Overview of Environmental and Hydrogeologic Conditions at McGrath, Alaska

By Joseph M. Dorava

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

Multiply	By	To obtain
millimeter (mm)	0.03937	inch
meter (m)	0.30481	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
cubic meter per second (m^3/s)	35.31	cubic foot per second
liter per second (L/s)	15.85	gallon per minute
liter per day (L/d)	0.2642	gallon per day
degree Celsius (°C)	°F = 1.8 x °C + 32	degree Fahrenheit (°F)

Sea level:

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

Abbreviated water-quality units used in this report:

mg/L, milligram per liter
mL, milliliter

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Abstract

The remote village of McGrath along the Kuskokwim River in southwestern Alaska has long cold winters and short summers. The village is located on the flood plain of the Kuskokwim River and obtains drinking water for its 533 residents from the Kuskokwim River. Surface spills and disposal of hazardous materials combined with frequent flooding of the Kuskokwim River could affect the quality of the drinking water. Alternative drinking-water sources are available but at greater cost than existing supplies. The Federal Aviation Administration (FAA) owns or operates airport support facilities in McGrath and wishes to consider the subsistence lifestyle of the residents and the quality of the current environment when evaluating options for remediation of environmental contamination at their facilities. This report describes the history, socioeconomics, physical setting, ground- and surface-water hydrology, geology, climate, vegetation, soils, and flood potential of the areas surrounding the FAA facilities near McGrath.

INTRODUCTION

The Federal Aviation Administration (FAA) owns and (or) operates airport, 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, the product of compilation, review, and summary of existing hydrologic and geologic data by the U.S. Geological Survey, in cooperation with the FAA, provides such information for the FAA facility and nearby areas at McGrath, Alaska. Also presented in this report is a description of the history, socioeconomics, and physical setting of the McGrath area

BACKGROUND

Location

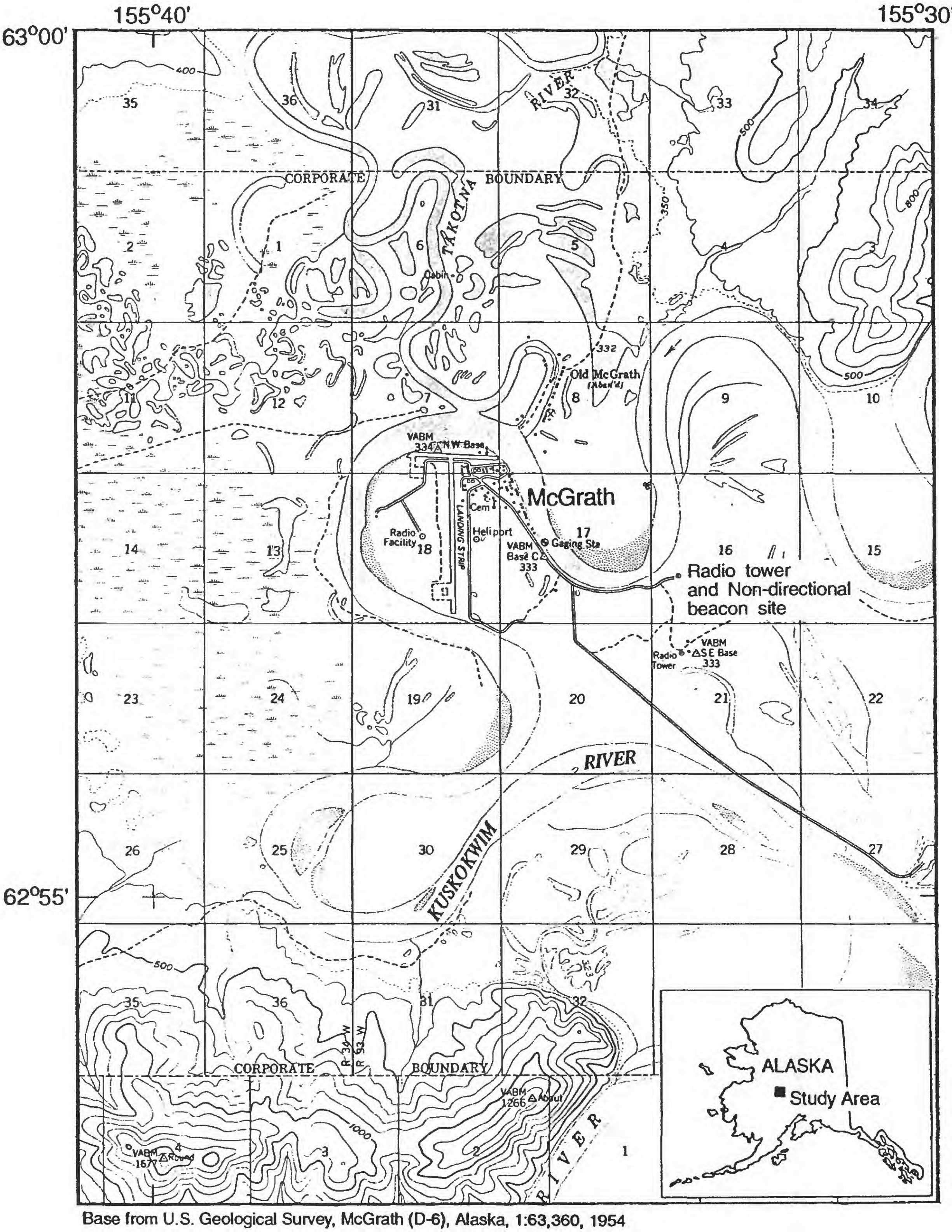
McGrath is located in southwestern interior Alaska (fig. 1) at latitude 62° 57' 30" N., longitude 155° 35' 55" W., approximately 350 km northwest of Anchorage and approximately 450 km southwest of Fairbanks. The village is located on the flood plain of the Kuskokwim River between the Tanana-Kuskokwim Lowlands to the south and east and the Kuskokwim Mountains to the north and west (Wahrhaftig, 1965). The present location of McGrath is on the south bank of the Kuskokwim River; however, the original townsite was across the Kuskokwim River near the mouth of the Takotna River. The original townsite was selected by early settlers because they needed water courses for transportation, but it was abandoned because of excessive flooding and bank erosion on the Takotna River near its mouth (Oswalt, 1980). The current location of the village is expected to be inundated with flood waters every 5 to 20 years (U.S. Army Corps of Engineers, 1977).

History

Oswalt (1980) describes the history and development of McGrath. The local area near McGrath played an important role in the Alaska gold rush because it was the farthest upstream location accessible by shallow-draft riverboats. The original townsite on both sides of the mouth of the Takotna River was founded in 1907 and was named for the U.S. Deputy Marshal Peter McGrath who was stationed there. In 1909, the Northern Commercial Company opened the first store in McGrath and two other stores opened soon after to support local mining activities. In 1920, more miners were working in the upper Kuskokwim area than in any other area of interior Alaska. Between 1908 and 1930, about $2,700,000 worth of gold was taken from the McGrath area. By 1924, the original village of McGrath had an airstrip and regular airmail service from Fairbanks. An airport was constructed in 1925 and biweekly air service to McGrath began in 1930. Severe flooding and erosion in 1927 and again in 1933 prompted residents to begin moving to a new location on the south bank of the Kuskokwim River. By 1938, the Northern Commercial Company had also relocated to the new south bank location, and by 1960, the last residents of the old townsite had relocated. McGrath was officially incorporated as a second class city on June 3, 1975 (Alaska Department of Regional and Community Affairs, 1984).

In 1920, the population of McGrath was 90 and by 1950 it had increased to 175. In subsequent years, the population of McGrath continued increasing from 241 in 1960 to 533 in 1991 (Christy Miller, Alaska Department of Community and Regional Affairs, written commun., 1993). The 1990 census indicated nearly equal numbers of Native and non-Native residents (U.S. Bureau of Census, 1991).

Native residents of McGrath are shareholders in Chamai Inc., the Native village corporation for McGrath. In 1976, Chamai Inc. merged with MTNT Ltd., an association of the area Native village corporations for the villages of McGrath, Telida, Nikolai, and Takotna. By virtue of this merger, MTNT Ltd. is entitled to receive approximately 300,000 acres of land in accordance with the Alaska Native Claims Settlement Act (Alaska Department of Regional and Community Affairs, 1984).



Base from U.S. Geological Survey, McGrath (D-6), Alaska, 1:63,360, 1954

0 1 2 3 MILES

0 1 2 3 KILOMETERS

CONTOUR INTERVAL 100 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 1. Location of McGrath

The FAA owns or operates numerous facilities in McGrath (fig. 2). These include living quarters, fuel storage, and a maintenance shop. A flight service station and remote communication air/ground (RCAG) facility are near the north end of the main runway. A very high frequency omnidirectional range tactical air navigational (VORTAC) site, a localizer facility, and a very high frequency (VHF) facility are along the west side of the main runway, and a non-directional beacon (NDB, fig. 1) is about 2.6 km east of the runways. A complete listing of FAA facilities in McGrath along with details of historical activities at these sites and suspected sources of contamination can be found in a report by Ecology and Environment (1992).

Socioeconomics

McGrath is a regional service and transportation center for area communities. McGrath's Native population is represented by a five-member traditional council that administers and reviews all Native health care and public services (Alaska Department of Regional and Community Affairs, 1984). The governmental functions of the village of McGrath are administered by an elected mayor and a seven-member village council.

McGrath has approximately 200 single-family homes, a school, a Regional Rural Education Center of the University of Alaska, a library, a post office, AM radio station, 3 stores, 2 churches, a roadhouse, a few taverns, and an airport (Alaska Department of Regional and Community Affairs, 1984). The airport, which consists of a 1.7-km-long (north-south) and a 0.5-km-long (east-west) asphalt runway, is located along the northwestern edge of the village (fig. 2) and serves as the main transportation link to most other communities.

No road connects McGrath to the rest of Alaska and the only year-round access is provided by the airport. The Kuskokwim River serves as a transportation corridor for boats and barges during open water and for snowmobiles and dogsleds during the winter. Electricity is provided by the privately owned McGrath Light and Power Company, which operates diesel-powered generators and a villagewide power distribution system (Alaska Department of Regional and Community Affairs, 1984). A public water-supply system serves most of McGrath; however, the central sewage collection system serves only the downtown area and residents in outlying areas dispose of their waste water and sewage in 5-gallon buckets that are hauled to the landfill (Leroy Reed, Alaska Department of Environmental Conservation, oral commun., 1993).

The economy of McGrath generally is based on government and service industry employment (Alaska Department of Community and Regional Affairs, 1984). Most residents supplement their income with limited subsistence activities, such as hunting, fishing, and trapping. The main source of subsistence food is fish that migrate up the Kuskokwim River. All five pacific salmon (chinook, coho, sockeye, chum, and pink) are routinely harvested from the river (Francisco and others, 1992). Sheefish, whitefish, char, rainbow trout, burbot, Arctic grayling, northern pike, blackfish, and longnose sucker are also caught for food from the Kuskokwim River and its tributaries (Francisco and others, 1992). Other subsistence food sources include waterfowl, black bear, brown bear, caribou, and moose that migrate through the local area or live close by. These natural food sources are supplemented by limited vegetable gardening and gathering of seasonal foods such as wild berries and waterfowl eggs. More than 3 million migratory waterfowl annually use the flyways along the Kuskokwim and Yukon Rivers near McGrath (Alaska Planning Group, 1974).

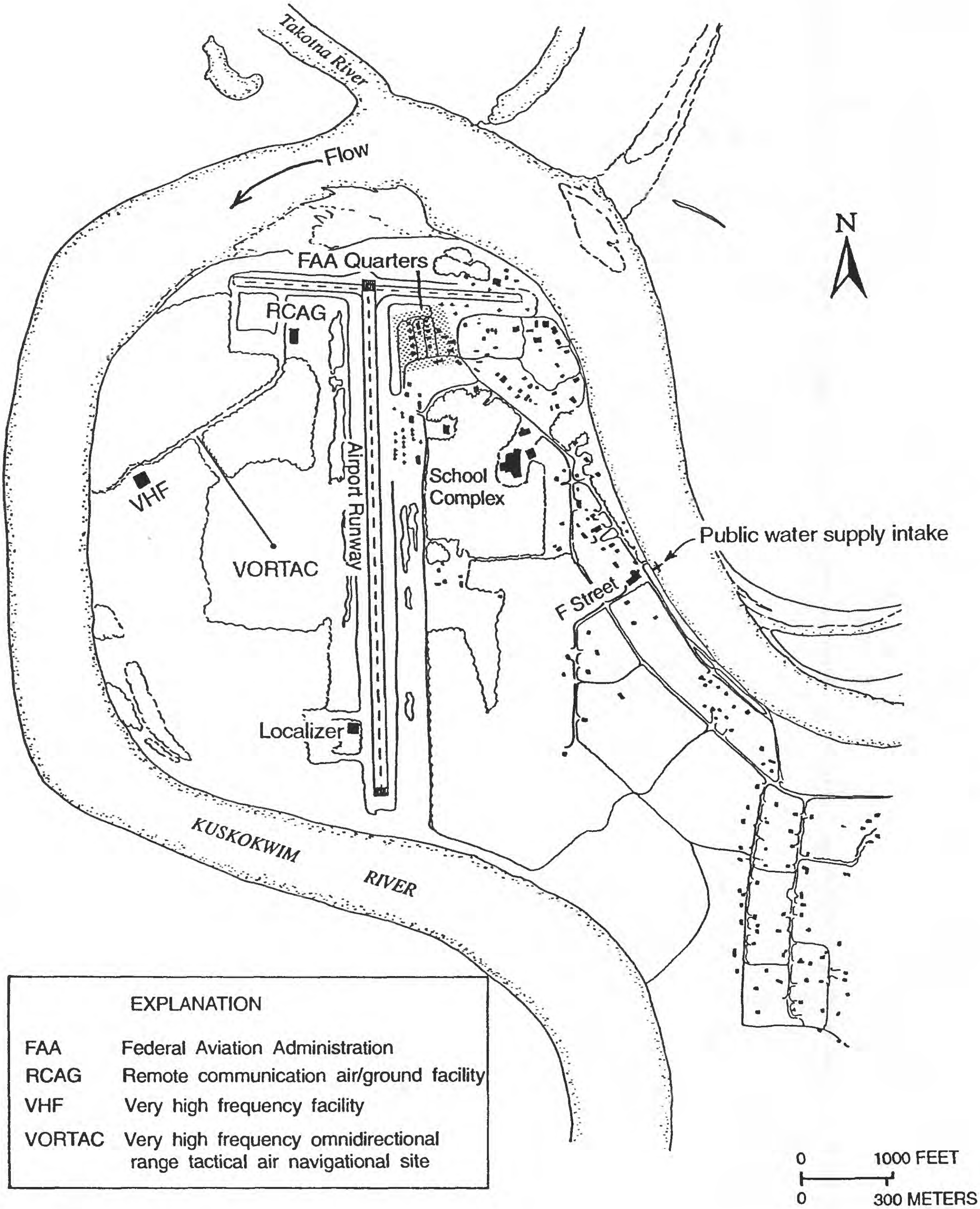


Figure 2. Village of McGrath (from aerial photographs by Aeromap US).

PHYSICAL SETTING

Climate

The climate of McGrath is continental with some maritime conditions in the summer (Hartman and Johnson, 1984). McGrath has great diurnal and annual temperature variations, low precipitation, low cloudiness, and low humidity. Mean annual temperature is -3.7 °C but temperatures have ranged from a maximum of 32.2 °C in June 1969 to a minimum of about -55 °C in December 1961 (table 1). Mean annual precipitation is 411 mm; the maximum monthly rainfall occurs in August and has a mean of 72.9 mm. Approximately 2,240 mm of snow falls annually; the maximum monthly snowfall occurs in December and has a mean of 434.3 mm (table 1).

Vegetation

The McGrath area has a variety of vegetation. Moderately to densely forested areas are along the rivers and sloughs (Hartman and Johnson, 1984). Wetland vegetation consists of mosses, shrubs, and black spruce in lowland areas west of the Kuskokwim River (Rieger and others, 1979). Barren hills or alpine tundra occur on the slopes of area hills, such as the Roundabout Mountains southwest of the village and on Apple Mountain to the northeast (Mertie and Harrington, 1924).

The riparian forested areas consist of white spruce, black spruce, tamarack, white birch, poplar, and cottonwood with a thick undergrowth of willow and alder (Mertie and Harrington, 1924). Some commercial quality white spruce timber exists on well-drained soils located on higher terraces near Cranberry Ridge, 6.5 km southeast of McGrath (Alaska Department of Community and Regional Affairs, 1984). Tall grasses and some moss form the ground cover in flood plain and upland areas that have been burned (Mertie and Harrington, 1924). The alpine tundra areas consist of Labrador tea, lichens, mosses, and sedges (Viereck and Little,1972).

Bedrock Geology

McGrath and most of the Kuskokwim River flood plain are underlain by Mesozoic sedimentary and metamorphic bedrock (Mertie and Harrington, 1924; Mertie, 1936; Cady and others, 1955). The oldest exposed bedrock is part of a 1,980-m thick section of sub-lithic sandstone, shale, and conglomerate of the Kuskokwim Group of Cretaceous age (Cady and others, 1955). Volcanic--plutonic complexes of upper Cretaceous age intrude and overlie the clastic sedimentary rocks in some locations away from the river, such as at Takotna Mountain to the west and Candle Hills to the southwest (Bundtzen and Laird, 1983). The local area is underlain by a layer of discontinuous permafrost (Fernald, 1960; Ferrians, 1965; Hartman and Johnson, 1984). Several well drillers' logs (appendixes 1 and 2) indicate the presence of ice or frozen soils at depths of 1 to 10 m.

Surficial Geology and Soils

McGrath is situated on a long, narrow lowland bordering the Kuskokwim River and the soils in this area are generally associated with the fluvial environment (Rieger and others, 1979). Five soil series have been mapped in the McGrath area (Schoephorster and Sprouse 1973). The primary soil type is the Takotna silt loam which is developed on flood plain deposits in well-drained areas that are frequently flooded on the south and east sides of the Kuskokwim River. The Takotna silt loam consists of a thin surface mat of partially decomposed organic matter overlying gray or olive gray stratified very fine sand and silt. Because of the well-drained characteristic of this soil type, it retains little moisture and permafrost is usually deep or absent in these soils.

Table 1. Mean monthly temperature, precipitation, and snowfall for the period 1942-87, McGrath
[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	-12.2	-7.0	-0.2	6.9	15.7	20.9	22.1	19.7	13.9	3.4	-5.8	-12.2	5.4
	(Record maximum, 32.2 °C, June 1969)												
Mean minimum	-27.6	-25.7	-19.9	-9.3	1.3	7.2	9.3	7.2	1.9	-7.7	-18.9	-26.7	-9.1
	(Record minimum, -55 °C, December 1961)												
Mean	-22.4	-18.7	-12.7	-3.3	6.8	13.0	14.7	12.2	6.6	-3.7	-15.0	-22.0	-3.7
Precipitation (mm of moisture)	20.6	18.8	19.0	18.5	21.3	39.6	54.9	72.9	55.6	31.5	30.0	28.4	411
Snowfall (mm)	345.4	269.2	264.2	208.3	20.3	0	0	0	22.9	248.9	424.2	434.3	2,240.3

Soils on the north and west side of the Kuskokwim River across from McGrath are mapped as Kuskokwim silt loam in poorly drained areas on low terraces along the Kuskokwim River and on north-facing slopes of the uplands. Kuskokwim silt loam consists of a thick surface mat of organic matter overlying a dark brown silt loam horizon underlain by a streaked or mottled dark gray silt loam. The permafrost table is shallow in this poorly drained soil, generally 0.2 to 0.3 m below the base of the organic mat or deeper, if this mat has been removed or disturbed.

Peat deposits are present in very poorly drained depressions and low-lying areas of the Kuskokwim River flood plain, such as the area on the west side of the Kuskokwim River northwest of McGrath. This soil type, mapped as Lemeta Peat, is usually saturated by water perched over permafrost present at depths of about 0.3 to 0.5 m, and usually indicates the presence of a barrier to ground-water infiltration or movement.

Surficial deposits that underlie McGrath are described in well drillers' logs (appendix 1) as stratified sandy to silty sediments that overlie sand and fine gravels at depths of 0 to 8 m. Fine sand, silt, and clay are present at depths to about 70 m. Soil temperature measurements made near the north end of the main runway indicate a seasonal frost depth of about 2 m and constant soil temperature above freezing at depths below 2 m (Aitken, 1964).

HYDROLOGY

Surface Water

McGrath is situated on the inside of a sharp meander loop of the Kuskokwim River and is nearly encircled by water (fig. 1). The Kuskokwim River flows from east to west past McGrath carrying water adjacent to all sides of the village except the southeast corner. The Takotna River enters the Kuskokwim River directly north of McGrath near the location of the original McGrath townsite. McGrath's location makes it susceptible to a meander cutoff. The Kuskokwim River is a meandering river with a sinuous, single-thread channel in the reach near McGrath. The river freely meanders across its flood plain and features such as oxbow lakes and meander scroll topography are common. During floods or periods of high water, flood plain deposits are easily eroded and the channel shifts laterally, often establishing a new course where meander bends intersect. This process of meander cutoff causes a temporary increase in stream velocity and initiates further erosion of meander bends. The Kuskokwim River could erode through the meander upstream from McGrath and reroute itself south and east of the village, leaving McGrath on an island no longer easily accessible to the river. Avoidance of similar processes motivated the previous relocation of McGrath away from the mouth of the Takotna River (U.S. Army Corps of Engineers, 1977).

Upstream from McGrath, the Kuskokwim River drains an area of about 30,300 km^2 (U.S. Geological Survey, 1974) that includes the rolling hills of the Kuskokwim Mountains and the high peaks of the Alaska Range. In its upper reaches, the Kuskokwim River flows through a narrow, deeply incised valley in the Kuskokwim Mountains. Near McGrath, the streambanks are low and the flood plain is wide.

A stream-gaging station was operated on the Kuskokwim River at McGrath by the U.S. Geological Survey from 1963 to 1973. During the 10 years the gage was operated, the mean annual discharge was 378.4 m^3/s, the maximum daily discharge was 2,000 m^3/s on June 6, 1964, and the maximum gage height reported was 8.08 m on May 18, 1972 (U.S. Geological Survey, 1974). The maximum gage height value was attributed to backwater from ice.

Ground Water

The direction of ground-water flow in the McGrath area is dominated by interactions with the Kuskokwim River. Generally, ground-water flow at McGrath is most likely across the meander loops, (fig. 3), but bank storage effects may reverse the trend locally during rising and falling stages of the river.

The general southward flow of ground water was simulated using the computer model MODFLOW (McDonald and Harbaugh, 1988) as a simple “steady-state relaxation” model. A relaxation model requires only that the elevations or hydraulic heads of the aquifer boundaries are known. In order for the relaxation model to be correct, all recharge and discharge are to and from the river. Thus, areal recharge must be negligible so that a ground-water mound does not develop within the meander loops. For many parts of Interior Alaska, and especially during the 8 months of winter, areal recharge by precipitation is negligible or nonexistent, and relaxation models can be used to predict flow directions adequately. The simulation model assumes that the relaxation criteria are met at McGrath and also assumes that flow is horizontal and the hydrologic characteristics of the aquifer material are homogeneous and isotropic within meander loops.

For the alluvial aquifer underlying McGrath, the aquifer boundary is the Kuskokwim River. The elevations of the river surface, as determined from hydraulic modeling and flood stage longitudinal profiling of the river (U.S. Army Corps of Engineers, 1977), define the hydraulic heads along the boundary of the aquifer. The simulated ground-water flow direction is driven by a head gradient of about 0.0025 m/m between the Kuskokwim River at the NDB site and the Kuskokwim River in the southeast quarter of section 20 (fig. 3), 1.6 km south. The head difference across this 1.6-km width was estimated by extrapolating longitudinal flood profiles of the Kuskokwim River (U.S. Army Corps of Engineers, 1977) to the area of section 20.

Aquifer tests done by drillers during construction of several wells were inconclusive in defining aquifer properties. One test produced a 7-m drawdown in a well that was pumped at 0.3 L/s for one hour. A second test produced no discernible drawdown in a well pumped at 0.4 L/s (appendix 2). Drillers’ logs indicate significant amounts of silt and sand in the alluvium, and permeabilities are expected to be less than in alluvial systems with coarser grained sediments. The depth to bedrock is about 70 m, measured at well SB03303307DDCC 001 at the FAA site (appendix 1).

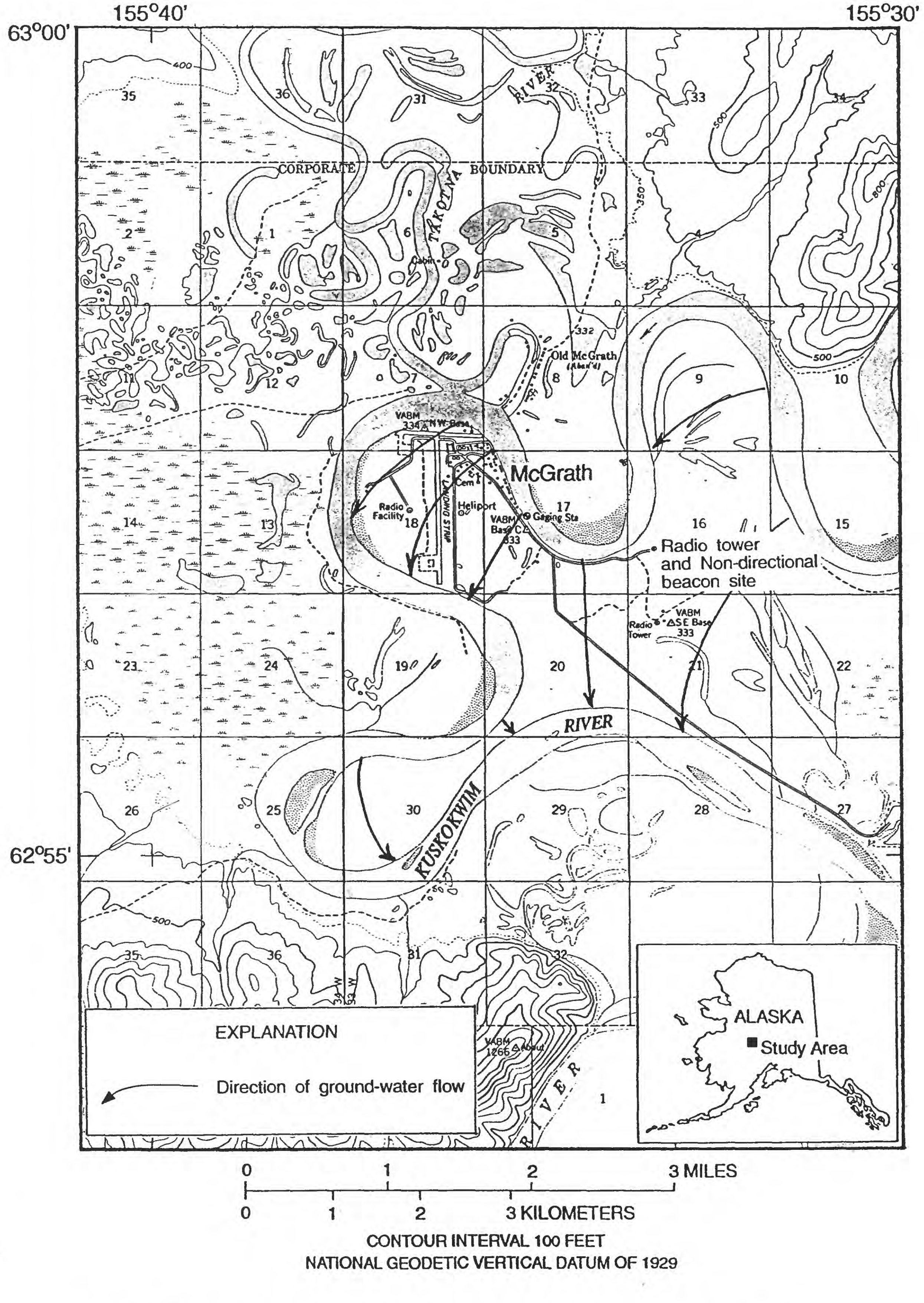


Figure 3. Simulated flow directions of shallow ground water near McGrath.

FLOODS

Floods are a major hazard in the McGrath area. The Kuskokwim River overflows its banks almost annually at McGrath and the effects of this flooding range from minor inconveniences to destruction of structures and facilities by erosion and flood waters. Pollution of the Kuskokwim River by hydrocarbons and sewage is also possible when floods inundate the McGrath area.

Streamflow records for the Kuskokwim River at McGrath are available for 1963-73 (U.S. Geological Survey, 1974) and for the Kuskokwim River at Crooked Creek for 1951-92 (U.S. Geological Survey, 1993) located about 280 km downstream from McGrath. The drainage basin of the Kuskokwim River upstream from Crooked Creek has an area of 127,400 km^2, and is about four times larger than the drainage basin upstream from McGrath. However, the long-term gage record from the Crooked Creek location has been used to verify the flood record obtained from the 10 years of discharge record at McGrath (U.S. Army Corps of Engineers, 1977).

The frequency of floods from runoff of rain and snowmelt for the Kuskokwim River at Crooked Creek was determined from the discharge record through 1990 (table 2) (Jones and Fahl, 1994). The frequency of floods from runoff of rain and snowmelt for the Kuskokwim River at McGrath was determined from the 1963-73 discharge record (table 2) (Jones and Fahl, 1994)

Table 2. Estimated peak discharges of the Kuskokwim River for various recurrence intervals

[Discharge in cubic meters per second]

Station location	Recurrence interval						
	2 years	5 years	10 years	25 years	50 years	100 years	500 years
Crooked Creek	4,670	6,290	7,310	8,610	9,540	10,500	12,700
McGrath	1,470	1,900	2,150	2,450	2,650	2,830	3,260

The flood frequency relations shown in table 2 are valid only for floods generated by rainfall and snowmelt runoff, and are not applicable to ice-jam floods, which are the most frequent (almost annual) and largest floods in McGrath (U.S. Army Corps of Engineers, 1977).

Ice-Jam Floods

Ice-jam flooding occurs when river ice broken during spring thawing is transported downstream and is blocked by a constriction, sandbar, or other obstruction such as a sharp meander bend. 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 and large volumes of stored ice move rapidly down the channel or across the flood plain, depending on the location of the ice-jam release.

Downstream from McGrath, several obstructive features work together to produce frequent ice-jam formations and subsequent backwater floods in the village. These features include a tight meander bend in the Kuskokwim River approximately 6 km downstream from McGrath and a sandbar on the east bank about 0.5 km upstream from this meander bend. An ice jam forms almost annually at one of these features, and during extreme conditions jams may back up ice for several kilometers.

Ice-jam floods may cause several times more damage than ice-free, open-water floods (Beltaos, 1990). This increased damage potential results from the movement of large ice volumes and the extreme velocities that result when ice jams release water. Records of historical flooding in McGrath indicate that ice jam floods have occurred in 1920, 1921, 1927, 1933, 1964, 1972, 1976, and 1991. Rainfall flooding has occurred only during the falls of 1922 and 1963 (U.S. Army Corps of Engineers, 1977 and 1993).

Flood-Protection Measures

Flood stage of the 100-year flood is a commonly used reference elevation above which new homes and buildings are constructed. The 100-year-flood stage at McGrath is 102.9 m (U.S. Army Corps of Engineers in 1977). The 1991 flood exceeded the 100-year-flood stage and caused severe damage to homes and businesses built before 1977 (U.S. Army Corps of Engineers, 1993). Building above the published 100-year flood stage is the only flood-protection measure currently in effect in McGrath.

Bank erosion along the Kuskokwim River is a more persistent threat to McGrath than flooding (U.S. Army Corps of Engineers, 1993). Erosion problems that resulted in the relocation of McGrath from its original site have been recognized as a continuing problem for the village in its current location. Darbyshire and Associates (1981) recommended that the village move to a higher site, known as Cranberry Ridge, about 6.5 km to the southeast.

The U.S. Army Corps of Engineers (1993) determined a 40-year average erosion rate of about 0.7 m per year for the south bank of the Kuskokwim River about 0.5 km upstream from the gaging station location in McGrath (fig. 1). An erosion rate of about 2 m per year over a 25-year period was estimated, using aerial photographs, for the outside corner of this same tight meander bend upstream from McGrath (F & J Consultants, 1981).

The Kuskokwim River is an actively meandering river and the process of meander cutoff is ongoing. Darbyshire and Associates (1981) reported that the exaggerated meander bend near McGrath and another one about 6 km downstream will both inevitably breach; however, the rate of meander migration at these locations is difficult to predict. Using the minimum and maximum migration rates determined from aerial photographs, the meander bend at McGrath could cut off any time from 3 to 100 years (Darbyshire and Associates, 1981). Riverbank stabilization projects have been started in McGrath and funding to raise road and runway elevations adjacent to the Kuskokwim River has been requested by the village (U.S. Army Corps of Engineers, 1993).

DRINKING WATER

Present Drinking Water Supplies

With the exception of a few homes in McGrath that have private wells, the drinking water is provided by a public system that withdraws, treats, and distributes surface water from the Kuskokwim River. The intake for the public distribution system is near the center of McGrath at the end of F Street (fig. 2), approximately 1.5 m below the water surface elevation at mean flow (Leroy Reed, Alaska Department of Environmental Conservation, oral commun., 1993). The Kuskokwim River represents a nearly inexhaustible source of drinking water for McGrath. In 1992, water use for McGrath was estimated at about 121,000 L/d. Mean annual flow of the Kuskokwim River at McGrath is about 378.4 m^3/s (U.S. Geological Survey, 1974). This discharge is more than 250,000 times the water usage in the village of McGrath and more than 30 times the quantity of water used in the entire State of Alaska in 1990 (Solley and others, 1993).

When the Kuskokwim River rises above flood stage, it causes contaminants on the surface of the land to mobilize and move into the public drinking-water supply or into inadequately sealed private wells. Even when wells are effectively sealed, flood waters may move contaminants such as sewage or petroleum products into previously uncontaminated areas, where the contaminants may infiltrate the aquifer.

Limited information is available on the quality of McGrath's drinking water. However, the quality of the Kuskokwim River was monitored at McGrath during the periods 1949-50 and 1965-73 (appendix 3). Water quality at the Crooked Creek gaging station has been monitored for more than 35 years (appendix 3). Water-quality data indicate that the Kuskokwim River is acceptable as a drinking-water source if the appropriate treatment is used to eliminate some constituents of concern, such as excessive concentrations of bacteria, sediment, and iron. The number of fecal coliform bacteria in the water, especially during the fall season following salmon spawning, has exceeded the maximum contaminant level goals of zero total coliforms for drinking water. On October 5, 1989, the fecal coliform count was 43 colonies/100 mL of water (U.S. Geological Survey, 1991). The dissolved iron content has been measured (U.S. Geological Survey, 1992) in concentrations above the 0.30 mg/L secondary maximum contaminant level goals set by the U.S. Environmental Protection Agency (1993) for drinking water. However, the drinking-water treatment processes currently utilized in McGrath are designed to reduce these constituents to recommended levels (Leroy Reed, Alaska Dept. of Environmental Conservation, oral commun. 1993).

Alternative Drinking Water Sources

The alluvial aquifer underlying McGrath may be an alternative water supply capable of meeting the needs of the community. Prior to the development of the public drinking-water supply, individual homes and businesses were served by private wells, but most wells were replaced by a surface-water source because of the high iron content of the ground water (Leroy Reed, Alaska Department of Environmental Conservation, oral commun., 1993). Several well water samples from McGrath (appendixes 1 and 2) confirm the presence of iron in concentrations greater than the 0.30 mg/L secondary maximum contaminant level goals set by the U.S. Environmental Protection Agency (1993) for drinking water. Clay layers identified at depths of about 70 m in well drillers' logs, (appendix 1) may indicate the presence of a deep confined aquifer that contains water meeting the present drinking water regulations. If the present public treatment and distribution systems could be utilized, this alternative supply could be developed, but at a significantly greater cost than the existing supply.

SUMMARY

The residents of McGrath are dependent on the airport or the river for transportation. Many residents are also dependent on the local environment because they practice a subsistence lifestyle. Frequent ice-jam flooding is hazardous to residents and their property. When the Kuskokwim River, the principal source of drinking water at McGrath, rises above flood stage and inundates the flood plain at the village, contaminants on the surface may become mobilized and subsequently transported into the drinking water supply or directly into inadequately protected wells. Ground water is an alternative drinking water supply that could be developed using the present treatment and distribution system.

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APPENDIX 1

Summary of U.S. Geological Survey well logs and ground-water-quality data that are available in the Ground-Water Site Inventory files for McGrath, Alaska.

Ground Water Site Inventory data base wells within 5-mile radius of McGrath, Alaska

Local well number	Depth of well (feet)	Water level (feet)	Date well construct-ed	Owner	Drillers log on file	Water quality avail-able
SB03303307DBCA1 004	35.0	14.00	04-19-79	MCGRATH CITY OF	Y	N
SB03303307DDCC1 001	26.0	12.00	09-00-55	FAA MCGRATH	Y	Y
SB03303307DDCC2 001	262.0	30.00	01-17-43	FAA MCGRATH	Y	N
SB03303307DDCC3 001	27.3	16.60	05-06-64	FAA MCGRATH	N	N
SB03303307DDDC1 002	24.0	--	08-18-46	WINCHELL OSCAR	N	Y
SB03303307DDDD1 003	20.0	--	09-18-40	SOLAN AL MCGRATH ROADHOUSE	Y	N
SB03303317BBBA1 001	23.0	9.00	07-12-45	LASKA PEARL	N	Y
SB03303317BBBA2 001	19.0	--	10-01-39	IVEY ALBERT	N	N
SB03303317BBBC1 003	27.0	6.00	10-15-41	PIERSON CHARLES	N	Y
SB03303317BBBC2 003	38.0	--	07-08-42	FARRANCE ART	Y	Y
SB03303317BBBD1 002	28.0	--	09-03-40	MORRIS ROADHOUSE	N	N
SB03303317BBBD2 002	28.0	16.00	06-12-46	GLAZIER THOMAS	Y	Y
SB03303317BBCD1 004	37.0	--	07-12-47	TEETER REVEREND R	Y	Y
SB03303317BCDA1 005	64.5	20.00	03-23-79	MCGRATH CITY OF	Y	N
SB03303318AACD1 002	22.3	13.10	06-02-59	FAA MCGRATH	N	Y
SB03303318AADA1 001	32.0	--	00-00-69	MCGRATH STATE SCHOOL	N	Y
SB03303318ADBC1 003	45.0	--	00-00-61	USBLM MCGRATH	N	Y
SB03303318ADBC2 003	38.5	9.00	06-11-76	USBLM MCGRATH	Y	N

APPENDIX 2

U.S. Public Health Service well logs and ground-water-quality data McGrath, Alaska

WELL LOG

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

LOCATION McGrath (Near HUB Air Apron) DATE STARTED April 18, 1979

DATE COMPLETED April 19, 1979 DRILLER Mark Anderson/Henry Horner

TOTAL DEPTH OF WELL 40' FT. CASING INSTALLED 41' DIAMETER 6"

GROUT N/A SCREEN SIZE 30 slot MFG. Johnson LENGTH 5 feet

STATIC WATER LEVEL 14' HRS. PUMPED ____ @ 20 GPM DRAWDOWN ____ F

Aquifer unsuitable due to water quality

DEPTH	HOLE DIAMETER / CASING DIAMETER / FORMATION
silt and brown	
Grading to coarse brown sand	10'
	16'
Med. to coarse brown sand, some gravel, loose silt	
	30'
Grey Med. to coarse sand	
Grey Med. to fine sand well sorted	
	40'
Some coarse, sand woody organics	

SOIL DATA TO 15 FT.

FEET THAWED Frozen soil top 6"

BOTTOM OF FROST & MATERIAL ____

SEASONAL OR PERMA FROST None

WATER DATA FIELD TEST

TASTE Clear to yellowish appearence

APPEARANCE FRESH ____

AFTER 24 HOURS ____

IRON 5 ppm as per hach test

CHLORIDES ____

TDS ____

PUMP TEST Bail test . STATIC LEVEL

PUMPING LEVEL ____ @ ____ GPM

AFTER ____ HRS.

HIGHEST RECOMMENDED PUMP RATE

WILL STATIC LEVEL CHANGE WITH

TIDES ____ OR FROST ____

Affected by level of Kuskokwim River

DEVELOP PROCEDURE ____

ESTIMATED MAN HOURS FOR DRILLING ____ HOURS FOR TOTAL JOB ____

CREW Mark Anderson/Henry Horner

Aquifer Test Field Data Sheet

Project No. 77-169 Project Name McGrath Well No. 2
Location of Well McGrath between airstrip and river
Depth of Well 30' Length of Casing 32 Casing Above Ground 2'
Date Drilling Completed 4-19-79 Driller Anderson-Horner

Date Tested 4-21-79 Static Water Level to TOC 17' 10"
Pumping Rate 15 gpm Tested By Anderson

Clock Time	Elapsed Time Since Pump Start	Depth to Water from TOC	Sounder Reading	Notes	Clock Time	Elapsed Time Since Pump Stop	Depth to Water from TOC	Sounder Reading	Notes
1:15pm	1 min	19' 6"			1:01pm	1	20'		
	2	19'10"				2	19'		
	3	20'				3	18'11"		
	4	21' 2"				4	18' 6"		
	5	21' 2"				5	18' 2"		
	6	21' 2"				6	18' 1"		
	7	21' 2"				7	18' 0"		
	8	21' 2"				8	17'10"		
	9	21' 3"				9			
	10	21' 3"				10			
	20	21' 3"							
	30	21' 3"							
	40	Stabilized and stayed							
	50	for 24 hours							
	60								
	70								
	80								
	90								
	100								
	200								
	300								
	400								
	500								
	600								
	700								
	800								
	900								
	1000								
	2000								
	3000								
	4000								
	5000								

Remarks

WELL LOG

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

LOCATION McGrath DATE STARTED 3-13 79

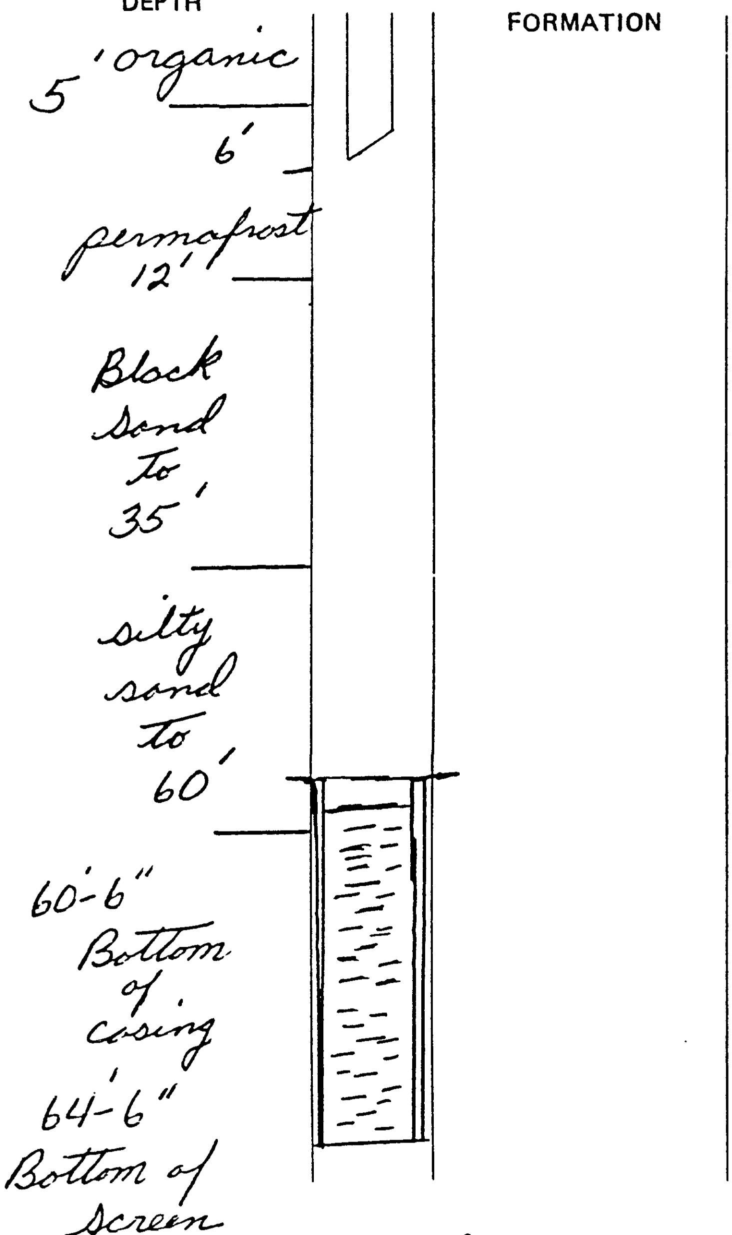
DATE COMPLETED 3-23-79 DRILLER Archibald

TOTAL DEPTH OF WELL 64'-6" FT. CASING INSTALLED 60-6" DIAMETER 6"

GROUT Bentonite SCREEN SIZE 15 slot MFG. Johnson LENGTH 5'7"

STATIC WATER LEVEL 20' HRS. PUMPED 1 @ 5 GPM DRAWDOWN 20 FT.

HOLE DIAMETER
CASING DIAMETER
DEPTH
FORMATION



SOIL DATA TO 15 FT.
FEET THAWED 6"
BOTTOM OF FROST & MATERIAL
SEASONAL OR PERMA FROST

WATER DATA FIELD TEST
TASTE iron
APPEARANCE FRESH
AFTER 24 HOURS
IRON 10 PPM
CHLORIDES
TDS

PUMP TEST 40' - STATIC LEVEL
PUMPING LEVEL 43 @ 5 GPM
AFTER 1 HRS.

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

DEVELOP PROCEDURE None

ESTIMATED MAN HOURS FOR DRILLING HOURS FOR TOTAL JOB

CREW Archibald

WELL LOG

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

LOCATION McGrath (Near HUB Air Apron) DATE STARTED April 18, 1979

DATE COMPLETED April 19, 1979 DRILLER Mark Anderson/Henry Horner

TOTAL DEPTH OF WELL 40' FT. CASING INSTALLED 41' DIAMETER 6"

GROUT N/A SCREEN SIZE 30 slot MFG. Johnson LENGTH 5 feet

STATIC WATER LEVEL 14' HRS. PUMPED ____ @ 20 GPM DRAWDOWN ____ F

Aquifer unsuitable due to water quality

DEPTH | HOLE DIAMETER | CASING DIAMETER | FORMATION

silt and brown

Grading to coarse brown sand — 10'

16'

Med. to coarse brown sand, some gravel, loose silt

30'

Grey Med. to coarse sand

Grey Med. to fine sand well sorted

40'

Some coarse, sand woody organics

SOIL DATA TO 15 FT.
FEET THAWED Frozen soil top 6"
BOTTOM OF FROST & MATERIAL ____
SEASONAL OR PERMA FROST None

WATER DATA FIELD TEST
TASTE Clear to yellowish appearence
APPEARANCE FRESH ____
AFTER 24 HOURS ____
IRON 5 ppm as per hach test
CHLORIDES ____
TDS ____

PUMP TEST Bail test . STATIC LEVEL
PUMPING LEVEL ____ @ ____ GPM
AFTER ____ HRS.

HIGHEST RECOMMENDED PUMP RATE
WILL STATIC LEVEL CHANGE WITH
TIDES ____ OR FROST ____
Affected by level of Kuskokwim River

DEVELOP PROCEDURE ____

ESTIMATED MAN HOURS FOR DRILLING ____ HOURS FOR TOTAL JOB ____

CREW Mark Anderson/Henry Horner

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health Service

Date Collected: 9-23-76 Time Collected: ----- By: N. Ovitt

Source of Sample: Raw water, FAA McGrath

Physical Observations, Remarks: Received in Calcium Hypochlorite container

[]	mg/l	Aluminum	[X] 1350	mmhos	Conductivity	[X] 308	mg/l	Hardness as $CaCO_3$
[]	mg/l	Arsenic	[X] 7.5	units	pH	[X] 900	mg/l	Alkalinity as $CaCO_3$
[]	mg/l	Barium	[]	mg/l	Ammonia Nitrogen-N	[]	mg/l	Acidity-T as $CaCO_3$
[]	mg/l	Boron	[]	mg/l	Kjedahl Nitrogen-N	[]	mg/l	Acidity Free as $CaCO_3$
[]	mg/l	Cadmium	[]	mg/l	Organic Nitrogen-N	[]	/100ml	Coliform-T
[X] 503	mg/l	Calcium	[]	mg/l	Nitrate(N)	[]	/100ml	Coliform-F
[]	mg/l	Copper	[]	mg/l	Nitrite(N)	[]	/100ml	Strep-F
[]	mg/l	Chromium-Total	[]	mg/l	Phosphorus (Ortho)-P	[]	units	Color
[]	mg/l	Chromium-Tri	[]	mg/l	Phosphorus (Total)-P	[]		
[]	mg/l	Chromium-Hex	[X] 6	mg/l	Chloride	[]		
[X] 2.1	mg/l	Iron-Total	[]	mg/l	Fluoride			
[]	mg/l	Iron-Dissolved	[]	mg/l	Cyanide			
[]	mg/l	Lead	[X] <1	mg/l	Sulfate			
[X] 44	mg/l	Magnesium	[]	mg/l	Phenol			
[]	mg/l	Manganese	[]	mg/l	MBSA			
[]	mg/l	Mercury	[]	mg/l	BOD			
[]	mg/l	Nickel	[]	mg/l	COD			
[X] 390	mg/l	Potassium	[X] 1200	mg/l	TD Solids			
[]	mg/l	Selenium	[]	mg/l	TV Solids			
[X] 437	mg/l	Sodium	[]	mg/l	Suspended Solids			
[]	mg/l	Silver	[]	mg/l	SV Solids			
[]	mg/l	Zinc	[]	JTU	Turbidity			

Transported by:
Received by:

Transported by:
Received by:

FOR LAB USE ONLY

Lab# 4836-2 Rec'd by: Se

Date sample rec'd: 9-30-76

Date analysis completed: 10-15-76

Date results reported: 10-19-76

Signed: [signature]

Date: October 19, 1976

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

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health

Date Collected: 9/23/76 Time Collected: ----- By: -----

Source of Sample: FAA Well - McGrath, Alaska

Physical Observations, Remarks: Treated Water

[]	mg/l	Aluminum	[X] 1570	mmhos	Conductivity	[X] 290	mg/l	Hardness as $CaCO_3$
[]	mg/l	Arsenic	[X] 7.0	units	pH	[X] 1030	mg/l	Alkalinity as $CaCO_3$
[]	mg/l	Barium	[]	mg/l	Ammonia Nitrogen-N	[]	mg/l	Acidity-T as $CaCO_3$
[]	mg/l	Boron	[]	mg/l	Kjedahl Nitrogen-N	[]	mg/l	Acidity Free as $CaCO_3$
[]	mg/l	Cadmium	[]	mg/l	Organic Nitrogen-N	[]	/100ml	Coliform-T
[X] 50	mg/l	Calcium	[]	mg/l	Nitrate(N)	[]	/100ml	Coliform-F
[]	mg/l	Copper	[]	mg/l	Nitrite(N)	[]	/100ml	Strep-F
[]	mg/l	Chromium-Total	[]	mg/l	Phosphorus (Ortho)-P	[]	units	Color
[]	mg/l	Chromium-Tri	[]	mg/l	Phosphorus (Total)-P	[]		
[]	mg/l	Chromium-Hex	[X] 50	mg/l	Chloride	[]		
[X] <0.1	mg/l	Iron-Total	[]	mg/l	Fluoride			
[]	mg/l	Iron-Dissolved	[]	mg/l	Cyanide			
[]	mg/l	Lead	[X] 1	mg/l	Sulfate			
[X] 40	mg/l	Magnesium	[]	mg/l	Phenol			
[]	mg/l	Manganese	[]	mg/l	MBSA			
[]	mg/l	Mercury	[]	mg/l	BOD			
[]	mg/l	Nickel	[]	mg/l	COD			
[X] 3	mg/l	Potassium	[X] 1040	mg/l	TD Solids			
[]	mg/l	Selenium	[]	mg/l	TV Solids			
[X] 272	mg/l	Sodium	[]	mg/l	Suspended Solids			
[]	mg/l	Silver	[]	mg/l	SV Solids			
[]	mg/l	Zinc	[]	JTU	Turbidity			

Transported by:
Received by:

Transported by:
Received by:

FOR LAB USE ONLY

Lab# 4809-2 Rec'd by: SE

Date sample rec'd: 9/23/76

Date analysis completed: 9/29/76

Date results reported: 9/29/76

Signed: Archie L. Green

Date: 9/29/76

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ANCHORAGE, ALASKA 99509

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health Service

Date Collected: 9-23-76 Time Collected: ----- By: N. Ovitt

Source of Sample: Treated water, FAA McGrath

Physical Observations, Remarks: Received in Calcium Hypochlorite container

[]		mg/l Aluminum	[X]	1400	mmhos Conductivity	[X]	316	mg/l Hardness as $CaCO_3$
[]		mg/l Arsenic	[X]	8.5	units pH	[X]	1100	mg/l Alkalinity as $CaCO_3$
[]		mg/l Barium	[]		mg/l Ammonia Nitrogen-N	[]		mg/l Acidity-T as $CaCO_3$
[]		mg/l Boron	[]		mg/l Kjedahl Nitrogen-N	[]		mg/l Acidity Free as $CaCO_3$
[]		mg/l Cadmium	[]		mg/l Organic Nitrogen-N	[]		/100ml Coliform-T
[X]	51	mg/l Calcium	[]		mg/l Nitrate(N)	[]		/100ml Coliform-F
[]		mg/l Copper	[]		mg/l Nitrite(N)	[]		/100ml Strep-F
[]		mg/l Chromium-Total	[]		mg/l Phosphorus (Ortho)-P	[]		units Color
[]		mg/l Chromium-Tri	[]		mg/l Phosphorus (Total)-P	[]		
[]		mg/l Chromium-Hex	[X]	18	mg/l Chloride	[]		
[X]	.7	mg/l Iron-Total	[]		mg/l Fluoride			
[]		mg/l Iron-Dissolved	[]		mg/l Cyanide			
[]		mg/l Lead	[X]	10	mg/l Sulfate			
[X]	46	mg/l Magnesium	[]		mg/l Phenol			
[]		mg/l Manganese	[]		mg/l MBSA			
[]		mg/l Mercury	[]		mg/l BOD			
[]		mg/l Nickel	[]		mg/l COD			
[X]	390	mg/l Potassium	[X]	1261	mg/l TD Solids			
[]		mg/l Selenium	[]		mg/l TV Solids			
[X]	416	mg/l Sodium	[]		mg/l Suspended Solids			
[]		mg/l Silver	[]		mg/l SV Solids			
[]		mg/L Zinc	[]		JTU Turbidity			

Transported by:
Received by:

Transported by:
Received by:

FOR LAB USE ONLY

Lab# 4836-1 Rec'd by: Se

Date sample rec'd: 9-30-76

Date analysis completed: 10-15-76

Date results reported: 10-19-76

Signed: Archie L. Shanika

Date: October 19, 1976

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907) 279-4014

P.O. BOX 4-1276 ANCHORAGE, ALASKA 99509 4649 BUSINESS PARK BLVD.

ANALYTICAL REPORT

Water Analysis(Facility) Alaska Area Native Health Service

Date Collected: 3/23/79 Time Collected: Unknown By: N. Archibald

Source of Sample: Well dated 3/23/79 McGrath

Physical Observations, Remarks: Very high iron content

	mg/l		mg/l		mg/l
[]Ag,Silver	<0.05	[]P,Phosphorous	0.37	[]Cyanide	
[]Al,Aluminum	<0.01	[]Pb,Lead	<0.05	[]Sulfate	13
[]As,Arsenic	<0.1	[]Pt,Platinum	<0.01	[]Phenol	
[]Au,Gold	<0.01	[]Sb,Antimony	0.05	[]Total Dissolved Solids	318
[]B,Boron	<0.01	[]Se,Selenium	<0.01	[]Total Volatile Solids	
[]Ba,Barium	0.4	[]Si,Silicon	5	[]Suspended Solids	
[]Bi,Bismuth	<0.01	[]Sn,Tin	0.02	[]Volatile Suspended Solids	
[]Ca,Calcium	106	[]Sr,Strontium	0.48	[]Hardness as $CaCO_3$	336
[]Cd,Cadmium	<0.010	[]Ti,Titanium	<0.01	[]Alkalinity as $CaCO_3$	308
[]Co,Cobalt	<0.05	[]W,Tungsten	<0.1	[]	
[]Cr,Chromium	<0.05	[]V,Vanadium	<0.01	[]	
[]Cu,Copper	<0.1	[]Zn,Zinc	<0.01	[]	
[]Fe,Iron	12	[]Zr,Zirconium	<0.01	[]	
				* * * * * *	
[]Hg,Mercury	<0.1	[]Ammonia Nitrogen-N		[]mmhos Conductivity	610
[]K,Potassium	1	[]Kjedahl Nitrogen-N		[]pH Units	7.4
[]Mg,Magnesium	9.6	[]Nitrate-N		[]Turbidity NTU	
[]Mn,Manganese	1.1	[]Nitrite-N		[]Color Units	
[]Mo,Molybdenum	<0.05	[]Phosphorus (Ortho)-P		[]T.Coliform/100ml	
[]Na,Sodium	2	[]Chloride	2	[]	
[]Ni,Nickel	<0.01	[]Fluoride		[]	

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P.O. BOX 4-1276
ANCHORAGE, ALASKA 99509
5633 "B" STREET

ANALYTICAL REPORT

CUSTOMER Alaska Area Native Health Service SAMPLE LOCATION: McGrath, Tract B, Alaska

DATE COLLECTED 3-23-79 TIME COLLECTED: ---

SAMPLED BY Pete Archibald SOURCE Well completed 3-23-79

REMARKS Extremely high iron level

Sample No. 4

FOR LAB USE ONLY

RECVD.BY GY LAB # 10032-4

DATE RECEIVED 3-29-79

DATE COMPLETED 3-29-79

DATE REPORTED 3-30-79

SIGNED

mg/l		mg/l		mg/l	
[]Ag, Silver		[]P, Phosphorous		[]Cyanide	
[]Al, Aluminum		[]Pb, Lead		[]Sulfate	
[]As, Arsenic		[]Pt, Platinum		[]Phenol	
[]Au, Gold		[]Sb, Antimony		[]Total Dissolved Solids	
[]B, Boron		[]Se, Selenium		[]Total Volatile Solids	
[]Ba, Barium		[]Si, Silicon		[]Suspended Solids	
[]Bi, Bismuth		[]Sn, Tin		[]Volatile Suspended Solids	
[]Ca, Calcium		[]Sr, Strontium		[]Hardness as $CaCO_3$	
[]Cd, Cadmium		[]Ti, Titanium		[]Alkalinity as $CaCO_3$	
[]Co, Cobalt		[]W, Tungsten		[]	
[]Cr, Chromium		[]V, Vanadium		[]	
[]Cu, Copper		[]Zn, Zinc		[]	
[]Fe, Iron	11	[]Zr, Zirconium		[]	
				* * * * * *	
[]Hg, Mercury		[]Ammonia Nitrogen-N		[]mmhos Conductivity	
[]K, Potassium		[]Kjedahl Nitrogen-N		[]pH Units	
[]Mg, Magnesium		[]Nitrate-N		[]Turbidity NTU	
[]Mn, Manganese		[]Nitrite-N		[]Color Units	
[]Mo, Molybdenum		[]Phosphorus (Ortho)-P		[]T.Coliform/100ml	
[]Na, Sodium		[]Chloride		[]	
[]Ni, Nickel		[]Fluoride		[]	

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHON
(907) 279-4(

P.O. BOX 4-1276 ANCHORAGE, ALASKA 99509 [redacted]
5633 "B" STREET

ANALYTICAL REPORT

CUSTOMER Alaska Area Native Health Service SAMPLE LOCATION: McGrath, Alaska

DATE COLLECTED Unknown TIME COLLECTED: Unknown

SAMPLED BY Unknown SOURCE Unknown

REMARKS

FOR LAB USE ONLY	
RECVD.BY AG	LAB # 100(
DATE RECEIVED	3-30-79
DATE COMPLETED	4-3-79
DATE REPORTED	4-4-79
SIGNED	Archie L. Green

	mg/l		mg/l		mg/l
[]Ag,Silver	<0.05	[]P,Phosphorous	0.37	[]Cyanide	
[]Al,Aluminum	<0.01	[]Pb,Lead	<0.05	[]Sulfate	13
[]As,Arsenic	<0.1	[]Pt,Platinum	<0.01	[]Phenol	
[]Au,Gold	<0.01	[]Sb,Antimony	0.05	[]Total Dissolved Solids	318
[]B,Boron	<0.01	[]Se,Selenium	<0.01	[]Total Volatile Solids	
[]Ba,Barium	0.4	[]Si,Silicon	5	[]Suspended Solids	
[]Bi,Bismuth	<0.01	[]Sn,Tin	0.02	[]Volatile Suspended Solids	
[]Ca,Calcium	106	[]Sr,Strontium	0.48	[]Hardness as $CaCO_3$	336
[]Cd,Cadmium	<0.010	[]Ti,Titanium	<0.01	[]Alkalinity as $CaCO_3$	308
[]Co,Cobalt	<0.05	[]W,Tungsten	<0.1	[]	
[]Cr,Chromium	<0.05	[]V,Vanadium	<0.01	[]	
[]Cu,Copper	<0.1	[]Zn,Zinc	<0.01	[]	
[]Fe,Iron	12	[]Zr,Zirconium	<0.01	[]	
				* * * * *	
[]Hg,Mercury	<0.1	[]Ammonia Nitrogen-N		[]mmhos Conductivity	610
[]K,Potassium	1	[]Kjedahl Nitrogen-N		[]pH Units	7.4
[]Mg,Magnesium	9.6	[]Nitrate-N		[]Turbidity NTU	
[]Mn,Manganese	1.1	[]Nitrite-N		[]Color Units	
[]Mo,Molybdenum	<0.05	[]Phosphorus (Ortho)-P		[]T.Coliform/100ml	
[]Na,Sodium	2	[]Chloride	2	[]	
[]Ni,Nickel	<0.01	[]Fluoride		[]	

APPENDIX 3

U.S. Geological Survey water-quality data for the Kuskokwim River

USGS Station No.15303600 - KUSKOKWIM RIVER AT MCGRATH, AK

WATER-QUALITY DATA,

WATER YEAR OCTOBER 1949 TO SEPTEMBER 1950

DATE	SURFACE AREA (SQ MI) (00049)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2) (00405)	ALKA-LINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	BICAR-BONATE WATER WH FET FIELD MG/L AS HCO3 (00440)	CAR-BONATE WATER WH FET FIELD MG/L AS CO3 (00445)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N) (00618)
AUG									
22...	11700	5	264	7.3	9.8	100	120	0	0.020

DATE	HARD-NESS TOTAL (MG/L AS CACO3) (00900)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM+ POTAS-SIUM DIS-SOLVED (MG/L AS NA) (00933)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)
AUG								
22...	120	24	34	9.4	6.4	1.0	34	0.20

DATE	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) (70300)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3) (71851)	IRON (UG/L AS FE) (71885)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	DRAIN-AGE AREA (SQ. MI.) (81024)
AUG								
22...	7.6	157	153	0.21	0.10	80	300	11700

WATER YEAR OCTOBER 1965 TO SEPTEMBER 1966

DATE	SURFACE AREA (SQ MI) (00049)	DIS-CHARGE, INST. CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	CAR-BONATE WATER WH FET FIELD MG/L AS CO3 (00445)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	DRAIN-AGE AREA (SQ. MI.) (81024)
JUL							
20...	11700	23800	272	8.1	0	300	11700

WATER YEAR OCTOBER 1966 TO SEPTEMBER 1967

DATE	TEMPER-ATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DIS-CHARGE, INST. CUBIC FEET PER SECOND (00061)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2) (00405)	ALKA-LINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	BICAR-BONATE WATER WH FET FIELD MG/L AS HCO3 (00440)	CAR-BONATE WATER WH FET FIELD MG/L AS CO3 (00445)
MAY										
28...	11.5	11700	30300	25	218	7.6	4.6	94	110	0
SEP										
29...	4.5	11700	15800	5	305	7.7	5.3	136	170	0

DATE	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N) (00618)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	SODIUM PERCENT (00932)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)
MAY										
28...	0.230	110	24	34	6.6	1.5	0.1	3	1.2	0.40
SEP										
29...	1.40	160	27	47	11	2.4	0.1	3	1.1	1.1

DATE	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)
MAY									
28...	22	0.30	6.2	129	10600	0.18	66	96	100
SEP									
29...	32	0.10	9.7	192	8200	0.26	12	31	91

DATE	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)	SED. SUSP. FALL DIAM. % FINER THAN 1.00 MM (70346)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3) (71851)	MANGA-NESE (UG/L AS MN) (71883)	IRON (UG/L AS FE) (71885)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	DRAIN-AGE AREA (SQ. MI.) (81024)
MAY									
28...	--	--	1.0	--	310	300	270	22100	11700
SEP									
29...	98	100	6.0	0	1400	300	334	14200	11700

WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DATE	TEMPER-ATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DIS-CHARGE, INST. CUBIC FEET PER SECOND (00061)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2) (00405)	ALKA-LINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	BICAR-BONATE WATER WH FET FIELD MG/L AS HCO3 (00440)	CAR-BONATE WATER WH FET FIELD MG/L AS CO3 (00445)
MAR										
20...	0.0	11700	4480	--	--	--	--	--	--	--
MAY										
15...	4.0	11700	48700	70	182	7.1	13	84	100	0
15...	4.0	11700	48700	--	182	--	--	--	--	--

DATE	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N) (00618)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	SODIUM PERCENT (00932)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)
MAR										
20...	--	--	--	--	--	--	--	--	--	--
MAY										
15...	0.050	100	18	33	4.6	0.90	0.0	2	0.90	0.60
15...	--	--	--	--	--	--	--	--	--	--

WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968--Contined

DATE	SULFATE DIS- SOLVED (MG/L AS SO4) (00945)	FLUO- RIDE, DIS- SOLVED (MG/L AS F) (00950)	SILICA, DIS- SOLVED (MG/L AS SIO2) (00955)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM (70337)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .008 MM (70339)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)
MAR										
20...	--	--	--	--	--	--	--	--	--	--
MAY										
15...	12	0.10	4.9	107	14100	0.15	--	--	--	--
15...	--	--	--	--	--	--	6	11	18	29

DATE	SED. SUSP. FALL DIAM. % FINER THAN .031 MM (70341)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	NITRO- GEN, NITRATE DIS- SOLVED (MG/L AS NO3) (71851)	IRON (UG/L AS FE) (71885)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	SEDI- MENT, SUS- PENDED (MG/L) (80154)	SEDI- MENT, DIS- CHARGE, SUS- PENDED (T/DAY) (80155)	DRAIN- AGE AREA (SQ. MI.) (81024)
MAR										
20...	--	--	--	--	--	--	300	40	484	11700
MAY										
15...	--	--	--	--	0.20	1500	300	--	--	11700
15...	47	71	92	100	--	--	300	954	125000	11700

WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DATE	TEMPERATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DISCHARGE, INST. CUBIC FEET PER SECOND (00061)	SPECIFIC CONDUCTANCE (US/CM) (00095)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM (70337)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .008 MM (70339)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. FALL DIAM. % FINER THAN .031 MM (70341)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)
MAR										
12...	0.0	11700	3890	151	--	--	--	--	--	--
MAY										
25...	11.0	11700	10600	281	--	--	--	--	--	28
JUL										
08...	13.5	11700	29600	239	8	12	14	18	25	31
AUG										
19...	11.5	11700	18100	291	9	13	--	22	--	39
SEP										
26...	1.0	11700	14600	278	2	6	--	12	--	31

DATE	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)	SED. SUSP. FALL DIAM. % FINER THAN 1.00 MM (70346)	SED. SUSP. FALL DIAM. % FINER THAN 2.00 MM (70347)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	SEDIMENT, SUSPENDED (MG/L) (80154)	SEDIMENT, DISCHARGE, SUSPENDED (T/DAY) (80155)	DRAINAGE AREA (SQ. MI.) (81024)
MAR									
12...	--	--	--	--	--	300	14	147	11700
MAY									
25...	52	64	85	100	--	300	218	6240	11700
JUL									
08...	36	43	82	99	100	300	1840	147000	11700
AUG									
19...	58	89	100	--	--	300	340	16600	11700
SEP									
26...	52	97	100	--	--	300	193	7610	11700

WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DATE	TEMPERATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DISCHARGE, INST. CUBIC FEET PER SECOND (00061)	TURBIDITY (JCU) (00070)	COLOR (PLATINUM-COBALT UNITS) (00080)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2) (00405)	ALKALINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	BICARBONATE WATER WH FET FIELD MG/L AS HCO3 (00440)	CARBONATE WATER WH FET FIELD MG/L AS CO3 (00445)	RESIDUE AT 105 DEG. C, DISSOLVED (MG/L) (00515)
MAR												
19...	1.0	11700	3950	--	--	346	--	--	--	--	--	230
JUL												
09...	--	11700	26600	--	--	268	--	--	--	--	--	--
AUG												
15...	13.0	11700	65200	--	--	252	--	--	--	--	--	--
SEP												
25...	5.0	11700	13500	2	10	312	7.8	4.0	130	160	0	--

DATE	RESIDUE TOTAL AT 105 DEG. C, SUSPENDED (MG/L) (00530)	NITROGEN, NITRATE DISSOLVED (MG/L AS N) (00618)	HARDNESS TOTAL (MG/L AS CACO3) (00900)	HARDNESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DISSOLVED (MG/L AS CA) (00915)	MAGNESIUM, DISSOLVED (MG/L AS MG) (00925)	SODIUM, DISSOLVED (MG/L AS NA) (00930)	SODIUM ADSORPTION RATIO (00931)	SODIUM PERCENT (00932)	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	SULFATE DISSOLVED (MG/L AS SO4) (00945)
MAR												
19...	5	--	--	--	--	--	--	--	--	--	--	--
JUL												
09...	--	--	--	--	--	--	--	--	--	--	--	--
AUG												
15...	--	--	--	--	--	--	--	--	--	--	--	--
SEP												
25...	--	0.00	170	39	45	14	2.5	0.1	3	1.2	0.80	35

WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971--Continued

DATE	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)	IRON, DISSOLVED (UG/L AS FE) (01046)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	GROSS ALPHA, DISSOLVED (PCI/L AS U-NAT) (01515)	GROSS ALPHA, SUSP. TOTAL (PCI/L AS U-NAT) (01516)	GROSS ALPHA, SUSP. TOTAL (PCI/G AS U-NAT) (01517)	GROSS ALPHA, SUSP. TOTAL (UG/G AS U-NAT) (01518)	GROSS BETA, DISSOLVED (PCI/L AS CS-137) (03515)	GROSS BETA, SUSP. TOTAL (PCI/L AS CS-137) (03516)	GROSS BETA, SUSP. TOTAL (PCI/G AS SR/ YT-90) (03517)	GROSS BETA, SUSP. TOTAL (PCI/G AS CS-137) (03518)
MAR												
19...	--	--	--	--	2.1	<0.3	<54	<80	3.2	0.6	120	120
JUL												
09...	--	--	--	--	--	--	--	--	--	--	--	--
AUG												
15...	--	--	--	--	--	--	--	--	--	--	--	--
SEP												
25...	0.10	9.3	80	20	--	--	--	--	--	--	--	--

DATE	RADIUM 226, DISSOLVED, RADON METHOD (PCI/L) (09511)	URANIUM NATURAL DISSOLVED (UG/L AS U) (22703)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) (70301)	SOLIDS, DISSOLVED (TONS PER DAY) (70302)	SOLIDS, DISSOLVED (TONS PER AC-FT) (70303)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM (70337)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .008 MM (70339)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. FALL DIAM. % FINER THAN .031 MM (70341)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)
MAR												
19...	0.05	0.80	--	--	--	--	--	--	--	--	--	--
JUL												
09...	--	--	--	--	--	20	25	32	41	51	69	89
AUG												
15...	--	--	--	--	--	14	21	30	40	50	71	90
SEP												
25...	--	--	186	6790	0.25	--	--	--	--	--	26	52

WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971--Continued

DATE	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3) (71851)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	GROSS ALPHA, DIS-SOLVED (UG/L AS U-NAT) (80030)	GROSS ALPHA, SUSP. TOTAL (UG/L AS U-NAT) (80040)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/YT-90) (80050)	GROSS BETA, SUSP. TOTAL (PCI/L AS SR/YT-90) (80060)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	DRAIN-AGE AREA (SQ. MI.) (81024)
MAR											
19...	--	--	--	300	3.1	<0.4	2.5	0.6	10	107	11700
JUL											
09...	99	100	--	300	--	--	--	--	406	29200	11700
AUG											
15...	98	100	--	300	--	--	--	--	1020	180000	11700
SEP											
25...	100	--	0.0	300	--	--	--	--	149	5430	11700

WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DATE	TEMPERATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DISCHARGE, INST. CUBIC FEET PER SECOND (00061)	TURBIDITY (JCU) (00070)	COLOR (PLATINUM-COBALT UNITS) (00080)	SPECIFIC CONDUCTANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STANDARD UNITS) (00400)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2) (00405)	ALKALINITY WAT WH TOT FET FIELD MG/L AS CACO3 (00410)	BICARBONATE WATER WH FET FIELD MG/L AS HCO3 (00440)	CARBONATE WATER WH FET FIELD MG/L AS CO3 (00445)	RESIDUE AT 105 DEG. C, DISSOLVED (MG/L) (00515)
MAR												
22...	0.0	11700	3950	5	0	328	7.8	4.6	148	180	0	210
JUN												
14...	14.5	11700	20100	20	--	275	--	--	--	--	--	180
JUL												
13...	16.5	11700	28100	--	--	265	--	--	--	--	--	--
AUG												
17...	15.0	11700	23400	90	--	286	--	--	--	--	--	--
SEP												
23...	3.5	11700	16800	7	20	281	7.7	4.4	112	140	0	190

DATE	RESIDUE TOTAL AT 105 DEG. C, SUSPENDED (MG/L) (00530)	NITROGEN, NITRATE DISSOLVED (MG/L AS N) (00618)	HARDNESS TOTAL (MG/L AS CACO3) (00900)	HARDNESS NONCARB WH WAT TOT FLD MG/L AS CACO3 (00902)	CALCIUM DISSOLVED (MG/L AS CA) (00915)	MAGNESIUM, DISSOLVED (MG/L AS MG) (00925)	SODIUM, DISSOLVED (MG/L AS NA) (00930)	SODIUM ADSORPTION RATIO (00931)	SODIUM PERCENT (00932)	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	SULFATE DISSOLVED (MG/L AS SO4) (00945)
MAR												
22...	27	0.00	170	26	48	13	2.6	0.1	3	1.1	0.30	30
JUN												
14...	87	--	--	--	--	--	--	--	--	--	--	--
JUL												
13...	--	--	--	--	--	--	--	--	--	--	--	--
AUG												
17...	--	--	--	--	--	--	--	--	--	--	--	--
SEP												
23...	44	0.050	140	30	39	11	2.0	0.1	3	1.0	1.2	31

DATE	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)	IRON, DISSOLVED (UG/L AS FE) (01046)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	GROSS ALPHA, DISSOLVED (PCI/L AS U-NAT) (01515)	GROSS ALPHA, SUSP. TOTAL (PCI/L AS U-NAT) (01516)	GROSS BETA, DISSOLVED (PCI/L AS CS-137) (03515)	GROSS BETA, SUSP. TOTAL (PCI/L AS CS-137) (03516)	RA-226, DISSOLVED, PLANCHET COUNT (PCI/L) (09510)	RADIUM 226, DISSOLVED, RADON METHOD (PCI/L) (09511)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L) (70301)
MAR											
22...	0.30	12	30	20	<1.0	0.4	2.1	0.8	--	0.05	196
JUN											
14...	--	--	--	--	<0.8	1.3	2.6	3.3	--	0.04	--
JUL											
13...	--	--	--	--	--	--	--	--	--	--	--
AUG											
17...	--	--	--	--	--	--	--	--	--	--	--
SEP											
23...	0.20	9.7	160	20	1.0	0.6	2.4	2.3	<0.1	--	163

DATE	SOLIDS, DISSOLVED (TONS PER DAY) (70302)	SOLIDS, DISSOLVED (TONS PER AC-FT) (70303)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM (70337)	SED. SUSP. FALL DIAM. % FINER THAN .004 MM (70338)	SED. SUSP. FALL DIAM. % FINER THAN .008 MM (70339)	SED. SUSP. FALL DIAM. % FINER THAN .016 MM (70340)	SED. SUSP. FALL DIAM. % FINER THAN .031 MM (70341)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)
MAR											
22...	2090	0.27	--	--	--	--	--	--	--	--	--
JUN											
14...	--	--	--	--	--	--	--	58	92	100	--
JUL											
13...	--	--	20	28	40	51	60	74	88	99	100
AUG											
17...	--	--	17	28	32	42	54	62	77	99	100
SEP											
23...	7390	0.22	--	--	--	--	--	17	36	96	100

WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972--Continued

DATE	HY-DROXIDE WATER WH FET FIELD MG/L AS OH (71830)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3) (71851)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	URANIUM DIS-SOLVED, EXTRAC-TION (UG/L) (80020)	GROSS ALPHA, DIS-SOLVED (UG/L AS U-NAT) (80030)	GROSS ALPHA, SUSP. TOTAL (UG/L AS U-NAT) (80040)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/YT-90) (80050)	GROSS BETA, SUSP. TOTAL (PCI/L AS SR/YT-90) (80060)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	DRAIN-AGE AREA (SQ. MI.) (81024)
MAR											
22...	0	0.0	300	0.22	<2.9	1.2	1.7	0.7	12	128	11700
JUN											
14...	--	--	300	0.70	<2.5	3.9	2.1	2.6	140	7600	11700
JUL											
13...	--	--	300	--	--	--	--	--	736	55800	11700
AUG											
17...	--	--	300	--	--	--	--	--	488	30800	11700
SEP											
23...	--	0.20	300	0.73	3.1	1.7	2.0	1.9	191	8660	11700

WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973

DATE	SAMPLE ACCT. NUMBER (00008)	TEMPER-ATURE WATER (DEG C) (00010)	SURFACE AREA (SQ MI) (00049)	DIS-CHARGE, INST. CUBIC FEET PER SECOND (00061)	TUR-BID-ITY (JCU) (00070)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	RESIDUE AT 105 DEG. C, DIS-SOLVED (MG/L) (00515)	RESIDUE TOTAL AT 105 DEG. C, SUS-PENDED (MG/L) (00530)	GROSS BETA, DIS-SOLVED (PCI/L AS CS-137) (03515)	GROSS BETA, SUSP. TOTAL (PCI/L AS CS-137) (03516)	RADIUM 226, DIS-SOLVED, RADON METHOD (PCI/L) (09511)	SED. SUSP. FALL DIAM. % FINER THAN .062 MM (70342)
OCT												
21...	--	0.5	11700	15300	4	275	--	--	--	--	--	34
MAR												
17...	--	--	11700	--	--	--	220	8	1.3	0.4	0.05	--
MAY												
23...	2202	--	11700	--	--	--	160	90	2.5	4.0	0.02	--

DATE	SED. SUSP. FALL DIAM. % FINER THAN .125 MM (70343)	SED. SUSP. FALL DIAM. % FINER THAN .250 MM (70344)	SED. SUSP. FALL DIAM. % FINER THAN .500 MM (70345)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	URANIUM DIS-SOLVED, EXTRAC-TION (UG/L) (80020)	GROSS ALPHA, DIS-SOLVED (UG/L AS U-NAT) (80030)	GROSS ALPHA, SUSP. TOTAL (UG/L AS U-NAT) (80040)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/ YT-90) (80050)	GROSS BETA, SUSP. TOTAL (PCI/L AS SR/ YT-90) (80060)	SEDI-MENT, SUS-PENDED (MG/L) (80154)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY) (80155)	DRAIN-AGE AREA (SQ. MI.) (81024)
OCT												
21...	60	97	100	300	--	--	--	--	--	120	4960	11700
MAR												
17...	--	--	--	300	0.69	5.0	<0.4	1.1	<0.4	--	--	11700
MAY												
23...	--	--	--	300	0.45	2.7	5.9	2.0	3.3	--	--	11700

WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	SAMPLE ACCT. NUMBER (00008)	SURFACE AREA (SQ MI) (00049)	RESIDUE AT 105 DEG. C, DIS-SOLVED (MG/L) (00515)	RESIDUE TOTAL AT 105 DEG. C, SUS-PENDED (MG/L) (00530)	GROSS BETA, DIS-SOLVED (PCI/L AS CS-137) (03515)	GROSS BETA, SUSP. TOTAL (PCI/L AS CS-137) (03516)	RADIUM 226, DIS-SOLVED, RADON METHOD (PCI/L) (09511)
OCT							
02...	843	11700	210	52	1.9	2.3	0.04

DATE	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	URANIUM DIS-SOLVED, EXTRAC-TION (UG/L) (80020)	GROSS ALPHA, DIS-SOLVED (UG/L AS U-NAT) (80030)	GROSS ALPHA, SUSP. TOTAL (UG/L AS U-NAT) (80040)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/ YT-90) (80050)	GROSS BETA, SUSP. TOTAL (PCI/L AS SR/ YT-90) (80060)	DRAIN-AGE AREA (SQ. MI.) (81024)
OCT							
02...	300	0.68	4.0	1.6	1.5	1.8	11700