROJECT NAME Public Health Service
Ft. Yukon PL-86-121

R & M CONSULTANTS, INC.

SUMMARY OF LABORATORY TEST DATA

DATE March 25, 1976

PARTY NO. ______ PAGE NO. 5

LAB NO.	BORING NO.	SAMPLE NO.	DEPTH	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	200	.02	.005	.002	FINE SPG	L.L.	P.I.	WET DENSITY	DRY DENSITY	MOISTURE CONTENT	CLASS
	13	1	5-6																		8.8	
		2	10-11		100	97	79	67	44	30	22	6									5.3	
		3	15-16																		8.2	
		4	20-21																		8.3	
		5	25-26																		7.9	
	14	1	5-6																		9.7	
		2	10-11																		16.7	
(68)		3	15-16																		11.2	
		4	20-21																		7.7	
		5	25-26																		7.3	
	15	1	5-6																		4.3	
		2	10-11																		6.7	
		3	15-16																		8.0	
		4	20-21																		7.4	
		5	25-26																		8.5	

REMARKS:

NOTE: SIEVE ANALYSIS = PERCENT PASSIN

Wei-Jen Lin
APPROVED

Swan Drilling Co.
4 Mile Steese Hwy.
Fairbanks, Alaska 99701

WELL LOG

STATE SCHOOL PUMP HOUSE
FORT YUKDN, ALASKA
1974

8" WELLS

WELL # 1
(Closest to Pump House)

0' - 2' Silt & Sand (frozen)
2' - 9' Silt & Sand
9' - 12' Black Mud
12' - 30' Gravel, Sand & Water

WELL # 2

0' - 2' Silt & Sand (frozen)
2' - 11' Silt & Sand
11' - 29' Gravel, Sand & Water

Water Static Level 13'
Water Temperature 33
Pumps Make 60 GPM each
Pump Test Well #1 & #2 for 1 hour at 60GPM each, Water Static Level remained at 13'
Well #1 & #2 have 15' Johnson's Screen (Stainless Steel) #60 Slot
Extended casing 4' 8" above ground level on both Wells
Installed WEBTROL 708TC154-3ph Turbine Pumps
Pumps set 21' from top of casing
Installed 15' Copper Heat Cables down Well #1 & #2
#EZ-CU-15-2
300W 120V 15' 2.5AMPS
2½" Pipe between Wells & Pump House has two (2) separate Heat Cables which are Auto-Trace Self-Limiting.

Fort Yukon School
Contract P-786
DB 131-4-29140

3/15/74

WATER ANALYSIS REPORT FORM

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

C 708

MAR 07 1975

NAME OR LOCATION: Fort Yukon Community System

COLLECTED BY: John Thomas DATE 2/18/75 HOUR: 500 PM

WATER SYSTEM

1. Well Type Driled Depth ~~[illegible]~~ 30' Gallons per minute 60
2. Surface Water: ______ Temporary ☐ Permanent ☒
3. Number of Homes Served: School-Comm. Center-State office Bld.
4. Treatment: ☒ Yes ☐ No New or Existing Source Existing

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
Iron (Fe)		0.3
Fluoride (F)		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

COLUMN 3

	Analysis	Limits
Sodium (Na)		200
Potassium (K)		
Sulfate (SO_4)		250
Sulfite ** (SO_3)		5.
Nitrate (NO_3)		10
Suspended Solids		
Arsenic (As)		0.
Copper (Cu)		1.
Cyanide (Cn)		0.
Phenols		0.
Zinc (Zn)		5.
Barium (Ba)		1.
Cadmium (Cd)		0.
Lead Pb)		0.
Silver (Ag)		0.
Mercury (Hg)		0.
Manganese (Mn)		0.
Oil	0.0	

Recd 2/20/75

2/28/75 DPGerber

COMMENTS: Made report of Oil Taste
Oil could be present but sample was to small-require 1qt for oil test. DPG

INSTRUCTIONS:

1. Rinse container several times in water source to be sampled.
2. Place cap on sample container firmly.
3. Place sample in carton mailer, and forward to: (70)

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

ANCHORAGE
ATLANTA
BETHESDA
BILLINGS
BOCA RATON
BOSTON
CHICAGO
CINCINNATI
CRANFORD
DENVER
FAIRBANKS
HONOLULU
HOUSTON
LOS ANGELES
NEW ORLEANS
NEW YORK
PHOENIX
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SANTA BARBARA
SEATTLE
SYRACUSE
WASHINGTON, D. C.
WHITE PLAINS

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

BEIRUT
CALGARY
JAKARTA
JOHANNESBURG RSA
LAGOS
LONDON
MADRID
MELBOURNE
PERTH
SINGAPORE
SYDNEY
TEHRAN
TOKYO
TORONTO
VANCOUVER B. C.

POST OFFICE BOX 30725 · FAIRBANKS, ALASKA 99701 · (907) 479-22[illegible]8
CABLE: DAMEMORE TELEX: (090) 35487

June 30, 1976

Office of the Service Unit Director
Department of Health, Education, and Welfare
Alaska Native Health Center
528 5th Room 210
Fairbanks, Alaska 99701

Attention: Tom Hartrich

Dear Mr. Hartrich:

The two water samples received by Dames & Moore on June 23, 1976 have been completed. The requested parameters and their respective values appear below.

Parameter	Value			
	Untreated Well Water		USGS	Treated Well Water
pH, pH units	7.7	6.5		7.8
Total Alkalinity, mg/l as $CaCO_3$	134	143	136	135
Bicarbonate, mg/l as $CaCO_3$	134	143	166	135
Carbonate, mg/l as $CaCO_3$	0	0		0
Total Hardness, mg/l as $CaCO_3$	147	200	150	147
Calcium, mg/l	43.5	51.6	.44	43.5
Magnesium, mg/l	9.3	13.6	9.8	9.3
Iron, mg/l	2.3	2.7	2.2	0.1
Sodium, mg/l	2.7	7.6	2.6	2.7
Manganese, mg/l	0.41		.48	0.41
Chloride, mg/l	2.1	11.0	0.8	3.4 ←
Fluoride, mg/l	0.29		0.1	0.31
Total Phosphate, mg/l PO_4-P	0.17		0.08	0.08
Sulfate, mg/l	23.1	46.1	23	23.1
Total Dissolved Solids, mg/l	127	227		93

Parameter	Value	
	Untreated Well Water	Treated Well Water
Σ Cation, me/l	3.15	3.05
Σ Anion, me/l	3.26	3.30

Insufficient untreated sample was provided to allow for an accurate nitrate determination. Tentative nitrate concentrations were determined as 44.7 mg/l NO_3-N for the untreated sample and 21.9 mg/l NO_3-N for the treated sample.

If you have any questions regarding these data, or if we can be of further service to you, please feel free to contact me.

Very truly yours,
Dames & Moore

Frederick L. Smith
Project Manager

FLS/vah

cc: Mercedes Russell

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

Date: 03-02-77

Name of Village: FT. Yukon, Alaska 99740 Name of Source: FT Yukon Pumphouse

Sampling Site: FT Yukon Community Well Collected By: John Thomas E.H.T.

WATER SOURCE (circle one:) C-860

[✓ Well,] Spring, Lake, River, Creek, Ditch, Slough, Other:

Sample Description: [✓ Raw,] Treated, Other: (Describe) Direct From Well

PURPOSE OF ANALYSIS

☐ 1. Water Approval for Building Permit. (Column 1)

MAR 11 19[illegible]

☒ 2. Routine Analysis. (Columns 1 & 2)

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

COLUMN 1

		Limits
Iron (Fe)	0.08	0.3
Fluoride (F)	0.1	1.5
Chloride (Cl)	☆	250
Phosphate (PO_4)	0.00	.05 good 30 poor
Total Hardness	59	50 soft 300 hard
Detergents	0	0
pH	6.8	6.5 8.5
Specific Conductance	141	

Rec'd 3/4/77

COLUMN 2

	Anal.	Limit
Magnesium (Mg)	5.2	125
Calcium (Ca)	14.5	300
Turbidity	8	5
Color	0	15
Bicarbonate (HCO_3)	☆	25 good 500 poor
Carbonate	☆	350
Alkalinity	☆	350
Total Dissolved Solids	118	500

COLUMN 3

	Analysis	Limits
Sodium (Na)		[illegible]
Potassium (K)		
Sulfate (SO_4)		250
Sulfite **(SO_3)		5.
Nitrate (NO_3)		10
[✓ Suspended Solids]	2.4	
[✓ Arsenic (As)]	0.000	0.
Copper (Cu)		1.
Cyanide (Cn)		0.
Phenols		0.
Zinc (Zn)		5.
Barium (Ba)		1.
Cadmium (Cd)		0.
[✓ Lead (Pb)]	0.02	0.
Silver (Ag)		0.
Mercury (Hg)		0.
Manganese (Mn)		0.

Comments: ☆ Insufficient sample for complete analysis.

3/9/77

No.

Instructions:

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

(73)

☐ Emergency
☐ Illness Suspect

WATER ANALYSIS REPORT FORM

Doc Lowe Or John H. Vansoth

Mail Report To: Dept of Environmental Conservation
Box 1601 Fairbanks, Alaska
99701

Explain: Test Water Well

C 815

Name: SWAN Drilling Co INC S. Yukon Well

Collected By: Swan Drilling Co INC. Date: 12-26 Hour: ______

Legal Address of Property: Lot ______ Block ______ U.S. Survey # ______

WATER SYSTEM

1. Well Type: 8" Casing Drilled Depth: 75' Gallons per Minute: 10 GPM
2. Surface Water: None Temporary ☐ Permanent ☒
3. Number of Homes Served: S[illegible]
4. Treatment: ☐ Yes ______ ☒ No

PURPOSE OF ANALYSIS

☐ 1. Water Approval for Building Permit. (Column 1)
☒ 2. Routine Analysis. (Columns 1 and 2)
☒ 3. Special: Check Specific Items for Analysis. [✓ (Columns 1, 2 and 3)]

---

(1)	Analysis	Limits
n (Fe)	0.06	0.3
oride (F)	0.68	1.5
Chloride (Cl)	4	250
Phosphate (PO4)	0.00	.05 good 30 poor
Total Hardness	124	50 soft 300 hard
Detergents	0	0.
pH	7.81	6.5 - 8.5
Specific Conductance	248	

(2)	Analysis	Limits
Magnesium (Mg)	22	125
Calcium Ca)	33	300
Turbidity	1	5
Color	5	15
Bicarbonate (HCO3)	138	25 good 500 poor
Carbonate	0	350
Alkalinity	113	350
Total Disolved Solids	168	500

(3)	Analysis	Limi
Sodium (Na)	3	200
Potassium (K)	< 1	
Sulfate (SO4)	22	250
Sulfite *(SO3)		5.0
Nitrate (NO3)	0.78	10.
Suspended Solids	0.5	
Arsenic (As)	0.00	0.0
Copper (Cu)		1.0
Cyanide (Cn)	Out Dated	0.0
Phenols	Out Dated	0.0
Zinc (Zn)	insufficient	5.0
Barium (Ba)	sample	1.0
Cadmium (Cd)		0.0
Lead (Pb)		0.0
Silver (Ag)		0.0
Mercury (Hg)		0.0
Manganese (Mn)	0.112	0.0

Rec'd 1/13/75

SANITARIANS COMMENTS:

by Don Gerber & K. Salsbury
1/21/75

RECEIVED
FEB 13 1975
DEPT. OF ENVIRONMENTAL CONSERVATION
NRO

* Requires Special Container

Instructions on Back

STATE OF ALASKA
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DOUGLAS LABORATORY FACILITY

④

VILLAGE SAFE WATER PROGRAM

TO BE COMPLETED BY SAMPLER

Sample Source or Location: Yukon River

Collected by: John Thomas

Address: River water in front of town

Sample Number: 19JT80

Village: Fort Yukon

State: Ak

Zip Code:

Sample Date: 4/7/80

☒ Surface Water ☐ Ground Water

☒ Untreated Water ☐ Treated Water

☒ Routine Sample ☐ Special Purpose Sample

Laboratory Analysis Number: 80040931

Received by: Parry Mothershead

Date: 4/9/80

	Limit	Mg/l
Arsenic	(0.05)	TR
Barium	(1)	0.11
Cadmium	(0.010)	ND
Chromium	(0.05)	ND
Iron	(0.3)	0.36
Lead	(0.05)	TR
Manganese	(0.05)	0.54
Mercury	(0.002)	ND
Selenium	(0.01)	ND
Silver	(0.05)	ND
Sodium	(250)	. TR
Calcium		50.
Magnesium		10.2
Potassium		1.5

ND=Not Detected
TR=Trace Detected

	Limit	Mg/l
Chloride		TR
Fluoride	(2.4)	TR
Nitrate — N	(10.)	ND
Sulfate		28.
Carbonate Alkalinity		120.
TFR @ 180° C		166.

pH	7.7	
Turbidity	1.7	NTU
Color	15.	PCU
Conductivity @ 25° C	272.	µmhos/cm

Date Analysis Completed: 5/7/80

Signature of Laboratory Supervisor:

Date Reported: 5/8/80

18-319(12/73)

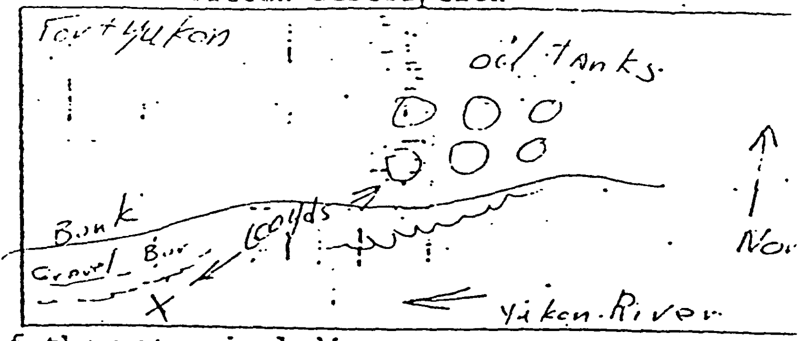
(75)

Sample # [illegible]

Village of: River Water At Fort Yukon

Special Information Lab #80040931

1. Specify the exact sample location so there is no confusion about where the sample was collected. Include a written description and a map or sketch.



2. Describe the physical appearance of the water including:

Color Clear

Taste good

Odor none

Turbidity none

3. Describe the area immediately surrounding the sample site including nearby honey bucket dumps, oil storage areas, landfills. ect.

4. Label each sample to include:

Name of Collector John Thomas

Time and date of collection 04-07-80 800 Am

Date sample mailed 04-07-80

Water temperature

Sample depths/distance from shore (for surface sources)

Tidal influence (if any)

Approximate flow rate

Depth of well

Pumping rate and drawdown of well

pH

5. ☒ Raw water ☐ Treated water

Comments Taken from the Yukon River at Fort Yukon

APPENDIX 4

Selected well drillers' logs, aquifer test data

and ground-water quality data for Fort Yukon, Alaska

from U.S. Geological Survey village files

```
DATE: 01/18/94              GROUND WATER SITES WITHIN 10 MILE RADIUS FT. YUKON, AK (Lat 663400 Long 1451600)              PAGE    1a

                                                                ALTITUDE
                                              DATE      DEPTH   OF LAND   WATER                       LOCATION         LOCATION   TYPE
                                              WELL     OF WELL  SURFACE   LEVEL   DISCHARGE              MAP              MAP     OF LOG
     SITE-ID          LOCAL WELL NUMBER    CONSTRUCTED  (FEET)   (FEET)   (FEET)    (GPM)                NAME            SCALE   AVAILABLE

663337145143201 FA02001217BBCC1001 51574     --          --       --       --        --                  --               --        -
663332145124701 FA02001217DAAD1  001      01-01-56      42.0    425.00     --       30.00     FORT YUKON C-3            63360       -
                                                                                     --                                              -
                                                                                     --                                              -
```

```
DATE: 01/18/94   GROUND WATER SITES WITHIN 10 MILE RADIUS FT. YUKON, AK (Lat 663400 Long 1451600)    PAGE   1b

                                                                         ASSIGNOR
                                                                         OF OTHER        OTHER
   LOCAL WELL NUMBER                           OWNER                     IDENTIFIER      IDENTIFIER

FA02001217BBCC1001 51574                        --                          --             --
FA02001217DAAD1  001      USAF FT YUKON                                 UNKNOWN         UNCONSOL
                                                --                      FT YUKON AFS    WELL 1
                                                --                      AKRG            50009
```

AKRG refers to AlasKa ReGister, an inventory number assigned to wells when "Well Schedules" were filed in a paper data base.

```
DATE: 01/20/94                                                                                               PAGE   1

C001   Site ID (station number)                         663337145143201
C002   Type of site                                     W
C004   Source agency code                               USGS
C006   District code                                    02
C007   State code                                       02
C008   County code                                      250
C009   Latitude                                          663337
C010   Longitude                                         1451432
C012   Local well number                                FA02001217BBCC1001 51574
C020   Hydrologic unit code                             19040403
C040   Date site record last updated                    19930709
C303   Date site record created                         19860314
C712   Data availability in other Ground Water files    NNNNNNNNNNNNNNNNNNNN
C802   Station-type codes                               NNNNNYN
C803   Agency use of site code                          A
C815   Locator sequence number                          01
C900   Station name                                     FA02001217BBCC1001 51574 FT YUKON COMM WELL
```

```
C001   Site ID (station number)                       663332145124701
C002   Type of site                                   W
C003   Record classification                          U
C004   Source agency code                             USGS
C006   District code                                  02
C007   State code                                     02
C008   County code                                    250
C009   Latitude                                        663332
C010   Longitude                                       1451237
C011   Lat-long accuracy code                         T
C012   Local well number                              FA02001217DAAD1  001
C013   Land-net location                              NENESES17 T020N R012E F
C014   Name of location map                           FORT YUKON C-3
C015   Scale of location map                          63360
C016   Altitude of land surface                         425.00
C017   Method altitude determined                     M
C018   Altitude accuracy                              25
C019   Topographic setting                            U
C020   Hydrologic unit code                           19040204
C021   Date well constructed                          19560101
C023   Primary use of site                            W
C024   Primary use of water                           P
C027   Hole depth                                      42.0
C028   Depth of well                                   42.0
C040   Date site record last updated                  19930803
C303   Date site record created                       19860227
C712   Data availability in other Ground Water files  YYYNNNNNNNNNNNNNNNNN
C802   Station-type codes                             NNNNNYN
C803   Agency use of site code                        A
C815   Locator sequence number                        01
C900   Station name                                   FA02001217DAAD1  001
C060   Date of construction                           1956
C063   Name of contractor                             UNKNOWN
C064   Source of construction data                    S
C065   Method of construction                         D
C066   Type of finish                                 T
C723   Record number for construction subrecord          1
C754   Record type for CONS subrecord of CONS file    CONS
C755   Last update for CONS subrecord of CONS file    19860314
C059   Parent seq. num. for HOLE subrecord of CONS file   1
C073   Depth to top of this interval                       .00
C074   Depth to bottom of this interval                  42.00
C075   Diameter of this interval                       6.00
C724   Record number for hole subrecord                  1
C756   Record type for HOLE subrecord of CONS file    HOLE
C757   Last update for HOLE subrecord of CONS file    19860314
C077   Depth to top of this casing string                  .00
C078   Depth to bottom of this casing string             29.00
C079   Diameter of this casing string                  6.00
C725   Record number for casing subrecord                1
C758   Record type for CSNG subrecord of CONS file    CSNG
C759   Last update for CSNG subrecord of CONS file    19860314
C901   Parent seq. num. for CSNG subrecord of CONS file   1
C147   Record sequence number                            1
C148   Date discharge measured                        19670807
C150   Discharge                                           30.00
C151   Source of discharge data                       S
C152   Method discharge measured                      R
```

```
C702   Last update -disch                                19860314
C703   Discharge type                                    P
C159   Date of ownership                                 1956
C161   Owner                                             USAF FT YUKON
C718   Sequence number for OWNR subrecord of MISC file     1
C768   Record type for OWNR subrecord of MISC file       OWNR
C769   Last update for OWNR subrecord of MISC file       19860314
C190   Other identifier                                  UNCONSOL
C191   Assignor of other identifier                      UNKNOWN
C736   Sequence number for OTID subrecord of MISC file     1
C770   Record type for OTID subrecord of MISC file       OTID
C771   Last update for OTID subrecord of MISC file       19860314
C190   Other identifier                                  WELL 1
C191   Assignor of other identifier                      FT YUKON AFS
C736   Sequence number for OTID subrecord of MISC file     2
C770   Record type for OTID subrecord of MISC file       OTID
C771   Last update for OTID subrecord of MISC file       19860314
C190   Other identifier                                  50009
C191   Assignor of other identifier                      AKRG
C736   Sequence number for OTID subrecord of MISC file     3
C770   Record type for OTID subrecord of MISC file       OTID
C771   Last update for OTID subrecord of MISC file       19860314
C115   Begin year of data collection                     1958
C116   End year of data collection                       1972
C117   Source agency for network data                    USGS
C118   Frequency of data collection                      I
C120   Type of analyses - QW network                     B
C706   Network data type -miscellaneous                  QW
C730   Sequence number for SPEC subrecord of MISC file     1
C780   Record type for NETW subrecord of MISC file       NETW
C781   Last update for NETW subrecord of MISC file       19860314
C184   Remark-date                                       19860227
C185   Remarks -misc                                     GRAVEL AQUIFER
C311   Sequence number for RMKS subrecord of MISC file     1
C788   Record type for RMKS subrecord of MISC file       RMKS
C789   Last update for RMKS subrecord of MISC file       19860314
```

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
A-32 Washington Auditorium
Washington 25, D.C.

October 2, 1957

Mr. Roger Waller
Ground Water Branch
U.S. Geological Survey
Box 259
Anchorage, Alaska

Dear Roger:

While picking through all the little pencilled notes and scraps of paper with tid-bits of information picked up during the summer, I note one that mentions a botanist or some such person running off with the samples collected from the Fort Yukon well drilled by the Alaska District CE. I wonder if you have succeeded in tracing the man's name. I am sorry I didn't see Jim Roy at the meetings, and that I didn't allow time to see him afterwards.

Also sorry to have missed the little get-together you had after the meetings.

Cleo and I left Snowshoe Lake on the 23rd of Sept after a few days of snow, had a good flight out and are getting settled back into our usual rut again. This year we get to see the fall colors twice- as it is still a balmy 75 or so in D.C. and the foliage is still more or less intact.

I appreciate any lead you can give me as to the identity of the man who made off with the samples from the Fort Yukon well. I believe it is important to try to contact him about getting a split if one remains or if he is a specialist trying to get the desired information as to the age and mode of deposition of this material.

Any help you may need from me in the Copper River or Yukon Flats, just ask-- you may not get much help if you ask where to drill for water, but perhaps my notes would be helpful.

Sincerely,

John

John R. Williams
Geologist

Fort Yukon — well samples,

Oct - 1957

Mr. James Roy
Geology Section
Alaska District, Corps of Engineers
Elmendorf A.F.B.
Anchorage, Alaska

Dear Mr. Roy:

Roger Waller of our Ground Water Branch has recently checked with you about the identity of the botanist who collected samples of the DE well at Fort Yukon, Alaska.

In turn, Roger has turned the name over to me, and I am enclosing a copy of my letter to him for your information

Thank you very much for your help. I hope we can either recover some samples from this botanist, or perhaps obtain the information we need on the age and depositional environment of the blue silt from the Fort Yukon well.

Sincerely,

John R. Williams
Geologist

Thanks, Roger.

A-32 Washington Auditorium

October 10, 1957

Dr. George Tulloch
Department of Biology
Brooklyn College
Bedford Avenue and Avenue H
Brooklyn 10, N. Y.

Dear Dr. Tulloch:

I have been informed by Mr. James Roy of the Geology Section, Alaska District, Corps of Engineers, that you obtained samples from a water well the Engineers were drilling at Fort Yukon, Alaska, in the fall of 1954.

In 1948-1950 the Geological Survey made a reconnaissance study of the Quaternary deposits of the Yukon Flats, the vast alluvial lowland surrounding Fort Yukon. I am now preparing the final maps and reports. Mr. Roy has kindly supplied the driller's log of this well for use in this report, but cannot furnish any samples of the materials encountered. This well is important (a) because it is the only well in the region that penetrates the surficial alluvial gravel and (b) because it extends to within 20 feet of present-day sea level without encountering hard rocks like those which form the hills surrounding the lowland.

From what we know from the driller's log, we can only postulate that the deposits of blue silt which lie beneath the alluvial gravel are quiet water deposits, possibly of marine, estuarine, or lacustrine origin. As far as age is concerned, the deposits might range from Quaternary to as far back as late Mesozoic.

It would be of great interest to me to learn whether your examination of these samples has enabled you to determine the environment of deposition (estuarine, marine, lacustrine), and whether there are microfossils that might give a clue as to the age of the blue silt from the Fort Yukon well.

Sincerely yours,

John R. Williams
Geologist

CC: files 2
James Roy
Roger Waller

Fort Yukon

John R. Williams, Military Geology
Washington, D. C.

October 8, 1957

Roger M. Waller, Ground Water
Anchorage, Alaska

Botanist who stole the samples!

I just called Jim Hoy and he gave me the name of the man who took the samples at Fort Yukon. He said that the man may not be at this address as it was a couple years ago.

The man was a botanist.
Dr. George Tulloch
Department of Biology
Brooklyn College
Bedford Ave. & Avenue H
Brooklyn 10, N. Y.

I hope your search for the information will be successful~~l~~. Let me know if I can be of further help.

I envy you and your seeing the fall colors twice. It is my favorite time of the year. We are having beautiful weather now. Nice and nippy every morning.

Thanks for your offer of help-if I may need it-on the Yukon Flats or Copper River. I hope I have the opportunity to askfor it.

Best regards
Roger

Resumé of 2/13/58

FORT YUKON

The site at Fort Yukon is near the village and east of the air strip. Hospital Lake lies near the location.

The Fort Yukon area is described in Professional Paper 264-F. Additional information adds to the knowledge of the area, as follows:

A deep hole was drilled about 2½ miles east of the village. Permafrost extended from the surface to 320 feet. Water-bearing silt (?) occurred from 390-425 feet. The material was too fine to permit developing a well. The hole was extended to 440 feet before abandoning. A test pit dug a thousand feet away from the well (near a slough) encountered thawed sand and gravel near the surface. The 20-foot pit produced 6-10 gallons per minute on testing in November and March of the 1954-55 winter. A 30-foot well was constructed near this location in 1955 and has been operating successfully since.

slough NE of school?

It appears that water might be found at shallow depths near Hospital Lake (an abandoned meander?) or similar bodies of water. Digging or jetting a well under these conditions seems feasible.

The reported 237-foot hole (p. 125 of Professional Paper 264-F) that encountered bedrock at Fort Yukon seems in error from more recent information, as given above. No additional information is available on this report.

The school at Fort Yukon has a water-intake structure in the channel of the Yukon River. Apparently much difficulty has been encountered in keeping the water from freezing and protecting the structure from flood damage. They are reported to be thinking of trying for shallow-water wells. They are located about 1000 feet from the Hospital Lake also.

[illegible]

USE ANCHORAGE ADDRESS FOR

DIVISION OF AVIATION
GLOVER BLDG., ROOM 202
ANCHORAGE, ALASKA

DIVISION OF AIR TERMINALS
P.O. BOX 6-243
ANCHORAGE, ALASKA

STATE OF ALASKA
DEPARTMENT OF PUBLIC WORKS
P.O. BOX 1361
JUNEAU, ALASKA

RICHARD A. DOWNING - COMMISSIONER

USE JUNEAU ADDRESS FOR.
DIVISION OF HIGHWAYS
DIVISION OF BUILDINGS ✓
DIVISION OF COMMUNICATIONS
DIVISION OF WATER & HARBORS
DIVISION OF PROPERTY & SUPPLY
DIVISION OF EQUIPMENT OPERATION
SOUTHEASTERN REGION

December 18, 1961

Re: Fort Yukon School Well

Mr. Roger Waller
U. S. Geological Survey
501 Cordova Building
555 Cordova Street
Anchorage, Alaska

Dear Mr. Waller:

This office is interested in the future development of a deep well for the school at Fort Yukon. As you may know, the original school obtained water through an infiltration well; however, when high water in 1959 eroded the bank, the water source was lost. An investigation revealed that there is a shallow well in the area, apparently in an old slough bed, approximately 1500 feet from the school. Sufficient potable water is available from this well; however, there has been a considerable problem of transmitting the water the approximately 1500 feet to the school.

Y-4

FY-5? or new school source

We are, therefore, interested in exploring the feasibility of a deep well on the school site, especially as related to the future expansion of the school, probably next year. We are unable to find any data indicating a well might be drilled or the probability of water at depth. We have a copy of the U. S. Geological Survey Circular No. 169 entitled "Summary of Ground Water Development in Alaska, 1950"; however, this report does not cover the Fort Yukon area. We would accordingly appreciate being advised of any information that you may have on the availability of water in the Fort Yukon area and also whether or not any subsequent publications have been issued.

Your cooperation will be greatly appreciated.

Very truly yours,

Leonard Lowell, Director
Division of Buildings

LL:sew

Central Alaska
IN REPLY REFER TO:
Fort Yukon
~~[illegible]~~

March 3, 1849

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room 501, Cordova Building
Anchorage, Alaska

December 29, 1961

Leonard Lowell, Director
Division of Buildings
Department of Public Works
P. O. Box 1361
Juneau, Alaska

Dear Mr. Lowell:

This letter is in answer to your's of December 18 regarding the feasibility of obtaining ground water from a deep well on the school site at Fort Yukon and whether there are any publications on water for that area.

Only one deep well attempt has been made in the Fort Yukon area. The Corps of Engineers drilled a hole at their site east of the village of Fort Yukon. The subsurface conditions found there probably prevail under the school site. Their report shows that ground was frozen to a depth of 390 feet. Water-bearing silty sand was encountered in the interval from 390 to 425 feet. Fifteen feet of non-water-bearing silt was encountered below. They could not develope a well in the water-bearing formation as 85% of the material passed through a 100-mesh screen. The hole was abandoned.

This test does not rule out the possibility of encountering coarser grained material at a similiar depth, or one at a greater depth, at the school site. The fact that a water-bearing formation is present is encouraging. An experienced driller with adequate equipment should be able to produce a well from this formation. Sand or gravel packing a well solves similiar situations in other parts of the U. S. If coarser material is present, a normal screened well would be adequate.

Shallow dug wells or gallery-type wells, such as was originally constructed and the one evidently supplying the school now, seem to be more practical in that area. However, they have to be constructed near the bank of the river or a side channel with the hazard of flooding and bank erosion. It is believed that the original installation was "doomed" because of removal of the vegetal cover in the area--which permitted the permafrost to thaw--which permitted the bank to erode faster. Perhaps another undisturbed site upstream (?) a little ways might provide a more economical installation to construct than trying for a deep well. Of course, a successful deep well should be less costly to operate and maintain.

There are no publications on water potential of this area that we are aware of.

Sincerely,

Roger M. Waller
Geologist in Charge
Ground Water Branch

Ft. Yukon

March 3, 1849

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room 501, Cordova Building
Anchorage, Alaska

January 15, 1962

Leonard Lowell, Director
Division of Buildings
Department of Public Works
P. O. Box 1361
Juneau, Alaska

Dear Mr. Lowell:

In reference to your letter of January 12 on ground water at Fort Yukon:

Enclosed is a copy of the Corps of Engineers well log as copied from their files by us. They gave us permission to release it to you and stated there is no report, other than the log, which would be useful to you. Mr. Willard Knoppe reported the above.

The District and we believe permafrost was <u>not</u> encountered at the 425-foot level. Regardless, the water would not be in a "pocket", because it was not highly mineralized. Generally, all "fresh" ground water can be said to have a source of recharge and a point of discharge with varying slow rates of movement between.

Sincerely,

Roger M. Waller
Geologist in Charge
Ground Water Branch

Enclosure

USE ANCHORAGE ADDRESS FOR

DIVISION OF AVIATION
GLOVER BLDG., ROOM 202
ANCHORAGE, ALASKA

DIVISION OF AIR TERMINALS
P.O. BOX 6-243
ANCHORAGE, ALASKA

STATE OF ALASKA
DEPARTMENT OF PUBLIC WORKS
P.O. BOX 1361
JUNEAU, ALASKA

RICHARD A. DOWNING - COMMISSIONER

USE JUNEAU ADDRESS FOR:
DIVISION OF HIGHWAYS
DIVISION OF BUILDINGS
DIVISION OF COMMUNICATIONS
DIVISION OF WATER & HARBORS
DIVISION OF PROPERTY & SUPPLY
DIVISION OF EQUIPMENT OPERATION
SOUTHEASTERN REGION

Rm

January 12, 1962

Re: Deep Well, Fort Yukon School

Mr. Roger M. Waller
Geologist in Charge, Geological Survey
Ground Water Branch, Water Resources Div.
Room 501, Cordova Building
Anchorage, Alaska

Dear Mr. Waller:

This will acknowledge your informative letter dated December 29 pertaining to the feasibility of the deep well in the Fort Yukon area. We note that the Corps of Engineers drilled a deep well at their site east of the village at Fort Yukon and indicated that the ground was frozen to a depth of 390 feet, with a layer of water-bearing silty sand from 390 to 425 feet.

We are wondering at this time whether or not the ground was frozen below the 425 foot depth indicating perhaps that the water-bearing strata was in a pocket or whether there was any perma frost below this level. We would also appreciate being advised on whom to contact in the Corps of Engineers to determine whether or not a report is available and in particular a copy of the well driller's log.

Any information that you could further furnish will be most helpful.

Very truly yours,

Leonard Lowell, Director
Division of Buildings

LL:ij

cc: Department of Education

ound Water Analysis
ological Survey - Anc e 19___

Lab No. [illegible]
[illegible]
(15)

State ___ ☐☐ 1 2 County ___ ☐☐ 3 4 Lat. 0 1 11 NS 5 10 11 Long. 0 1 11 12 18

Seq. No. ☐ 19 Date Coll. [illegible] 20 25 Sampling Depth 26 29 Type^c ___ 30

Well Location Ft. Yukon School
1500 hrs
Collected by ___

Owner ___ Appearance ___ WBF ___

Specific Conductance
R (KCl) 337
R Sample 1102
31 35 306

pH 36 38 7.5 | Temp °F 39 41

Silica .547 | 42 44 12 | .54

Calcium | TH 3.20 | ~~2.20~~ 2.39 | 45 49 48 | .02

Magnesium 50 53 9.9 | .81

Sodium % Na ___ 54 58 2.1 | .09

Potassium 59 61 .6 | .02

3.31
~~[illegible]~~ epm cations

2.72	HCO$_3$ 62 65 166
	CO$_3$ 66 67
.54	SO$_4$ 10ml 2.40 .90 1.50 68 72 26
.02	Cl 50ml 1.31 1.15 .16 73 78 .6
☒	Data Source^d 79 | Card Q | Q
.00	F 10ml 26 28 .0
00	NO$_3$ 2ml 1.000 29 32 .0
	PO$_4$ 33 35
3.28 epm anions	(91) % of Error 2.9

Total Alkalinity 50ml
~~[illegible]~~ 8.32
as HCO$_3$ 166
as CaCO$_3$ 136
as CO$_3$ 82

B 36 38

Al 39 41

Iron .194 Total .67 42 (dis)

Mn 46

Cu 50

Pb 53

Zn 55

Dissolved Solids 58 Residue
64 Calc 18

Hardness 70
8.50
.4
3.20
Total 160
HCO3(0.82) 136
74 Non-Carb 2

Color 78 79 110 | Card R R

ınd Water Analysis
Logical Survey - Ancho. 19___

Lab No. 11654 68-9
1925-53

:te ______ 1 2 County ______ 3 4 Lat. 0 1 11 NS 5 10 11 Long. 0 1 11 12 18

q. No. 19 Date Coll. 0 2 0 2 6 8 20 25

Sampling Depth 26 29

Type^c ______ 30

ıll Location Fort Yukon School
120 ft
from Tops

Collected by ______

WBF ______

Appearance ______

mer ______
20°C

ecific Conductance
R (KCl) 351
R Sample 1157
31 35 | 3 | 0 | 3 |

I 36 . 38 | 7 . 5 |

Temp °F 39 41

.ı:ca .555
42 44 | | | 17 |

alcium
45 44 49 [redacted]

TH 3.02
2.20 [redacted]

agnesium 10
50 53 [redacted]
.82 [redacted]

Sodium % Na ______
33.5 54 58 | | | | 9.7 |
.12

Potassium 38.5
59 61 | | 2.2 |
.06

2.72

HCO3
62 65 | | | 1 | 6 | 6 |

CO3
66 67

.52

SO4 10
2.27
.82
1.45
68 .2 | | | 2 | 5 . |

.02

Cl 50
5.97
5.78
[illegible]
.19
73 78 | | | | | .7 |

Data Source^d 79 | Card Q | Q

.01

F 10
1.944
26 28 | | .2 |

.00

NO3 2
1.006
29 32 | | | .1 |

PO4
33 35 | . |

3.20 epm cations
3.27 epm anions
92
% of Error ✓

Total Alkalinity 50
19.58
11.26
8.32
as HCO3 166
as CaCO3 136
as CO3 82

B 36 38 | . |

Al 39 41 | . |

Iron [redacted] 1.65 Total [redacted]
42 (dis) 4 | | | . |

Mn 46 49 | | . |

Cu 50 5 | | . |

Pb 53 5 | . |

Zn 55 | . |

Dissolved Solids
58 Residue
64 Calc | | | | 18

Hardness
Total 70 | | 1 | 5 |
HCO3(0.82) 136

Non-Carb 74 | | | 1 |

Color 78 79 | 1 | 0 |

Card R

F₃ Only

GW

ANALYSIS NOTES

Lab. No. 13266
USPHS

Source City Well -

Location Ft. Yukon

___ 1/4 ___ 1/4 ___ 1/4 Sec. ___ T ___ R ___ ___ Merid. Field/Office No. ___

Date coll. 1-20-70 Time ___

Coll. by Gladfelter

Field detns: Temp. (°C) ___ pH ___

Sp. cond. (μmhos) ___ Eh ___

Appearance ___

Remarks:

Well Type ___ Use ___

Depth (ft.) ___ Cased to (ft.) ___

Diam. (in.) ___ Date drilled ___

Water level (ft.) ___

Discharge ___ (93)

W. B. F. ___

Owner ___

Percent Sodium

SAR

Free CO_2

Copper (Cu)

Zinc (Zn)

Analyst Snyder

Date started 3-2-70 Date completed 3-2-70

Checked by ___ ACF ___

Send results to: Sanitarian Aide, John Thomas
U.S. Public Health Service
Fort Yukon, Alaska 99740

GW
ANALYSIS NOTES

Lab. No. 13211-69-241
USPH

Source Fort Yukon City System

Location Fort Yukon

___ 1/4 ___ 1/4 ___ 1/4 Sec. ___ T ___ R ___ ___ Merid. Field/Office No. ___

Date coll. 1-9-70 Time 11:00 a.m.

Coll. by John Thomas

Field detns: Temp. (°C) ___ pH ___

Sp. cond. (µmhos) ___ Eh ___

Appearance ___

Remarks:

Well Type ___ Use ___

Depth (ft.) ___ Cased to (ft.) ___

Diam. (in.) ___ Date drilled ___

Water level (ft.) ___

Discharge ___

W. B. F. ___

Owner ___

(94)

Percent Sodium

SAR

Free CO_2

Copper (Cu)

Zinc (Zn)

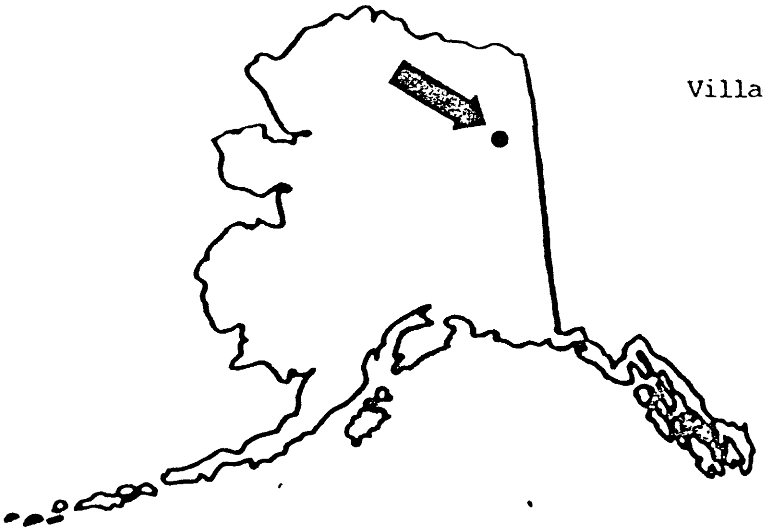
Analyst- DICK SNYDER

Date started JAN 21 1970 Date completed JAN 20 19[illegible]

Checked by ___ ACF ___

INVENTORY OF RURAL SANITATION SERVICES

JAN / 1979
Month / Year



Village: FORT YUKON

Population: 714 Class: 2ND

Region: DOYON LTD.

Number of Homes: 147

I. WATER SUPPLY

A. Domestic Water Use

Present Supply: DPW INFILTRATION GALLERY/ RAPID SAND FILTRATION/ FLOCULATION WATERING POINT/TRUCK DELIVERS TO SOME HOUSES/50 GPM FROM TWO WELLS

Adequacy of Present Supply: GOOD QUALITY AND QUANTITY DRINKING WATER/RAW WATER Fe 2.3 ppm/TDS 127 ppm/HARDNESS 147 ppm/TREATED WATER Fe .1 ppm/HARDNESS 147 ppm/TDS 193 ppm

Planned Improvements in Water Supply: PHS HAS PRELIMINARY PLANNING MONEY BUT PROJECT IS STALLED BECAUSE OF EASEMENT PROBLEMS IN VILLAGE

History of Water Supply Projects: 1973 - WATERING POINT CONTAMINATED WITH FUEL OIL - 2 NEW WELLS WERE DRILLED

B. Industrial & Institutional Use

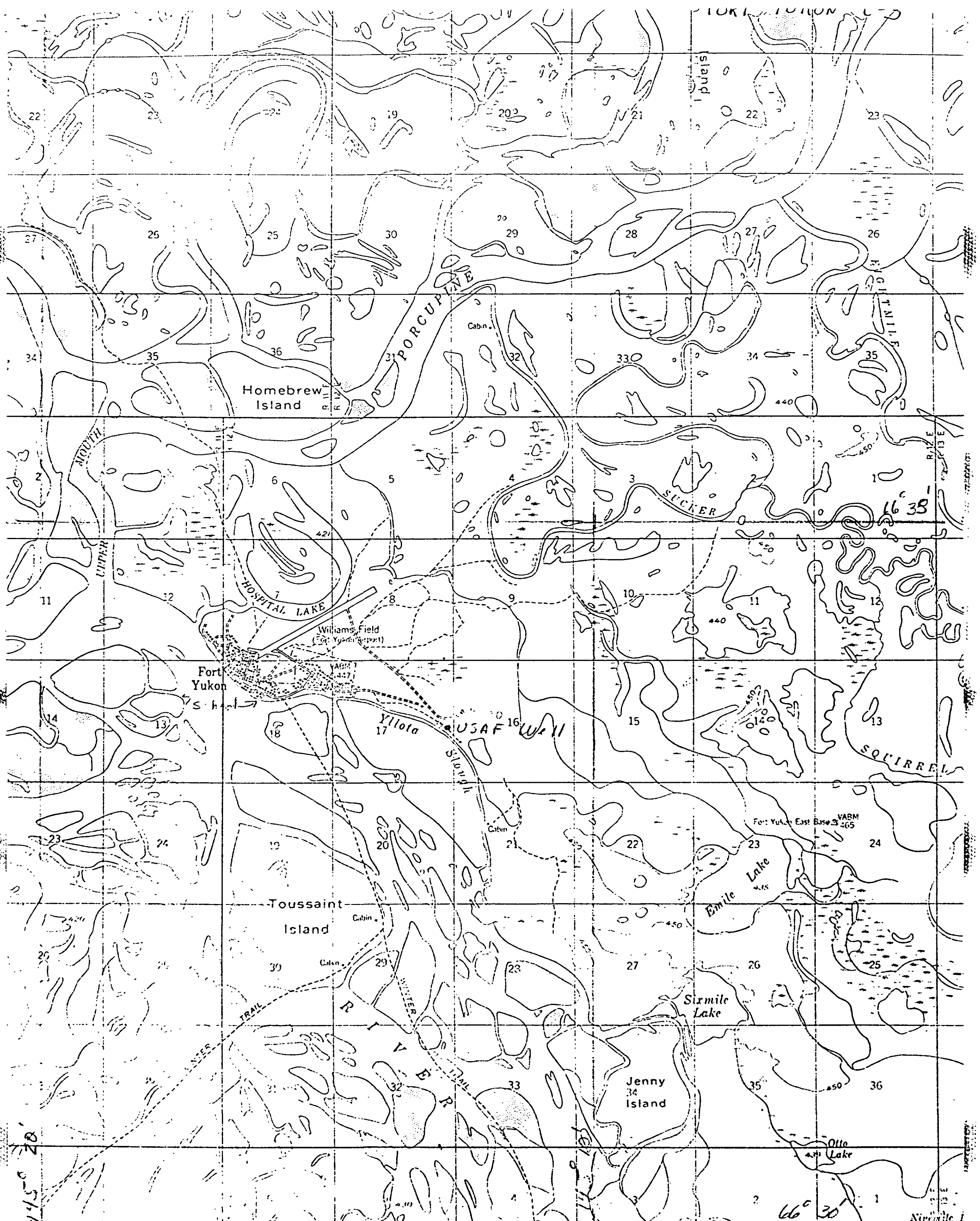
Describe User	Present Supply	Adequacy
MILITARY RESTAURANTS SCHOOL CLINIC STORES (2) OFFICE (2) CHURCHES (2)	OWN SUPPLY/COMMUNITY WATERING POINT FOR ALL OTHERS	SEE ABOVE

II. WASTE DISPOSAL

A. Solid Waste Disposal Method(s): DUMP ONE MILE OUT OF TOWN/MAINTAINED AND COVERED BY CITY

B. Domestic Sewage Disposal Method(s): FEW HONEY BUCKETS/MANY PRIVIES

C. History of Waste Disposal Projects: NO DATA


FORT YUKON C-3
Island
PORCUPINE
Homebrew Island
MOUTH
UPPER
RIVER
EIGHTMILE
Cabin
SUCKER
66° 35'
HOSPITAL LAKE
Williams Field (Fort Yukon Airport)
Fort Yukon
School
YABM 447
Yllota Slough
USAF Well
SQUIRREL
Fort Yukon East Base 3
YABM 465
Emile Lake
Toussaint Island
WINTER TRAIL
RIVER
Sixmile Lake
Jenny Island
Otto Lake
145° 20'
66° 30'
Ninemile I
FORT YUKON B-3
R 12 E
R 13 E
440
450
421
420
430
22
23
24
19
20
21
27
26
25
30
29
28
34
35
36
31
32
33
2
1
6
5
4
3
11
12
7
8
9
10
14
13
18
17
16
15
24

2GW

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER ANALYSIS

Location Fort Yukon County
Source Depth (ft) Diam (in.)
Cased to (ft) Date drilled Point of coll.
Owner
Treatment Use
WBF WL Yield
Temp (°F) Appear. when coll.
Collected Feb 6, 1973 By
Remarks

	mg/1	me/1		mg/1	me/1
Silica (SiO_2) dissolved	9.2		Bicarbonate (HCO_3)	85	1.39
Aluminum (Al)			Carbonate (CO_3)	0	.00
Iron (Fe) dissolved	.009				
Manganese	.340		Sulfate (SO_4)	140	2.91
			Chloride (Cl)	2.7	.07
			Fluoride (F)	.1	.006
Calcium (Ca)	49	2.44	SAR	.1	
Magnesium (Mg)	13	1.07	Nitrate (NO_3) as N dis	.06	.005
Sodium (Na) Diss	4.3	.18	Phosphate dis ortho	.00	
Potassium (K) Diss	2.5	.06	Sodium percent	5	
			Phos ortho dis as P	.00	
Total		3.76	**Total**		4.39

	mg/1		
Dissolved solids:		Specific conductance (micromhos at 25° C)	417
Calculated	263	pH	6.7
Residue on evaporation at 180°C		Color	1
Hardness as $CaCO_3$	180		
Noncarbonate	110		
Alk as $CaCO_3$	70		

Lab. No. Col 16439 Field No. Project USPHS

```
                  UNITED STATES DEPARTMENT OF THE INTERIOR
                             GEOLOGICAL SURVEY
                    CENTRAL LABORATORY, DENVER, COLORADO

                         WATER QUALITY ANALYSIS
                    LAB ID # 212020 RECORD # 24137                                    MAIL TO FAIRBANKS
                                                                                      SCHEDULES USED:  1
SAMPLE LOCATION: FA02001117BCBB001  51574                                             NUMBER OF DETERMIN
STATION ID: 663337145143201    LAT.LONG.SEQ.: 643337 1451432 01                       COST OF ANALYSIS $
DATE OF COLLECTION: BEGIN--760622  END--            TIME--1630                        SUBMIT CORRECTIONS
STATE CODE: 02 COUNTY CODE: 250 PROJECT IDENTIFICATION: 470200370                       WITHIN 15 DAYS F
DATA TYPE: 2  SOURCE: GROUND WATER          GEOLOGIC UNIT:                              CENTRAL LAB ID #
COMMENTS:                                                                             WRD-QW FILE STORAG
   FT YUKON ALASKA MUNICIPAL WELL                                                       STATION HEADING
                                                                                        HEADER FILE WAS

ALK.TOT (AS CACO3)     MG/L      136    MANGANESE DISSOLVED  UG/L      480
ARSENIC DISSOLVED      UG/L        6    NO2+NO3 AS N DISS    MG/L        0.25
BARIUM DISSOLVED       UG/L      200    PHOS ORTHO DIS AS P  MG/L        0.08
BICARBONATE            MG/L      166    PHOSPHATE DIS ORTHO  MG/L        0.25
CADMIUM DISSOLVED      UG/L        0    POTASSIUM DISS       MG/L        1.8
CALCIUM DISS           MG/L       44    RESIDUE DIS CALC SUM MG/L      180
CHLORIDE DISS          MG/L        0.8  RESIDUE DIS TON/AFT                0.24
CHROMIUM DISSOLVED     UG/L        0    SAR                                0.1
COLOR                             18    SELENIUM DISSOLVED   UG/L        0
COPPER DISSOLVED       UG/L        2    SILICA DISSOLVED     MG/L       12
FLUORIDE DISS          MG/L        0.1  SILVER DISSOLVED     UG/L        0
HARDNESS NONCARB       MG/L       14    SODIUM DISS          MG/L        2.6
HARDNESS TOTAL         MG/L      150    SODIUM PERCENT                   4
IRON DISSOLVED         UG/L     2200    SP. CONDUCTANCE LAB            301
LEAD DISSOLVED         UG/L        2    SULFATE DISS         MG/L       23
MAGNESIUM DISS         MG/L        9.8  ZINC DISSOLVED       UG/L      240

                                                       ANIONS
                 CATIONS
                                                        (MG/L)        (MEQ/L)
                 (MG/L)       (MEQ/L)                   166             2.721
CALCIUM DISS       44           2.196 BICARBONATE         0.8           0.023
MAGNESIUM DISS      9.8         0.807 CHLORIDE DISS       0.1           0.006
POTASSIUM DISS      1.8         0.047 FLUORIDE DISS      23             0.479
SODIUM DISS         2.6         0.114 SULFATE DISS        0.25          0.018
                                      NO2+NO3 AS N D
```

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE Ft Yukon

Date ...., 19...... Field No. 22½

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

Source of data CE St Paul 1948 Inves. AF Constr. Arctic + Subarctic area

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

Map 122 ft E of CAA Weather Sta Bldg

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

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

Tenant .... Address ....

Driller .... Address ....

3. *Topography* flat - grassy

4. *Elevation* 417 ft. above/below ....

5. *Type:* Dug, [✓ drilled], driven, bored, jetted 7/11-14 1946

6. *Depth:* Rept. 22½ ft. Meas. .... ft.

7. *Casing:* Diam. 2" iron pipe 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.) ....

....

....

0 - 1½ silt loam
1½ - 5 loam
5 - 6 silt loam
6 - 7½ gravel + sand

7½ - 10 sand + gravel

~~10 - 18~~ sand
10 - 22½
~~18~~

frozen ground @ 5.2 feet

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Fort Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 25

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

Source of data DE Memo 16 Aug 55 - DE files

1. *Location:* State Tanana Sta County Ft Yukon
Map north of runway + aircraft parking area
.......¼ ....¼ sec. .... T .... N/S R .... E/W

2. *Owner:* USAF Address ......
Tenant Tanana Sta Address Ft Yukon
Driller ...... Address ......

3. *Topography* ......

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

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

6. *Depth:* Rept. 75 ft. Meas. ...... ft.

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

(100)

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.) Over

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

0-1½ ft silty sand + roots

1½-6 ft thawed non-frost susceptible silty sand

6-75 ft frozen non-frost susceptible silty sand.

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE
Date May 22, 1958, 19 Field No. FY-1
Record by P.R.Lord Office No.
Source of data Bulletin 872, p.16

1: *Location:* State Alaska ~~County~~ Central
Map
¼ ¼ sec. T N/S R E/W
2. *Owner:* Address Ft. Yukon
Tenant Address
Driller Address
3: *Topography*
4. *Elevation* ft. above/below
(101)
5. *Type:* Dug, drilled, driven, bored, jetted 1935+
6. *Depth:* Rept. 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.) Reported bedrock at 237'
Drill hole

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE
Date 4/4/63, 19 Field No. FY-[illegible]
Record by M Office No.
Source of data USPHS Rept #2

1: *Location:* State ALASKA County C
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. 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.) USPHS Rept P 18

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date March 18, 1959, 19...... Field No. FY-2

Record by P.R.Lord Office No. ......

Source of data data copied from D.E.files-RW

1. *Location:* State Alaska ~~County~~ Central
   Map Fort Yukon (C-3)
   ...... ¼ ...... ¼ sec. ...... T ...... N/S R ...... E/W
2. *Owner:* U.S.Army (D.E.) Address Fort Yukon
   Tenant ...... Address 2½ miles from village
   Driller District Engineers Address ......
3. *Topography* terrace (?)
4. *Elevation* ...... ft. above/below
5. *Type:* Dug, [✓ drilled], driven, bored, ~~jetted~~ Summer 1954
6. *Depth:* Rept. 440 ft. Meas. ...... ft.
7. *Casing:* Diam. (see back) in., to ...... in. Type ......
   Depth ...... ft., Finish ......
8. *Chief Aquifer* Water From 390 ft. to 425 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 W-B material too fine to develop
13. *Quality* ...... Temp ...... °F.
    Taste, odor, color ...... Sample Yes/No
    Unfit for ......
14. *Remarks:* (Log, Analyses, etc.) (Over) Hole abandoned
    Pollen samples collected - see info file

(102)

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

Well located near site of powerplant
Log:

48 ft
100 ft

Material	Thickness	Depth
Silty sand	46	46
Frozen sandy gravel	102	148
(Frozen) impervious silt	172	320
Impervious silt	70	390
Silty sand (water)(heaved 100' in casing)	35	425
Silt (water shut off)	15	440

at 115' casing froze tight-24 hrs. to thaw out
at 210' drive sample-grey silt with thin clear ice lenses.

Started hole with 6" casing - couldn't drive beyond 335'
Second hole 8" casing to 148'
6" casing to 380'
4" casing to 425'

.0058"

Water-bearing material mechanical analysis 85% pass #100 (~~30~~)
15% " #200

.0029"

Hole abandoned.

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date March 18, 1959, 19 Field No. FY-3

Record by P.R.Lord Office No.

Source of data data dopied from DE files-RW 2/12/58

1: *Location:* State Alaska ~~County~~ Central

Map

¼ ¼ sec. T N/S R E/W

2. *Owner:* U.S.Army (DE) Address Fort Yukon, Alaska

Tenant Address

Driller District Engineers Address

3: *Topography* ~~terrace~~ bank, slough

4. *Elevation* ft. above/below

5. *Type:* [✓ Dug], drilled, driven, bored, jetted Nov 1954

6. *Depth:* Rept. 20 ft. Meas. ft.

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

Depth ft., Finish

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

Others

X 9. *Water level* 8 ft. [✓ rept.] meas. 19 above/below

which is ft. above/below surface

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

Power: Kind Horsepower

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

Drawdown 3 ft. after 12 hours pumping 10 G. M.

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

Adequacy, permanence

13. *Quality* Temp 33° °F.

Taste, odor, color Sample [✓ Yes] No DE# 10219

Unfit for

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

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

Location: 900' SSE of deep hole, 10' north of slough, 1½ miles downstream from junction of slough and river

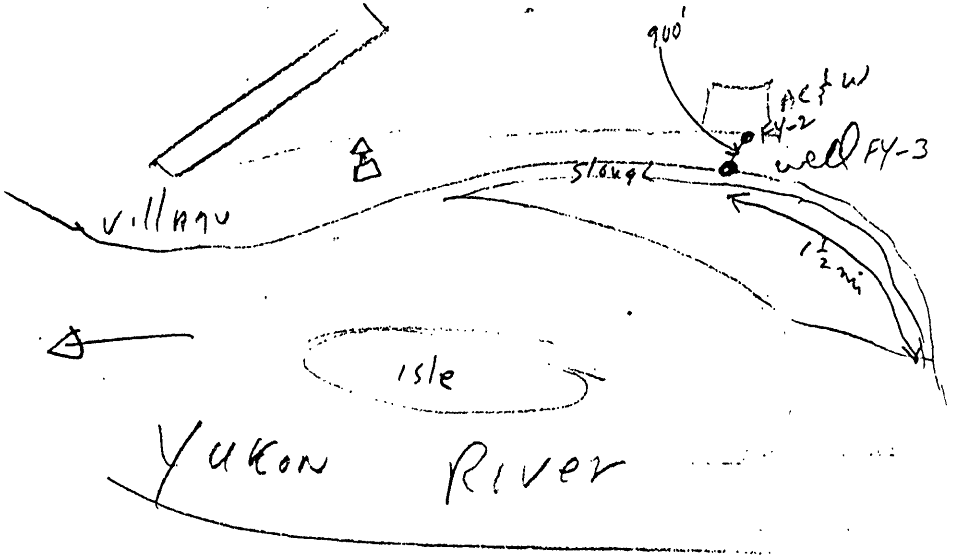
Log:

Material	Thickness	Depth
Silt, tan (vegetal material to 4')	5'4"3	5'4"3
Silt, blue-grey (thawed)	3	8'4"3
Coarse gravel with cobbles(¼" ave.size)	3'3"	11'7"
(probed) sand, fine	8'5"	20'

(Froze to 16"and from 4' to 5'4")
Hit water at 9'6"

Land surface is 15-25' above slough bed.

March 1955, test pit repoened.
Water level 8 1/3', 1 1/3'dd after 15 hours @ 6½ gpm. recovered in few minutes. Temperature 33°F. Conclusions that shallow well feasible near-slough where thawed areas are-in the coarse material. Evident that gravels are present throughout the Ft. Yukon area and on the river bottom.



9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date May 22, 1959, 19 Field No. FY-4
Record by P.R.Lord Office No.
Source of data RW notes 6/12/57 pers obs

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

2. *Owner:* Alaska Dept. of Ed. Address Ft. Yukon
Tenant Address
Driller Layne ? Address

3: *Topography* River bank

4. *Elevation* ft. above/below

5. *Type* [✓ Dug], drilled, driven, bored, jetted ~~Nov~~ Oct 19 ~~57~~ 55

6. *Depth:* Rept. 15± ~~60~~ ft. Meas. ft.

7. *Casing:* Diam. 3±' ~~in.~~, to in., Type
Depth ft., Finish gravel filled caisson

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

9. *Water level* river 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.

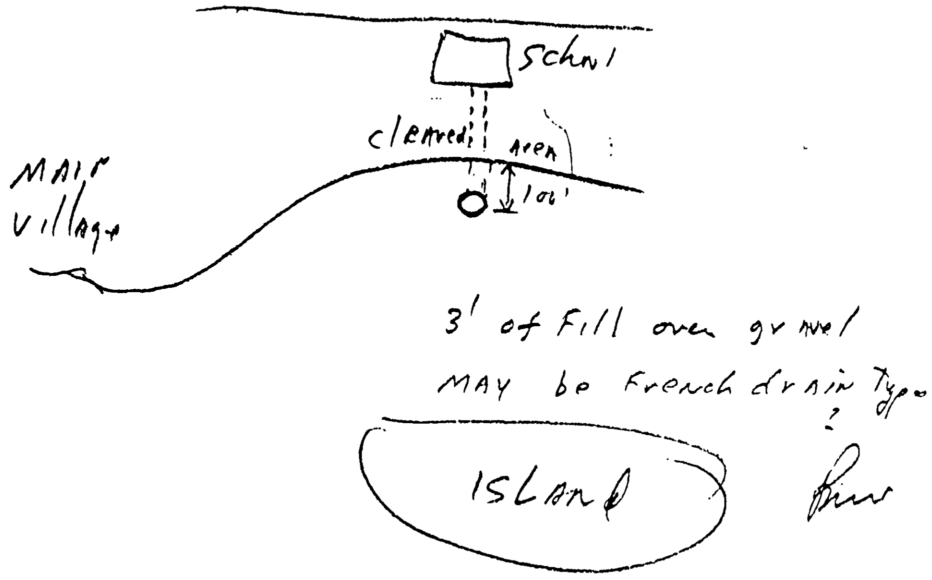
12. *Use:* Dom., Stock, [✓ PS], RR., Ind., Irr., Obs.
Adequacy, permanence Freeze up 1956-57 - unused

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

14. *Remarks:* (Log, Analyses, etc.) [redacted]
11-1-57 Dept of Ed (Isaacs) says river ice threatening Dept Ed
5/21/59 well washed out last week repts Lowell (Ed.

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

(104)



3' of fill over gravel
MAY be French drain type ?

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Fort Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 25

Record by TRO EIS 274 1960 Office No. ....

Source of data 929th Engr. Airfield Bn. rept. 1947
& 7 Mar. (plan on file Wash. DC AT Pd (Gr))

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

2. *Owner:* .... Address ....
   Tenant .... Address ....
   Driller 929th Engr. Address ....
3. *Topography* Alluvial plain [illegible]
4. *Elevation* ±425.47 ft. above/below ....
5. *Type:* Dug, [✓ drilled], driven, bored, jetted June 20-25 1947
6. *Depth:* Rept. 25 ft. Meas. .... ft.
7. *Casing:* Diam. ...... in., to ...... in., Type ......
   Depth ...... ft., Finish ....
8. *Chief Aquifer* None 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.) 0-2½ sand + silt,
    2½ to 25 ft fine gravel. Permafrost to 25 ft

(105)

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Ft Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 40

Record by TRW EIS 274 1960 Office No. ......

Source of data 925th Engrs airfield site dept 1947

[illegible]

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

Map ....

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

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

Tenant .... Address ....

Driller 925th Engrs Hillman [illegible] drill Address ....

3. *Topography* ....

4. *Elevation* 434.8 ft. above/below ....

5. *Type:* Dug, [✓ drilled], driven, bored, jetted June 27-30 1947

6. *Depth:* Rept. 40 ft. Meas. ...... ft.

(406)

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

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

8. *Chief Aquifer* None 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.) 0 - ? silt sand; ? to 25 ft fine gravel; 25-40 feet medium gravel
Permafrost to 40 feet

U. S. GOVERNMENT PRINTING OFFICE 10—62891-1

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Fort Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 89

Record by TRW EIS 274 1960 Office No. ......

Source of data 925th Engrs airfield site dept 1947

E of town - plans on file Wash. D.C.: AT+P files

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

Map ....

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

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

Tenant .... Address ....

Driller 925th Engrs Hillman [illegible] Address ....

3. *Topography* ....

4. *Elevation* 415.5 ft. above/below ....

5. *Type:* Dug, [✓ drilled], driven, bored, jetted June 13-25 1947

6. *Depth:* Rept. 89 ft. Meas. ...... ft.

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

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

8. *Chief Aquifer* None 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.) 0-3½ ft sand + silt
3½ to 89 ft fine gravel
Permafrost to 89 feet

U. S. GOVERNMENT PRINTING OFFICE 10 [illegible]

14

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Ft. Yukon

WELL SCHEDULE

Date Nov 21, 19 61 Field No. FY-5?

Record by

Office No.

Source of data Water Sources used by USAF in Alaska

1. Location: State ALASKA ~~County~~ CENTRAL
Map Fort Yukon (C-3)
¼ ¼ sec. T N/S R E/W
2. Owner: USAF Address Ft. Yukon
Tenant Address
Driller ? Address
3. Topography Terrace(?)
4. Elevation 410' ft. above ~~below~~ SL
5. Type: Dug, drilled, driven, bored, jetted 19
6. Depth: Rept. 18 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 other info (see old [illegible]!!)

(107)

U. S. GOVERNMENT PRINTING OFFICE 16—62801-1

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date 2-12 (data obtained), 19 58 Field No. FY-5

Record by RMW Office No.

Source of data F. Russell (C of E)

1. Location: State Alaska ~~County~~ Western
Map Fort Yukon (C-3)
¼ ¼ sec. T N/S R E/W
2. Owner: U. S. Air Force Address
Tenant Address
Driller Address
3. Topography slough bank
4. Elevation ft. above/below
5. Type: Dug, drilled, driven, bored, jetted Nov 1957
6. Depth: Rept. 60 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. ~~[illegible]~~
Adequacy, permanence lots of water – AC&W
13. Quality Temp °F.
Taste, odor, color Sample Yes No
Unfit for
14. Remarks: (Log, Analyses, etc.) located in vicinity of C of E test pit (FY-3)
all thawed

U. S. GOVERNMENT PRINTING OFFICE 16—62801-1

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date 12-27, 1961 Field No.
Record by R.M. Walker Office No.
Source of data letter from Dept of Ed 12-

1: *Location:* State alaska ~~County~~ Central
Map Fort Yukon (C-3)
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. shallow 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. supplies school
Adequacy, permanence
13. *Quality* Temp °F.
Taste, odor, color Sample Yes/No
Unfit for
14. *Remarks:* (Log, Analyses, etc.) 1500' from school

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Ft Yukon

WELL SCHEDULE

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

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

Source of data ....

1. *Location:* State .... County ....
   Map ....
   .... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* Don Schulz Address Broadmoor Acres Ft Yukon
   Tenant .... Address ....
   Driller K Hatch Address Fa
3. *Topography* fl
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, [✓ drilled], driven, bored, jetted ...... 19....
6. *Depth:* Rept. 147 ft. Meas. .... ft.
7. *Casing:* Diam. 3 in., to ...... in., Type ....
   Depth 147 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.) 120 ft heat tape

(109)

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

0 - 8	gravel sand
8-10	gravel sand water
10-116	frozen gravel sand
116-146	sand water
146-147	sand gravel water

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Ft Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 72

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

Source of data driller

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

Map ....

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

2. *Owner:* J P Rego Co. Address Lt 16 Blk 3 Ft Yukon

Tenant .... Address ....

Driller K Hatch Address Fx

3. *Topography* ....

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

5. *Type:* Dug, [✓ drilled], driven, bored, jetted 8/22 1963

6. *Depth:* Rept. 72 ft. Meas. .... ft.

7. *Casing:* Diam. 4 in., to .... in., Type ....

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

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

Others ....

9. Static *Water level* 9 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 5 hours pumping 20 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.) ....

	0-3	gravel-silt fill
frozen	3-18	silt sand
	18-22	sand gravel
	22-32	sand
	32-48	sand gravel
	48-59	gravel sand
	59-70	sand water wood leaves
	70-72	sand gravel water

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Ft Yukon

WELL SCHEDULE

Date ...., 19...... Field No. 132
Record by .... Office No. ....
Source of data driller

1. *Location:* State .... County ....
Map ....
.... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* Howard Graves Address Copper St. Ft Yukon
Tenant .... Address ....
Driller K Hatch Address Fa
3. *Topography* ....
4. *Elevation* .... ft. above/below .... 63?
5. *Type:* Dug, [✓ drilled], driven, bored, jetted .... 19......
6. *Depth:* Rept. 132 ft. Meas. .... ft.
7. *Casing:* Diam. 4 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.) ....

(111)

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

0-17 sand silt
17-130 frozen sand gravel
130-132 sand gravel water

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date Sept 10 - 63, 19 Field No.
Record by VM Office No.
Source of data DRILLERS LOG

1. *Location:* State ALASKA County Ft. YUKON
Map
¼ ¼ sec. T N/S R E/W
2. *Owner:* J. P. REGO Address LOT 16, BLK 3
Tenant Address
Driller K. HATCH Address FBX
3. *Topography*
4. *Elevation* ft. above/below
5. *Type:* Dug, [✓ drilled], driven, bored, jetted 8/22 19 63
6. *Depth:* Rept. 72 ft. Meas. ft.
7. *Casing:* Diam. 4 in., to in., Type
Depth ft., Finish
8. *Chief Aquifer* From ft. to ft.
Others
9. *Water level* 9 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.)

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

(112)

0-3' -	THAWED	GR-SI - FILL
3-18' -	FROZEN	SI-SA
18-22' -	"	SA-GR
22-32' -	"	SA
32-48' -	"	SA-GR
48-59' -	"	GR-SA
59-70' -	THAWED	SA - WATER, WOOD + LEAVES
70-72' -	"	SA-GR WATER

STATIC WATER - 9'
PUMPED 5 HR - 1200 GPH

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date 9/10/63, 19...... Field No. ......

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

Source of data DRILLERS LOG

1. *Location:* State ALASKA County FT. YUKON
   Map ......
   ...... ¼ ...... ¼ sec. ...... T ...... N S R ...... E W
2. *Owner:* JACK RILEY Address FT. Y
   Tenant ...... Address ......
   Driller K. HATCH Address FBX
3. *Topography* ......
4. *Elevation* ...... ft. above below ......
5. *Type:* Dug, [✓ drilled], driven, bored, jetted 9/7 1963
6. *Depth:* Rept. 66 ft. Meas. ...... ft.
7. *Casing:* Diam. ...... in., to ...... in., Type ......
   Depth ...... ft., Finish ......
8. *Chief Aquifer* ...... From ...... ft. to ...... ft.
   Others ......
9. *Water level* 11 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.) ......

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

(113)

0-42' - THAWED - SI
42-56' - " SI - TR - ROCK
56-65' - " ROCK - WATER
~~65-66~~
65-66' - " ROCK + WATER

PUMPED 1 HR - 10 GPM, CLEARED UP IN 10 MIN - GOOD WATER

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date ~~10~~ 7/16/63, 19...... Field No. ......
Record by M ...... Office No. ......
Source of data DRILLERS LOG

1. *Location:* State ALASKA County Ft. Yukon
Map ......
...... ¼ ...... ¼ sec. ...... T ...... N/S R ...... E/W
2. *Owner:* J. P. REGO Address Lot 6+5 BLK-3
Tenant ...... Address ......
Driller R. HATCH Address FBX
3. *Topography* ......
4. *Elevation* ...... ft. above/below ......
5. *Type:* Dug, [✓ drilled], driven, bored, jetted 9/4 19 63
6. *Depth:* Rept. 46 ft. Meas. ...... ft.
7. *Casing:* Diam. 4 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.) ......

0-3' - THAWED - SD'
3-5' - FROZEN - SD
5-10' - " SI-GR
10-16' - " SA-GR
16-36' - " SA-GR
36-42' - THAWED SA
42-45' - " SA
45-46' - " SA-GR- WATER

CLEANED UP, IN 10 MIN 1200 GPH
PUMPED 3 HRS

60' HEAT TAPE

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

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date SEPT 10 - 63, 19...... Field No. ....

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

Source of data DRILLERS LOG

1. *Location:* State ALASKA County Ft, Yukon
   Map ....
   .... ¼ .... ¼ sec. .... T .... N/S R .... E/W
2. *Owner:* J. P. RiGo Address Lot 304, BLK 1
   Tenant .... Address ....
   Driller K. HATCH Address FBX
3. *Topography* ....
4. *Elevation* .... ft. above/below ....
5. *Type:* Dug, [✓ drilled], driven, bored, jetted 8 19 63
6. *Depth:* Rept. 67 ft. Meas. .... ft.
7. *Casing:* Diam. 4 in., to .... in., Type ....
   Depth .... ft., Finish ....
8. *Chief Aquifer* .... From .... ft. to .... ft.
   Others ....
9. *Water level* 8 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.) ....

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

(115)

0-2' - THAWED - SI
2-8' - FROZEN - SA - SI
8-12' - " SA - GR
12-37' - " SA - GR
37-55' - " SA - GR
55-62' - " SA
62-66' - " SA - GR
66-67' - THAWED SA - GR - WATER

PUMPED 1200 GPH - NO SAND
STATIC - 8'

9–185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date SEPT 10 63, 19 Field No.

Record by M Office No.

Source of data DRILLERS LOG

1. *Location:* State ALASKA County FB, YUKON

Map

¼ ¼ sec. T N/S R E/W

2. *Owner:* J. P. REGO Address Block 1-Lot 10

Tenant Address

Driller K. HATCH Address FBX

3. *Topography*

4. *Elevation* ft. above/below

5. *Type:* Dug, [✓ drilled], driven, bored, jetted 8/28 1963

6. *Depth:* Rept. 46 ft. Meas. ft.

7. *Casing:* Diam. 4 in., to in., Type

Depth ft., Finish

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

Others

9. *Water level* 8 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.)

(116)

0-1' – THAWED – SI

1-8' – FROZEN – SI

8-14' – " SA – GR

14-20' – " SA

20-24' – " ~~GR~~ GR-SA

24-29' – " SA-GR

29-35' – THAWED SA WATER

35-42' – " GR-SA- WATER

PUMPED 15 HR MAKING SAND

42-46' – THAWED SA-GR – WATER

CLEANED W/ FAST, NO SAND

1200 GPH – 2 HEAT TAPES CHARGED to

this-WELL – 160' + 80'

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date Sept 10 63, 19...... Field No. ......

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

Source of data DRILLERS LOG

(117)

1. *Location:* State ALASKA County FT. YUKON

Map ......

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

2. *Owner:* DON SCHULZ Address BROADMOOR ACRES

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

Driller K. HATCH Address F.BX

3. *Topography* ......

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

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

6. *Depth:* Rept. 147 ft. Meas. ...... ft.

7. *Casing:* Diam. 3 in., to ...... in., Type ......

Depth 147 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.) ......

0-8'	THAWED	GR-SA
8-10' -	"	GR-SA - WATER
10-116' -	FROZEN	GR-SA
116-146' -	THAWED	SA- WATER
146-147' -	THAWED	SA-GR - "

120' HEAT TAPE

9-185
(October 1950)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date Sept 10 63, 19...... Field No. ......

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

Source of data Drillers Log

1. *Location:* State Alaska County Ft. Yukon

Map ......

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

2. *Owner:* Howard Graves Address Copper St. Ft. Y

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

Driller K. Hatch Address FBX

3. *Topography* ......

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

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

6. *Depth:* Rept. 132 ft. Meas. ...... ft.

7. *Casing:* Diam. 4 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.) ......

(118)

0-17' Thawed SA-SI
17-130' Frozen SA-GR
130-132' Thawed SA-GR Water

APPENDIX 5

Alaska Department of Environmental Conservation

ground-water quality data from the public water supply system at Fort Yukon

```
SECONDARY TEST RESULTS
PAGE 1
14 JUN 1994
PWSID. priname....................... smpldate labnum.... C... C.. C.... F...... F... I... M.... O.. p.. S... S... T... Z.. LOCATION..
                                                          H    O   O     L       O    R    A     D   H   O    U    D    I
                                                          L    L   R     U       A    O    N     O       D    L    S    N
                                                          O    O   R     O       M    N    G     R       I    F         C
                                                          R    R   O     R       I         A             U    A
                                                          I        S     I       N         N             M    T
                                                          D        I     D       G         E                  E
                                                          E        V     E       -         S
                                                                   I             A         E
                                                                   T             G
                                                                   Y             E
                                                                                 N
                                                                                 T
                                                                                 S

Zero Records Processed
```

```
INORGANIC TEST RESULTS (UG/L)
PAGE 1
14 JUN 1994
PWSID. SYSTEM........................ SAMPLE.. A.... B.... C.... C.... F.... M.... N.... N.... N N.. S.... 9.... 9.... location.......
        NAME                           DATE    R     A     A     H     L     E     I     I     I I   E     O     O
                                               S     R     D     R     U     R     T     T     T T   L     L     C
                                               E     I     M     O     O     C     R     R     R+R   E     E     O
                                               N     U     I     M     R     U     A     I     A I   N     A     P
                                               I     M     U     I     I     R     T     T     T T   I     D     P
                                               C           M     U     D     Y     E     E     E E   U           E
                                                                 M     E                             M           R

360256 Ft. Yukon Public Water System  03-11-80
360256 Ft. Yukon Public Water System  09-25-85 <5    200   <5    <50   110   <.2   200               <2                CITY BUILDING
360256 Ft. Yukon Public Water System  05-01-89 2.0   <50   <5    <5    1700  0.3   <500              5
360256 Ft. Yukon Public Water System  04-05-93 ND    191   0.1   ND    1080  ND    100   ND    100   6.0               CITY BLDG
360256 Ft. Yukon Public Water System  04-11-94                                     160   100   260                     CITY BLDG
```

```
KEY TO ABREVIATIONS

ND = NOT DETECTED
NT = NO TEST
```

```
PAGE    1                                                           14:19:42  14 JUN 1994
PWSID. SYSTEM NAME.................. SAMPLE....  LAB...... LOCATION............ EPA.......
                                      DATE      NUMBER                        METHOD
                                                                              NUMBER
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .
                                                                               .

360256 Ft. Yukon Public Water System 08-12-91   A113251    GROUND WATER WELL   502.2
360256 Ft. Yukon Public Water System 11-05-91   A115219                        502.2
360256 Ft. Yukon Public Water System 03-02-92   A116423    UNLISTED            502.2
360256 Ft. Yukon Public Water System 06-22-92   A118338    CITY BUILDING       502.2

4 Records Processed
```

```
PAGE    1                                                                                                  14:19:45  14 JUN 1994
B......... B......... B......... B......... B......... B......... N......... S......... T......... C......... C......... C.........
E          R          R          R          R          R          -          E          E          A          H          H
N          O          O          O          O          O          B          C          R          R          L          L
Z (1)      M          M          M THM      M THM      M          U          -          T          B (1)      O (2)      O THM
E 5.0      O          O          O          F          O          T          B          -          O 5.0      R 100.     R
N          B          C          D          O          M          Y          U          B          N          O          O
E          E          H          I          R          E          L          T          U          -          B          D
           N          L          C          M          T          B          Y          T          T          E          I
           Z          O          H                     H          E          L          Y          E          N          B
           E          R          L                     A          N          B          L          T          Z          R
           N          O          O                     N          Z          E          B          R          E          O
           E          M          R                     E          E          N          E          A          N          M
                      E          O                                N          Z          N          C          E          O
                      T          M                                E          E          Z          H                     M
                      H          E                                           N          E          L                     E
                      A          T                                           E          N          O                     T
                      N          H                                                      E          R                     H
                      E          A                                                                 I                     A
                                 N                                                                 D                     N
                                 E                                                                 E                     E

ND         ND         ND         .3         ND         ND         ND         ND         ND         ND         ND         ND
.3         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         0.4        ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         0.3        ND         ND         ND         ND         ND         ND         ND         ND

4 Records Processed
```

121

```
PAGE     1                                                                                                  14:19:48  14 JUN 1994
C......... C......... C......... 1......... O......... P......... D......... 1......... M......... O......... D......... 1.........
H          H          H          2          -          -          I          4          -          -          I          1
L          L          L          D          C          C          B          D          D          D          C          D
O          O THM      O          I          H          H          R          I (1)      I          I (2)      H          I
R          R          R          B          L          L          O          C 75.0     C          C 600.     L          C
O          O          O          R          O          O          M          H          H          H          O          H
E          F          M          O          R          R          O          L          L          L          R          L
T          O          E          M          O          O          M          O          O          O          O          O
H          R          T          O          T          T          E          B          R          R          D          R
A          M          H          3          O          O          T          E          O          O          I          O
N                     A          C          L          L          H          N          B          B          F          E
E                     N          H          U          U          A          Z          E          E          L          T
                      E          L          E          E          N          E          N          N          U          H
                                 O          N          N          E          N          Z          Z          O          A
                                 R          E          E                     E          E          E          R          N
                                 O                                                      N          N          O          E
                                 P                                                      E          E          M
                                 R                                                                            E
                                 O                                                                            T
                                 P                                                                            H

ND         4.6        ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         10.0       ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         11.0       ND         ND         ND         ND         ND         ND         ND         ND         ND

4 Records Processed
```

```
PAGE     1                                                                                      14:19:52  14 JUN 1994
1......... 1......... C......... T......... D......... 1......... 1......... 2......... 1......... 1.........
2          1          I          R          I          2          3          2          1          3
D          D          S          A          C          D          D          D          D          D
I (1)      I (1)      1  (2)     N (2)      H          I (2)      I          I          I          I
C 5.0      C 7.0      2  70.0    S 100      L          C 5.0      C          C          C          C
H          H          D          1          O          H          H          H          H          H
L          L          I          2          R          L          L          L          L          L
O          O          C          D          O          O          O          O          O          O
R          R          H          I          M          R          R          R          R          R
O          O          L          C          E          O          O          O          O          O
E          E          O          H          T          P          P          P          P          P
T          T          R          L          H          R          R          R          R          R
H          H          O          O          A          O          O          O          O          O
A          Y          E          R          N          P          P          P          P          P
N          L          T          O          E          A          A          A          E          E
E          E          H          E                     N          N          N          N          N
           N          Y          T                     E          E          E          E          E
           E          L          H
                      E          Y
                      N          L

ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND

4 Records Processed
```

```
PAGE    1                                                                                         14:19:55  14 JUN 1994
E......... E......... F......... H......... I......... P......... N......... N......... S......... 1......... 1.........
T          T          L          E          S          -          A          -          T          1          1
H          H          U          X          O          I          P          P          Y          1          2
Y (2)      Y          O          A          P          S          H          R          R (2)      2          2
L 700.     L          R          C          R          O          T          O          E 100.     T          T
B          E          O          H          O          P          H          P          N          E          E
E          N          T          L          P          R          A          Y          E          T          T
N          E          R          O          Y          O          L          L                     R          R
Z          -          I          R          L          P          E          B                     A          A
E          D          C          O          B          Y          N          E                     C          C
N          I          H          B          E          L          E          N                     H          H
E          B          L          U          N          T                     Z                     L          L
           R          O          T          Z          O                     E                     O          O
           O          R          A          E          L                     N                     R          R
           M          O          D          N          U                     E                     O          O
           I          M          I          E          E                                           E          E
           D          E          E                     N                                           T          T
           E          T          N                     E                                           H          H
                      H          E                                                                 A          A
                      A                                                                            N          N

ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         6.6        ND         ND         ND         ND         ND         ND         ND         ND

4 Records Processed
```

```
PAGE    1                                                                    14:19:58  14 JUN 1994
T......... T......... 1......... 1......... 1......... 1......... T......... 1......... 1......... 1.........
E          O          2          2          1          1          R          2          2          3
T          L          3          4          1          2          I          3          4          5
R (2)      U (2)      T          T          T (1)      T          C (1)      T          T          T
A 5.0      E 1000.    R          R          R 200      R          H 5.0      R          R          R
C          N          I          I          I          I          L          I          I          I
H          E          C          C          C          C          O          C          M          M
L                     H          H          H          H          R          H          E          E
O                     L          L          L          L          O          L          T          T
R                     O          R          O          O          E          O          H          H
O                     R          O          R          R          T          R          Y          Y
E                     O          R          O          O          H          O          L          L
T                     B          B          E          E          Y          P          B          B
H                     E          E          T          T          L          R          E          E
Y                     N          N          H          H          E          O          N          N
L                     Z          Z          A          A          N          P          Z          Z
E                     E          E          N          N          E          A          E          E
N                     N          N          E          E                     N          N          N
E                     E          E                                            E          E          E
                                 -

ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND
ND         0.5        ND         ND         ND         ND         ND         ND         ND         ND
ND         ND         ND         ND         ND         ND         ND         ND         ND         ND

4 Records Processed
```

```
E 1
....... T.........
        O
        T
1)      A (2)
.0      L 10000
        -
        X
        Y
        L
        E
        N
        E
        -
        -
        -
        -
        -
        -
        -
        -

        ND
        ND
        ND
        ND

ecords Processed





IOLOGICAL RESULTS (PICOCURIES/LITER)
E 1
 JUN 1994
ID. FILENO..... SYSTEM...................... S SAMPLE.. C QTR1 DATE QTR2 DATE QTR3 DATE QTR4 DATE  LAB.... G.....
                 NAME                        A  DATE    O                                         NUMBER   R
                                             M          M                                                  O
                                             P          P                                                  S
                                             L          O                                                  S
                                             E          S                                                  -
                                             -          I                                                  A
                                             T          T                                                  L
                                             Y          E                                                  P
                                             P          ?                                                  H
                                             E                                                             A

256 740.07.001  Ft. Yukon Public Water Syste   03-11-80                                          00000
256 740.07.001  Ft. Yukon Public Water Syste R 08-13-91 Y                                        F109237  ND
```

APPENDIX 6

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

YUKON RIVER AT RAMPART

Chemical analyses, in parts per million, March 1954 to September 1956

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 on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Non-carbonate			
1954																		
Mar. 21	a 12,700	6.5	0.03	38	8.0	2.5	0.7	128	25	0.6	--	0.2	145	128	23	256	7.3	--
June 1-10	--	5.2	.01	31	6.7	2.3	1.0	100	30	1.0	--	1.5	128	105	23	210	6.8	--
June 11-20	--	5.6	.01	35	11	4.5	.8	106	52	.8	--	5.0	167	133	46	282	6.6	--
June 21-30	--	5.8	.01	32	8.0	3.9	1.1	96	39	.8	--	6.3	144	113	34	244	6.6	--
July 1-10	--	6.1	.01	31	7.3	2.5	1.0	103	30	.8	--	.5	130	107	23	222	6.5	--
July 11-20	--	6.2	.01	35	8.0	2.8	1.2	115	31	.8	--	.6	143	120	26	246	6.5	--
July 21-31	--	6.0	.01	35	8.1	3.0	1.1	111	33	1.0	--	3.6	146	121	30	250	6.8	--
Aug. 1-10	--	6.5	.08	33	9.2	5.2	.9	113	31	.8	0.1	3.3	146	120	28	249	--	15
Aug. 11-20	--	6.8	.08	33	8.8	4.0	1.3	116	27	1.1	0	2.2	141	119	24	245	--	50
Aug. 21-31	--	6.2	.08	35	7.9	5.8	1.1	114	31	1.0	.1	5.8	150	120	26	266	--	5
Sept. 1-10	--	6.6	.04	34	7.9	4.3	1.2	116	30	1.0	.1	3.6	169	117	22	251	8.0	10
Sept. 11-20	--	8.5	.02	35	7.8	6.0	1.1	112	32	1.0	.1	9.4	170	119	28	258	7.9	10
Sept. 21-30	--	7.2	.01	33	7.8	4.9	1.1	109	31	1.0	.1	9.0	163	114	25	248	8.0	10
1955																		
Apr. 5	a 10,600	8.1	.02	41	8.2	3.9	1.6	140	26	1.0	.0	.9	160	136	21	274	7.2	5
June 1-10	330,000	4.6	.08	23	8.1	4.1	.6	76	29	.2	.1	4.4	111	91	28	186	7.8	40
June 11-20	309,000	6.2	.12	33	13	3.8	.6	115	46	.5	.1	1.6	162	136	42	266	7.9	20
June 21-30	277,000	4.6	.10	26	8.4	3.5	.8	82	35	1.8	.1	2.1	122	99	32	209	7.7	60
Aug. 1-10	171,000	5.7	.00	31	7.6	3.0	1.8	108	28	.8	.1	.4	131	109	20	227	7.7	5
Aug. 11-20	168,000	6.4	.03	33	7.8	5.0	1.8	108	30	1.2	.1	3.5	142	114	26	247	7.3	10
Aug. 21-31	215,000	5.8	.05	28	8.0	3.9	1.0	91	31	.2	.1	3.8	127	103	28	223	7.9	15
Sept. 1-10	215,000	5.9	.05	32	11	3.7	1.0	109	41	.5	.1	2.4	152	125	36	260	7.4	10
Sept. 11-20	155,000	5.9	.05	30	7.2	4.9	1.0	100	28	.8	.1	4.1	131	104	22	231	7.6	15
Sept. 21-30	128,000	5.7	.05	29	8.3	3.9	1.2	94	28	.5	.1	6.7	129	106	29	229	7.8	8
1955																		
Oct. 1-15	98,900	6.3	.08	32	7.5	3.7	1.0	104	26	.8	.0	4.7	133	111	26	237	7.0	8
1956																		
May 28-31	369,000	.2	.00	21	6.0	2.2	1.0	63	22	.2	--	.6	111	77	25	169	6.3	65
June 1-5	297,000	1.1	.00	22	7.5	3.0	1.0	70	27	.5	--	.3	121	86	28	181	6.3	55
June 6-10	273,000	4.7	.00	29	9.0	3.5	.8	93	37	.5	.0	.2	133	109	33	230	7.3	20
June 11-12	270,000	4.0	.00	33	12	4.3	1.0	105	49	1.0	.0	.5	157	132	46	270	7.4	10
June 25-30	309,000	5.8	.00	33	10	3.5	1.1	105	41	.5	.0	.5	147	123	37	257	7.1	20

a Discharge at time of sampling.

YUKON RIVER AT RAMPART--Continued

Chemical analyses, in parts per million, March 1954 to September 1956--Continued

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 on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Non-carbonate			
1956																		
July 1-10	259,000	6.0	0.00	37	10	3.7	1.2	116	42	0.8	0.0	0.5	158	133	38	275	7.2	20
Aug. 1-10	172,000	7.4	.00	32	6.7	2.9	1.5	108	24	.0	.1	.4	128	107	19	222	7.7	5
Aug. 11-20	250,000	6.5	.00	31	8.8	3.8	1.0	96	36	.5	.0	2.3	137	114	35	238	7.5	20
Aug. 21-31	215,000	7.6	.00	32	8.2	3.1	1.0	102	34	1.0	.0	.8	138	114	30	236	7.4	15
Sept. 1-10	171,000	7.3	.00	31	6.9	2.8	1.3	103	25	1.2	.0	.6	127	106	21	217	7.5	15
Sept. 11-20	141,000	6.8	.00	29	6.9	2.7	1.2	95	26	.5	.0	.6	121	101	23	216	7.2	20
Sept. 21-30	172,000	6.9	.00	32	5.8	2.6	1.0	102	27	1.0	.1	.5	127	104	20	220	7.2	20

YUKON RIVER AT RAMPART--Continued

Temperature (°F) of water, water years 1954 to 1956

	1954			1955			1956				
Day	June	July	Aug.	June	Aug.	Sept.	May	June	July	Aug.	Sept.
1	50	55	58	50	61	44	--	44	65	--	--
2	49	56	58	53	62	44	--	44	60	--	--
3	52	60	58	53	60	46	--	45	65	--	--
4	46	61	58	54	62	45	--	47	65	--	--
5	45	61	57	53	63	45	--	53	57	--	--
6	45	63	58	55	63	46	--	54	57	--	--
7	56	62	59	54	62	47	--	55	--	--	48
8	56	65	60	48	61	47	--	56	--	--	57
9	56	59	60	50	60	48	--	55	--	--	47
10	55	60	61	49	61	48	--	56	--	--	48
11	55	59	63	46	60	47	--	55	--	--	49
12	54	60	63	48	58	49	--	56	--	--	47
13	54	62	63	46	58	47	--	--	--	--	46
14	54	63	62	42	56	44	--	--	--	--	48
15	55	64	60	46	56	43	--	--	--	--	47
16	54	64	62	47	55	45	--	--	--	--	45
17	52	64	61	47	55	45	--	--	--	--	49
18	53	65	60	49	54	46	--	--	--	--	48
19	53	66	60	51	54	46	--	--	--	--	47
20	54	61	59	46	53	45	--	--	--	--	46
21	53	59	58	49	52	46	--	--	--	51	46
22	54	59	58	46	50	44	--	--	--	50	45
23	52	59	58	45	49	45	--	--	--	50	45
24	55	60	56	53	48	44	--	--	--	53	40
25	56	59	57	54	47	43	--	56	--	53	44
26	58	58	57	56	49	38	--	55	--	52	38
27	57	59	57	56	49	38	--	65	--	50	40
28	58	57	55	56	48	42	43	60	--	50	48
29	60	57	54	56	48	38	43	62	--	52	39
30	55	57	53	55	44	39	41	64	--	52	38
31	--	57	53	--	45	--	41	--	--	54	--
Average	54	60	59	50	55	44	--	--	--	--	--

Periodic determinations of suspended-sediment discharge, water year October 1954 to September 1955

Date	Discharge (cfs)	Suspended sediment	
		Mean concentration (ppm)	Discharge (tons per day)
1954			
Oct. 9	93,000	97	24,400
1955			
Apr. 5	10,600	2	57

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 $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Noncarbonate			
FORTYMILE RIVER NEAR BOUNDARY																		
July 31, 1957........	1,100	11	0.08	20	7.5	4.6	1.2	65	37	0.5	0.3	2.1	116	81	28	166	7.4	50
YUKON RIVER AT EAGLE																		
Mar. 23, 1957.......	13,900	6.6	0.00	28	11	2.8	1.3	114	24	0.5	0.2	0.4	131	115	22	231	7.5	5
June 18.............	229,000	6.2	.16	31	6.6	2.0	1.3	108	19	.5	.2	.4	120	104	16	211	7.5	10
July 31	155,000	6.7	.05	25	7.4	2.2	1.2	90	25	.2	.2	.3	112	93	19	189	7.7	5
Aug. 29	118,000	4.7	.03	27	9.5	3.4	1.7	106	27	.5	.0	.2	126	106	19	221	7.5	5
BIRCH CREEK AT CIRCLE																		
July 28, 1957	447	6.4	0.08	25	7.1	6.0	1.5	63	45	2.8	0.2	0.3	125	92	40	209	6.9	20
YUKON RIVER AT RAMPART																		
Oct. 1-10, 1956	a 120,000	7.1	0.00	30	6.5	3.0	1.0	97	24	0.5	0.0	0.4	120	102	22	206	7.6	20
Oct. 11-20..........	a 59,500	9.7	.00	38	8.6	5.0	1.3	134	29	.8	.0	.4	159	130	20	266	7.1	5
Oct. 21-28..........	a 43,400	9.7	.00	45	11	4.8	1.8	159	35	1.2	.1	.4	187	158	27	315	7.4	0
Dec. 2	29,400	7.4	.00	27	6.6	2.3	1.0	46	20	.8	.2	.3	113	94	16	188	7.8	3
Mar. 22, 1957	16,800	7.0	.00	31	11	3.2	1.6	128	26	1.0	.2	.3	144	123	18	253	7.3	0
July 27	198,000	6.1	.08	31	11	2.8	1.3	110	33	.2	.2	.3	140	123	32	238	7.7	5
Aug. 30	189,000	4.9	.03	28	10	3.0	1.1	104	29	.2	.1	.5	128	111	26	223	7.3	20
LITTLE TOK RIVER NEAR TOK JUNCTION																		
May 23, 1957		10	0.06	35	7.8	2.1	1.3	104	34	2.0	0.1	1.6	145	120	34	246	7.7	20
Aug. 1		8.7	.03	38	11	2.9	.9	133	35	.2	.1	.2	163	140	31	278	7.4	5
Sept. 17		10	.00	43	11	3.2	.4	148	38	2.5	.1	.1	182	152	31	304	7.3	0

a Daily mean discharge.

Chemical analyses, in parts per million, March to August 1960

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 (calculated)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Noncarbonate			
Mar. 3, 1960	19,000	7.1	0.00	23	3.1	1.1	0.5	74	12	2.0	0.2	0.2	85	70	10	134	8.0	0
Apr. 6	18,000	8.2	.00	39	10	3.9	1.7	144	21	4.5	.3	.7	160	138	20	282	8.1	5
May 27-29............	253,000	6.4	.12	24	6.2	2.8	1.3	80	23	1.0	.2	.9	105	86	20	179	7.7	50
May 30, 31, June 1, 2..	285,000	7.0	.10	30	9.5	3.7	1.1	103	36	1.0	.1	1.2	141	114	30	235	7.7	50
June 3-9	267,000	9.0	.10	35	13	5.0	1.2	122	46	1.0	.2	.8	171	141	41	294	7.8	30
June 10-13............	237,000	7.8	--	26	10	2.7	1.0	93	28	2.5	.2	1.0	125	106	30	198	7.8	40
June 18-27............	246,000	8.0	.07	29	16	4.0	1.2	117	40	3.5	.0	1.0	161	138	42	258	7.5	20
July 1-3, 5-10	251,000	7.3	.10	30	10	3.5	1.0	106	34	1.0	.2	.9	140	116	29	236	7.8	25
July 11-12, 14-20	226,000	8.7	.02	34	10	4.1	1.1	116	36	2.5	.2	.7	154	126	31	253	7.7	10
July 21-31............	199,000	8.7	.02	33	8.3	3.5	1.2	108	36	1.0	.2	.6	146	116	28	236	7.4	10
Aug. 1-10	277,000	8.6	.02	32	12	3.7	.9	111	39	1.5	.2	1.4	154	130	38	248	8.2	20
Aug. 11-20	230,000	7.6	.02	34	12	3.4	1.1	118	39	1.5	.2	1.2	158	134	38	256	7.7	20
Aug. 21-23	228,000	13	.02	37	13	4.7	1.2	128	44	1.0	.2	1.1	180	146	38	289	8.3	10

Temperature (°F) of water, July to August 1960
/Once-daily measurement at 6 p.m.7

Day	July	August	Day	July	August	Day	July	August
1	--	54	11	--	54	21	67	53
2	--	52	12	--	56	22	64	52
3	--	53	13	--	57	23	65	51
4	--	52	14	--	58	24	64	--
5	--	50	15	--	54	25	63	--
6	--	50	16	--	53	26	63	--
7	--	46	17	--	53	27	60	--
8	--	48	18	--	53	28	58	--
9	--	50	19	65	54	29	57	--
10	--	52	20	66	53	30	55	--
						31	54	--

30-4680. YUKON RIVER AT RAMPART, ALASKA--Continued

Temperature (°F) of water, water year October 1963 to September 1964

Month	Day 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	Aver-age
October.......																																
November.....																																
December.....																																
January........																																
February.......																																
March..........																																
April...........																																
May.............																																
June............																																
July............																																
August.........	53	52	51	53	54	54	53	53	54	52	53	54	54	54	54	53	53	54	54	53	52	52	52	52	51	50	50	51	50	49	--	52
September.....	46	46	43	42	42	41	41	40	40	40	40	40	41	41	41	41	40	39	40	40	40	40	40	40	40	39	39	39	39	38	--	41

Periodic particle-size analyses of suspended sediment, water year October 1963 to September 1964

(Methods of analysis: B, bottom withdrawal tube; C, chemically dispersed; D, decantation; N, in native water; P, pipet; S, sieve; V, visual accumulation tube; W, in distilled water)

Date of collection	Time (24 hour)	Water tem-per-ature (°F)	Sam-pling point	Discharge (cfs)	Sediment concen-tration (ppm)	Sediment discharge (tons per day)	Suspended sediment											Method of analysis
							Percent finer than size indicated, in millimeters											
							0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	
June 26, 1964.....	1715	57		608000	420		21	26	33	44	55	74	87	98	100			SBWC

30-4680. YUKON RIVER AT RAMPART, ALASKA

LOCATION.--At gaging station on left bank at Rampart, 0.8 mile downstream from Squaw Creek, 1.2 miles downstream from Minook Creek, and 3.5 miles upstream from Russian Creek.
DRAINAGE AREA.--199,400 square miles, approximately.
RECORDS AVAILABLE.--Chemical analyses: June 1954 to September 1964.
Water temperatures: June 1954 to September 1964.
Sediment records: June 1962 to September 1963.
EXTREMES, 1954-56, 1960-63.--Water temperatures: Maximum, 67°F July 21, 1960.

Chemical analyses, in parts per million, water year October 1963 to September 1964

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 $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Noncarbonate			
June 1-15, 1964.....	816200	4.0	0.06	22	6.1	2.6	1.0	73	18	2.8	0.1	0.1	93	80	20	150	7.2	50
June 16-30..........	739300	5.8	.13	26	7.3	2.2	.6	85	24	1.4	.1	.2	110	95	25	186	7.2	40
July 1-31...........	433800	5.0	.08	31	12	3.6	.4	101	46	1.4	.1	.2	150	126	43	252	7.4	30
Aug. 1-31...........	290900	5.2	.04	31	10	3.8	.9	105	39	2.1	.2	.9	145	119	33	239	7.6	40
Sept. 1-30..........	203800	5.8	.07	32	9.2	2.8	1.6	109	28	1.4	.2	.4	136	118	29	233	7.7	20

30-4680. YUKON RIVER AT RAMPART, ALASKA

LOCATION.--At gaging station on left bank at Rampart, 0.8 mile downstream from Squaw Creek, 1.2 miles downstream from Minook Creek, and 3.5 miles upstream from Russian Creek.
DRAINAGE AREA.--199,400 square miles, approximately.
RECORDS AVAILABLE.--Chemical analyses: June 1954 to September 1965.
Water temperatures: June 1954 to September 1964.
Sediment records: June 1962 to September 1963.

Chemical analyses, in parts per million, water year October 1964 to September 1965

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 $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium, magnesium	Noncarbonate			
Oct. 1-31, 1964..	103800	6.2	0.00	36	9.7	3.0	1.0	121	30	2.5	0.2	.3	149	130	29	249	7.7	10
Sept. 28, 1965...	201000	6.6	.04	24	8.0	6.0	1.4	92	29	.4	.3	.5	121	93	18	190	8.3	25

Periodic determinations of suspended-sediment concentration and particle-size analyses, water year October 1964 to September 1965
(Methods of analysis: B, bottom withdrawal tube; C, chemically dispersed; D, decantation; N, in native water;
P, pipet; S, sieve; V, visual accumulation tube; W, in distilled water)

Date of collection	Time (24 hour)	Water temperature (°F)	Sampling point	Discharge (cfs)	Sediment concentration (ppm)	Sediment discharge (tons per day)	Suspended sediment: Percent finer than size indicated, in millimeters											Method of analysis
							0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	
July 19, 1965.....	1800	--		266000	220		24	37	48	56	63	69	86	99	100			SBWC
Sept. 28..........	1000	38		195000	170							54	68	94	98	100		V

30-4680. YUKON RIVER AT RAMPART—Continued

Chemical analyses, in parts per million, May to August 1962

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 (Calculated)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
														Calcium magnesium	Noncarbonate			
May 28-31, 1962......	618,000	4.7	0.02	21	3.0	1.3	1.3	65	13	2.0	0.1	1.8	80	65	12	128	8.1	60
June 1-10............	742,000	5.5	.03	21	4.7	1.4	1.3	72	12	2.0	.1	1.3	84	73	14	141	7.4	55
June 11-20...........	607,000	7.6	.02	24	4.3	1.6	1.0	82	15	1.5	.1	.8	96	72	11	163	7.6	30
June 22-30...........	517,000	7.1	.02	28	6.3	2.1	1.1	98	20	1.0	.1	.9	115	97	17	195	7.7	25
July 1-10............	456,000	6.4	.02	29	6.8	2.2	1.2	100	22	1.5	.0	1.3	119	101	19	205	7.6	20
July 11-20...........	347,000	6.4	.02	34	11	3.6	1.2	120	37	1.0	.1	1.8	155	132	33	264	7.7	10
July 21-30...........	301,000	7.1	.02	35	13	4.0	.9	126	43	1.0	.1	1.6	168	141	38	281	7.9	10
July 31, Aug. 1-8....	317,000	8.5	.02	36	13	3.8	1.1	127	43	1.0	.1	1.9	170	145	41	285	7.6	15
Aug. 9-17............	305,000	7.8	.02	41	15	4.3	1.1	144	50	1.5	.1	1.0	193	162	44	317	8.0	10
Aug. 24..............	249,000	6.0	.07	32	8.3	2.3	1.3	112	25	1.0	.2	.2	131	114	22	213	8.0	20
Aug. 25,29-31........	284,000	6.1	.05	34	9.2	2.6	.6	118	32	1.0	.2	.2	144	124	27	239	8.0	30
Sept. 1-7............	345,000	7.5	.05	27	8.1	2.2	.7	93	29	1.5	.2	.6	123	102	26	200	8.3	40

YUKON RIVER AT RAMPART--Continued

Chemical analyses, in parts per million, October 1960 to August 1961

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Cal-cium (Ca)	Mag-nesium (Mg)	Sodium (Na)	Potas-sium (K)	Bicar-bonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (Calculated)	Hardness as $CaCO_3$ Calcium mag-nesium	Hardness as $CaCO_3$ Non-carbon-ate	Specific conduct-ance (micro-mhos at 25°C)	pH	Color
Oct. 10, 1960 ...	134,000	7.2	0.00	30	12	3.4	1.1	117	28	2.0	0.1	0.1	142	124	28	241	7.5	10
Dec. 9	a 24,200	9.0	.03	39	12	3.4	2.0	152	27	1.5	.2	.8	170	147	22	286	7.6	5
Jan. 21, 1961 ...	a 23,500	8.3	.02	36	12	2.6	1.8	144	27	2.0	.1	.3	161	140	22	277	7.6	0
Feb. 26	a 18,800	6.8	.07	39	9.5	5.4	2.5	144	22	3.0	.0	.4	160	136	18	278	7.6	5
May 20-26	333,000	6.8	.02	20	4.0	1.8	1.6	63	15	1.0	.1	1.2	83	66	15	139	7.4	70
May 27-31, June 1-3,5,6	445,000	7.5	.02	23	5.5	2.2	1.3	76	20	1.5	.1	1.0	99	80	18	156	7.8	50
June 6	a 463,000	6.1	.02	27	3.8	.9	.9	86	14	1.0	.1	.7	97	83	12	165	7.5	45
June 10-18	428,000	8.0	.02	26	5.0	2.4	1.4	88	17	1.5	.1	.9	105	86	14	164	7.9	40
June 19, 24-30 ..	369,000	7.7	.02	36	9.0	3.7	.8	112	38	1.0	.1	1.4	153	127	35	257	7.7	20
July 1-8, 10	318,000	7.9	.02	36	11	4.3	.9	119	40	1.0	.1	1.1	161	135	38	274	7.6	10
July 11, 15-22 ..	234,000	8.1	.03	31	8.6	3.1	1.0	107	30	1.0	.1	.7	137	113	26	231	7.4	30
July 23-31	241,000	8.2	.05	30	8.3	2.9	1.2	108	28	1.0	.1	1.0	134	109	20	224	7.8	30
Aug. 1, 3-7, 10 .	212,000	11	.03	34	8.0	4.6	1.5	118	32	1.0	.1	1.2	151	118	21	240	7.7	10
Aug. 11-20	291,000	7.6	.02	34	6.3	4.1	1.6	108	30	1.0	.2	1.2	139	111	22	229	7.6	20
Aug. 21-28,30,31.	257,000	8.0	.02	42	9.5	5.1	1.4	136	40	1.0	.2	1.5	176	144	32	290	7.8	20

a Discharge at time of sampling.