Overview of Environmental and Hydrogeologic Conditions at Moses Point, Alaska

By Joseph M. Dorava, Robert P. Ayres, and William C. Sisco

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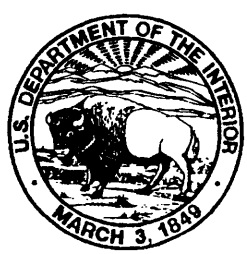

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNIT

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
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.

Abbreviated water-quality unit used in this report:

mg/L, milligram per liter

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Abstract

The Federal Aviation Administration facility at Moses Point is located at the mouth of the Kwiniuk River on the Seward Peninsula in northwestern Alaska. This area has long cold winters and short summers. The Federal Aviation Administration owns or operates airport support facilities at the Moses Point site and wishes to consider the subsistence lifestyles of area residents and the quality of the current environment when evaluating options for remediation of environmental contamination at their facilities. Currently no operating wells are in the area, but the vulnerability of the aquifer and other alternative water supplies are being evaluated because the Federal Aviation Administration has a potential liability for the storage and use of hazardous materials in the area.

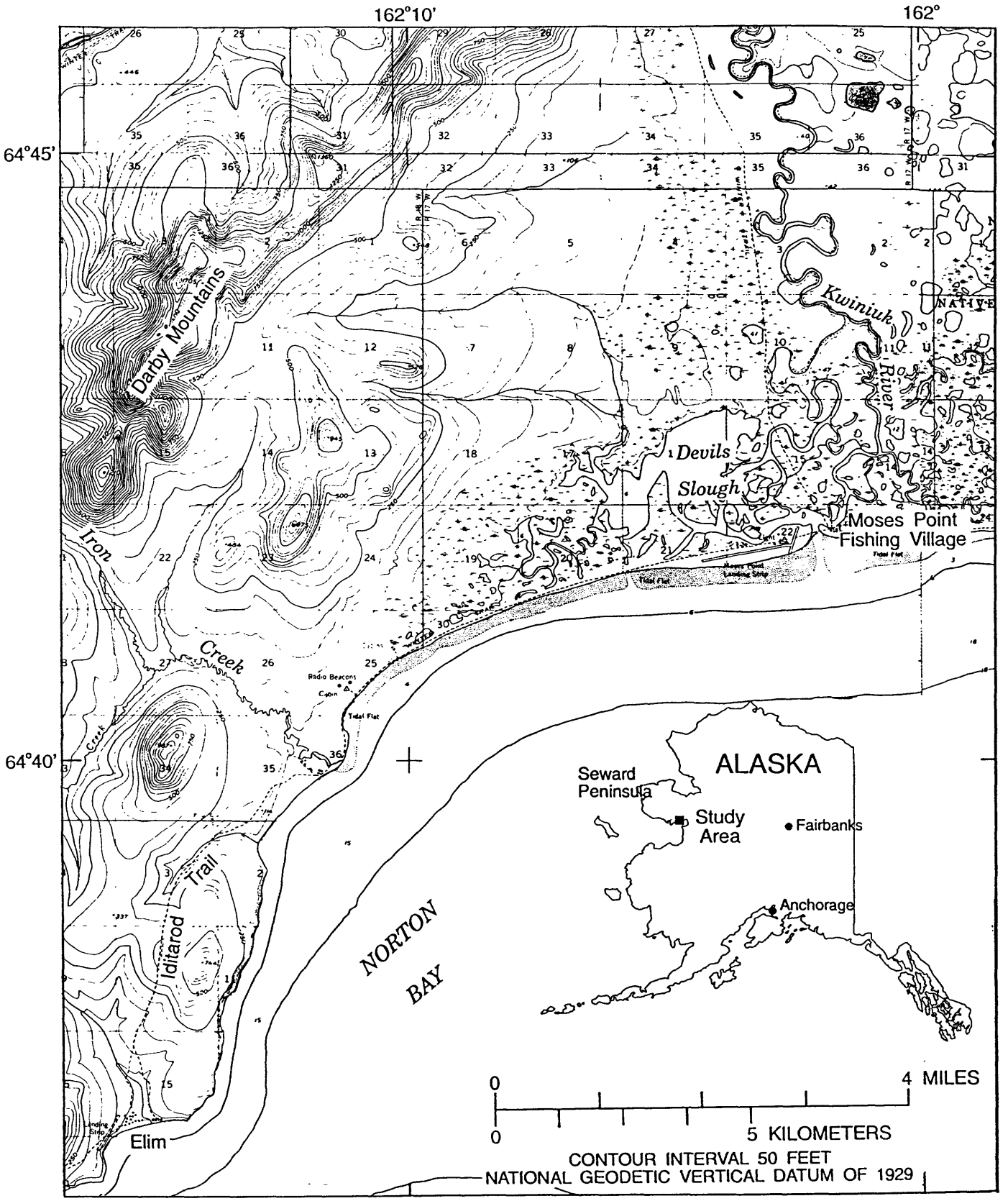
INTRODUCTION

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, 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 Moses Point, Alaska. Also presented in this report is a description of the history, socioeconomics, and physical setting of the Moses Point area.

BACKGROUND

Location

The Moses Point FAA station is on the Seward Peninsula in northwestern Alaska along the north coast of Norton Sound at latitude 64°41'49"N., longitude 162°02'30"W. (fig. 1). The station is at the mouth of the Kwiniuk River approximately 8 km northeast of the village of Elim, 160 km east of Nome, and approximately 740 km northwest of Anchorage.



Base from U.S. Geological Survey, Solomon (C-1, D-1), Norton Bay (C-6, D-6), Alaska, 1:63,360, 1950

Figure 1. Location of Moses Point and surrounding area.

History

The Seward Peninsula, which was originally part of the Bering land bridge, is thought to have been settled about 40,000 years ago (Selkregg, 1976). Traditional settlement patterns for the Norton Sound area were centered around the harvest of small sea mammals, fish, and caribou (Selkregg, 1976). The Moses Point area has been a traditional subsistence harvest area for the people of neighboring Elim since the settlement was founded in the early 1900's (Darla Jemewouk, Elim Municipality Utilities, oral commun., 1994).

The people of Elim, the closest village to Moses Point, are Inupiat of the Malemiut subgroup (Alaska Department of Community and Regional Affairs, 1994). Important subsistence species for Elim residents are salmon, seal, beluga, waterfowl, muskrat, ground squirrel, hare, moose, caribou and fur bearers such as the land otter, lynx, mink and wolverine. These natural food sources are supplemented by the gathering of wild berries (Selkregg, 1976). The village of Elim maintains a fish camp at Moses Point across the mouth of the Kwiniuk River from the FAA facilities (U.S. Army Corps of Engineers, 1991).

A detailed summary of FAA real estate interests and activity near Moses Point is compiled in a report by Ecology and Environment, Inc. (1992). The Moses Point FAA station was originally constructed between 1940 and 1941 when the U.S. Department of Commerce was authorized by the U.S. Department of the Interior, Office of Indian Affairs, to install and occupy an emergency landing strip at Moses Point for the defense of Alaska during World War II. In May 1942, the Civil Aeronautics Administration (CAA) was granted a 10-year license to occupy and use the airfield and the surrounding land. The U.S. Army took control of the facility in 1942 and built a small base. In 1949, ownership of the facility was transferred to the Elim Native Corporation. The FAA has not used the station since 1967, with the exception of maintaining the VOR (very high frequency omnidirectional range) and NDB (nondirection beacon) facilities (fig. 2). The FAA has not manned the Moses Point facilities since 1972: the runway and taxiway have not been maintained and the existing houses have only been used periodically by the Elim Native Corporation.

Socioeconomics

The Moses Point site currently has no year-round residents and no commercial operations in progress. The site consists of a runway and taxiway, a main complex (which contains buildings for living quarters, a maintenance facility, a power house, and a library/recreation facility) a VOR and NDB (fig. 2) (Ecology and Environment, 1992). Moses Point can be reached by air or from the neighboring community of Elim by a dirt road built to provide residents access to fishing grounds. Norton Bay also provides access for boats and barges during open water months and for snowmobiles and dogsleds during the winter months (Alaska Department of Community and Regional Affairs, 1994). The Iditarod trail passes through the Moses Point area (fig. 1).

During the 1970's and 1980's a fish-processing plant was operated at Moses Point, but was closed because of poor returns of salmon. Some commercial fishing takes place during the Coho salmon run in August, but the fish are processed and sold elsewhere (Darla Jemewouk, Elim Municipality Utilities, oral commun., 1994). The residents of Elim currently use Moses Point for their annual subsistence harvest of fish, mainly the five species of Pacific salmon and Pacific herring (Alaska Department of Community and Regional Affairs, 1994). This supply is supplemented by the resident fish which include Dolly Varden char, suckers, whitefish, trout, grayling and blackfish.

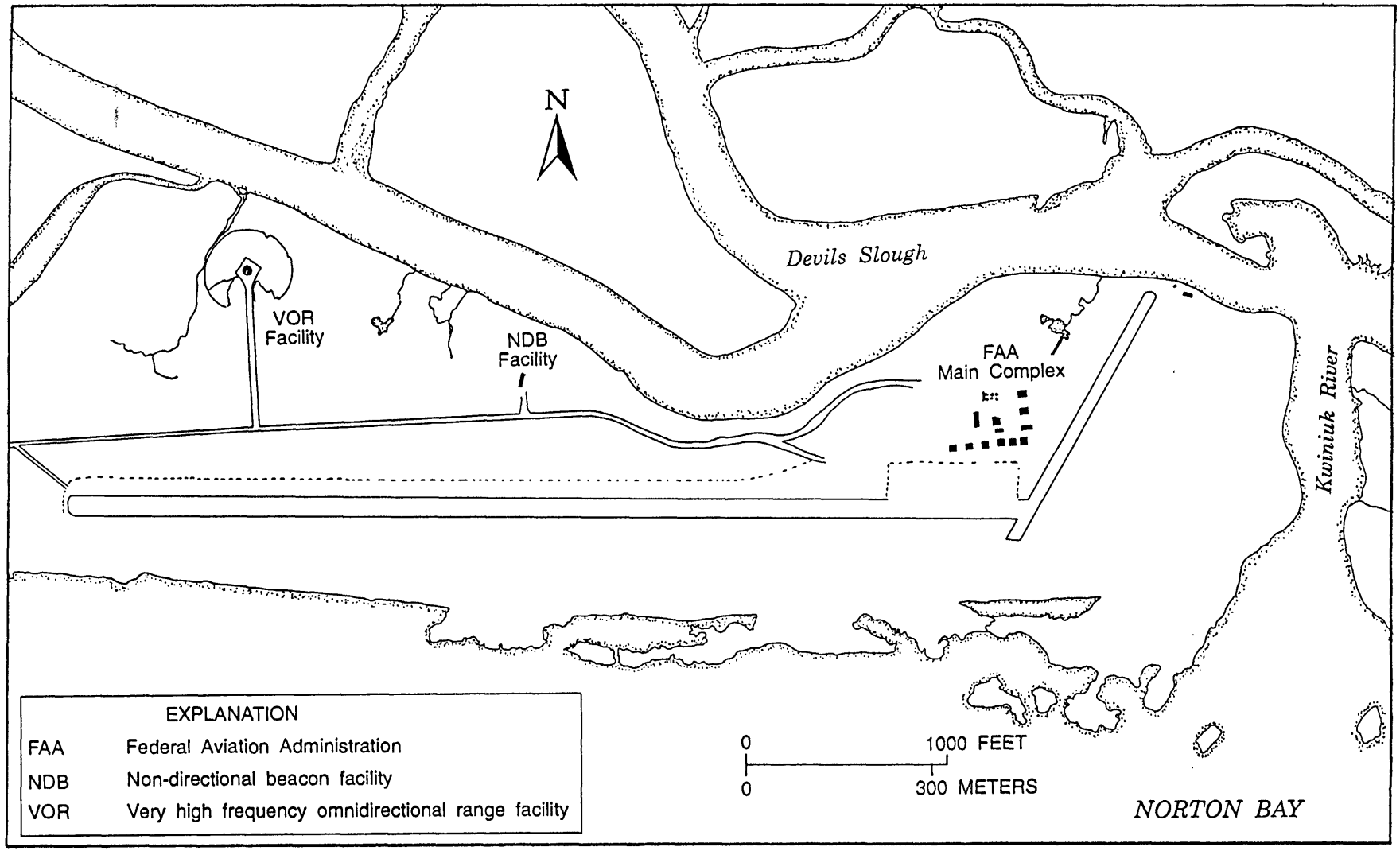


Figure 2. Location of Federal Aviation Administration facilities near Moses Point.

PHYSICAL SETTING

Climate

The climate of the coastal lowland area near Moses Point is transitional maritime bordering on continental (Hartman and Johnson, 1984). Summers are cool and winters are long and cold. Winters are influenced considerably by the freezing of Norton Sound making for a cold, relatively dry, climate. The freezing of Norton Bay usually occurs in early October to mid-November and breakup usually occurs by the end of May (Selkregg, 1976). During the summer months when Norton Sound is ice free, the influence of the maritime climate is considerable. The summer is cool and most rainfall occurs from July through September (table 1). The mean annual temperature is -2.1 ^{o}C, but temperatures range from a July mean maximum of 18.3 ^{o}C to a January mean minimum of -22.4 ^{o}C (Leslie, 1989). Mean annual precipitation is about 490 mm; about 1,425 mm of snow falls annually (Leslie, 1989). Mean monthly temperature, precipitation, and snowfall are summarized in table 1.

Vegetation

The area around the Moses Point FAA facility is predominantly moist coastal lowland and includes many marshes. To the north, the land cover is predominantly wet tundra and includes many shallow lakes and little topographic relief. Rooted aquatic plants cover shorelines and bottoms of shallow lakes. The vegetation of the wet tundra is dominated by sedges, mosses, willows, alder, and scattered black spruce (Rieger and others, 1979). Upland areas farther to the north are covered by spruce-hardwood forests. The upland vegetation consists of paper birch, scattered white spruce, and black spruce (Viereck and Little, 1972). Plants in the understory include willows, roses, wheat grass, fireweed, ferns, and mosses (Selkregg, 1976).

The FAA facility is on a sandy spit where vegetation consists of beach grasses and sedges adjacent to tundra wetlands (U.S. Army Corps of Engineers, 1990). Vegetation east of the facility is composed mostly of poorly drained short grass tundra. Vegetation to the west is composed of short grass tundra and areas of scattered trees and shrubs. The sandy coastal areas may be inundated periodically during storm tides, but the Moses Point area generally is well drained. The beaches lack vegetation around the FAA site because of past ground disturbing activities and gravel fill.

The local area is flat but some micro-relief, generally less than 1 m in height, is provided by peat ridges and polygonal features related to frost action and ice wedges. A small number of woody plants, such as willow and alder, grow on the driest sites where the micro-relief keeps them above the standing water table (U.S. Army Corps of Engineers, 1990).

Bedrock Geology

The Moses Point FAA facility is on a sandy spit where the ground is generally flat. To the north, the terrain gradually increases in elevation forming the foothills of the Darby Mountains (fig. 1) where bedrock exposures are generally composed of Paleozoic age marble (Till and others, 1986). The marble is a white to very light grey, medium to coarse-crystalline deposit that weathers to form barren grey-colored hills. The hills are more than 500 m in elevation and are 10 km inland northwest of the mouth of the Kwiniuk River. This light-colored marble is interbedded with dolomite that is brecciated, fossiliferous, and dark gray to black in color (Miller and others, 1972). The depth to bedrock and its thickness near the Moses Point FAA facility are unknown.

Table 1. Mean monthly temperature, precipitation, and snowfall for the combined periods 1922-76 and 1985-87, Moses Point
[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	-12.7	-8.7	-5.1	2.3	10.9	17.4	18.3	15.6	11.5	2.1	-5.8	-12.7	2.8
(Record maximum, 33.3 °C, June 1922)													
Mean minimum	-22.4	-19.3	-17.1	-7.9	0.4	6.1	8.1	7.2	2.6	-5.2	-13.9	-21.9	-6.9
(Record minimum, -52.2 °C, January 1947)													
Mean	-17.7	-14.0	-11.0	-2.8	5.7	11.7	13.2	11.4	7.1	-1.5	-9.8	-17.3	-2.1
Precipitation (mm of moisture)	20.6	22.4	23.9	16.0	25.7	37.3	60.5	117.6	72.4	37.1	27.9	27.4	489
Snowfall (mm)	215.9	226.1	243.8	111.8	27.9	Trace	--	Trace	2.54	101.6	236.2	261.6	1,425

Surficial Geology

Unconsolidated deposits of Quaternary age consisting of colluvial and alluvial sediments, coastal beaches, spits, and bars that rest upon the bedrock basement have been described in detail by Till and others (1986). The upland deposits consist of silty colluvium derived predominantly from windblown or frost-rived materials. Hilltops and ridges are covered with angular, frost-rived bedrock rubble, and valley slopes include aprons of inactive alluvial fans. The active channel of the Kwiniuk River and its terraces, overbank areas, and flood plains are covered with stratified deposits of sorted gravel, sand, and silt. Lowland areas east and west of the Kwiniuk River and north of the Moses Point FAA facilities contain thick deposits of silt and peat. These deposits consist of weakly stratified, well-sorted eolian silt and sand, organic-rich silt, and detrital peat. They contain a high volume of interstitial ice and ice wedges and are concentrated in marshy, topographic depressions. The modern beach deposits adjacent to Norton Sound are made up of clean sand and cobble-sized material.

Near the FAA facilities, surficial materials are predominantly sands with organics near the surface grading to porous sands and gravels. Finer grained sands exist along the edges of abandoned and active river channels (U.S. Army Corps of Engineers, 1991; Selkregg, 1976). Past uses of the area have left the site denuded of most organic matter (U.S. Army Corps of Engineers, 1991). Permafrost is expected to be absent along the beach but is present inland with an active layer 1 to 2 m thick (U.S. Army Corps of Engineers, 1990; Hopkins and others, 1955). Selkregg (1976) reports that a well near Moses Point was drilled through unconsolidated deposits--mostly sand and gravel, silt, and clay--and reported no frozen ground.

Soils

Two principal soil types are present in the Moses Point area (Rieger and others, 1979). One formed in the foothills and valleys from the thick deposits of loamy colluvium. This soil, the most extensive in the area, was formed in poorly drained colluvial deposits beneath a thick peaty surface mat and consists of a mottled, dark gray silt loam that contains dark streaks of frost-churned organic material over ice-rich perennially frozen material. The second less extensive soil formed along the river terraces and channels from gravelly alluvium and in well-drained areas near ridges and rounded hills. This soil has a thin mat of organic matter overlying a very dark grayish brown to dark brown gravelly silt loam layer underlain by olive gray stony silt loam or loam. This soil is coarse, and does not retain enough moisture in the upper layer, so it generally prohibits ice-rich permafrost formation to depths below about 1 m. Permafrost in the area of the FAA facility is discontinuous and when present is thought to be shallow (Ferrians, 1965; Williams and Waller, 1970; Rieger and others, 1979).

HYDROLOGY

Surface Water

The primary surface-water bodies within about 5 km of the Moses Point FAA facilities are Norton Bay, Kwiniuk River, Iron Creek, and Devils Slough. Norton Bay is continuous with the Bering Sea by way of Norton Sound. The FAA facilities are located between Norton Bay (to the south) and Devils Slough (to the north). The mouth of the Kwiniuk River is about 0.5 km east of the facility between the Moses Point fishing village and the FAA landing strip (fig. 1). Iron Creek flows from northeast to southwest about 5 km west of the FAA facilities at Moses Point (fig. 1).

The Kwiniuk River drains the southern Darby Mountains and empties into Norton Bay. It has a drainage area of about 350 km^2 and a mean annual discharge of about 9 m^3/s, estimated from equations developed by Parks and Madison (1985). Iron Creek, another nearby stream flowing into Norton Bay has a drainage basin of about 40 km^2 and an estimated mean annual discharge of 1 m^3/s (Parks and Madison, 1985). Devils Slough, an abandoned meander channel of the Kwiniuk River, is about 2 km long and 1.5 km wide. It lies north of the Moses Point FAA facility and is subject to tidal influences.

Floods

Floods at Moses Point have not been documented and flood records are unavailable; however, flood records exist for the neighboring community of Elim. This village is in a similar coastal setting and is at an elevation of about 13 m, whereas Moses Point is at an elevation of about 14 m. The Army Corps of Engineers (1993) rates the coastal flood hazards of Elim as low and none of the residential units are located within the 100-year flood plain (Alaska Department of Community and Regional Affairs, 1994). Elim has no streams flowing through the community; therefore, coastal storm surges are the only identified flood hazards. Severe coastal floods were recorded at Elim in 1917, 1946, and 1974 (U.S. Army Corps of Engineers, 1993). Because Moses Point is only 1 m higher in elevation than Elim, it was most likely subjected to high water at the same time.

Flooding caused by storm surges, similar to that experienced in Elim, will most likely occur in the fall months when Norton Sound is open and ice free. Winds are able to blow across vast open stretches of water developing high waves and a possible storm surge tide. Normal tide range for the Norton Sound area is less than 1 m (Brower and others, 1977; Hartman and Johnson, 1984). A 100-year storm surge tide is expected to be about 23 m high for the marine area near Moses Point (Brower and others, 1977). The 100-year storm surge tide would inundate all of the FAA facilities. The 10-year tide, reported to be about 15.5 m high (Brower and others, 1977), would overtop the land surface near the facilities which are at an elevation of about 14 m.

Flooding at Moses Point caused by the Kwiniuk River is probably minor because of the large area of low-lying tundra and marsh north of the FAA facilities, which provides storage and greatly attenuates flows on the flood plain.

Ground Water

The foothills of the Darby Mountains, lying to the north of Moses Point (fig. 1), form a ground-water divide. Shallow ground-water flow generally is from these uplands towards the coast. Ground water probably flows in the direction of topographic gradients to the valley bottoms, where it discharges to streams and shallow lakes. Ground water at the Moses Point facility is thought to be shallow, approximately 3 to 4 m below the land surface, and is most likely subject to saltwater intrusion (U.S. Army Corps of Engineers, 1990; Hopkins and others, 1955). Three out of four shallow ground-water wells drilled to provide drinking water to the FAA facilities were abandoned because of saltwater intrusion (Ecology and Environment, 1992). Ground water is not currently withdrawn near the Moses Point FAA facilities (U.S. Army Corps of Engineers, 1991; Darla Jemewouk, Elim Municipal Utilities, oral commun., 1994).

Selkregg (1976) describes the coastal lowlands near the Moses Point area as being capable of providing ground water at an estimated average rate of about 4 to 40 L/s with a chloride content of more than 500 mg/L. Marine gravel and sand in spits, barrier bars, raised beaches and some deltas near Moses Point may contain small quantities of ground water. These types of features are known to contain ground water in the Nome area; however, heavy pumping or seasonal storm surges may result in saltwater intrusion.

Ground-water investigations at the villages of Koyuk, about 50 km northeast of Moses Point, and Shaktolik, about 75 km southeast, indicate that adequate ground-water sources of drinking water could be obtained from the coastal lowland aquifers by installing shallow horizontal infiltration pipes or locating shallow vertical wells inland away from saltwater influences (Waller, 1958). These innovative techniques may have application at the Moses Point site if a source of drinking water from the shallow coastal aquifer is needed.

Drinking Water

The FAA facility at Moses Point originally obtained drinking water from shallow wells near the coast but abandoned all but one because of saltwater intrusion (Ecology and Environment, 1992). The fish-processing plant that operated at the Moses Point facility discontinued using the last well when an oil sheen appeared on the water (Darla Jemewouk, Elim Municipal Utilities, oral commun., 1994). There are no records or water samples to indicate the quality of water from any of these wells.

The Kwiniuk River probably represents the most viable alternative source of drinking water available for the Moses Point area. Because of seasonal movements of population in and out of the area, discharge of the Kwiniuk River is sufficient to support the activities currently present at Moses Point. However, no water-quality records exist for the Kwiniuk River and the development and treatment costs of this alternative drinking source could be significant.

Other possible sources of drinking water for the Moses Point site are Iron Creek, small pockets of ground water that may exist inland, or development of a water transfer system from the neighboring community of Elim where spring water is treated with fluorine and chlorine.

SUMMARY

The remote location of Moses Point makes it dependent on the airport and the neighboring community of Elim for access. The subsistence lifestyles of area residents make them dependent on a sustainable environment. Saltwater intrusion and reports of contamination have prevented coastal lowland wells at Moses Point from producing acceptable drinking water. Drilling new wells in locations away from saltwater influences or contamination may provide adequate drinking water. The Kwiniuk River and Iron Creek also represent an alternative drinking-water supply, but because these streams are 0.5 to 5 km away from the Moses Point FAA facility and because there is no drinking water distribution system in Moses Point, the development of these sources may be uneconomical. Drinking water may be transported from Elim to satisfy short-term needs.

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