AIRPORT DESIGN AND CONSTRUCTION CONSIDERATIONS FOR IMPROVING LIFE-CYCLE COSTS IN THE YUKON-KUSKOKWIM DELTA ALASKA

AUGUST 30, 2004

AKSAS PROJECT 56405
PSA P32044

PREPARED FOR
ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

PREPARED BY
GEOENGINEERS, INC.

File No. 0868-014-00

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AIRPORT DESIGN AND CONSTRUCTION CONSIDERATIONS FOR IMPROVING LIFE-CYCLE COSTS IN THE YUKON-KUSKOKWIM DELTA ALASKA

SECTION 1 - INTRODUCTION AND BACKGROUND

This report presents the results of a study of the materials and methods historically used for constructing airports in remote communities of the Yukon and Kuskokwim River Delta Region of Western Alaska. A vicinity map showing all of the study area airports is presented as Figure 1. The study was initiated by the Aviation Construction Section of the Alaska Department of Transportation at the request of the Airports branch of the Federal Aviation Administration. It was executed by GeoEngineers, Inc. in association with several specialty sub-consultants and other experts in this field.

This report addresses the present conditions and construction practices currently used in Western Alaska, and the common problems and costs resulting from such practices. The report also attempts to evaluate the potential cost-effectiveness of selected improvements in construction methodologies and recommends future experimental trials of new materials, designs and practices. The economics and life-cycle cost advantages of new and innovative approaches were reviewed and appropriate field trials and bid analyses recommended.

1.1 OBJECTIVES AND SCOPE

The primary objective of the study was to determine if there are more cost effective methods and materials for constructing airfields in the Yukon-Kuskokwim (Y-K) Delta region of Alaska than those which have historically been used. Fourteen community airports were selected for this investigation as representative of construction practices in the Y-K Delta region. Airfield construction methods used in all of the cold regions of the northern hemisphere were also investigated and evaluated for potential use in Alaska. An examination was also made of new and innovative methods used for stabilizing embankments where fine grained soils or permafrost conditions exist.

1.2 METHODS OF STUDY

The study was initiated by searching various research databases for reports and information related to airfield construction and operation in the cold regions of the northern hemisphere. All available engineering geology reports on past field studies at the 14 communities included in this study were reviewed for soils information and recommendations. Consultants familiar with Russian and Scandinavian airfield practices were also employed. Alaska Department of Transportation and Public Facilities (ADOT&PF) personnel were involved through a series of meetings and personal contacts, as well as through questionnaires. Additional specific questionnaires were employed to obtain input from contractors, aircraft operators and communities.

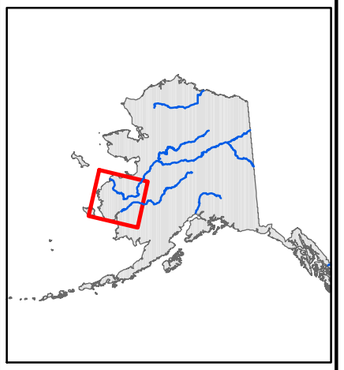
Three field trips were made to visit selected airports and observe construction and maintenance problems on a first-hand basis, with limited field sampling and testing performed on these visits.

1.3 COOPERATING CONSULTANTS

Our team of researchers and consultants included in-house senior arctic geotechnical engineers and specialized consultants from the Anchorage area including DCEsch Research, Arctic Pacific Enterprises LLC, and Asphalt Pros. Foreign consultants contributing to the report included Dalaeroproject from Khabarovsk, Russia, and VISTA Utredning from Oslo, Norway.

Legend

- Airport In Study
- Community
- River



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and Public Facilities

Yukon-Kuskokwim (YK) Delta,
Alaska

Vicinity Map

Figure 1

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SECTION 2 - REGIONAL SETTING

2.1 GEOGRAPHY

The Yukon and Kuskokwim Rivers are Alaska's largest rivers, both flowing westerly into the Bering Sea and collectively draining the Interior Regions of Central Alaska, bounded by the Alaska Range to the south and the Brooks Range to the north. The Yukon also carries water westward from much of the Yukon Territory, which bounds Alaska on the east. The deltas of these great rivers merge and flow onto a huge coastal delta plain. The delta is bounded on the West by the Bering Sea and Kuskokwim Bay and it extends some 260 miles to the east to Russian Mission on the Yukon and to Aniak on the Kuskokwim River. From north to south it is approximately 240 miles wide. It is home to 25,000 people in 34 lowland village communities, while 20 additional villages are located in the upriver regions of the Delta.

Because of the abundant fishery resources, almost all of these Alaskan villages are located along the various rivers draining the Y-K Delta. Each village of significant size has at least a school, a health center and a need for access to transportation services at all seasons of the year. Since there are essentially no roads in the region, materials and heavy supplies are imported by barges and boats in summer. However, air service is the only reliable year-round transportation mode, and is also the means for delivery of nearly 50 million pounds of mail annually.

From the Bering Sea and Kuskokwim Bay shores outward, shifting marine shoals predominate for many miles offshore and restrict access by large ships. Kuskokwim River depths allow barges with drafts of up to 20 feet to carry loads as far upriver as Bethel, except during low water periods. The U.S. Coastal Pilot guide recommends a vessel draft of no more than 15 feet to regularly access Bethel, which has the only significant port in the Y-K region.

The mouth of the Yukon is even less accessible to shipping due to the many shallow and shifting channels and entrance bars through which the river enters the ocean. Two approaches are commonly used: Kwikluak Pass from the south is the deepest approach, allowing tugs and barges with drafts up to 8 feet to enter at high water; Apoon Pass is the approach from St. Michaels and Nome on the north, and is restricted to drafts of around 4 feet at lower water levels. Both approaches must be entered at maximum tide levels with specialized shallow draft river barges. In consequence, Yukon River villages are commonly served by barge shipments of freight carried downriver from the Alaska railroad terminal at Nenana.

2.2 GEOLOGY AND HYDROLOGY OF REGION

Surficial Deposits and Soils

Surficial deposits on the Y-K Delta of Southwest Alaska are primarily composed of fluvial silt and sand deposited by the Yukon and Kuskokwim River systems and the associated deltaic deposits along the western coast, as illustrated on Figure 2. These deposits range from overbank flood and slack water deposits of fine-grained sand, silt, and organic material to bar accretion deposits of coarse-grained sand and gravel. In places, deposits have been reworked by eolian and wave action processes to form beaches, bars, spits, and dunes. Isolated areas of glacial and alluvial deposits also are present in upland areas. The unconsolidated deposits range in thickness from 700 feet near Bethel to 50 feet near St. Marys, and have been dated from Pleistocene to Recent. Permafrost is sporadically distributed throughout the region, ranging from moderately thick to thin, with the maximum depth to base of permafrost found 600 feet below ground surface.

Bedrock

Bedrock exposures on the Y-K Delta include Precambrian to Cretaceous metasediments, and are found in the eastern portion of the Y-K Delta, Nulato Hills in the north portion of the region, and a small outcropping of Cretaceous sandstone and shale on the western portion of Nelson Island. Volcanic cones and Quaternary basalt flows are found in the region and form some of the sparse topography in the Central Y-K Delta, including Ingrisarak Mountain near Chevak; Kochliagok Hill, 20 miles east of Chevak; and Ngrichuak Hill, 30 miles south-southeast of Numan Iqua. Intrusive rocks are also present, most notably a late Cretaceous granodiorite forming the Askinuk Mountains north of Chevak.

Geomorphology

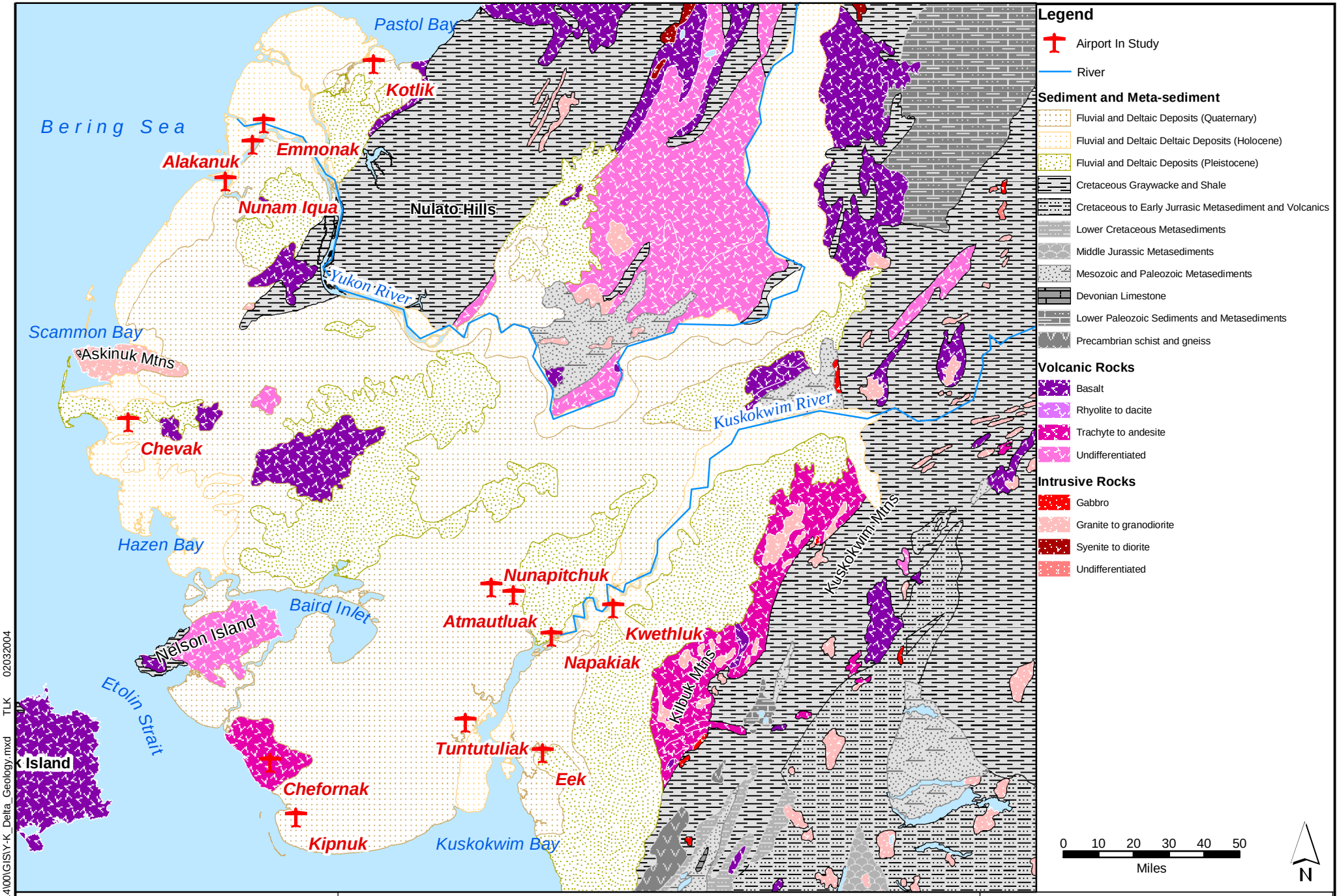
The land surface consists of a broad flood plain with the Kuskokwim River to the south and the Yukon River to the north, with numerous sloughs and oxbow lakes bordered by the Kilbuk and Kuskokwim mountains to the east, transitioning to a deltaic environment bordered by the Bering Sea to the west. Due to the geologic history of the area as a recipient of accretionary arcs, there are seemingly incongruous metasediment belts and intrusive bodies forming topographic highlands such as Nelson Island, the Askinuk Mountains, and the Nulato Hills to the north. The flood plain is interrupted with occasional volcanic cones and the resulting flow deposits, forming relatively low centrally radiating topographic highlands.

Hydrological Aspects

The Yukon and Kuskokwim Rivers transport the erosion products from much of Alaska and the Yukon Territory. When these rivers leave the mountain and hill country and begin to form their deltas, they progressively drop much of their sediment loads starting with the larger gravel particles first, followed by coarse and then fine sand-sized particles. Nearly all of the Y-K Delta consists of flat terrain, with 40 to 50 percent of the surface covered by shallow lakes and small ponds. During summer flood stages, or when localized flooding is caused by river ice jams during spring breakup of the rivers, the river floodwaters occasionally spread out over the entire delta areas and the finest suspended sediment particles drop to the surface of the land where they intermix with the local vegetation. The resultant soils which build up over time typically are termed organic silts, while the clay sized particles remain in suspension and are carried out to finally drop to the bottom of the sea to form marine clay deposits.

On the Kuskokwim River the river levels are influenced by the Bering Sea tides as far upriver as Bethel, which is located some 50 miles from the mouth. Thus while silty sands are the predominating soils at and upriver of Bethel, sandy soils are essentially absent and organic silt soils are pervasive in areas downriver. The same is true of the lower Yukon, where sands and gravels are essentially absent and only sandy organic silts are commonly found downriver of Mountain Village. However, some deposits of fine sand have been found in the river bars along the lower Yukon; an improvement in potentially useable soils over the lower Kuskokwim, where only silts have been found.

Because of the poor erosion resistance of these fine-grained soils, riverbank erosion and deposition are common and all river channels are in a continuing state of migration. Communities historically were mobile and housing units were moved periodically. However, the establishment in recent years of permanent community facilities such as schools, tank farms, health centers and airfields creates the need to attempt to arrest riverbank erosion; often a futile effort. Docking facilities are difficult to establish and maintain, and barge landings must be done in soft and muddy soil conditions.



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Yukon Kuskokwim (YK) Delta, Alaska

Surficial and Bedrock Geology

Figure 2

River and sea ice prevents freight movements by water for much of the year. Sea ice in the Bering Sea usually retards or prevents shipping to Delta villages between November and May, while river ice forms on the Yukon and Kuskokwim in mid-October and goes out in mid-May. Breakup on the Yukon may take many days or weeks for all upriver ice to flow out, due to its greater length than that of the Kuskokwim.

2.3 CLIMATE AND TRENDS

Information on the local climate of the Delta was considered essential to this study for evaluating the presence and stability of permafrost soils, the effects of weather on airfield embankment construction and long term performance, and for analyzing the various design features proposed for improving that performance. It is also useful for providing information to contractors as to the lengths and timing of the construction seasons. Climatic data stations selected for this study included Hooper Bay and Mekoryuk on the west, Aniak on the east, Bethel on the southeast and Emmonak on the north side of the Delta. Bethel, by far the largest community in the region, has the longest climatic record history, dating back to 1924. Bethel climate records have commonly been cited as representative of the weather at essentially all other Y-K Delta community airport sites in the various ADOT&PF engineering geology reports reviewed under this study. Data for Bethel from 1949 to 2003 and for the other communities for varying periods of records was obtained from the Western Region Climate Center (www.wrcc.dri.edu). Alaska Observation Station data can also be accessed through the National Oceanographic Administration (http://aawu.arh.noaa.gov). These records provide mean monthly averages and extremes of temperature, precipitation, wind and cloud cover.

Mean annual air temperatures were found to be relatively consistent across the Delta, varying from 28.2 degrees Fahrenheit (°F) at Aniak and 28.3°F at Russian Mission on the east side of the Delta to 28.7°F at Emmonak on the northwest coast and 29.3°F at Mekoryuk on north side of Nunivak Island, which lies just west of the Delta. The intensity of the freezing and thawing seasons are commonly calculated as the cumulative number of days times the daily differences between the air temperature and 32°F, termed the Freezing Index (FI) in winter, and Thawing Index (TI) in summer. These figures are expressed as degree-days (°F-days) of freezing or thawing in a given season. As might be expected, seasonal temperature ranges were greater away from the ocean, with mean annual freezing indices ranging from 2,940°F-days on the seacoast at Hooper Bay to 3,500 at Emmonak and rising to 4,090°F-days at Aniak on the upriver end of the Delta. Summertime thawing indices were only slightly greater at the inland sites, ranging from 2,500°F-days at Russian Mission and 2,520 at Aniak and declining to 2,420 at Emmonak and Hooper Bay, and to dropping to 1,920°F-days at the offshore island site of Mekoryuk.

The thawing season typically starts earlier at the upriver communities, with thaw commencing about April 25th at Aniak as compared to May 6th at Emmonak and May 11th at Mekoryuk. Typical thawing season lengths were again relatively consistent, ranging from 158 to 167 days. The winter freezing season (avg. daily temps. below 32°F) typically begins about October 8th at Aniak and October 20th at Mekoryuk. However in the past two (abnormally warm) years the freezing season did not really commence at Bethel until November 7th in 2002 and November 9th in 2003.

Construction season weather would ideally be warm and dry. However, the Y-K Delta summer weather is typically cool, cloudy and wet. The summer season runs from early May to mid-October. June through September are the wettest months, with about three inches of precipitation in August and 10 to 12 inches of rain during the summer season. Average annual precipitation values range from 16 to 20 inches across the Delta. The evaporation of soil moisture in the Delta region is also hindered by frequent periods of light rain and fog, as well as by low summer air temperatures, cloud cover and high humidity levels.

The best summary of Delta weather comes from the records at Bethel (Table 1). The average number of days with measurable precipitation (over 0.1 inch) ranged from 11 per month in May to 18 per month in August. Thunderstorms were rare with less than two per year noted. In the average summer, only 12 days had temperatures exceeding 70°F, and average daily humidity levels ranged from 75 percent in May to 85 percent in August. Heavy fog was noted on three to six days per month during the thawing season. Cloudy days predominated, with average cloud covers ranging from 75 percent in May to 85 percent in August.

Wind levels on the Delta are typically moderate to high, with average daily wind speeds at Bethel of 10 to 15 miles per hour (mph), and maximum gusts of 50 mph in summer and 77 mph in winter. Web sites such as the western Region Climate Center provide mean monthly wind speeds for various sites in the region. Winds at Aniak, the most easterly site in the region, are lower that over most of the outer Delta. Wind assists in the evaporation of soil moisture; however the presence of so many lakes and ponds and the high humidity levels preclude much evaporation.

Snowfall has occurred in every month except July and August at Bethel, with winter month maximums over the past 50 years ranging from 13 inches in October to 36 inches in November and December. At the various communities in this study, the annual average snowfall ranges from 45 to 60 inches per year, with annual precipitation amounts ranging from 16 to 22 inches, including the water content of the snowfall. Winter winds redistribute the snow by creating windswept areas and deep snow accumulations in low and brushy areas. This results in significant differences in soil freezing and controls the presence or absence of permafrost.

In summary, the Y-K Delta weather conditions are relatively similar across the region. Temperatures and winds are marginally conducive to permafrost preservation but rising trends in mean annual temperatures are of concern. The cool, cloudy and wet summer conditions act to retard evaporation. Therefore soils cannot be expected to dry significantly in summer except under unusually dry weather conditions.

2.4 PERMAFROST CONDITIONS

Permafrost conditions on the Y-K Delta are the result of the combined effects of climate, soils conditions, terrain, vegetation and surface water in the following ways:

- Air temperatures averaging below the freezing point facilitate the progressive freezing of soils.
- High wind speeds act to cool the surface to the average air temperature and increase the seasonal evaporation of surface water to create a net cooling effect.
- Cloudy conditions retard solar heating of the surface.
- Wet or saturated organic surface soil layers provide insulation in summer and conduct heat out of the ground when frozen in winter, because their frozen thermal conductivity is much higher that their thawed conductivity.
- Vegetation may serve to reduce solar heating of surfaces in summer, but vegetation reduces the cooling effects of wind-driven evaporation in summer and traps snow in winter to insulate the ground surface.

- Snow depths are strongly controlled by terrain and wind, with elevated areas becoming almost snow free and adjacent low areas accumulating thick insulating snow covers.

- Shallow ponds which freeze to the bottom each year may be underlain by permafrost, while deeper pond and lake bottoms will generally be free of permafrost.

In the Y-K Delta these factors combine to create extremely irregular and discontinuous permafrost conditions, with low ground and wet areas commonly free of permafrost while adjacent mounds and elevated plateaus, commonly termed "palsas," are underlain by ice-rich permafrost soils. In fact the permafrost creation process appears to have acted to sculpt the land surface because the permafrost areas remain as elevated palsa mounds and plateaus due to the accumulation of excess ice in the underlying soil. Adjacent areas of thawed ground remain as low ground, and are typically lower by 3 to 6 feet. As low areas they accumulate most of the wind blown snow, which intensifies the ground temperature differences. Transitions between thawed and frozen ground may occur several times along a runway alignment.

One 60-foot-deep borehole was drilled in an area of undisturbed terrain near the Bethel airport for long term monitoring of permafrost under a long term National Science Foundation study, being performed by Dr. Thomas Osterkamp, but was last logged for temperatures in 1988. Figure 3 shows data from that borehole in comparison to similar holes logged at Nome and Kotzebue.

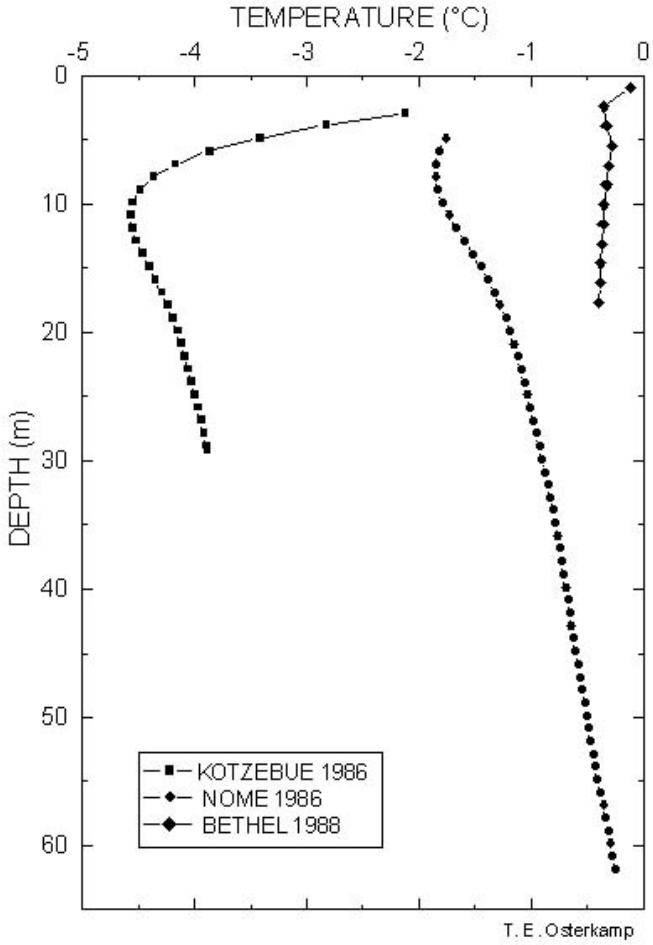
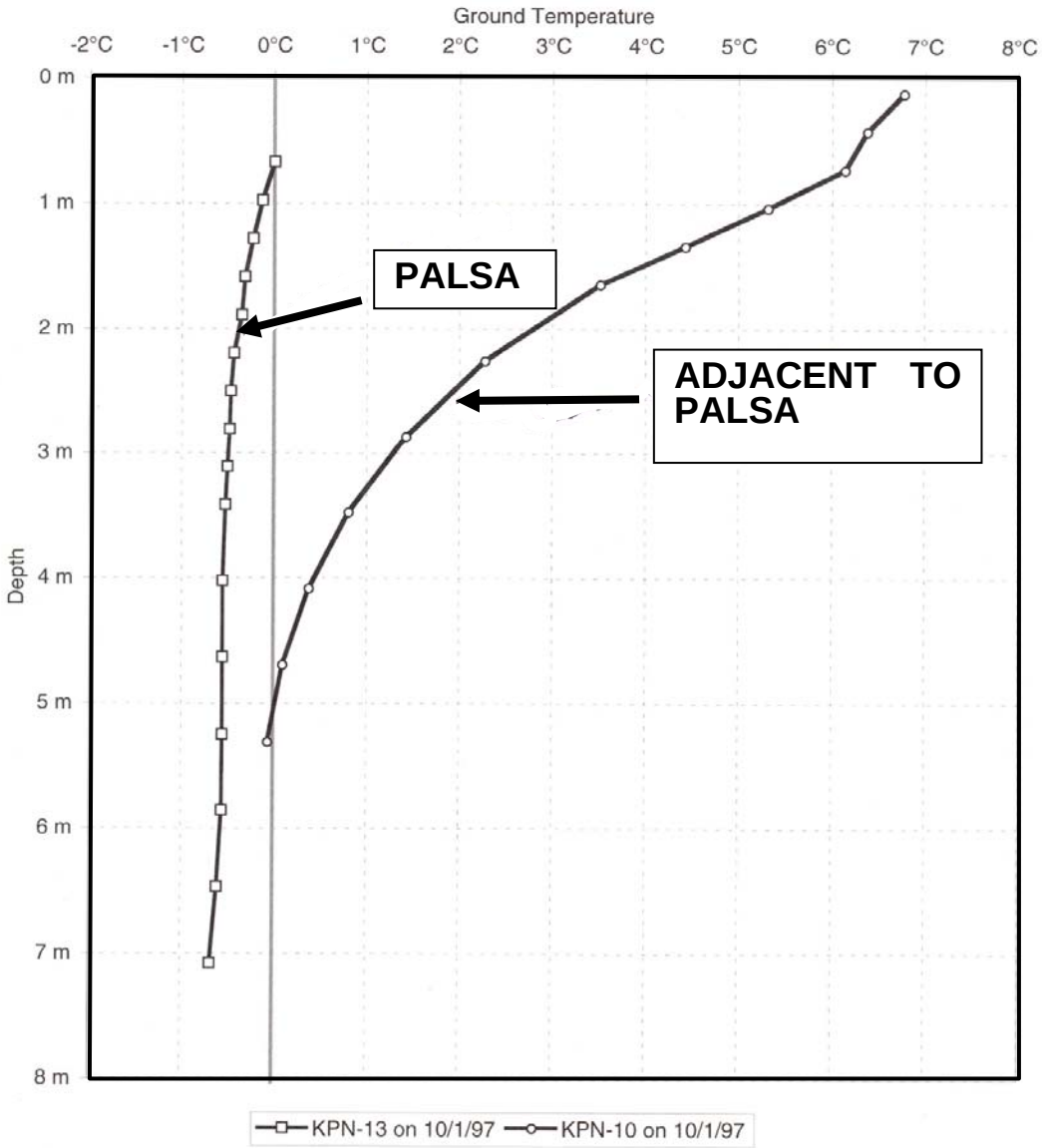


Figure 3
Ground Temperature Profiles

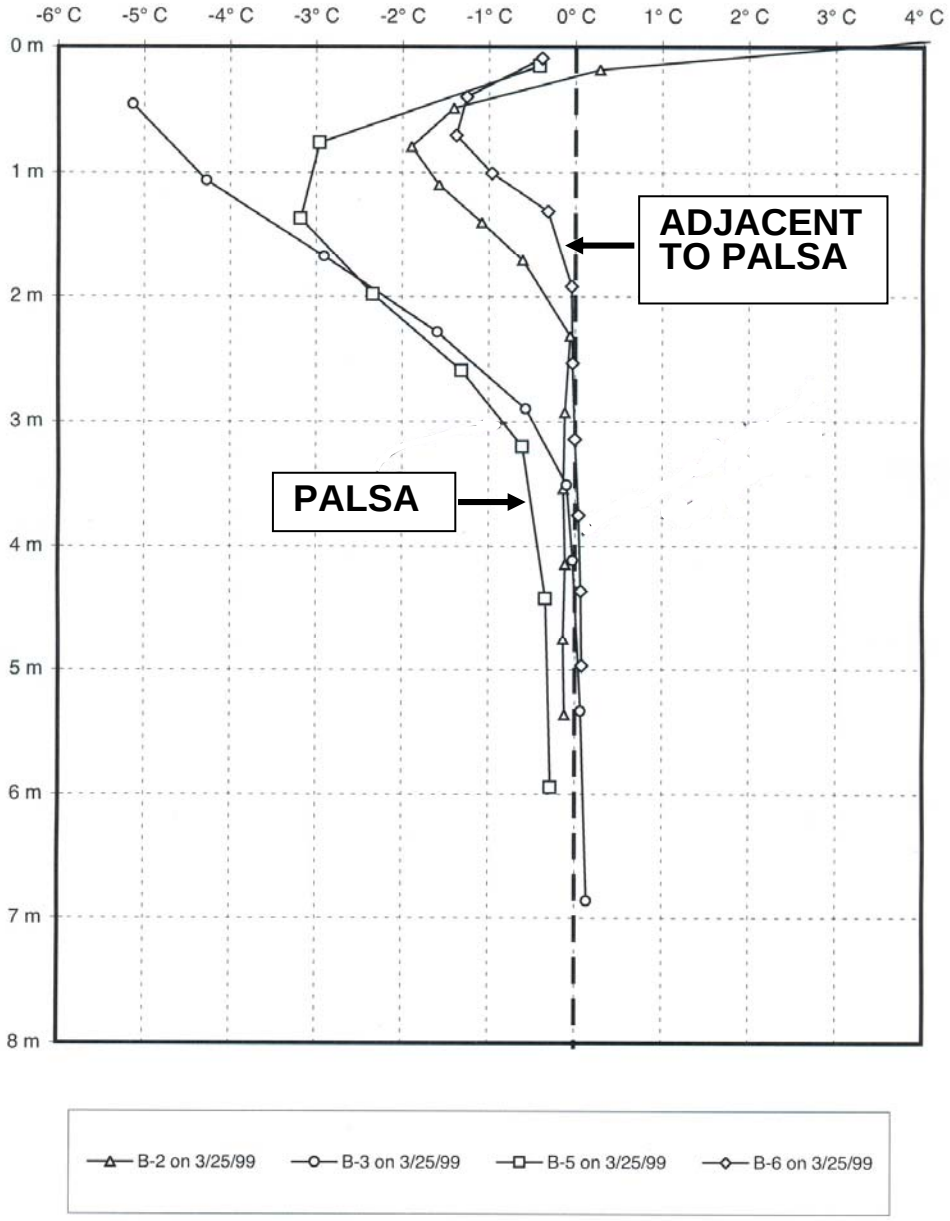
Bethel permafrost at that location and time had temperatures of -0.5 to -0.7°F (-0.3 to -0.4 degrees Celsius [°C]) at depths of 10 to 60 feet.

Permafrost temperature data has rarely been taken in geological investigations for proposed or existing airfields, due to a reluctance of managers to spend the extra funds needed to purchase and install sensors and to fund later return to field sites to monitor temperatures. Therefore most permafrost temperature data from the region comes from monitoring programs on boreholes or pilings for buildings such as schools and health centers. Three plots of soil temperatures to depths of 23 to 25 feet at proposed airport locations at Kipnuk, Kwethluk and Quinhagak were provided by Duane Miller & Associates. (Figures 4 through 6). Temperature differences between elevated palsa mounds and adjacent low-lying wet areas are noted on these plots.



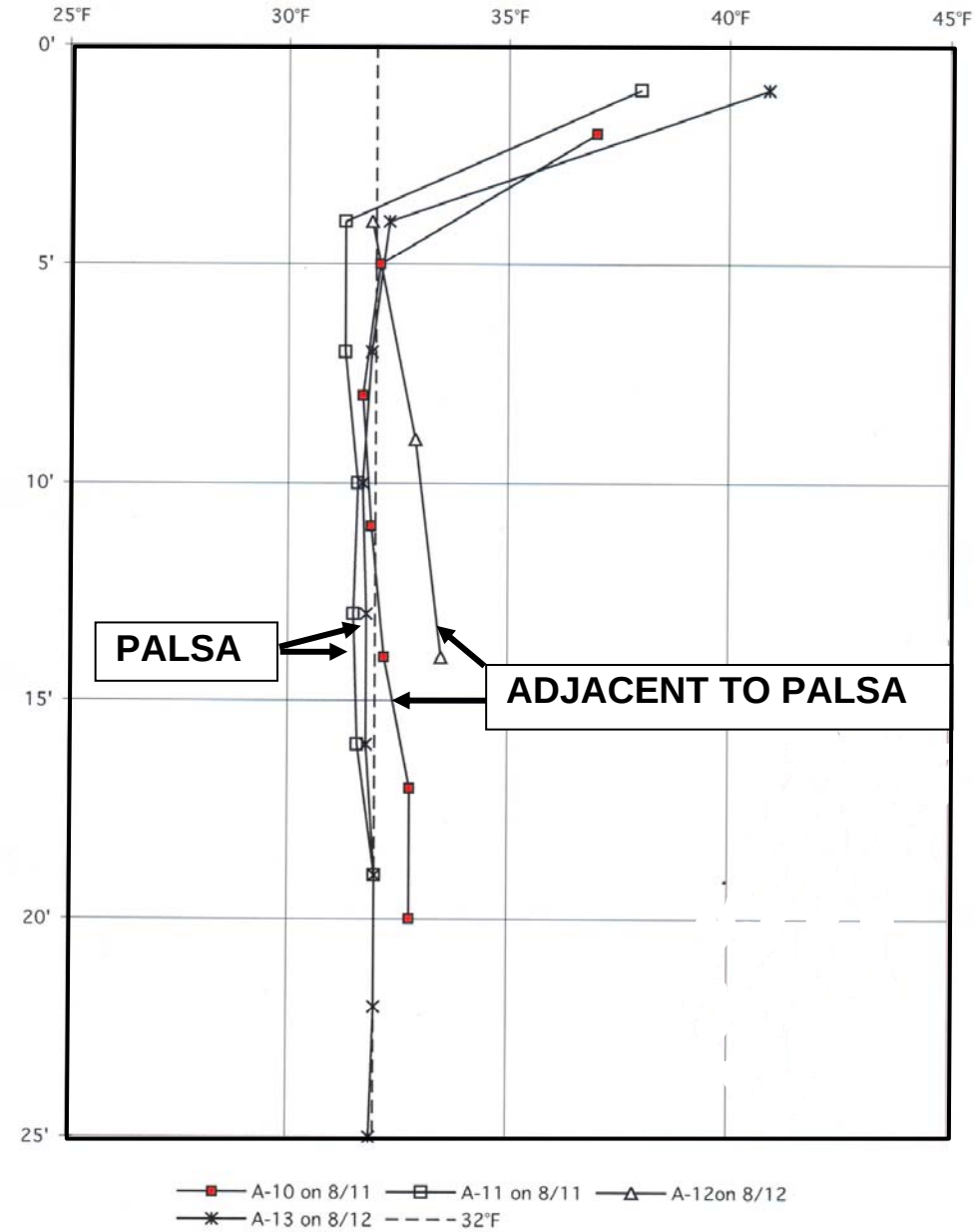
Duane Miller & Associates

Figure 4
Ground Temperature Profiles at Kipnuk Airport Site



Duane Miller & Associates

Figure 5
Ground Temperature Profiles at Kwethluk Airport Site



Duane Miller & Associates

Figure 6

Ground Temperature Profiles at Quinhagak Airport Site

The temperature versus depth plots for Kipnuk (Figure 4) demonstrate the common difference in ground temperatures and thaw depths related to elevated "palsas" or peat plateaus underlain by permafrost at 31°F, versus nearby lower wet ground which is permafrost free. Data from Kwethluk (Figure 5) again demonstrates the temperature differences between palsas underlain by permafrost at 31.3 to 31.5°F

(-0.3° to -0.4°C), and adjacent lower wet areas overlying thawed or actively thawing soils. At Quinhagak, the data (Figure 6) again show permafrost at 31.5° to 31.8°F versus adjacent low ground at 33° to 34°F at depths of 10 to 20 feet.

Global Warming Concerns

Air temperature trends have been analyzed by the Geophysical Institute of the University of Alaska for 19 Alaska sites for the 30 year period from 1971 to 2000. This analysis is available on the web at http://climate.gi.alaska.edu. The data demonstrate progressive warming of air temperatures at all 19 Alaska weather stations analyzed, with a mean warming value of 2.69°F over the 30 year period. The mean warming values for Bethel, Nome and McGrath, the closest stations to the Y-K Delta, were 3.08°F, 2.28°F and 3.25°F respectively. Mean annual temperatures for Bethel from 1971 to 2003 are shown on Figure 7.

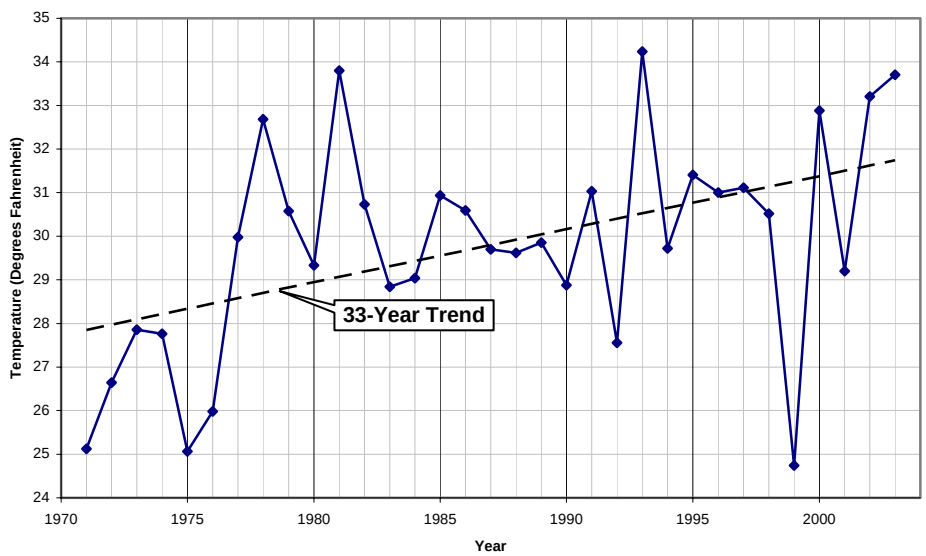


Figure 7
Last 33 Years of Mean Annual Temperatures - Bethel, Alaska

Bethel's five year running averages from 1924 to 2003 are presented in Figure 8, and indicate a long term average of approximately 29.3°F. Analysis of temperature trends indicates a relatively warm period from 1935 to 1945 and a cold period from 1946 to 1976. Overall, a slow decline in the mean annual temperatures occurred between 1925 and 1975, where the averages cooled from 30°F to 28°F. This was followed by a significant 3.5°F warming trend between 1975 and 2003. Year to year averages have varied greatly. The warmest and coldest years on record were 1981 (34.2°F) and 1999 (24.7°F). Eight of the 79 years of record had annual averages above 32°F, with three of the last four years being abnormally warm. Data indicate that warm years are primarily due to warmer winter and springtime temperatures rather than hot summers.

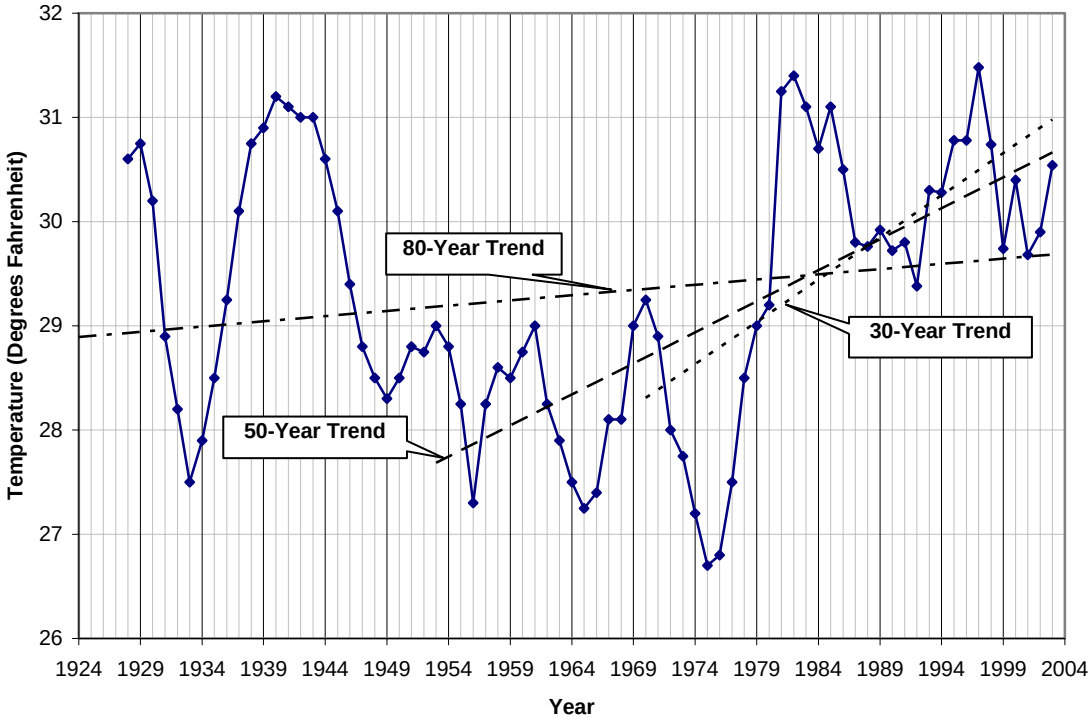


Figure 8
5-Year Running Average Temperatures and Temperature Trends - Bethel, Alaska

The greatest seasonal warming at the close of the last 30 years has been in the springtime season (April 21 to June 21), with indicated warming at Bethel of 7.6°F and 6.71°F at McGrath for the spring season (Bolling, S.A., 2000). The season of least warming was Autumn (September 21 to December 21) with warming of +0.21°F at Bethel and cooling of -0.24°F at McGrath. Statewide average warming in these two seasons averaged +4.23°F in spring and +0.33°F in the autumn season (Bolling, 2000).

Warming and thawing of Alaska's permafrost soils have been studied for the past 25 years by temperature logging of boreholes at 36 remote locations. General warming of permafrost in Interior Alaska of from 0.9°F to 2.5°F has been noted (Osterkamp, 2003).

Warming trends for Alaska are consistent with forecasts of computer prediction models developed by various agencies for analyzing the effects of rising atmospheric carbon dioxide over the next century; in that the Arctic and sub-Arctic regions are predicted to warm by two to three times the average global temperature change. The 3°F rise in annual air temperatures indicated for the Delta region of Alaska over the past 50 years creates a concern for the future gradual melting of the permafrost of the region. For airfield embankments founded on ice rich permafrost this will mean progressive long term settlement problems for the foreseeable future. Of even greater concern is the fact that essentially all significant housing units and larger structures in the region have been and are being founded on piling presumed to

be anchored in and supported by permafrost. This is because of the lack of shallow bedrock or gravel deposits on which to support these facilities.

Designing for the Y-K Delta Climate

Examination of the regional climate data and trends provides a basis for thermal analysis of freeze and thaw depths and short and long term analyses of the thermal stability of permafrost foundation soils. Bethel temperature data have been analyzed to determine the mean annual temperatures as noted above, and also to calculate the seasonal freezing and thawing indexes over the past 80 years (T. Moses and D. Esch, 1989). Temperature data from the Western Region Climate Center for several other communities in the region have been analyzed for average values to expand the data base. Historical results are presented in Table 1. Projections of global climatic warming will require adjustments to these values for future conditions. The 2001-2003 Bethel data in this table may provide some guidance for analysis of changes in the near future.

Table 1
Temperature and Freeze-Thaw Index Values for Five Y-K Delta Sites

Site	Term- Years	Thawing °F-days (TI)	Length days	Freeze °F-days (FI)	Length Days	Annual Temp °F
Bethel-average	1923-2003	+2,640	168	-3,590	197	29.4
Bethel-max	1 year in 20	+3,200		-4,900		
Bethel –min	1 year in 20	+2,250		-2,400		
Bethel	2001	+2,530	152			29.2
Bethel	2002	+3,195	207	-3,730	196	33.2
Bethel	2003	+3,125	214	-2,120	165	33.7
Aniak-average	1949-1990	+2,750	165	-4,090	200	28.2
Emmonak	1977-1994	+3,275	160	-3,550	205	28.7
Mekoryuk	1949-1973	+1,920	165	-2,900	200	29.2
Russian Mission	1966-1987	+2,520	159	-3,880	206	28.0
Regional average		+2,620	164	-3,000	202	28.7

Thermal analyses were made based on soils data and probed thaw depths at two airfield embankment sites. They indicated that appropriate n-factors (ratios of air to surface freezing and thawing indices) should be approximately 1.0 for both freezing and thawing seasons.

2.5 DEMOGRAPHICS

The fourteen communities included in this study are:

Community	Population	Runway Dimensions (feet)	Date of Last Construction
Alakanuk	pop. 659	2,200x 50 (existing)	2002
		4,000x 75 (under constr.)	2004
Atmautluak	pop. 291	3,300x 60	2002
Chefornak	pop. 419	3,300x 60	2002
Chevak	pop. 854	3,300x 60	2002
Eek	pop. 291	3,300x 60	2002
Emmonak	pop. 745	4,400x 100	2004
Kipnuk	pop. 644	3,300x 60	2002
Kotlik	pop. 633	4,400x 100	1999
Kwethluk	pop. 730	3,300x 60	2002
Napakiak	pop. 351	3,300x 60	1983
Napaskiak	pop. 408	3,300x 60	1984
Nunam Iqua (Sheldon Point)	pop. 204	3,300x 60	1999
Nunapitchuk	pop. 512	2,040x 60	1984
Tuntutuliak	pop. 377	3,300x 60	2002

A detailed demographic description of each community is presented in the Arctic Pacific Enterprises report (Appendix D, Page 4). Additional information can be found in the State of Alaska Community Profiles database at http://www.dced.state.ak.us/cbd/commdb/CF_CIS.htm.

SECTION 3 - AIRPORT DESIGN, CONSTRUCTION AND MAINTENANCE OPERATIONS

3.1 HISTORICAL OVERVIEW

Airplane access to villages in the Y-K Delta region was first accomplished by float or ski planes on the rivers in summer and winter. This was followed by construction in the 1960s and 1970s of narrow strips up to 2,000 feet in length by 28 to 35 feet in width, located as close to the villages as possible given the local terrain. To avoid the risk of flooding, higher ground was desirable and the first embankments were usually constructed by "side borrow" or simply excavating adjacent soils by dozer and pushing up an elevated embankment of silty soils, which then had to drain and stabilize over several seasons. Design work involved primarily setting the Scope of Work and preparing contracts for the execution on basically a "Design-Build" basis.

Construction of the first airfields was frequently done through equipment rental contracts in which contractors supplied equipment and operators, and the (then) Division of Aviation of the Alaska Department of Public Works directed the work. These early airfields were first used only in winter or late summer when the surface was sufficiently dry and stable. Barge imported gravel surfacing layers were later placed under contracts to provide an all weather surface.

Recent population and air traffic increases created demands for access by larger aircraft able to carry more passengers, mail and freight. Demands grew for lighting of the runways to allow nighttime landings. This created the need for longer and wider runways; the current minimum size for new construction being a gravel surfacing area 3,300 feet long by 60 feet wide per statewide ADOT&PF guidelines. In the future there will be a need to lengthen some airfields to 4,000 feet by 100 feet wide to allow for larger fuel and freight deliveries. Many of the older airstrips, however, can no longer be lengthened at their current locations, due to adjacent river channels, concerns over flooding, or proximity to the community buildings.

These and various other concerns must be addressed in site selection for airfields. Frequently the best sites will be on higher ground some distance from the village, creating the need for access by roads or boardwalks. From an engineering standpoint, the decision may seem simple. However, the problems of site selection seldom revolve around engineering and soil concerns, but environmental restrictions, terrain factors, ownership, wind direction and community demands must be taken into consideration.

3.2 AIRPORT DESIGN PRACTICES AND STANDARDS

Airport design and construction supervision duties for airfields in the Y-K Delta region are split between the Anchorage (Central Region) and Fairbanks and Nome (Northern Region) offices of the ADOT&PF, with the Kuskokwim region and south-central coastal airports assigned to Anchorage and the Yukon and coastal area airports from Scammon Bay north assigned to the Northern Region. Design standards for airfields are set by the Federal Aviation Administration (FAA). The current requirements for Airport Design are contained in FAA Advisory Circular (AC) No. 150/5300-13, which is updated periodically and is currently up to Change #7 as of October 1, 2002. Airfield length dimensions are specified for the class of aircraft using the facility and must meet the operational requirements of the aircraft manufacturers and the guidance of AC 150/5325-4. Airfield width consists of the runway surface width, the shoulders and the Runway Safety Area (RSA) which is an additional area outside of the sides and ends of the runway itself. Finally, an Obstacle Free Zone (OFZ) dictates that a zone free of obstacles be maintained outside of the edges of the runway, sloping upward at a 3:1 slope for 200 to 300 feet, depending on approach visibility minimums and aircraft landing speeds.

Airplane Design Group I aircraft, typical of the airplanes of small Alaska operators such as the single engine Cessna 206 and 207, generally require a length of 3,200 to 3,300 feet, with a length of 3,300 feet chosen for current designs for most of the Delta airfields. For visual flight operations with 3/4-mile approach visibility minimums, the indicated widths per Table 3-1 of AC #150/5300-13 include a 60 foot surfacing width, 10-foot-wide shoulders, and a RSA top width total of 120 feet. The required end safety areas add 240 feet at each end, for a total length of 3,780 feet. For permitting access by flights operating with lower minimum visibility levels, the recommended width increases to 300 feet wide, and the end safety areas lengthen to 600 feet at each end.

These standards are not rigid, but are open to some negotiation depending on local conditions and economic considerations. In practice, the high costs of construction have often dictated use of narrower and shorter embankments and thinner gravel surface layers than FAA standards recommend. Aircraft operators are made aware of the conditions at each airfield and must make their own decisions as to what equipment and what loadings and under what conditions they will land at each site. To design all airfields in the Y-K Delta to the most rigid FAA requirements would result in costs so high that very few communities could be provided with acceptable air service.

In view of the various considerations in locating and designing airfields, geotechnical concerns almost always take a back seat in selecting the best site. As discussed above, the use of the highest ground for airfield embankments generally results in permafrost foundation soils and progressive long term settlements, while lower elevation thawed ground will be wet and subject to flooding, increased frost heaving and short term settlements.

3.3 Phased Construction And Schedules

When local silt sources must be used for building airfield embankments, phased construction, requiring two separate contracts spaced several years apart, has been the method used for most airfield embankments in the Y-K Delta region. The Phase 1 contract provides only for the placement and attempted densification of a silt embankment containing sufficient material to reach the desired final shape and grade after several years of settlement of the foundation soils and the embankment itself. The embankment is usually seeded to resist erosion.

Several years' time is then allowed for the embankment to thaw, consolidate and gain sufficient surface strength to allow the work of importing and placing one or more layers of sand and gravel to form the final surface. This and all other work as required for creating an operational airport is done under a second contract, hence the use of the terms "staged or phased construction." While this process eventually creates a useable embankment and airfield, the waiting time for "stabilization" of wet silt embankments may be very long and some embankments do not appear to dry out over time at all. Attempts to force project completion in a one-or two-year contract have also not been successful, since the contractor will be forced to attempt surface gravel layer placement when the embankment is still too soft and unstable.

3.4 Typical Airport Construction Operations

As noted above, in the 1960s and 1970s airfield construction was often done by equipment contracts, with the goal of construction of as many embankments as possible with the limited funds available. Materials sources for these early embankments were generally the closest possible sources, whether frozen or thawed. Typical Delta soil structures consist of one or more feet of surficial peat and moss underlain by organic silts, with organic contents and moisture (or ice if permafrost) decreasing with depth. Bulldozers were commonly the equipment used to strip the organic layers and then push the silty soil up to form an

embankment several feet in height. Because of the excessively wet condition of this embankment soil, compaction was not possible, so it was left to drain over several years. To speed the strength gains and to provide for runoff of rain and snowmelt water, periodic reshaping of the top was often done with whatever equipment was available. For a several year period, airport maintenance forces had funding to move small equipment such as a dozer and compactor between sites during the summer, to shape and compact the surface of each site and thereby accelerate the drying out of the embankments.

Periodic vibration of wet silt causes the moisture to bleed to the surface in the process of "dilatency." The soil then gains slightly in density as some of the excess water is released. However, too much vibration creates a fluid or "quick" condition and the equipment bogs down. Operator skill is essential in such operations. This periodic densification process may be the simplest way to achieve a stable embankment, but there are problems of achieving this under contract due to the variable timing needed, the uncertainty of results, and the strong influence of the weather. No engineering analysis of the progression of density and strength gains for such periodic compaction work was ever done to guide future operations. It is also unlikely that the densification benefit ever penetrated more than one to two feet into the embankments.

When embankments became sufficiently stable to support hauling equipment, which generally required several years, gravel was imported by barge from remote sources and a more stable surface layer was applied to create a (nearly) all-weather airfield. However, most airfields in the region still must be closed for one to two weeks during the spring thaw due to ponded water and soft surfaces.

Construction programs over the past 10 to 15 years have become much larger and more expensive, to build the longer and wider runways, lighting systems, taxiways, parking aprons and maintenance equipment storage buildings dictated by future design aircraft and expanding populations. However, increased competition has lowered some costs, particularly for imported gravels. While prices in the 1970s and 1980s ranged from $200 to as much as $250 per cubic yard in place, current gravel prices are in the $70 to $90 range.

New airport sites are now more distant from the villages they serve, and farther from riverside barge access points. Borrow sources are also more distant, requiring truck hauls and temporary haul roads. Larger equipment creates more stability problems in excavating, placing and attempting compaction of the commonly used wet silt borrow materials, requiring more winter construction to avoid the problems and wet conditions of summertime work.

3.5 CONTRACTOR CONSIDERATIONS

Contractors face daunting problems in airfield construction in the Y-K Delta region. Simply to bid rationally on projects requires considerable knowledge and experience in and of the region. Mobilization of supplies and equipment involves barge operations from Anchorage (1,100 nautical miles) or Seattle (1,800 nautical miles). Barge shipments are possible only for the five-month season of open water. Low water can restrict access to many village sites. The lower Yukon has offshore and entrance channel bars which restrict barge and tug drafts to about 8 feet at springtime high water, and to 4 or 5 feet at later times; while barging upriver to Bethel encounters Johnson Bar, which restricts drafts to 15 to 20 feet depending on river levels. Smaller rivers leading to other communities can restrict drafts to only four feet (S. Brice at Brice Construction; personal communication).

Barge landings are typically on soft muddy bottoms, and barge anchorage points must be installed (Photo 1). Shore access points must face competition with local boats and skiffs, as well as fish drying

racks. Soft conditions dictate the need to improve the landing area. Therefore, mobilization costs can be 10 to 20 percent of the project cost, and bids can exceed several million dollars.

Photo 1
Typical barge landing at Kasigluk

Access to airfield sites from the barge landing point is the next challenge of the contractor, since village area roads, if any, are inadequate to carry truck loadings. Generally, an airport access road must be built or upgraded by the contractor, and may or may not be done under a contract bid item. Roads can create localized flooding problems if inadequate drainage is not installed.

Borrow site access is also often a problem which is most often solved by waiting until freezing conditions stabilize the commonly soft organic terrain, and using early winter timing to haul and place the fills. Some borrow sites may require river, lake or slough ice crossings, for which usability dates are difficult to predict due to occasional warm weather patterns.

Embankment construction in itself poses the problem of trafficability, since wet silt and wet sand causes equipment to bog down. The large equipment most favorable for low-cost hauling and compaction is often too large and heavy to traverse the soft soil being placed (Photos 2 and 3). When wet weather contributes to a lack of soil drying, the project can be brought to a halt. Winter construction is often the best alternative, but embankments built in winter can take years to thaw, settle and stabilize.

Photo 2
Large-tire 6x6 Volvo trucks for hauling gravels and fill on soft embankments

Photo 3
Vibratory compactor working on saturated sandy silt embankment fill at Kwethluk

Other issues must be dealt with by the successful contractor, including housing for work crews, local hire and training, fuel storage and availability, electrical power needs, community support, and environmental conflicts. At the completion of work, site cleanup and remediation and return shipment of equipment by barge must be scheduled to avoid problems of freezing conditions and ice development on rivers and on the ocean. As a direct result, bids are generally much higher than those at more favorable locations.

3.6 CONTRACT CLAIMS

Contractor claims and the problems of their fair resolution have been a too-frequent outcome of hurried construction work scheduling. Because of the access problems and high mobilization costs to get supplies and equipment to and from the area, and the need to use barge access which is possible only during the short summer season, small problem claims can become major cost items. The search for reliable methods and economical solutions to the embankment construction problems of using wet or frozen silt in a wet and commonly freezing environment, was the purpose for initiating this study. Reducing the life-cycle time and costs of constructing and operating airfields in the Y-K Delta region, while avoiding the two-staged approach to completed airfields, is foreseen as a major benefit to the State of Alaska.

3.7 CONTRACT BID TABULATIONS

Contract bid prices for those contract items pertinent to this study have been tabulated and summarized in Table 2.

3.8 COMMUNITY AND AIRPORT INFRASTRUCTURE

Information on the infrastructure of the communities selected for this study has been extracted from the Alaska Community Information Summaries, as presented by the Alaska Department of Community and Economic Development (http://dced.state.ak.us/cbd/commdb/CF_CIS.htm) (see Appendix D). Airport-related data and condition information was extracted from the FAA website (www.Alaska.FAA.gov) (see Appendix D). Plan and cross-section view from the latest airfield construction work are included for most sites. This information is attached as Appendix G.

3.9 ENVIRONMENTAL ISSUES

Environmental issues related to airfield construction operations at the locations selected for this study are extensively discussed in the individual Environmental Assessment (EA) and Environmental Impact Statements (EIS) prepared in the pre-construction phases of work, and will not be explored in further detail here. However, in summary, the chief concerns over work in the Y-K Delta region always relate to the pervasive presence of rivers, lakes and wetlands, coupled with the Yukon Delta National Wildlife Refuge declaration overlying almost all of the lands in the region. These concerns generally restrict the possible airfield sites and often prevent the expansion of existing runways. Elevated sites which may be most suitable for construction from an environmental standpoint are, however, also the sites most likely to be underlain by ice-rich permafrost, and therefore become the most troublesome due to long-term settlement problems.

3.10 MAINTENANCE

Airfield maintenance is generally performed by experienced ADOT&PF personnel from Bethel or Nome, operating ADOT&PF equipment located at each airport site. This equipment generally consists of a variety of motorgraders, loaders or small dozers. Surface regrading of the airstrip and apron is generally

done immediately after spring breakup, and again in late fall before freeze-up. At some locations, qualified local operators are hired to conduct the grading operations. Generally there are no stockpiles of good quality surface course materials available in these communities. Where most of the surface course material has been eroded or bladed down the sideslopes, special material supply contracts are awarded for rebuilding the runway surface. Maintenance crews also perform some remedial work on sideslope erosional gullies by infilling with soil materials and reseeding.

ADOT&PF bids out snow removal contracts for each airstrip for the winter season. Local ADOT&PF equipment is made available to the successful contractors. These contracts generally range from $8,000 to $15,000 for each airport.

Table 2
Airport Construction Bid Tabulations

	Alakanuk Airport Relocation (1/30/02)	Atmautluak Airport Reconstruction Phase II (8/16/02)	Chefornak Airport Relocation (7/24/02)	Chevak Airport Relocation (2/25/99)	Eek Airport Relocations Stage II (8/5/02)	Emmonak Airport Rehabilitation (9/1/01)	Kipnuk Airport Relocation Phase I (3/27/01)	Kotlik Airport Improvements (8/15/95)	Kwethluk Airport Relocation (9/18/01)	Nunam Iqua Runway Extension Phase II (2/24/99)	Nunam Iqua SREB (6/22/94)	Average (Total)	Average (per Unit)
G-100 Mobilization	$871,000	$675,000	$850,000	$750,000	$485,000	$685,000	$810,000	$400,000	$600,000	$288,000	$72,000	**$ 589,636**	
G-130(a-d) Field Office & Laboratory	$30,000	$30,000	$20,000	$35,000	$25,000	$27,800	$10,000	$48,000	$42,000		$7,500	**$ 27,530**	
G-131(a-d) Engineering Transportation	$30,000	$5,000	$35,000	$18,000	$34,000	$25,000	$18,000	$25,000	$30,000	$17,000		**$ 23,700**	
G-150a Equipment Rental, Caterpillar D-8N Crawler						$6,200		$160,000		$9,800		**$ 58,667**	
G-150b Equipment Rental, Caterpillar D-4H Crawler						$5,290		$135,000				**$ 70,145**	
G-150c Equipment Rental, Hitachi EX-200L						$5,530		$110,000 ea (3)				**$ 167,765**	
G-150f Equipment Rental, Manual Rammer Compactor						$7,690		$30,000				**$ 18,845**	
P-151 Clearing	$183,000					$80,900			$190,000			**$ 151,300**	
P-152a Unclassified Excavation		$650,000 (120,000 CY)			$40,000 (3,000 CY)				$230,000 (43,000 CY)	$36,000 (4,500 CY)		**$ 92,750**	**$ 8.00 (CY)**
P-152h Borrow Type 1						$1,518,380 (115,000 CY)	$2,530,000 (376,000 CY)		$1,600,000 (240,000 CY)			**$ 1,882,793**	**$ 8.90 (CY)**
P-152j Borrow Embankment	$3,200,000 (400,000 CY)		$5,400,000 (492,300 CY)	$2,000,000 (330,700 CY)	$150,000 (7,500 CY)							**$ 2,687,500**	**$ 11.30 (CY)**
P-154a Subbase Course					$2,300,000 (36,600 CY)	$1,220,000 (18,000 CY)		$309,000 (4,890 CY)		$450,000 (6,753 CY)		**$ 1,069,750**	**$ 65.10 (CY)**
P-191c Geotextile Drainage	$15,000 (4,400 SY)											**$ 15,000**	**$ 3.40 (SY)**
P-208a Crushed Aggregate Surface Course		$1,400,000 (128,00 CY)			$1,300,000 (14,400 CY)	$1,215,000 (11,700 CY)				$523,000 (7,160 CY)	$5,500 (47 CY)	**$ 888,700**	**$ 98.60 (CY)**
P-208b Aggregate Surface				$2,200,000 (61,893 CY)				$145,000 (1,710 CY)	$1,000,000 (11,000 CY)			**$ 1,115,000**	**$ 82.30 (CY)**
P-208e Aggregate Surface Course Stockpiled		$10,500 (100 CY)		$22,000 (675 CY)		$5,000 (100 CY)			$9,500 (100 CY)	$4,500 (67 CY)		**$ 10,300**	**$ 75.30 (CY)**
P-680 Geotextile Fence		$21,000 (1,525 Y)	$70,000 (6,700 Y)	$25,000 (4,510 Y)	$15,000 (1,000 Y)		$32,000 (2,800 Y)		$30,000 (1,777 Y)			**$ 32,167**	**$ 12.20 (Y)**
P-681a Geotextile Separation		$6,500 (3,000 SY)		$85,000 (58,000 SY)	$135,000 (72,500 SY)			$80,000 (23,110 SY)		$60,000 (24,200 SY)		**$ 73,300**	**$ 2.30 (SY)**
P-681b Geotextile Reinforcement									$160,000 (83,000 SY)			**$ 160,000**	**$ 1.90 (SY)**
P-681c Geogrid					$290,000 (71,900 SY)							**$ 290,000**	**$ 4.00 (SY)**
T-901a Seeding					$20,000 (9 Acre)					$15,000 (5 Acre)	$1,500 (0.26 Acre)	**$ 12,167**	**$ 2,748.00 (Acre)**
T-901b Topsoiling									$60,000 (20,100 SY)			**$ 60,000**	**$ 3.00 (SY)**
T-901d Seeding	$53,000	$25,000	$95,000	$60,000		$35,000	$30,000	$50,000	$19,000			**$ 45,875**	
T-908a Mulching		$14,000* (16,250 lb)			$37,000 (44,000 SY)		$30,000* (43,780 lb)		$23,000 (20,100 SY)			**$ 26,000**	**$ 1.00 (SY)**
Fuel					$5,000				$5,500	$7,000		**$ 5,833**	
Erosion Control Fabric								$125,000 (69,350 SY)				**$ 125,000**	**$ 1.80 (SY)**
Geotextile Floating Curtain, Sediment Control							$28,000 (400 Y)					**$ 28,000**	**$ 70.00 (Y)**
Fertilizing							$25,000					**$ 25,000**	
Project Total	**$ 4,382,000**	**$ 2,837,000**	**$ 6,470,000**	**$ 5,195,000**	**$ 4,836,000**	**$ 4,836,790**	**$ 3,513,000**	**$ 1,837,000**	**$ 3,999,000**	**$ 1,410,300**	**$ 86,500**		

*** Quantities not included in the calculated average because of incompatible units.**

SECTION 4 - GEOTECHNICAL INVESTIGATIONS AND REPORTS

4.1 Scope Of Studies

For the typical Y-K Delta airfield relocation or extension project, field investigations are performed under the direction of the ADOT&PF regional geologist. The scope of this work involves the determination of the moisture contents and classifications of soils, and the presence of water tables and permafrost soils. It also commonly involves a search for suitable borrow sources for embankments.

4.2 Methods And Equipment

Field crews consisting of a driller, helper and field geologist usually work during the winter months, using track-mounted auger drilling equipment which has been barged or flown to the site. Multiple test holes will be drilled to depths of 8 to 10 feet in the area of the proposed embankment to define the thermal condition of the subgrade. Soil samples obtained will be tested for soil gradation, moisture content and organic content. In permafrost areas it is common to extract core samples using toothed core barrels or Shelby tubes. Cores or auger samples are visually classified, and ice contents and layers are noted and estimated as to volumes. Samples are then shipped to regional testing laboratories for gradation, moisture and organic content tests. Consolidation, permeability and strength testing of samples is essentially never done. Measurement of permafrost temperatures is also not done except on rare occasions, since this will require installing sensors or casings and then waiting days or weeks for thermal stabilization of the boreholes, which often fill with water.

In addition to investigation of the subgrade soil conditions, most field studies involve exploratory drilling to locate and define the properties of suitable local borrow sites for soils for embankment construction. Often, several sites in the area will be drilled and sampled to define and document suitable borrow sources.

4.3 Design Recommendations

Based on the field exploration program, the Regional Materials Engineer or the Regional Geologist will provide recommendations to the airport designer for suitable borrow sources. Recommendations may also include estimations of expected embankment settlements and other foundation problems to be addressed in the design and construction stages. Design recommendations may be included in the geotechnical report, or may be submitted separately by memorandum.

SECTION 5 - GRANULAR MATERIALS SOURCES

5.1 LOCAL SOURCES

The majority of communities in the Y-K Delta do not have readily-accessible granular borrow sources. Very wet, fine-grained, silty sands and silts are generally excavated nearby and used for embankment fill (Photo 4). There are a few exceptions, such as Chefornak which has some poor quality weathered basaltic gravels and Mountain Village which also as a low grade weathered rock quarry. The Bethel vicinity has medium-grained sand deposits which are used for embankment fill at many of the Lower Kuskokwim River communities.

Photo 4
Silt borrow sites infilled with water at Alakanuk

5.2 REGIONAL SOURCES

Good quality granular materials are generally imported by barge from just a few sources. The Birch Tree pit, located on a gravel bar upstream of Bethel, produces reasonably good quality alluvial gravels with degradation (ATM T-13) values in the 40 to 50 range. Contractors working in the area have indicated that the source is nearly depleted and that new workings have been started in an uphill area. Kalskag Quarry further upstream on the Kuskokwim River has recently been brought into use as a source of good quality crushed rock with degradation values in the range of 60 to 80. Aniak, a less commonly used quarry source, also produces good quality granular materials.

The Platinum area gravel pit and quarry appear to be a popular source of granular materials in the Y-K Delta communities. Crushed rock from Platinum has degradation values averaging 80. Pit run alluvial gravels from the area have degradation values averaging 30.

Goodnews Bay, located at the head of a shallow bay east of Platinum, has a quarry site that is capable of producing U.S. Army Corps of Engineers-approved rip-rap. Access to this site is difficult, however, since the shallow waters of the bay allow the operation of only the shallowest draft lightering barges. Generally the material has to be reloaded onto larger ocean-going barges at Platinum.

Nome gravels and crushed rock are also sources of good quality granular material. This material has not been used extensively in the Y-K Delta area primarily due to economic considerations.

5.3 LONG DISTANCE SOURCES

Contractors have considered importing gravels from as far away as Point MacKenzie, near Anchorage. A deep-water port with efficient loading facilities and large ocean-going barges could make sources such as this an economical alternative to the regional sources that are currently used. In the past, granular materials have also been barged in from Seattle and British Columbia. Very few Y-K Delta communities can be accessed by deep water barges and have suitable docking and unloading facilities. This necessitates material transfer to smaller, shallow, draft river barges (Photo 5). Bethel can be reached by ocean-going barges which can dock and unload at existing facilities.

Photo 5
Gravel transfer from ocean-going barge to shallow draft barge.

SECTION 6 - MATERIALS TESTING AND ACCEPTANCE

6.1 APPROACH TO SPECIFICATIONS

The drafting of specifications for testing and acceptance of project materials and specification conformance on airfield projects is the responsibility of the Regional Materials Engineers of the ADOT&PF. Most items used in this work which are imported from major cities are routinely tested and accepted at the time of shipment and will not be considered further here. The testing programs of concern are those for soil and aggregates placed in the final work where field testing is needed to determine conformance with specifications.

Specifications for the compaction of soil and aggregate layers in airfield embankments are recommended by the FAA (Advisory Circular AC/150/5370-10A), titled Standards for Specifying Construction of Airports. The specifications for normal airfields set minimum densities as a required percentage of "maximum density" as determined by American Society for Testing and Materials (ASTM) Test Method D1557. The above FAA advisory, in the "Notice to Users," states that "verbatim incorporation of these standard is not practical because of the numerous decisions which must be made by the Engineer regarding local materials, methods and requirements" but there is a need *"to ensure that sound engineering judgment is applied,"* and it is fortunately noted that "FAA field representatives have the authority to approve modifications to Standards."

6.2 EXCAVATION AND EMBANKMENT SPECIFICATIONS

Clearing and grubbing of the embankment foundation is requested by the FAA Advisory, followed by compaction of the top 6 inches to 99 percent of maximum density for cohesive soil and to 100 percent of the ASTM D698 maximum density for granular soil. In contrast, in permafrost terrain the surface vegetation mat is commonly retained to retard thawing of the foundation soil, and to act as a filter layer against intrusion of embankment materials. Therefore no attempt can be made to compact the foundation soil. Likewise, FAA requirements such as *"no rolling is to be allowed when the lower course is soft and yielding," "no work during freezing temperatures,"* and *"when soil is too wet to compact, all work shall stop until dried"* would not allow airfield construction in the Delta if strictly applied.

6.3 EMBANKMENT CONSTRUCTION

Specifications for the particle size gradation and moisture contents of borrow materials used in embankments are rarely if ever used where sources are only silt, and would be almost impossible to enforce. Where sand may be obtained, a specification used to exclude the more silty soils has required that the percentage passing the #200 sieve be no greater than 30 percent. The usual approach is to designate a borrow pit location for excavation of the required materials, with that site selected based on geological borehole investigations of alternative sites, and to accept the resultant product. However, it is usual to require that the commonly present overlying organic peat layers be excavated and wasted prior to silt excavation, and that ice deposits be removed if the source soils are frozen.

It must be recognized that compaction of wet silt is not possible under the cold and wet field conditions of the Delta, where the drying of such soil to the proper moisture to allow maximum densities to be achieved, designated as the "optimum moisture," is impractical if not impossible. In dryer climates, moisture can be removed by tilling and aerating the soil, but the cool and frequently wet Delta weather would commonly result in adding additional water from rain rather than the drying of tilled up soil. A more commonly used specification is one requiring a specified roller and a minimum number of

coverages, or simply *"compaction to the satisfaction of the Engineer."* Typical silty soils from thawed sources will have field moistures ranging from 30 to 60 percent, while optimum moisture for compaction will range from 15 to 20 percent. Frozen (permafrost source) soil will have moisture contents ranging from 50 percent to over 100 percent, with these moistures expressed as a percentage of the weight of dried soil solids. Many permafrost sample cores are noted as having 50 percent or more "visible ice."

Compaction of frozen silt soil, when permafrost pit sources are used, must be done as far as possible by use of heavy rollers to break down the frozen chunks. Frozen soil compaction cannot normally create the desired voidless structure, so some subsequent springtime snow melt water infiltration must be anticipated. Therefore, an embankment placed with soil from a frozen borrow site would take longer to consolidate and stabilize in future years. Though frozen pits may be preferred by contractors, ADOT&PF personnel were unanimous in preferring thawed sources. Where wet pits are used, a common approach is to allow its use in early winter then freezing is occurring, which aids access and reduces water problems.

6.4 Surfacing Layer Construction And Testing

To carry wheel loadings, the silt embankments constructed in phase one construction will be graded, compacted as well as practical, and topped in the second phase contract with one or two layers of sand and gravel borrow, generally imported by barge. A possible new method for tests on existing silt embankment surfaces to determine their load carrying capacity and the requirements for surface layer thicknesses would directly measure the surface strength by resistance to penetration with the Dynamic Cone Penetrometer (DCP). This test, which has been correlated with the California Bearing Ratio (CBR) test, will be further discussed in a later section. A specified synthetic may be placed on top of the silt embankment to provide a separation and/or reinforcement function. These gravel and sand layers, termed the aggregate base and (underlying) subbase, must be placed in 3-inch- to 8-inch-thick layers and tested to determine their conformance to density standards unless the underlying embankment is too soft and yielding to obtain the required compaction levels of 100 percent of the maximum determined per ASTM D698.

Field density measurements in Alaska are usually made by use of nuclear density test equipment. However, Federal regulations prohibit shipment of such equipment by passenger aircraft, creating an occasional problem for inspectors. The use of compaction method specifications is preferred where possible to avoid the need for costly freight shipments of nuclear gauges and the frequent contractor claim that soft embankments make compaction to a specified density impossible.

Aggregate quality and gradation specifications apply to imported aggregates. Samples for conformance testing can be tested on site or shipped to a central laboratory for testing. Quality and durability requirements are not always met by the aggregate sources in the region, and particle size breakdown during the multiple handling operations of processing, barge loading and unloading, and placement and compaction again create acceptance problems for inspectors.

6.5 Density Testing Vs Method Specifications

As noted in Section 6.4, attainment of specified densities is the FAA-preferred method of compaction control. It documents that the desired results have been achieved, while allowing the contractor a choice of equipment to perform the work. One concern, however, is that the maximum density can vary significantly within the same material type. This places doubt on the percent compaction measured by the nuclear test. Specifying compaction by roller type and coverages can require close inspection to document conformance, and can fail to achieve the desired results. Excessive compaction effort can also cause

temporary strength losses in the underlying embankment soils if moisture levels are high enough to lead to liquefaction from equipment vibrations and loadings. Acceptance by strength measurement, such as by use of the Dynamic Cone Penetrometer (DCP) test, should be considered.

6.6 CLAIMS AND PROBLEMS

The most common types of contractor claims relating to embankment construction are those relating to soft soil conditions on embankments and haul routes. These problems can lead to the need for contract extensions or even to the cancellation of scheduled work items needed to complete the project. Such claims might be minimized by specification of maximum equipment sizes and types, or by strictly controlling construction timing to take advantage of freezing conditions. While such specifications serve to reduce the contractor's risk, they reduce contractor flexibility and increase bid prices. Contractor experience in the region will serve to reduce problems and claims, but unfortunately cannot be used as a basis for determining contract award.

SECTION 7 - EMBANKMENT PERFORMANCE

7.1 DRAINAGE OF EXCESS MOISTURE AND STRENGTH GAINS OVER TIME

Slow and unreliable strength gains in embankment soil over time is the most common problem in construction of Delta airfields. As noted previously, airfield embankments, and access roads where needed, are almost universally built of organic silt or silty sand from borrow sites located some short distance from the airport site. Embankments are typically constructed to heights of 5 to 8 feet and occasionally to 10 feet or more to avoid flooding. They are usually constructed by use of thawed soil having original moisture contents at the borrow site of from 30 to 50 percent. Occasionally, silt borrow must be taken from permafrost soil sources, where frozen moisture contents range from 50 percent to more than 100 percent. Embankments are often built in late fall or early winter since haul routes and wet pits are more stable at that time. Rarely are these initial "Phase I" embankments monitored to observe their drainage and strength gains over time by periodically measuring changes in moisture contents, water tables and densities. However, the successful project completion in Phase II contract work is dependent on having a reasonably stable embankment on which to place the thin gravel surfacing which is commonly specified. Verification of the embankment strength levels should be done prior to Phase II project initiation.

The only soil moisture data found from boreholes in older airfield embankments was from the Kotlik and Chevak airfields. These records were located in reviews of the many historical files of Geotechnical reports written from Y-K Delta airfield soil investigation work. During the September 19th field trip made for this study, additional moisture samples were taken by hand auger at three airfield sites to gain an insight into the moisture and strength properties of embankments at Kipnuk, Eek and Kwethluk.

Kotlik Embankment Data

One airfield embankment site for which some useable data was found was the airfield at Kotlik, located on the most northerly channel of the Yukon. It was constructed in 1988 by pushing up lateral dikes to the 3- to 4-foot height, and then filling the center by pumping dredged material consisting of fine sand and silt from Kulmogon slough into the diked-off area. The embankment was then left to drain for six years. This embankment was investigated in April of 1994 on two cross-sections with seven borings in each, prior to designing for the completion of the embankment. This was a case of an extremely wet embankment, with unknown moisture contents after placement by the dredging operations. After the six-year waiting period, moisture contents averaged 65 percent (range of 23 to 164 percent) from 31 samples taken in this 6-foot-high embankment, as compared to a 35 percent average (range of 25 to 65 percent) in the underlying original ground, indicating poor drainage of the initial wet embankment and conditions still too weak to carry significant loadings. These moisture samples, taken in late winter on mostly frozen samples, may have been higher than the summertime values due to ice segregation from frost heaving.

Chevak Airfield Data

Data from an investigation of one of the early airfields, located at Chevak, was found in the 1999 soil investigation report for the newly relocated airport site constructed about 2001. The initial airstrip was built in 1971 by the side borrow method, expanded in the winter of 1981-82 to 90 feet by 2,400 feet, and surfaced with six inches of aggregate over a geotextile in 1983. In the soil investigation work, 10 samples were taken in November 1995 of the 1982 embankment fill material, which was built from local silty sand and organic silt. Soil was thawed to the 6.0- to 6.5-foot-depth and had average moisture contents of 19 percent in the silty sand layers and 30 percent in the organic silt. The optimum moisture for the sand

was 12 percent and the maximum density was 113.5 pounds per cubic foot (pcf). According to the geotechnical report (1995), this old embankment had settled by more than 3 feet over 12 years. The new Chevak airfield embankment, completed in the spring of 2002, has suffered significant wind erosion (Photo 6) and it is likely that some of the settlement of this new embankment was also from thermal degradation.

Photo 6
Wind erosion of embankment at Chevak, June 2003.

Kipnuk Site

At the Kipnuk site the currently active airfield embankment was constructed in the early 1980s. The final shaping, compaction and surfacing gravel layer placement were done by contract in 1986. Because of the lack of an access road to the river, transfer of surfacing gravels from barge to airfield was done by a Vertol 107 helicopter at a unit in-place cost of $134/ton (approximately $250 per cubic yard). Phase I construction of the new airfield embankment was completed in 2001 under contract, with placement of approximately 375,000 cubic yards of local organic silt borrow.

Moisture contents of silt under the shoulder area of the older operational runway embankment, on samples taken on September 19, 2003, were 32 to 34 percent at depths of 0.5 to 3.5 feet. The new and much larger embankment, which intersects the previous runway at its south end, was tested at two locations for penetration resistance by the DCP test, and moistures were also obtained to depths of 4 feet. In an area of significant post-construction settlement at 300 feet from the north end, moisture contents were 41 percent in the top foot and ranged from 47 to 51 percent between 2 and 4 feet in depth. In a dryer and more representative area at 500 feet from the north end, moisture contents averaged 34 percent in the top 4 feet of the embankment, and varied only from 33 to 35 percent in four samples; essentially the same as beneath the 18-year-old operating airfield embankment. Indicated CBR values calculated from the

DCP penetration data averaged 4.1 beneath the old runway shoulder, versus CBR values of 1.4 and 2.9 beneath wet and normal areas of the new embankment. Test data are summarized in Table 3.

It is apparent that the silt in the new embankment at Kipnuk still has low densities and high moistures, which results in the low CBR strength values. Silt soil beneath the old operational runway have strengths at least twice as high but are still very weak by engineering standards.

Table 3

Test data from September 19, 2003, Dynamic Cone Penetrometer (DCP) and moisture content tests and probed frost depths at Kipnuk Airport site. (California Bearing Ratio [CBR] values calculated from DCP data.) Embankment of organic silts.

Kipnuk Location	Embankment New in 2001 at 500 Feet South		Embankment New in 2001 at 300 Feet South		Old Runway on Shoulder	
Depth (feet)	CBR	Water and Organic Contents (percent)	CBR	Water and Organic Contents (percent)	CBR	Water and Organic Contents (percent)
0-1	2.9	34.8 and 4.0	1.4	41.2 and 5.9	3.2	34.1 and 4.5
1-2	3.6	34.1 and 4.7	0.6	50.0 and 7.4	5.0	32.2 and 4.6
2-3	2.3	33.5 and 3.7	2.0	47.0 and 6.5	4.0	34.1 and 4.8
3-4	--	--	1.7	51.4 and 7.4	--	--
Thaw Depth 09/19/03	6.6 feet		5.6 feet		6.0 feet	

Eek Airport

Moisture and DCP testing were also carried out at the new Eek airfield during the September 2003 field visits. Eek, like Kwethluk, was under construction at this time, but was in the final phase, with the silt embankment initially placed by winter construction and completed in April of 1999. Sampling and DCP testing was done to the 3-foot depth on September 19, 2003, at both Stations 29+70 and 45+10. Test results showed moisture contents to be very consistent between these locations, with an average of 36 percent and a range of 33.5 to 38.6 percent. Organic contents were again consistent at 4.4 to 4.9 percent. Indicated CBR values at Station 29+70 were 5.5, 4.5 and 6.3 for the 0- to 1-foot, 1- to 2-foot, and 2- to 3-foot intervals. Values indicated for CBR at Station 45+10 were 2.8, 2.6 and 3.6. Eek test data are summarized in Table 4. Eek is similar in soils types to Kipnuk, both sites being remote from any sources of fine sand which might speed drainage of embankments and reduce the need for phasing embankment construction over a period of years.

Table 4

Data from DCP, tests, moisture content samples and frost depth probes at Eek Airfield from the site visit on September 19, 2003. Embankment of organic silts.

Eek Location	New Embankment in April 1999; Test at Station 19+70		New Embankment in April 1999; Test at Station 45+10	
Depth (feet)	CBR	Water and Organic Contents (percent)	CBR	Water and Organic Contents (percent)
0-1	5.5	35.7 and 4.6	2.8	33.5 and 4.5
1-2	4.5	36.6 and 4.5	2.6	35.8 and 4.4
2-3	6.3	36.7 and 4.6	3.6	38.6 and 4.9
Thaw Depth 09/19/03	7.9 feet		7.1 feet	

Kwethluk Site

Testing for DCP data and soil moistures at Kwethluk was done on September 19, 2003. This new airfield embankment had been constructed of local fine silty sands in late 2002 and early 2003. It was scheduled for completion in 2003, and was under active construction for placement of the final surfacing layer. A reinforcing geosynthetic grid (EnkaGrid™) had been placed beneath the top layer of gravel surfacing. The embankment soil at this site was fine silty sand rather than the organic silt of the lower river areas. A typical gradation sample indicated 99 percent passing the #40 and 39 percent passing the #200 sieves. A typical maximum density test per ASTM D-1557 resulted in a maximum density of 117 pcf at 12 percent moisture. Embankment placement and project completion were being done under a single 2-year contract. However, the embankment was actively bleeding water upward at some locations during the DCP and sampling program. The top surface was extremely soft, even after the gravel surfacing was placed and compacted on top of a geotextile and the reinforcing grid. Passage by a pickup truck resulted in extreme deformations and the threat of becoming stuck. This excess water problem is believed to be the result of active thawing and release of excess moisture from the underlying ice-rich permafrost.

Sampling and DCP testing was done at the edge of the installed surfacing layers to measure the strength values of the underlying embankment soil. Tests at Station 0+600 from the surface to a depth of 3 feet indicated moisture contents of 21 to 22 percent, and CBR values varying from 1 to 5 in the top foot, and from 6 to 14 between depths of one and three feet. This area was chosen for its extremely soft condition. It was in a part of the embankment where the foundation soil had been stripped of the surficial peat and organic layers in a cut made to reduce the final grade, thereby exposing the underlying permafrost soils and causing accelerated thawing.

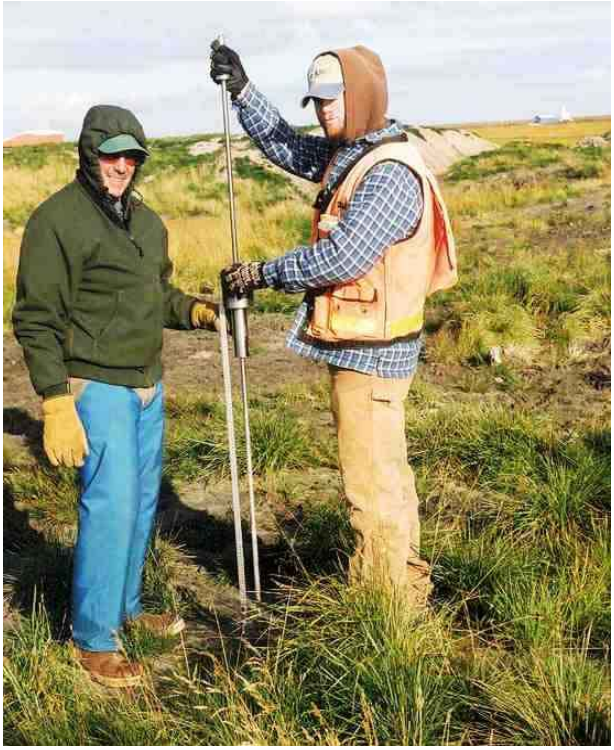


Photo 7
Cone penetration testing equipment.

Tests were also made at Station 0+790, representing a more normal condition of the embankment. Samples from depths of one to four feet had moisture contents of 17 to 20 percent, while the top foot had a moisture of only 12 percent, which is approximately the optimum moisture for compaction. Related CBR values as indicated by the DCP test were between 5 and 12 in the first foot of depth, and between 12 and 15 below that to a depth of 30 inches. The maximum thaw depths at the time of sampling were 6.6 feet at Station 0+600 and 7.7 feet at Station 0+790.

Following the above field sampling work at Kwethluk, a full program of DCP testing was done at nine locations on this airfield on October 2, 2003. Tests at Station 0+656 are considered representative of the 0+600 tests above. Indicated CBR values were 1.1 to 1.8 at 0 to 12 inches, 1.5 to 6 at 12 to 24 inches, and 6 to 8 at 24- to 36-inch depths. Tests at Station 0+822 should compare with test results and moistures at Station 0+790. Indicated CBR values were 5 to 10 at 0 to 12 inches and 20 to 30 at 12 to 36 inches, indicating good strength values at this location and extremely variable strength values at different points on this new embankment. Test data for Kwethluk are summarized in Table 5.

Table 5

Test data from DCP, moisture content samples and frost depth probes at Kwethluk Airfield from site visit on September 19, 2003. Embankment of fine silty sand.

Kwethluk Location	New Embankment in 2002 at Station 0+600		New Embankment in 2002 at Station 0+790	
Depth (feet)	CBR	Water and Organic Contents (percent)	CBR	Water and Organic Contents (percent)
0-1	1.5	20.8 and 1.6	9	12.0 and 1.4
1-2	8	22.4 and 2.1	10	17.3 and 1.2
2-3	10	21.0 and 2.1	13	19.6 and 1.4
3-4	--	--	--	20.1 and 1.4
Thaw Depth 09/19/03	6.6 feet		7.75 feet	

7.2 Discussion Of Data

Because of the extreme width of airfield embankments and the presence of underlying saturated soils or permafrost, drainage paths to drain excess water from embankment soil must be either upward by capillary action or laterally for distances of up to 75 feet. The organic contents of typical delta silt soils range from 4 to 8 percent by weight, or 8 to 15 percent by volume, and tend to capture and hold water as would a sponge. Thus embankments tend to resist drainage of excess moisture. The wet, cool, cloudy summertime weather of the Delta region also retards evaporation which might otherwise act to dry fill materials from the top downward.

Permafrost foundation soil tends to thaw deeper and consolidate more over time beneath the embankments than around the edges and in the surrounding terrain, creating a "bathtub effect" beneath the embankment with nowhere for water to go. Also, during the freezing season, frost heaving will occur within the embankment, drawing the water upward toward the surface which has drained downward in the thawing season. This creates an up and down movement of water over the course of the year and results in the typical springtime thaw weakening of the embankment. Finally, placement of embankments during the freezing season allows for a loose embankment structure with voids which become saturated from springtime melt-water and rainfall infiltration.

Moisture content and strength test data, when analyzed versus depth, do not demonstrate that deeper soil is consistently wetter or weaker, as would be expected if soil was drying out from the surface downward. Rather, moisture contents in silt embankments seem to stabilize at about the same level throughout the upper three to four feet, and to remain at moisture contents of about 30 to 35 percent for many years. Such soil will never be compactable to high densities. Therefore it appears obvious that typical embankments are not really drying out much over time, unless they are placed in a very high moisture condition as from frozen sources. Silty sand soil, as found in the Kwethluk-Bethel-Nunapitchuk and upriver areas, will drain more rapidly and might therefore be expected to stabilize at low enough moisture contents to allow compaction to meet specifications.

7.3 SLOPE EROSION FROM RUNOFF

It appears common for Phase I embankments awaiting stabilization to accumulate ponded water at various locations. As ponds enlarge they eventually overtop the side of the embankment and a runoff channel is created which can erode into a series of gullies, as shown by Photo 8. This problem occurs because the typical sand and silt of the Delta are highly erodible, and because the soft condition of new embankments prevents the fine grading of the surfaces.

Photo 8
Kwethluk erosion gully from surface water runoff.

Such gullies are commonly repaired by use of geotextile fences and barriers, and by adding additional local soil and re-grading and compacting the area. Use of sandbags and seeding was also reported as successful in treating erosion gullies at Chevak.

7.4 LAKESIDE EROSION FROM WAVE ACTION

The common occurrence of lakes and ponds, as well as flooding from extreme high tides, and ponds created by borrow pits adjacent to airfield embankments, can all result in problems of erosion from water and wave action on the embankment slopes. Photo 9 shows slope erosion from tides at Kipnuk. A variety of methods have been attempted to control this erosion, including geotextiles and the seeding of willow sprigs to form a vegetation and root mass to resist wave action.

Photo 9
Slope erosion at Kipnuk from tidal channel.

7.5 PERMAFROST-RELATED THAW-SETTLEMENT PROBLEMS

At many sites, airfields have been constructed, entirely or in part, on ice rich permafrost foundation soil. It is common to see estimates of visual ice contents exceeding 50 percent of the soil volume in permafrost area borehole samples in the Delta region. Therefore, thawing may result in settlements on the order of half of the depth of thawing into the permafrost. Data on the magnitudes of thaw related settlement problems of these airfield embankments is rarely obtained, because periodic elevation surveys have not been done, and also because reliable benchmarks which do not move from frost jacking are costly and difficult to install and maintain. The only data or references to settlement problems seen in reviews of numerous geotechnical reports for the Y-K Delta airfields came from Chevak. At that site the original embankment, constructed in 1982 over frozen silt permafrost, was investigated in November of 1995. Runway settlements over the 13 years were noted as averaging 0.9 meters (36 inches), with a maximum of 1.5 meters (59 inches).

Some airfields, such as Nunapitchuk, have been successfully insulated with 4 to 6 inches of Polystyrene foam boards to prevent or retard the thawing of permafrost foundations (Johnson & Bradley, 1988). The runway on the paved Bethel airport has had ongoing permafrost thaw-settlement related problems, in spite of major efforts to control the problem, such as the installation of inclined thermosyphons beneath the major problem areas.

FAA's Airport Master Records frequently advise pilots of dips and sags or even sinkholes in Delta area runways. Sags from settlement also pond water and cause soft spots and rutting in rainy periods, creating hazards for aircraft operators. In gravel surfaced runways, periodic re-grading of the surface can maintain acceptable conditions by continually filling in the low spots, provided sufficient surfacing gravel

thicknesses have been placed at the time of construction, to avoid exposing the underlying weaker soils after the surface re-grading work.

7.6 SHOULDER CRACKING PROBLEMS

Longitudinal cracking of embankment side slopes and shoulder areas is a typical problem resulting from construction of embankments on ice rich permafrost. It is caused by deeper thawing beneath the lower side slopes where the embankment cover is thinnest. Thaw settlements in this critical area undermine the support for the shoulder areas above, and slope surfaces move down and outward resulting in progressive crack widening. Additional lateral movement of material may occur to fill the void, hence creating a concave surface which prevents proper drainage. The cracks themselves allow moisture from runoff and rain to penetrate the fill. Crack control in this area is especially critical on airfields since cracks encroach on the safety area for aircraft, and undermine the lateral lighting system. Photo 10 shows typical shoulder cracking.

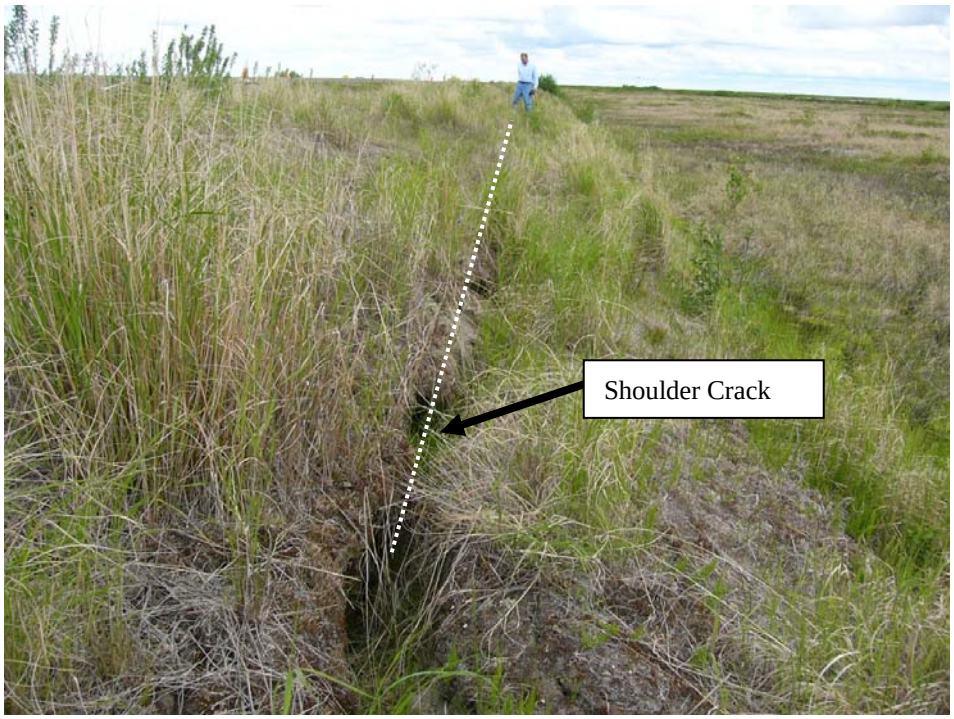


Photo 10
Shoulder cracking at Nunapitchuk.

7.7 FROST HEAVING AND THAW WEAKENING

Frost heaving is often confused with permafrost thaw-settlement problems, since both can cause sags and dips in the surface. However, frost heaves will be a problem only in mid to late winter, and may correct themselves during thawing. Uniform embankments will generally heave uniformly and this will not be noticeable. The primary problem with frost heaving is the moisture drawn upward in winter and the resulting problems of softness and rutting during the spring thaw. Most Delta airfields suffer from spring thaw problems and must be closed to traffic for one to two weeks. Keeping traffic off has been the historical method of dealing with frost heave problems of this type.

Frost heaving and capillary action of silty soil used in embankments are also major reasons why silt embankments do not dry out and gain significant strength over time as they would in warmer environments. The amount of frost heave which can occur in silty soil with an available source of water is enormous, and such soils can easily gain 25 to 50 percent in volume during freezing. The search for solutions to this problem has resulted in a considerable amount of testing and research. Simple or economic solutions remain to be discovered.

7.8 CULVERTS AND DRAINAGE

At many sites, proposed airfield locations encounter small sloughs, water courses, or tidal channels which must either be relocated or carried beneath the embankment in culverts. At several of the sites visited, culverts bedded in silt or fine sand embankments had failed due to erosion from water flowing around or beneath the pipes. Photo 11 shows such a failure at Kipnuk (June 2003). The practice of bedding and surrounding culvert pipes with fine erosion-prone silts and sands almost guarantees that water will flow around and beneath the pipes. Higher flows will then erode the backfill, and pipe failures will result. Solutions will require innovative designs and probably the importation of some gravel quantities to provide for a solid bedding and backfill zone which can resist erosion. Differential settlement from permafrost thaw may also cause pipe joint failures.

Photo 11
Kipnuk - Sinkholes at Culvert Failures

SECTION 8 - FIELD VISITS AND INVESTIGATIONS

8.1 JUNE AND SEPTEMBER 2003 SITE VISITS

Three field trips were conducted during the summer season to visit selected Y-K Delta airfields. Notes on our observations, photographs, sampling and test data are presented in detail in Appendix E. Tables 3, 4 and 5 summarize Dynamic Cone Penetrometer (DCP) test results, California Bearing Ratio (CBR) strength values calculated form these DCP measurements and water content and organic content data. Typical gradation, moisture content and organic content data is presented on Figure 9.

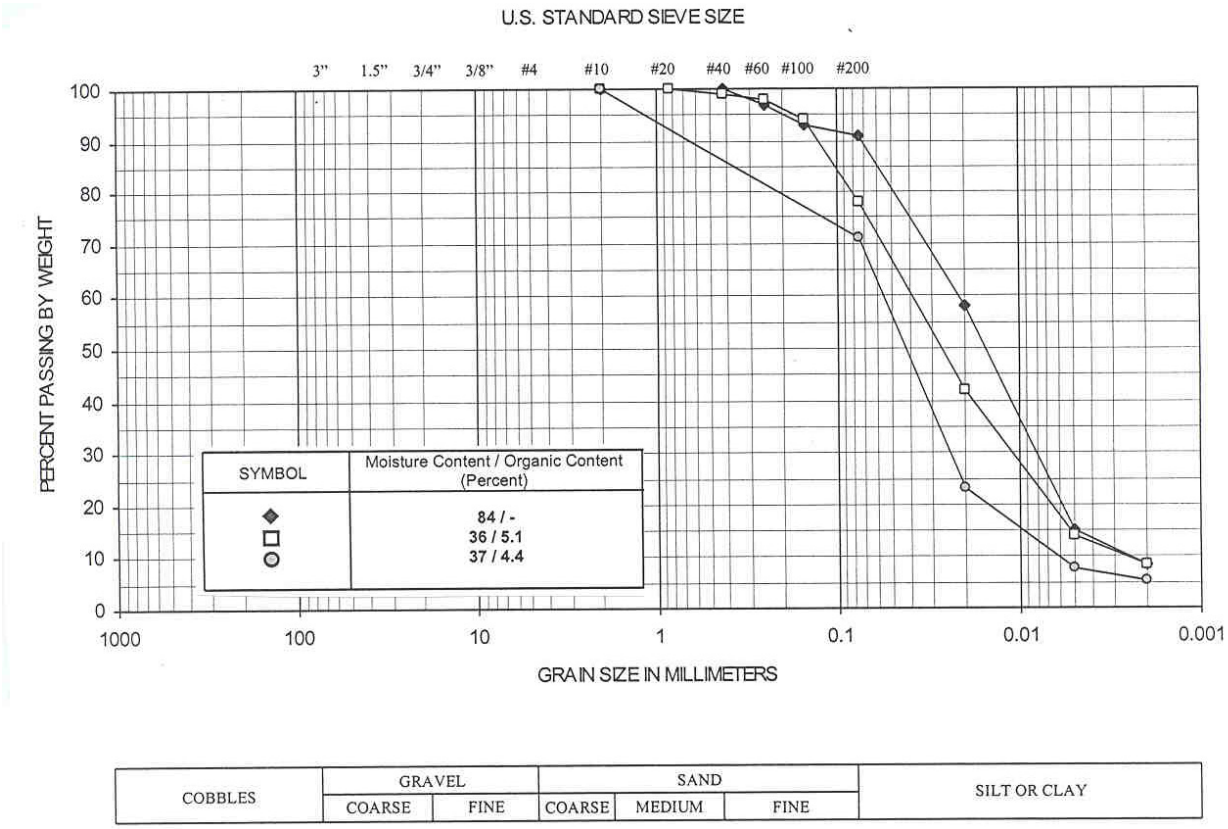


Figure 9
Eek Airport – New Embankment Soils Classification Testing Results (September 19, 2003)

SECTION 9 - LITERATURE SEARCHES

A comprehensive reference bibliography was compiled to include citations of existing studies and documentation in the subject areas of design, construction, maintenance and performance of unpaved, unsurfaced, and dirt runways, road embankments and building foundation pads on wet, poorly drained, fine-grained sand and silt materials, permafrost, frost heave and thaw settlement, water and wind erosion, dust control techniques, and geotextile and insulation applications for stabilizing and dewatering of silty soils. Particular focus was given to case studies and guidance materials relevant to Alaska, Northern Canada, Northern Europe and Russia.

The reference bibliography includes citations for journal articles, research studies, government reports, conference proceedings, professional papers, military guidance manuals, and textbooks, pulled from aggregated digital geologic and geotechnical literature resources such as the American Geological Institute's GEOREF database, the ASCE Civil Engineering database, CRREL (the Cold Regions Research and Engineering Laboratory database sponsored by the US Army Corps, the National Science Foundation and the American Geological Institute), CISTI (Canada Institute for Scientific and Technical Information) database, NTIS (National Technical Information Service), the U.S. Transportation Research Board, The U.S. Army Corps of Engineers Waterways Experiment Station library, and the U.S. Air Force Civil Engineer Support Agency. Other Canadian literature sources included Transport Canada - Canada Airfield Engineers, the CSTR (Canadian Surface Transportation Research Maintenance & Construction Division), the Transportation Association of Canada, and the Canadian Aviation Maintenance Council. To ensure sufficient thoroughness of this research, WWW searches were conducted using Google.com and NorthernLight.com. In addition, climatic data for Y-K villages was obtained from the State Climate Summaries compiled by the Desert Research Institute's Western Region Climate Center (WRCC, at http://www.wrcc.dri.edu) and the U.S. Army Corps' Alaska Engineering Design Information System (AEDIS, at https://m2.crrel.usace.army.mil/aedis/index.html).

SECTION 10 - QUESTIONNAIRE AND INTERVIEW RESULTS

In spite of the many questionnaires sent out to communities, contractors, aircraft operators and ADOT&PF personnel, the most useful input was obtained by direct interviews or phone contacts, and by meetings with collective ADOT&PF staff members. Input from ADOT&PF design staff was minimal, while construction and maintenance staff were most helpful. Most of the airport design staff members contacted had a rather short experience base, while construction staff had more experience and were able to provide more information on problems encountered. Contractor response by questionnaire completion was again minimal, but phone interviews were very helpful on specific questions.

Community satisfaction with airfields was generally high, while aircraft operators often commented that surface maintenance grading and snow removal should receive higher priorities.

To obtain a historical view of the airfield construction program and problems, it was necessary to interview retired ADOT&PF staff. Inputs from Dan Pavey, retired State Chief Geologist, and from Richard Briggs, retired Chief of Design and Construction for the Central Region, proved to be particularly helpful.

The questionnaires used in the interview phases of this study are included in the Arctic Pacific report.

SECTION 11 - EXPERIENCE AND PRACTICES IN OTHER COUNTRIES

11.1 CANADIAN EXPERIENCE

An extensive internet data search as well as personal phone calls were made to obtain information on similar design and construction problems in the arctic and subarctic regions of Canada. This effort met with little success. It appears that there are very few isolated communities that could be considered to have similar subsurface conditions i.e. fine grained poorly drained soils with discontinuous permafrost and cool moist climates. Almost all of these sites had ready access to large amounts of granular resources with which to build up well drained hard surfaced embankments. Geotextiles were used in some cases to act as a separator between the granular fill and the native soils.

11.2 RUSSIAN THEORY AND PRACTICE

Dalaeroproject of Khabarovsk was retained to research current practice and historical experience in the design, construction and operation of airports in areas of poorly drained fine grained soils and permafrost in northern Russia. Their extensive report is included in Appendix A. Russian practice appears to be much more formalized and detailed than North American practice. A number of ideas extracted from that report have been incorporated in discussions and recommendations herein.

11.3 NORWEGIAN EXPERIENCE

VISTA Utredning AS located in Oslo, Norway, was tasked with researching airports meeting similar criteria such as those found on the Y-K Delta. VISTA's report is included here in Appendix B describes conditions and design approaches for three airstrips located on Spitzbergen Island (Longyear, Ny Aalesund, and Svea) and one on Jan Mayen Island. Contacts made with the Finnish and Swedish CAA confirmed that no relevant experience existed there. The Norwegian experience is well described in the report. The paved runway at Longyear suffers from thaw settlement problems due to ice rich subsoils. Insulation in some areas has mitigated some of the settlement. The embankment was primarily constructed of local tills and weathered bedrock from cut and fill operations. It is assumed that asphalt and aggregate was imported from the mainland.

The Svea airstrip was constructed with crushed rock rubble, surfaced with a fine gravel wearing course all imported from the mainland. No significant problems were reported with runway operations. Gravel for maintenance again is imported from the mainland.

The airstrip at Ny Aalesund is constructed similarly with crushed local rocks for embankment fill and a surface course of gravel imported from the mainland.

The Jan Mayen runway is constructed with fine volcanic sand and some very poor low density gravels. The runway experiences softening during spring breakup and summer rains generally precluding aircraft operations.

11.4 PRACTICES IN FINLAND

Appendix C includes a report by Asphalt Pros of Alaska presenting knowledge of design and construction techniques used in Finland. Since no direct airport experience was found, the focus was shifted to road construction in similar difficult conditions. Practices in Finland are similar to those in use in North America. Subgrade insulation layers are occasionally used, including the use of lightweight expanded and sintered clay (LECA) particles as insulation.

SECTION 12 - ALTERNATIVE DESIGN FEATURES FOR POSSIBLE Y-K DELTA USE

The basic purpose of this study was to investigate other regional and other world design and construction practices, materials and equipment, along with the results of research records; and to suggest ways of applying them to construction of airfields on the Y-K Delta. Literature searches were conducted, along with contacts with contractors, suppliers and airport design groups in other cold region countries as described previously. Experience from highway research programs was especially helpful. Highway research is consistently funded to state highway agencies on an annual basis through the Federal Highway Administration as a set percentage of the annual highway program funds. The more difficult part of the work of applying results from elsewhere is estimation of costs and long term benefits of each design feature.

Where cost data is not known or easily estimable it is left to the reader to pursue their own estimates. In many instances it will be necessary to initiate field trials in order to make reasonable future cost estimates. Treatments are listed by purpose and function.

12.1 PERMAFROST THAW SETTLEMENT CONTROL FEATURES

12.1.1 Pre-Thawing Methods

The results of stripping surface organic layers to expose the bare soil surface to the sun were first reported in Alaska by Linnel (1973), and field trials of several different surface treatments were evaluated by the ADOT&PF from 1980 to 1983 at a site near Fairbanks (Esch, 1984). In that study, simply stripping away the trees, brush and surface moss increased the thaw depth to 5.6 feet after two years and to 7.9 feet after four years. It caused surface settlements of one foot after the first two years. Soils were organic silts somewhat similar to the Y-K Delta area, with moisture contents ranging from 50 to 65 percent in the top 3 feet and from 35 to 45 percent below that depth. Settlements were minimal after the first two summers had thawed the top 5 feet of soil, since most of the excess moisture was contained in the upper soil layers—a situation somewhat similar to the Y-K Delta. Deeper thawing by about 15 percent was obtained by placing a layer of clear 6-mil polyethylene film over the stripped areas. Placement of a one foot-thick layer of gravel over the stripped surface resulted in similar thaw depths but increased settlements by about 15 percent due to the surcharge effect. The gravel allowed light vehicle traffic and prevented vegetation re-growth which slows the thawing process.

Pre-thawing has rarely been used on highways in advance of construction, generally due to the fact that lands in the path of new roads are not purchased until just before construction—a problem which might be avoided on the Delta, where airfield embankments are commonly left to stabilize for several years before completion. This procedure is low in cost and has obvious potential in areas where high moisture content permafrost soils are relatively near the surface and will cause long term settlements over time as they thaw. Even pre-thawing for only one or two thawing seasons will result in significant reductions in long term settlements. This procedure would also be useful to prepare the foundation where runway lengthening is planned.

The construction process would require that a small bulldozer be moved to the new airport site by the end of the summer season, and used in March or April to push the organic layers up into berms at both sides of the proposed runway embankment. Embankment construction could follow after two or more summer seasons of thawing. Following construction the organic layer could be pushed or pulled up to cover and protect the side-slopes.

Considerations in use of this method are as follows:

Pros of Method:

- Relatively low in cost
- Reduces or eliminates long term settlements
- Addresses risk of a warming climate
- Minimal equipment and mobilization
- Excavated organics will provide a slope protection layer in later embankment construction

Cons of Method:

- Delays construction work
- Requires mapping of permafrost areas and ground ice extents
- May require separate contract
- Requires thin organic layer at surface to minimize quantities
- Surficial organic (peat) layers must be removed for effective thawing
- May create thaw ponds unless well drained

Costs of Work:

- Site dependent based on equipment, operator availability and organic layer thickness

12.1.2 Insulation Layer Applications

The first airfield installation in Alaska of polystyrene foam insulation was constructed in 1969 at Kotzebue (Esch & Rhode, 1976). Since then, airfields in the western region of Alaska at Buckland, Deering, Nunapitchuk, Mountain Village and St. Michaels have also been successfully insulated, usually with two 2-inch layers of extruded expanded polystyrene foam board. Of these airports, the only insulated site in the Y-K Delta is that at Nunapitchuk (Johnson & Bradley, 1988). The use of insulation is considered a proven technology (Esch, 1986). There is also adequate prior bid information on which to base estimates of cost. Insulation is most effective at reducing the overall thaw depths when placed as near to the surface as practical, usually at about the 18- to 24-inch depth, allowing for a reasonable depth of burial for lighting systems.

Peat has also been used at one Alaska highway site, where 4 to 5 feet of frozen peat was installed beneath the roadway embankment to prevent the long term thawing of ice-rich permafrost. That installation was moderately successful in slowing the roadway induced long term thawing of the foundation soils, but a period of several years of settlement was reported as the peat layer thawed and annual thaw depths reached a new state of equilibrium (Reckard & Esch, 1988). Placing an additional peat thickness as insulation is not recommended for the Delta airfields, although it is done in Russia under certain conditions (Dalaeroproject Report; Appendix A). However, the pre-existing surficial peat and moss layers should be retained as natural insulation beneath fills over permafrost, unless pre-construction thawing of ice rich foundation soils is to be done as discussed above. Peat used as slope coverings will also reduce slope erosion and provide some thermal protection to the slope.

Pros of Method:

- Reduces total depth of thaw to about 0.5 to 1.0 foot beneath the insulation layer
- Reduces required embankment thickness
- Easily placed with minimal equipment
- Reduces or eliminates long term settlements and related repair costs

Cons of Method:

- Will not provide total thaw protection if climate warms significantly
- Surface frost may form more frequently and differentially over insulation
- Requires relatively stable, smooth surface to place insulation boards
- Requires light equipment to place overlying sand and gravel layers
- Does not solve the problem of progressive thaw below side slopes

Costs of Materials and Installation:

- Insulation Board costs $0.30 per board foot measure (fbm) FOB Anchorage
- Shipping costs are site dependent
- Installed costs are available from historical bids (no recent use in large quantities)

12.1.3 Thermosyphons For Ground Refrigeration

Thermosyphons are 2-phase natural convection tubes, which are partially filled with a purified single liquid such as ammonia, carbon dioxide or propane, which maintains an equilibrium with its gaseous phase. They are commonly used to refrigerate pilings, such as those which provide frozen vertical soil support pilings on much of the Alyeska pipeline. For that project, more than 120,000 thermosyphons were installed (Heuer, Long & Zarling, 1985). The belowground sections can also be installed nearly horizontally as done at the Bethel airfield (McFadden & Siebe, 1986) and on Bethel Highway. On that highway project, completed in 1990, thermosyphons were placed in trenches at a 9-foot spacing at the base of the embankment and covered with a layer of polystyrene insulation to provide the greatest possible benefit (Esch, 1996). A spacing of 10 feet between units is recommended for future installations, provided that a thermal analysis justifies the final design. In such applications the thermosyphons cool the ground in winter and the insulation retards soil warming in the summer, leading to progressive ground cooling of several degrees over time. This combined system may be the only hope for long term preservation of permafrost in a warming climate. Information from the Russian contribution to this report on their airfield practices (See Appendix A) indicates that even very long thermosyphons, up to 300 feet can be effective when placed in trenches.

Pros of Method:

- Positive method of cooling foundation soils
- Resistant to climatic warming effects
- Relatively simple low tech installation
- Can provide cooling and freezing of critical sideslopes

Cons of Method:

- Radiator sections must be kept low to avoid air space encroachments
- Requires trench cutting equipment
- High costs
- Need for periodic monitoring for damage and leakage

Costs of Materials and Installation:

- Costs per unit are estimated by Arctic Foundations based on design selected
- Thermosyphons (80 feet by 3-inch diameter) are currently estimated at $2,500 to $3,000 each F.O.B. Anchorage
- Installation trenching and placement costs vary with site
- Full airfield treatment would be in excess of $1,000,000

12.1.4 Rock Fill For Convection Cooled Embankments

The concept of placing large rock layers of high porosity to allow cold air currents to create convective cooling cells in winter has been developed and patented by Dr. Doug Goering of the University of Alaska at Fairbanks with the support of the ADOT&PF. This treatment has been applied at three experimental sites on roads in the Fairbanks area (Goering, 1994 & 2001). Crushed rock or "boulder rejects" from processing of gravels can be used. Rock from 6 inches to 10 inches in maximum size has been used to date, although 4- to 8-inch-sized rock may also be effective. Ideally the rock used would be all of one size; in practice sizes will range over a 40 percent range. Minimum layer thicknesses of 2 feet appear necessary to obtain the cooling effect, with 3 feet providing more effectiveness. When uniform rock sizes are used, the overall density of the mass will be in the range of 100 to 120 pcf, and will provide a strong and relatively lightweight fill structure, The rock layer is then capped with a heavy geotextile layer and a 10- to 12-inch layer of crushed gravel surfacing.

Such layers have proven effective in cooling the foundation soil over a period of several years. In winter, the cold and more-dense air at the top of the rock voids descends to the bottom of the layer and warm air at the bottom is forced to the surface where it cools and repeats the cycle. In summer the air in the voids remains stable, with cold air remaining at the bottom; the overall rock layer thereby acts as an insulation layer.

Pros of Method:

- Actively cools foundation soils to preserve permafrost
- Provides a strong structural section
- Requires only minimal compaction
- Low density maximizes the volume per ton of material hauled
- By sorting and screening before crushing, smaller rock can provide crushed gravel for surface layer
- Can provide slope cooling to prevent longitudinal cracks

Cons of Method:

- Rock sizes may be difficult to handle
- Not all sources can provide proper rock sizes
- Blasting and screening required at source
- Processing Costs may be relatively high

Costs of Materials and Installation:

- Rock prices available from highway use of ACE - Fairbanks project bid at $5.00 per ton at pit
- Platinum quarry site – estimated at $30 per ton barge loaded
- Estimated at $100 per cubic yard in place – shipment from Nome
- Geotextile cost of $1.90 to $5.00 per square yard

12.1.5 Wood Chip Fills

The use of wood chip fill layers has been tested at several locations in the Eastern United States as a means of providing an economical insulation layer to reduce frost heave. Wood chips can also provide a structural layer function when used over wet silts or silty sands, as demonstrated by recent trial uses on local Bethel area roads (L.J. Davis, personal communication). While not structurally as competent as crushed gravels, wood chips are not susceptible to springtime thaw weakening. Wood chips were used to provide a lightweight embankment on the Parks highway near Fairbanks to reduce the load by 30 percent on an ice-rich permafrost foundation which was causing creep failure of a 30-foot-high embankment (Reckard, 1990). A 20-foot-thick layer of wood chips derived from fire-killed trees was used to replace much of the original rock fill, reducing settlement rates by 40 percent.

Wood chips are best obtained by chipping relatively dry trees, such as the beetle-killed or fire-killed trees all too common in Alaska. Wood chip layers from green trees can generate significant internal heat due to spontaneous combustion effects, and are not suitable for use over permafrost. Wood chips have been produced in large quantities and exported from Homer, Alaska, in recent years, but low world prices for chips has resulted in the end of that operation. Wood chip production on the upriver areas of the Yukon and Kuskokwim could provide the needed source and create a local jobs program for area residents, or chips could be imported from the Pacific Northwest. Some wood chip production is planned for the Mat-Su Valley at Point Mackenzie in the near future.

Pros of Method:

- Possible use of regionally available wood resources and labor
- Light weight of chips allows large volumes to be easily transported by barge or truck
- Insulation value provides for reduction of frost heave and/or permafrost thawing
- Resistance to springtime thaw-weakening

Cons of Method:

- Chip production is labor intensive and industry not now active in Alaska
- Wood chips are resilient and require thicker granular layer at surface than sand or rock fills
- Spreading operation requires tracked equipment and chips are difficult to traverse with trucks
- Relatively high costs
- Can generate internal heat

Costs of Materials and Installation:

- Chip prices fluctuate with the world market and are a common commodity used in paper and wood products
- Shipping costs by barge are distance dependent
- Installation costs similar to borrow placement
- Chip prices in British Columbia averaged $85 US per ovendry metric ton (2,204 pounds), or about $35 per cubic yard at an in-place density of 30 pcf

12.1.6 Geosynthetic Reinforcement Of Shoulders And Embankments

Reinforcing the tops of the embankment shoulders to prevent the embankment spreading and the formation of longitudinal cracks, which form when permafrost thaws and settles more beneath the lower slope areas, is a subject which has received major highway research efforts by the ADOT&PF (Kinney & Savage, 1989). Use by Russian engineers is also discussed (Appendix A). The best apparent success has been from the use of a double layer consisting of a layer of woven geotextile beneath a layer of "geogrid," both placed from 8 to 12 inches below the shoulder surface and extended well back from the shoulder break point to provide anchorage. The overall benefits of this approach have not yet been determined. Design procedures were developed by Kinney (1993). Russian practice (Appendix A) suggests the wrapping of the entire side-slope area by first placing the bottom of the geosynthetic beneath the toe area of the fill, wrapping the material up over the completed side-slope, and then anchoring it beneath the top layer of fill for a considerable distance back from the shoulder point. This will provide resistance to shoulder cracking and also to slope erosion, but the large volume of confined material will place tremendous tensile stresses on the geosynthetic. To avoid solar and equipment damage, the geotextile must be covered by soil and seed, or by gravel.

Reinforcing embankments by installing a blanket of geotextile or geogrid beneath or within the embankment, in expectation of reducing differential settlements due to thaw of permafrost, has been frequently done over the past 20 years. However, the results have been less than satisfactory and several

studies have indicated that no benefits could be seen (Reckard, 1988, Johnson, 1983). Tests by Kinney (1987) demonstrated the ability of geosynthetics to span voids, and determined that the maximum width which might be spanned was in the range of 8 feet. However, considerable surface deformation still occurred even over such small subsurface voids. The hope that some settlement reduction benefits may occur, and the relatively low costs of materials, both still lead to such installations being specified in spite of the poor chances of success.

Pros of Method:

- Can reduce or prevent shoulder cracking if adequately designed
- Material and installation costs are minor
- Materials are easily transported
- May increase trafficability during construction

Cons of Method:

- Installation of lighting and cables must be above reinforcement
- Further field trials needed; benefits unproven to date for reducing shoulder problems
- Reduction of surface settlements unlikely

Costs of Materials and Installation:

- Reinforcement geotextile bid item P-681b may apply (Kwethluk bid at $1.90 per square yard)

12.2 Silt Embankment Drainage And Stabilization Methods

12.2.1 Periodic Vibration And Re-Grading For Drainage

One of the first methods used on silt embankments in the Y-K Delta, during the stabilization period following placement of frozen or wet but thawed organic silts, involved periodic compaction by vibration and reshaping by wide pad crawler tractors to provide lateral drainage. This was usually done by maintenance forces with equipment transported from site to site to perform this work on roughly a monthly basis. Saturated silt and silty sand soils will commonly consolidate slightly and release some of the held water when vibrated. However, continuing vibration may actually liquefy the soil and bog down the operating equipment, so periodic single coverage by vibratory compactors pulled by tracked equipment has been used.

More extreme vibratory methods are used in the process of "vibroflotation" in which a large vibratory probe is lowered into the soil to induce liquefaction and to consolidate deep layers. However, in silts the drainage process is slower and times for strength recovery is longer—often several days or weeks. By periodically vibrating such soils, incremental dewatering and strength gains can be obtained.

Pros of Method:

- Speeds consolidation process
- Reshaping reduces ponding and slope erosion gullies
- Can control surface vegetation growth

Cons of Method:

- Difficult to specify method-operator controlled
- Requires periodic barge transport or equipment dedicated to each site for season
- Results not guaranteed to produce benefit
- Results have never been monitored; engineering analysis needed to measure benefits, sensitivity to soils type and number of and frequency of treatments

Costs of Equipment and Operations:

- Equipment rental, transport and operation costs needed vary with site and with access conditions

12.2.2 Geocomposite Drains

A geocomposite drain is basically a flattened tube drain formed by wrapping a non-woven geotextile around a plastic core. Construction of the core determines the water carrying capacity and resistance to crushing, while the geosynthetic wrap controls the resistance to plugging by the surrounding soil fines. Proper design and installation are needed to assure that surface loads do not crush or plug the drains, and that water entering the drains has an exit which will not plug by freezing or by soil intrusion. Over the past 10 years, geocomposite drains have been extensively installed as edge drains along concrete highway pavements in the United States and elsewhere. However, many of these installations have reportedly failed due to plugging by soil fines or covering of outlets (Kinney, 1996).

Use of geocomposite "sheet drains" of the types designed for installation behind retaining walls or of "geonets" designed for drainage of water and leachates from landfills should be considered. More than 50 products of this type are listed in the GFR Specifiers Guide (2004), although most would not be suited for placement directly into wet silt fills. Manufacturer guidance is needed for product selections.

As a precautionary note; the installation of any drain system must be done below the expected water table, whether it is temporary or permanent, to have any chance of collecting and draining away excess water from the fill. However, when placed above the water table, such full coverage sheet drain products will serve as capillary cutoff layers, and aid in reducing frost heave and thaw weakening problems (Henry and Holtz, 2001). No data on static water tables within or beneath embankments could be found in any of the many geotechnical reports reviewed for this study. Data was also absent on the soil moisture characteristic curves for organic silt soils, to determine their moisture retention characteristics from capillary forces with water available at the base of the fill.

Pros of Method:

- Potentially simple method of draining away excess water from embankments
- Relatively low in cost
- Materials easily transportable

Cons of Method:

- Designs usually lack field data on static water levels
- Long transfer distances and shallow water levels in surrounding terrain
- Problem of creating and maintaining flow from drain outlets in freezing conditions
- Engineering analysis of drainage potentials has not been done
- No field experience in similar conditions

Costs of Materials and Installation:

- Geocomposite drain product costs vary with product; for example Akwadrain, a 12-inch-wide strip drain costs $0.75 per lineal foot F.O.B. Anchorage
- Installation costs minimal

12.2.3 Vertical Wick And Stone Column Drains

Vertical drains and stone columns are commonly installed in soft saturated foundation soils to speed consolidation by allowing drainage of excess water upward to the surface. They are most commonly used in clay soils but may have benefits in organic silts. Use of vertical geosynthetic wick drains may be effective. Vertical sand or gravel columns, 16 to 24 inches in diameter, to connect granular drainage layers placed both above and below the silt embankment soils have been suggested by the Russian engineers (Appendix A). This approach would require installation of a basal layer of gravel prior to excavating and placing the local silt borrow materials, with vertical drains on 5- to 10-foot spacings (Figure 16, Appendix A). This method may also provide the benefit of creating a capillary cutoff to prevent groundwater from being drawn upward to feed the frost heaving soil forces within the fill, provided that the base layer of gravel extends above the water table.

An alternate to use of gravel layers and stone or sand columns would be the installation of one of the geosynthetics called sheet geonet products. More than 50 products of this type are available (GFR, 2004). Sheet drains are designed to provide positive water drainage, and would also serve as capillary cutoff layers if above the water table, possibly also reducing frost heaving and spring thaw weakening. Combining geonets with vertical wick drains would provide more rapid drainage where water tables are high enough to justify the expense.

Pros of Method:

- Should provide positive drainage and faster stabilization
- More drainage potential than simple horizontal drain installations
- May reduce frost heaving and capillary moisture gains
- Base drainage layer will provide more stability for fill

Cons of Method:

- Expense of importing and placing gravel layer before silt fill placement
- Costs of geosynthetics sheet drains and problems of placing, requiring a stable layer sloped to drainage outlet location beneath sheet drains
- Specialized augers and equipment required for drain installation
- Silts may still be resistant to gravity and lateral drainage

Costs of Materials and Installation:

- Imported gravel costs from Table 2, Items P-154a and P-208e, average $70 per cubic yard.
- Drain augering and installation costs undetermined
- Sheet drain costs vary with product chosen

12.2.4 Drainage Galleries

Positive drainage could be created at many airfield sites by installing perforated subdrainage pipes surrounded by gravel filter collection layers in shallow trenches placed into the foundation soils. Such drainage pipes would need to lead to suitable discharge points in low lying areas adjacent to the embankment, or to internal drainage sumps with sump pumps to de-water the fill areas. Many swampy but potentially useful agricultural areas have been drained throughout the United States by the simple installation of drainage tiles leading to waterways. Concerns about reverse flooding of systems with external drainage outlets from high river levels or tidal effects would need to be addressed.

Pros of Method:

- Internal drainage sumps not susceptible to local area flooding
- Positively controls static water levels within embankment
- Accelerates drainage and stabilization of embankment

Cons of Method:

- Settlement of embankment may prevent pipes from draining externally
- Silt soils may still hold water by capillarity; i.e. this method will not work in unsaturated soils

Costs of Materials and Installation:

- Polyvinyl chloride (PVC) drain pipe and fittings low in cost
- Sump and pump system and installation costs undetermined

12.2.5 Capillary Barriers

The use of polyethylene plastic sheeting as a positive barrier to water movement was tested by a 1973 installation at the Kwigillingok Airport. The intent was to allow the newly placed 3-foot-thick silt fill to dry without taking up water by capillary action from the saturated foundation soils (Johnson, 1983). The fill was probed in late in 1974 and found to be still very wet, with water ponded on top of the membrane because the drainage of water downward was prevented by the membrane. It was later necessary to remove the membrane to provide vertical drainage. Similar reports have been documented about the poor performance of other thin geotextile layers, which have plugged with soil fines and prevented downward drainage.

Certain porous non-woven geotextiles may limit the upward migration of water and reduce any related frost heaving by serving as capillary cutoffs, while still allowing the downward gravity drainage of water. Such geotextiles must not wet or absorb water. However, research on the effectiveness of polypropylene nonwoven fabrics, considered to have the highest potential benefit in such applications, were found to become ineffective when infiltrated with silt particles. Installation of a capillary cutoff must be above the long term water table to function properly. Use of geonet products situated above the water table would provide a more reliably effective capillary cutoff, as well as lateral drainage as noted above. Geonets are the only type of geosynthetic cutoff layer likely to have success in the field, based on the research of Henry and Holtz (2001). Photo 12 illustrates one such commercial product manufactured by TENAX.

Photo 12
Nonwoven geotextile with a core of Geonet.

Pros of Method:

- Can reduce capillary water drawn upward to freezing front
- Reducing capillary flow and frost heave may speed drying of embankment
- Costs relatively low
- Simple installation

Cons of Method:

- Stable layer of soil in lower embankment needed for placement
- High water tables will cancel effect
- Benefits not demonstrated in field use
- Soil moisture transfer within a soil layer can still provide water for some frost heaving
- Vapor phase transfer of moisture can still occur

Costs of Materials and Installation:

- Product costs vary widely in the range of $4 to $8 per square yard F.O.B. Anchorage
- Installation costs undetermined, but soil layer preparation costs must be included

12.2.6 Electro-Osmotic Dewatering And Electrical Silication Stabilization

Electro-osmosis is a method of soil dewatering by applying DC voltages between electrode casings. Electro-osmosis has been used to dewater slow draining clayey soils and poorly drained hydraulic fills. This method was used to stabilize a downtown Anchorage landslide area after the 1964 Alaska earthquake. Use of electrochemical stabilization by combining electro-osmosis with injection of sodium silicate and occasionally calcium chloride as a hardener system through the anode casings, is discussed in the Appendix A, Section 17 contribution to this report. This method reportedly binds the soil by formation of silicic acids. It has not been applied to date in Alaska. Horizontal (cathode) casings could potentially be laid at the base of the embankment, with anode wires placed near the upper surface.

Pros of Method:

- Potentially able to provide dewatering of saturated fills in one season
- Injection of stabilizer will improve the silt soil strength properties
- Horizontal installations simple to install

Cons of Method:

- May not be effective in moving capillary water in unsaturated organic soils
- Field experience and cost data lacking
- Electrical DC power source required; local power is very expensive

Costs of Materials and Installation:

- Copper pipe cathode and anode wires

12.2.7 Geobags And Geotubes

The technology of using large geotextile tubes and bags to contain and dewater fine-grained soils such as sands, silts and even sewage sludge was developed in the 1980s (Bogossian et.al. 1982) and has been improved over the past 15 years (Fowler et.al. 1994). It may hold promise for the containment and dewatering of the wet organic silt soils common to the Y-K Delta. In this process, as used for constructing dikes and embankments (see Photo 13), large tubes are created of appropriate geotextiles chosen for their strength and filtration capabilities, based on tests with the actual soils to be contained. (Fowler & Trainer, 1996). For airfield embankments, a small dredge would be used to liquefy the silty soils and pump the soil into tubes laid across the proposed runway. Tubes of 10 to 20 feet in diameter and of runway width would be filled to perhaps the 40 to 60 percent level, sewn shut at the entry end and allowed to drain (see Photo 14). Drainage is said to be rapid due to the short travel paths for the water to the outside of the tube. The soil is restrained by the bag and forms a relatively strong and stiff unit. Soil stabilizers could also be added as the soil is pumped. Completed bags would be very resistant to erosion and the embankment would also be resistant to lateral spreading and cracking forces. This method would be most suitable for summer construction, and would avoid the need for excavation and hauling equipment and haul roads. Naturally, some development work based on field trials is needed to apply it to the Y-K Delta region.

Photo 13
Geotubes used to form embankment to retain saturated fill

Photo 14
Geotubes filled with pumped sludge material

Pros of Method:

- Summertime operations in soft soil conditions easily done
- Combines soil and geotextile into relatively stiff system
- May eliminate need for trucks and haul roads
- Stabilizers can be added during pumping

Cons of Method:

- Thawed borrow site required
- Technology must be developed for Y-K Delta soils and conditions
- Specialized equipment is required for filling/installation
- UV degradation on exposed bag surfaces

Costs of Materials and Installation:

- Costs unknown

12.3 Side-Slope Treatments To Control Erosion

Side slope erosion has become a major problem at some airfields due to wave action from ponds and lakes adjacent to runways, erosion from storm surges and related tidal flows, river flooding and runoff from water ponded on top of the embankment, and wind erosion. Silt and fine sand soils are extremely erosion prone and reliable slope protection methods are expensive. Slope seeding is commonly done to

provide a resistance to minor erosion forces, but is unable to cope with wave action or concentrated runoff of storm water. The use of geosynthetics to control erosion of side slopes has commonly involved the installation of vertical silt fences after gully formation begins. Other methods include seed combined with rolled erosion control products (RECPs), geogrid products, and geotextile wrapped embankment slopes. Finally, many erosion control efforts applied to erosion gullies or other problem areas have involved simple sandbags filled with soil. Discussion of specific erosion control materials and methods is as follows:

12.3.1 Fabric Wrapping Of Slopes With Overlays Of Gravel Or Rock

Russian literature suggests the use of geotextile layers anchored beneath the toe of the embankment and wrapped up and over the slope to be finally anchored beneath the top layers of fill. The geotextile layer is then covered with a gravel layer for protection (Figure 15 of Appendix A). This should provide a positive anchorage for the fabric and an erosion resistant covering as long as flows are relatively low. For more severe erosion from wave action, the gravel would be replaced or topped with a layer of rock riprap.

Pros of Method:

- Should prevent water from eroding beneath fabric
- Protection for all up to heavy wave action with gravel overlay
- Riprap topping will provide higher level protection

Cons of Method:

- Installation may be difficult in winter operations due to large soil chunks
- Requires importing and hauling gravel or rock layers for topping
- High costs of imported gravel and rock

Costs of Materials and Installation:

- Bid Item P-681b; Reinforcement Geotextile may be representative ($1.90 per square yard at Kwethluk)
- Riprap or gravel covering may be estimated from contract bid items

12.3.2 Geoweb™ Cells For Erosion Control

Geoweb™ is a product developed by the Corps of Engineers and the Presto Company (www.vjfmarketing.com/geoweb.htm) for a type of polyethylene honeycomb expandable grid which is shipped flat but which creates open cells when stretched out (see Photo 15). This product type has since been generically termed "geocells," and other manufacturers have created more than 40 competing products. The original purpose was to provide a sand confinement system for vehicle travel across loose, dry, beach sands and gravels. The cells are available in different sizes and depths from 3 to 9 inches. In use the cells are expanded, staked in place, and filled with fine sand, gravel or topsoil. Seeding of the topsoil serves to tie the system together and provide erosion resistance. Sprigging of slope areas with willow shoots has been done at some airport sites, and might be a useful addition to Geoweb™ installation sites. For protection from more severe water erosion, the cells can be filled with concrete to create a linked and flexible riprap blanket.

Photo 15
Geoweb "geocell" product partially expanded from flat package.

<u>Pros of Method:</u>

- Provides positive protection for wind and water erosion from surface runoff
- Local soils materials may be useable
- Compact packages for shipment
- Concrete filling of cells can create a riprap layer

Cons of Method:

- Not adequate for wave action protection unless concrete filled
- Labor intensive installation
- Relatively expensive

Costs of Materials and Installation:

- Materials costs for 6-inch tall cells: $3.08 per square yard FOB Anchorage
- Installation costs undetermined

12.3.3 Geotextiles As Silt Fences And Barriers

Placement of silt fences supported by wood stakes, which allow water penetration but retain the soil fines, has been a commonly used expedient if temporary method of controlling erosion of silty soils. Eventually the geotextiles become plugged by fines and erosion products divert around the barriers. Placing continuous geotextile fences along slopes at intervals of elevation can create a series of terraces and permanently retain soils when the system is properly seeded.

Pros of Method:

- Simple and cheap materials
- Allows use of local soils

Cons of Method:

- Fences must be anchored into slope to avoid undercutting
- Labor intensive installation
- Relatively ugly
- Temporary installation

Costs of Materials and Installation:

- Available from bids for Item P-680 ($4 per lineal foot)

12.3.4 Composite Fabric Blankets And Seeding

A considerable variety of products which combine vegetation growth with fabrics are available on the market. They include more than 60 degradable natural fiber products, and more than 20 different nondegradable polymer products (GFR, 2004) for longer erosion resistance. These products, termed Rolled Erosion Control Products (RECPs), are laid and pinned to the slopes following seeding. Success requires a flexible and conformable fabric applied in close contact with the soil for the plant roots to attach it to the soil. If water runoff flows beneath the fabric layer, it can still cause erosion gullies. These products can provide better resistance to slope erosion by water and wind than the commonly used hydro-seeding method.

Pros of Method:

- Can provide long term reinforcement to slope vegetation
- Minimal equipment required
- Easy to repair slopes

Cons of Method:

- Labor intensive installation
- Erosion below fabric possible
- Seed types must be suitable to Delta area
- Keeping vegetation growing over time may be problem

Costs of Materials and Installation:

- Materials costs vary with product. Typical anticipated costs range from $1.70 to $2.00 per square yard F.O.B. Anchorage
- Installation costs undetermined

12.4 PAVEMENT STRUCTURES FOR SILT EMBANKMENTS

The term "pavement structure" refers to the combination of stabilized or un-stabilized soil and aggregate layers which must provide structural support for wheel loadings, and includes all progressively stronger layers from the embankment or foundation soil upward to the surface. Finding an effective method of stabilizing the fine sands and organic silts common to the Y-K Delta has long been the goal of research by the ADOT&PF Research Section, and many studies have been made. An excellent summary of Alaskan experiences with soil stabilizers was prepared by Hicks (2001). Stabilization of local soils must be weighed against the importation of better materials with a longer performance history.

New stabilizers continue to come onto the market, including exotic chemical resins and products such as fibers for soil reinforcement. Tests of stabilizers must consider not only the mixing difficulties and the strength and curing rates under wet, cool field conditions, but also the resistance of stabilized soils to breakdown under freeze-thaw and frost heave forces.

The standard surfacing material for Y-K Delta airports has always been imported crushed gravels or crushed rock which must meet gradation, fracture and durability (quality) requirements. Due to the extremely high costs of importing gravels for the surface layer; high and overly optimistic hopes have often been placed on the use of geosynthetics for separation and reinforcement of the gravel surface layer when placed over wet silts. An early attempt to separate and reinforce the one foot thickness of gravel surfacing placed at Tuntutuliak in 1977 was reported on by Johnson (1983). Even though a layer of Typar 3401™ geotextile had first been placed and the aggregate was placed by large tire (4-foot-diameter and 12 pounds per square inch [psi]) tricycle "tundra trucks," both the underlying silt and the geotextile were pumped up through the gravel. The job had to be delayed several months until the silt had gained some strength before work could be completed.

Reinforcement of granular bases to reduce the required overlay thickness is an area covered by several studies and field trials. Current experience from full scale testing (Department of the Army COE, 2003) indicates that the only geosynthetics able to significantly reinforce a granular base are the polypropylene or High Density Polyethylene (HDPE) open mesh grid type products, either made from an extruded sheet which is punched and drawn in two directions to form an open grid, or integrally formed such as Tensar's Geogrid™ (www.tensar.co.uk). It is important that the aggregate particles lock into the grid openings to provide a truly reinforced structure. Standard practice commonly calls for a layer of non-woven geotextile separation fabric beneath the geogrid, but the need for this is still unresolved. Experience with reinforced gravel overlay placement operations on embankments built of wet silts or fine sands has demonstrated that very large surface deformations, on the order of inches, can still occur. In most cases the placement operation is structurally more critical than any later loadings from aircraft.

Alternatives to gravel surface layers which might be considered for use on airfields include prefabricated mats and pre-cast concrete panel systems. Russian practice utilizes pre-cast concrete panels, and military operations commonly utilize preformed mats.

12.4.1 Construction Equipment and Scheduling Considerations

It must be recognized that pavement structure designs should consider the equipment used to place and compact the surface courses, and the commonly soft and weak embankment condition at the time of placement. In many cases, the hauling equipment loadings will be far greater than the aircraft ultimately using the facility, and will require placement of a much thicker granular surface layer if placement is to be done in the thawing season. The design alternatives to this problem appear to be the specification of maximum equipment sizes, the requirement for placement of surface layers on a frozen embankment, or the attempt to place responsibility for this problem on the contractor.

12.4.2 Silt Stabilization

A major study of stabilizers for organic silts from the Bethel area was performed by L. Danyluk (1986). This soil had 12 percent organics, and an optimum moisture of 29 percent at the maximum density of 79 pounds per cubic foot. That study tested nine different soil stabilizers but found no readily acceptable products or combination of products when tested for strength and resistance to frost heaving. Stabilizers tested included cement, lime, fly ash, asphalt emulsions, tetra-sodium phosphate and calcium acrylate. Russian experience suggests the use of sodium silicate, a common stabilizer used for grouting, as a stabilizer with or without Portland cement or calcium chloride as hardeners. (Appendix A, Section 17). In Russia, these stabilizers are said to work with peaty or silty soils and to be "very cheap." Sodium silicate, commonly called "waterglass" is a mixture of Na_2O and SiO_2, as a heavy liquid with a specific gravity of about 1.6 and a pH of 12. Laboratory tests with Y-K Delta soils are required to establish the proper mix and the benefits of any stabilizer.

Another innovative means of stabilizing clayey soils, which may work on silts, is the use of small synthetic fibers intermixed with the soil for providing tensile reinforcement. Fiber-soil mixes were probably the first soil stabilization method developed and have been in use for thousands of years. Modern materials and mixing equipment make this approach one for further consideration.

Pros of Method:

- Local soil use will reduce the costs of imported sand
- More rapid stabilization of newly constructed silt embankments
- Earlier project completions possible

Cons of Method:

- Special equipment required for thorough mixing
- Some products susceptible to cold and wet weather problems
- Costs of stabilization not yet known
- Risk of failure to create improved soil properties

Costs of Materials and Installation:

- Undetermined

12.4.3 Sand Stabilization

A large laboratory study of sands and potential stabilizers for Y-K Delta-area silty sands focused on Portland cement and asphalt emulsions (Gentry and Esch, 1985). After sampling soils at 13 communities and 22 sites in the Y-K Delta area, four sand types were included in this laboratory testing program. They included a very clean sand from St. Michaels, a uniform fine sand from Hooper Bay (3 percent silt), and two Bethel area sands selected for medium (9 percent) and high (20 percent) silt contents. The study found that all four of these sand types resulted in suitable products when mixed with 4.7 to 5.7 percent CSS-1 asphalt emulsion and 1.5 percent Type II cement. Stabilized sand soils have been used at the Bethel airport where cement stabilized sand base course layers have been successfully stabilized in two projects over time. At Shishmaref, an emulsion-stabilized sand was used for a surfacing layer over sand filled Geoweb™ cells.

Based on the favorable results of the laboratory study, a field trial on a road segment was made at Bethel (Kozisek & Rooney, 1986). This project used locally available equipment including a grader with scarifier, an asphalt distributor and compaction roller to stabilize a 350-foot length of roadway. The method used, grader mixing, and manual cement distribution would not be recommended for future use due to the partial emulsion break prior to mixing and the poor uniformity of the product, but the results were at least partially successful and indicated promise if a traveling mixer were to be used for the work.

A second type of stabilizer for sands and gravels was developed and patented by the British Columbia Ministry of Transportation and Highways for use as a treated base and patented as BC Stabilizer™(Hicks, 2001). It uses a combination of asphalt emulsion and lignosulphonate, a paper mill waste product often used alone for dust control. It reportedly should be used on surfaces with good drainage and a dry environment; making it marginal at best for Y-K Delta area use.

Pros of Method:

- Sands suitable for soil stabilization are available in some areas of the Y-K Delta, such as Hooper Bay, Chevak and Bethel
- Importing sands is cheaper than importing gravels
- Acceptable surfaces can be created with sands and stabilizers
- BC stabilizer may be the most economical product

Cons of Method:

- Stabilized sands would not be re-gradable to fill settlement area dips as gravels are
- The mixing and stabilization process requires proper procedures, specialized equipment and close quality control for success
- Stabilization work is weather sensitive
- End product costs may exceed imported gravels
- Most stabilized sands have been used as bases for asphalt pavements

Costs of Materials and Installation:

- Cement costs affected by shipping and handling costs
- Asphalt emulsion costs affected by shipping and storage costs
- Field mixing and compaction require specialized equipment
- Imported sand costs are site dependant

12.4.4 Imported Sand For Subbase

Depending on the airfield site, sand for the construction of the subbase layer might be imported from Bethel on the Kuskokwim, or from coastal villages such as St. Michaels or Hooper Bay where beach or dune sands might be accessed. As a cautionary note, sands which are very clean may be difficult to handle and compact without tracked equipment, however, they will be the most resistant material to frost heaving and thaw weakening, and will be stable when covered with a surfacing layer of gravel.

Pros of Method:

- Reduces gravel thickness requirements
- Regionally available
- Suitable for stabilization

Cons of Method:

- May approach costs of imported gravels
- Barge hauling and multiple handling still required
- Loss of material in handling may be higher due to similar appearance to local silts

Costs of Materials and Installation:

- Bethel sand borrow costs estimated at $8 per cubic yard at Bethel dock
- Barging and placement costs vary with site

12.4.5 Surfacing With Pre-cast Or Pre-Formed Products

The expedient airfield surfacing programs of the U.S. Army and Air Force have developed, tested and used almost every conceivable type of "landing mats" over the past 60 years, and development and testing continues to this day at the Waterways Experiment Station of the Corps of Engineers. The latest and best products seen during a visit in August of 2003 were a 3/4-inch-thick custom fabricated fiberglass mat system and the commercially available 4.25-inch-thick Dura-Base™ (www.composite-tech.com) composite HDPE panels. These panels, available in full (8-foot by 4-foot) and half panel sizes, weigh 1,050 pounds for the full panels, and have a net surface area of 90 square feet (see Photo 16). This product appears able to support multiple loaded truck passes when placed over silt or clay soils with CBR strengths as low as one to two, similar to the organic silt soils in newly constructed embankments observed in this study of the Y-K Delta airports. In use, the mats are interlocked by twist pin locks but are removable, repairable and easily placed by use of backhoe or loader (see Photo 17). However, costs are high, and these products have not been tested for friction levels, or under aircraft landing and braking forces. As re-useable panels, they may have uses for barge landings or temporary access roads.

Photo 16
Photo of Durabase™ mats showing overlap and twist pin locks.

Photo 17
Durabase™ used as access road on soft, saturated soils.

Russian experience often involves the use of pre-cast concrete panels to form runway surfaces. Such panels can also be placed directly on soft foundations or embankment soils. In Russia such panels are mass-produced in various sizes (Appendix A). Panels are 2 meters by 6 meters (6.5 feet by 19.6 feet) in size, with thicknesses of 14 to 25 centimeters (cm) (5.5 to 10 inches). Weights would range from 4.5 to 8.5 tons each. They are factory made, and trucked, rail shipped or shipped to the sites for installation. Barge shipment of such panels would be needed in Alaska, probably from a casting plant in Anchorage. Pre-cast surfacings may allow single phase airfield construction with wet silt embankment soils.

Pros of Method:

- Rapid placement over existing embankment soils
- Less thickness and weight to haul to site than importing gravels
- Reusable; can be used for temporary haul roads and barge landing areas
- Can be lifted for leveling of foundation soils
- Mat surfaces do not blow or get graded away as do gravel surfacings
- Compatible with shallow layers of plastic foam insulation
- Quantities are easily measured for payment

Cons of Method:

- Dura-Base mats are expensive unless re-used for temporary work sites
- Concrete panels would require a new design and casting
- Leveling operations are labor intensive

Costs of Materials and Installation:

- Dura-Base 8-foot-by-14-foot panels F.O.B. Anchorage costs: $1,950/panel ($200/cubic yard)
- Dura-Base for full 3,300-foot-by-75-foot runway surface = $5-6 million plus placement
- Pre-cast concrete panel costs: undetermined

12.4.6 Reinforced And Fabric-Separated Aggregate Surfacing Layers

Geosynthetic reinforced gravel layers might be used to reduce the total required gravel thickness. The structurally critical time is often the time of placement. The desired performance is that of preventing pumping and upwelling of the silt foundation soils and allowing equipment to haul, place, compact and grade the surface gravel layers. The stresses created in the wet silt embankments by heavy equipment will often cause some partial liquefaction and the entire embankment will deflect like a mattress. Embankment strength recovery will occur over days or weeks as excess pore pressures dissipate. Generally, if the gravel layers can be placed properly they will provide a form of surcharge and the underlying silts will consolidate further over time, resulting a more stable embankment following the end of construction.

Geosynthetic separation layers may, over time, reduce the intrusion and mixing of silt into the valuable gravel surfacing layer, and are primarily needed during the spring thaw period. However, placing a too-thin layer of gravel over the geotextile can lead to problems as the gravel layer wears or is graded away during plowing and leveling operations. Geotextiles suitable for this purpose will be the heavy non-woven fabrics. Thinner fabrics which have the openings plugged with fines can actually restrict drainage and increase the surface softness in spring or during heavy rains.

12.4.7 Geogrid Reinforcement Layers

Extremely stiff (high modulus) synthetic grid products (geogrids) appear to be the most suitable for purposes of tensile reinforcement of granular layers, as noted above. The geogrid should be placed in a way that allows the aggregate particles to enter the grid openings and interlock with the tensile members. Some reduction in gravel thicknesses is possible with this method, and the designer should examine the latest literature and the appropriate manufacturers' recommendations before making decisions on thickness reductions. The benefits of geogrids are dependent on the strength levels of the underlying foundation or embankment soils. The Department of the Army (references 2003 and 1990) provide procedures for estimating the benefits and gravel layer thickness reductions which may be expected through use of geogrid reinforcement of granular surfacing layers. It should be noted that unless foundation soils are extremely weak (CBR 0.5-1.5), little or no reduction in granular surface thickness can be justified, based on full scale testing work. Thickness reduction benefits from studies of geosynthetics on low volume roads are not considered applicable to airfields because the ruts which form, and tension the fabrics on channelized road traffic will not occur on airfields where wheel loads are spread widely. The only airport in this study to employ a geogrid was at Eek (Photo 18).

Photo 18
Enkagrid placed in loose folds above geotextile at Eek.

Pros of Method:

- Relatively economical, lightweight and compact for shipping
- Simple placement operations
- Gravel thickness reductions may be possible

Cons of Method:

- Slows gravel placement
- May slide and deform during placement over soft soils
- Re-grading of surface may expose geosynthetics
- Cost may not be justified by performance gains

Costs of Materials and Installation:

- Bids on item available (P-681c)
- Bid price was $4 per square yard at Eek (2003)
- Eek project included separation geotextile (P-681a) below grid; total was $5.90 per square yard
- Eek costs for geogrid and separation geotextile were equivalent to added 2.3 inches of crushed gravel

12.4.8 Geotextiles For Separation Of Soil And Aggregate

Separation geotextiles are one of the oldest uses of geosynthetics, and are designed simply to avoid mixing between layers—a particular problem when very expensive imported gravels are placed directly on soft soils. Crushed surfacing gravels used on Y-K Delta airports will cost from $80 to $100 per cubic yard. When mixed with silt, gravels become soft during rains, and subject to water gain from frost action which causes springtime thaw weakening. Protection of the investment in gravel at remote airports appears to be a wise idea. However, where a sand subbase layer is used between the silt and the gravel surface, such mixing concerns are minimized. Where very thin gravel layers (thickness is less than 8 inches), the use of a separation layer will often result in the surface exposure of that layer at some later time. Adequate cover thickness must be used to provide for future gravel losses and re-grading of gravel to fill sags and dips. Photo 19 illustrates exposed geotextile along a roadway leading to the new airport construction site.

Photo 19
Chevak roadway with exposed geotextile.

<u>Pros of Method:</u>

- Should preserve investment in gravels
- Economical and simple installation
- Products easily shipped
- Allows simple thickness measurements for thickness of gravel surface layer.

Cons of Method:

- Fabric may plug with fines and restrict drainage
- May become unsightly if exposed at surface

Costs of Materials and Installation:

- Costs available from contract bids: (Item P-681a)
- Average bid price was $2.30 per square yard (five projects)
- Cost equivalent to one inch of added gravel surfacing

12.4.9 Dust Control Agents

Use of dust control agents applied to or mixed into the final aggregate surface layer is an application not often used on airfields, but which may have significant value for preserving the investment in gravels. Each cloud of dust which arises from aircraft taxiing and takeoff represents a loss of fines from the gravel. Rock particles slowly break down into fines over time, accelerated by various things such as grading and plowing, wheel loadings and frost action. Gravel devoid of fines is unstable and subject to being tossed off by snow plowing operations. In addition to preventing the loss of the gravel layer, dust control provides a healthier environment by reducing respiratory problems and also reduces wear on aircraft engines. For these reasons the Denali Commission (www.denali.gov) recently announced a major dust control program for six Alaskan villages in the Bering Straits Region, with the project (A-2002-10) funded at $500,000. The closest of the six included communities to the Y-K Delta was Unalakleet, located about 95 miles north of the Yukon Delta. Reports on that work were not available at this time.

Products commonly used for dust control, such as sodium, calcium or magnesium chlorides (Reckard,1988) may not be suitable for airfields due to their corrosion potentials on aircraft parts. However, stabilizers such as those derived from papermill waste products, termed lignins from their contents of lignin sulfites, sulfates or sulfonates, would be more acceptable. Asphalt based products may be the most effective and durable under wet conditions. Combinations of lignins and asphalt products have been developed and used extensively in Canada. The various heavy or waste oils commonly used in the past may be no longer considered environmentally acceptable, although vegetable oils still have merit. Bentonite clays have also been applied as binders for dust control in Alaska. For a full treatment of the many product alternatives, the reader is directed to the dust control manual published by the U.S. Dept. of Agriculture (Bolander & Yamada, 1999).

Pros of Method:

- Controlling dust conserves the valuable aggregate surface layer
- Respiratory problems are reduced in adjacent communities
- Visibility is improved
- Aircraft parts wear is reduced

Cons of Method:

- Annual or biennial treatments often required
- Wet weather surface softness can be increased
- Some products create messy residues on equipment

Costs of Materials and Installation:

- Product costs vary greatly with product chosen
- Application requires distributor and mixing by grader-scarifier or tiller, followed by compaction by rollers or equipment routing

SECTION 13 - RECOMMENDATIONS FOR DESIGN PHASE IMPROVEMENTS

13.1 GEOTECHNICAL STUDIES FOR NEW AIRFIELD LOCATIONS

The geotechnical field investigation approach used for essentially all of airfields and borrow sites examined in this study involved wintertime operations with small transportable drill equipment to recover soil samples, which were then shipped to laboratories for testing. Occasional use was made of toothed Shelby tubes or core barrels to recover undisturbed samples of permafrost soils. While winter operations permit easy access to sites without damage to the tundra surface, investigations during the thawing season will simplify the mapping of permafrost boundaries. Drilling and sampling in winter may be the most expensive means of obtaining field data due to generally lower productivity caused by extreme cold, reduced daylight and drifting snow.

During this review, there was no apparent use of geophysical exploration tools which might more easily and cheaply delineate permafrost area boundaries and differing soil conditions, thereby minimize the required number of borings and samples. There was also minimal use during the thawing seasons of lightweight mechanized or manual probing equipment (Esch, 1982) which could better define the thawed versus frozen states and the strength properties of foundation and borrow site soils. Finally, there was a conspicuous lack of information on the properties of previously constructed or Phase I embankments with regard to equilibrium moisture contents, densities, strength properties and internal water tables.

The strength properties of previously constructed embankments can be determined by dynamic cone penetrometer (DCP) testing or by vane shear testing. No records were found to indicate that any such testing had ever been done.

13.1.1 Recommendations

- Field studies should consider use of geotechnical methods such as non-contact resistivity and ground penetrating radar.
- Thawing season investigations using portable probe systems should have a place in field studies of permafrost presence and boundaries.
- Sufficient soils data should be obtained from the uppermost 8 to 10 feet of permafrost soils to predict the amount of thaw related settlement which could occur upon thawing.
- Data should be obtained by investigations of typical existing embankments to indicate the magnitudes and rates of settlement and frost heaving, the progression of water content changes and drainage of internal water over time, and the internal water tables and changes throughout the thawing season.

13.2 PHASE CONSTRUCTED EMBANKMENT DESIGN

To determine the ability of phase-constructed silt embankments to support pavement structures, field monitoring programs should be established which measure the changes in moisture contents and strength levels over time, both during the course of the thawing seasons and from year to year. No data could be found to demonstrate the rate of drainage and strength gains over time. Without some measurements of subgrade strength in both spring and summer, it is not possible to rationally design the structural layers needed to support wheel loadings. Use of a field strength indicator test such as the manually operated

dynamic cone penetrometer (DCP) test or the more mechanized static cone penetration or vane shear tests would provide the needed data for design purposes, while water content and static water level measurements are required for evaluating the potential benefits of installing drainage layers or drainage systems.

13.2.1 Recommendations

- Investigate and monitor water levels and moisture content changes over time within several typical silt embankments, both on first phase embankments awaiting completion and on operational airfields.

- Determine the soil strength levels by field cone penetration tests.

- Design overlays and geosynthetic layer reinforcement on the basis of CBR values derived from field cone penetration testing of embankments.

- Utilize CBR based airfield pavement design charts such as those developed by the Department of the Army (TM5-822-12; 1990).

13.3 PHASED CONSTRUCTION ELIMINATION

Large savings could be achieved by avoiding the need to construct Delta airfields in two phases. Simply avoiding the costs of two mobilizations, the costs of twice arranging local offices, laboratories, housing and transportation, and all of the doubled geology, design, advertising, construction supervision and related costs would result in estimated savings of one to two million dollars per airfield. This money could be better used to build projects in one stage by reducing the silt embankment layer thickness, and applying the savings to pay the costs for an additional 1.5 to 3 feet of gravel fill. Importation of more sand subbase to replace some of this gravel would be even more cost effective. Layered structures with a gravel or sand drainage layer placed first and thinner silt inter-layers placed above will provide more stability and faster drainage, which should allow single- project construction operations.

Sites for airfield construction over ice rich permafrost soils would benefit from initial stripping of vegetation to pre-thaw the foundation soils and eliminate some or most of the long term thaw related settlement. This could be done under small contracts at relatively low cost, with equipment hauled by self propelled barges with front loading ramps. Phasing construction in this way would also avoid the huge costs of the normal two-phase project where embankments are built to grade and allowed several years to stabilize. Pre-thawing would avoid the problems of the first summer after embankment construction, where thawing of underlying wet material creates an underlying saturated layer resulting in extreme weakening.

The use of insulation layers and possibly also of inclined thermosyphons should be considered where deeper ice-rich soil deposits will result in severe long term thaw settlement problems. There is a consensus among scientists that Alaska's climate will continue to warm significantly in this century. This will result in long term settlement problems for those airfields founded on ice rich permafrost.

13.3.1 Recommendations

- Pre-thawing of permafrost foundation soils should be done by preliminary stripping of organics and allowing one or more years of thawing prior to embankment construction. Good site drainage is needed to achieve a net benefit.

- Alternatives to building high embankments of wet or frozen organic silts which require multiple contracts for completion of work should be utilized.

- Construction of embankments and completion of all work under one contract may be accomplished by use of thicker subbase and gravel surfacing layers.

- Increasing the thickness of the crushed gravel surface layer will prevent future maintenance problems, since irregular settlements and re-grading of the surface to correct them can reduce the surface layer thicknesses below the required minimums.

- Before rational increases in the specified thicknesses of surfacing gravel layers can be justified, data is needed on the magnitudes of differential settlement along existing runways. The changes in gravel overlay thicknesses which have occurred over time as the gravel surface is periodically re-graded to re-level the airfield, would provide information on the most cost-effective gravel surface thickness.

13.4 NEW CONSTRUCTION TIMING SPECIFICATIONS

Excavation and placement of the usually saturated or frozen silt borrow materials used for embankment construction often dictates that excavation and placement be done in late fall or winter. By this time of year, haul routes become frozen and stable and water inflow into borrow pits is minimized. Embankments also freeze and become temporarily stable, but compaction of soils which are actively freezing or frozen is difficult. Snow and ice inclusion with the embankment soils is an additional problem. Embankments placed under such conditions do not achieve adequate density. They are therefore not resistant to the inflow of springtime melt water, and probably gain significant additional amounts of water at that time.

This construction timing approach therefore may extend the embankment drainage and stabilization times by one or more years. Alternatives for restricting placement operations to thawing season only conditions should be explored.

13.4.1 Recommendations

- Review specifications and procedures to explore the potential for requiring placement and compaction of silt soils under thawing conditions.

- Specify use of imported gravel or sand for a stable initial drainage layer at the bottom of silt fills.

- Require placement and compaction of silts in layers not to exceed 1 foot in thickness, with gravel interlayers at no more than 2-foot intervals.

- Require capping of all silt embankments with a minimum of 1-foot-thickness of gravel prior to springtime thawing.

13.5 MAINTENANCE COST REDUCTION

The most expensive operation in extending the life of airfield embankments is that of importing additional gravels for resurfacing of runways and repairing erosion problems under a future contract. Surface gravel thicknesses will be reduced over time due to wind erosion, loss of materials from snow plowing and grading operations, and the heavy re-grading needed to fill dips and sags which occur from permafrost thaw and settlement, and from erosion by water.

13.5.1 Recommendations

- Surface layer thicknesses should be increased to provide the added materials needed to offset these future losses. Small stockpiles of gravel should be included in the original contract to provide material for future re-leveling of settlement areas.

SECTION 14 - RECOMMENDED NEW DESIGN AND CONSTRUCTION TECHNIQUES

14.1 INNOVATIVE FEATURES FOR IMPROVING EMBANKMENT STABILITY

Many innovative features have been presented and discussed above. Internal drainage of silty embankment soils to remove excess water and increase consolidation pressures may be very helpful, provided that internal embankment water tables are high enough to justify drains…a condition which must first be verified by actual monitoring of typical embankments. Of those discussed, the features considered to hold the most promise of improving embankment stability, listed in their order of expected benefit, include the following:

1. Rock layers for creating the convection cooled embankment condition (will also enhance ground cooling to preserve permafrost)

2. Internal drainage by use of geocomposite drains (sheet drains) or conventional subdrains installed below the water table at the base of embankments, leading to lower level external discharge points or to sumps equipped with pumping systems.

3. Use of geosynthetic composite drainage layers placed at an intermediate level in the silt embankment to serve as a capillary cutoff, allowing downward drainage of water but preventing upward flow by capillary action.

14.1.1 Recommendations

- Evaluate the economics and problems of importing crushed rock sorted to the 4- to 8-inch or 6- to 10-inch size ranges to install a 2.5-foot-thick layer in the core of a new embankment. This will provide a strong structure requiring minimal compaction and providing a cooling effect to preserve the frozen state of permafrost foundation soils. If favorable, design at least a portion of an embankment for experimental construction with this treatment.

- Design and specify embankment sections which incorporate geosynthetic drainage and capillary cutoff layers, to increase the rate of drainage and reduce frost heaving of embankments.

14.2 ACHIEVABLE SOIL COMPACTION ACCEPTANCE PROCEDURES

Standard FAA design procedures and specifications rely on strict moisture and density control for acceptance of pavement structure layers. Fortunately the specifications allow for alternative acceptance procedures. For many of the Y-K Delta airports, compaction of embankment soils to the specified density levels is not possible due to their high retained moisture contents and the lack of summertime drying under normal weather conditions. Also, the elastic nature of the embankment often makes compaction to specifications of the commonly used thin gravel overlays an impossible task.

14.2.1 Recommendations

- Compaction specifications should be of the either/or type, where a method of rolling, number of passes and coverage are specified, but the contractor is allowed to use other less costly procedures if he achieves the specified densities.

- Density testing with nuclear gauges using a regulated source has become standard practice. However the costs and difficulty of transporting the equipment dictate that for remote projects such as these, simpler methods such as the sand cone or balloon test should be utilized for measurement of densities.

14.3 EROSION CONTROL IMPROVEMENTS IN METHODS AND MATERIALS

During field visits to selected airports under this study, several types of erosion attack on embankments were noted. Because of the common use of extremely erodible silts and fine sands to construct embankments, any flow of water directed down or along the unprotected surfaces quickly erodes these materials (see Photo 20). Wind erosion also attacks embankments built of fine sands, which may lack the silty or clayey fines needed to support growth of vegetation. Erosion of soils under and around culverts is a particularly severe problem, which often leads to the total failure of such installations. Proposed solution to erosion problems are as follows.

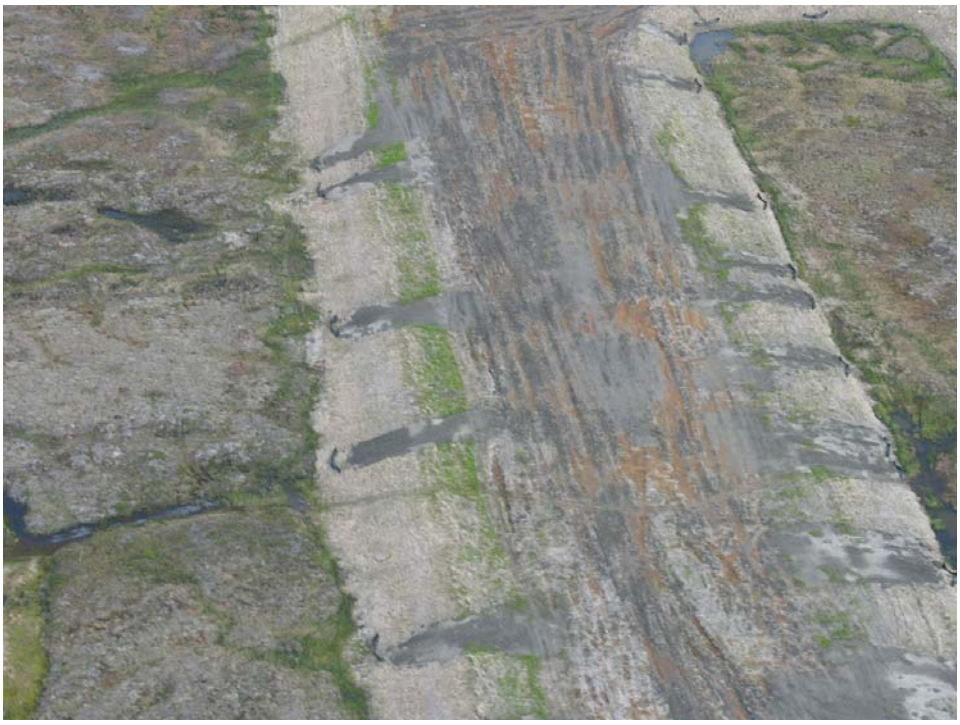


Photo 20
Erosion gullies developed along the slopes of the embankment at Eek
were repaired with additional fill.

14.3.1 Slope Erosion Prevention

Prevention of flow concentrations from water ponding on top of Phase constructed embankments could only be achieved by periodic re-grading of the top of the embankment to fill settlement areas, thereby causing more uniform runoff and avoiding flow concentrations. Building and completing embankments under one project, with adequate gravel thickness on the top surface to allow correction of settlement problems by periodic re-grading, would prevent most such erosion problems. Adequate seeding, mulching and fertilizing of side slopes is a necessary companion step to provide erosion resistance. Where

available, use of slope coverings of topsoil, peat and organic matter from preliminary site stripping will provide additional slope protection. Use of one of the nondegradable geosynthetic rolled erosion control products (RECPs), in combination with seeding, is recommended for severe erosion problem sites. Areas under wave attack or subjected to lateral flows may require sand bag, rock or concrete armor, best designed by an experienced hydrologist.

Recommendations:

- Where possible, cap embankments immediately after construction with sufficient gravel and sufficient crown to prevent rutting and ponding of water which leads to runoff concentrations.

- Re-grade embankment top as needed to fill dips and avoid ruts and ponding which can concentrate runoff.

- Use locally available topsoil, peat and mosses as slope coverings if available from site stripping operations.

- Apply erosion control products and seed to slopes and adjacent shoulder areas to reinforce root system of grasses.

- For more severe erosion areas apply geotextile to slopes and cover with layer of gravel or rock as directed by hydrologist.

14.3.2 Wind Erosion Problems

Certain sites such as Chevak, Bethel and Hooper Bay have locally available fine sands which dry out and become subject to wind erosion (see Photo 21). Lack of silt or clay fines in these sands can lead to failure of the slope seeding. The simplest approach would be to apply topsoil or products from site stripping operations to cover the slopes. Where such products are not locally available, soil stabilizers such as the sodium silicates or various proprietary sand stabilizers should be considered for slope treatments. Organic mats which retain moisture and resist erosion should also be considered. As an alternate, slope coverings of imported gravels applied over appropriate geotextiles, or geoweb products, may be used.

Photo 21
Wind erosion of sand embankment at Chevak.

Recommendations:

- Apply topsoil or organic layer stripping products such as peat and moss as slope coverings, followed by seeding and mulch.
- Apply soil stabilizers to bind sands against erosion.
- Install organic mats (rolled erosion control products)
- Install geotextile over slopes with a covering of gravel.
- Install geoweb cellular products to retain sand and seed.

14.3.3 Culvert Failures From Erosion

Culverts bedded in and backfilled with silts or fine sands are almost guaranteed to fail by erosion due to water flow and erosion around and beneath the pipe (see Photo 22). Some positive means of cutting off water flow around the pipe must be used, at least at both ends but preferably along the entire length. The conventional solution is to bed and backfill at least the lower half of all culverts with compacted gravel. Other methods, such as of creating cutoff walls to direct all flows into the pipe may also have merit. Differential settlement can also lead to failures at pipe joints.

Photo 22
Sinkhole from culvert failure at Kipnuk.

Recommendations:

- Require that all culvert pipes be bedded and backfilled to at least mid height in properly compacted gravel or well graded coarse to medium sand.
- Provide riprap aprons at entry and exit points to prevent scour holes.

14.4 REDUCTION OF MATERIAL QUANTITIES

Many of the embankments examined appear to be excessively thick. It is recognized that the height may be dictated by the need to avoid occasional flooding, or to reduce snow drifting problems. However, where this is not a problem, thinner and more economical embankments should be used. Simply mounding up tall embankments of local silts does nothing for structural support values, and may simply delay the drainage and stabilization times. Thinner but structurally and thermally adequate fills could be created by first pre-thawing ice rich permafrost soils for one to two years to minimize long term settlements, and applying a rock fill of 2.5 to 3 feet in thickness, topped by 1 foot of gravel surfacing. No silt borrow excavation would be required by this method. Where a taller embankment is dictated by water levels, imported sands or the thinnest possible silt borrow layer should be used. Gravel surface layers

could also be replaced by thinner, pre-cast concrete panels placed over the central landing portion of the embankment as is commonly done in Russian practice.

Recommendations:

- Consider reducing embankment heights and related quantities of fill materials with prethawing of ice-rich permafrost foundation soils by use of preliminary stripping of the organic layer, followed by one to two seasons of thawing before embankment placement.

- Obtain adequate thermal resistances and thaw depths beneath thinner runway embankments by use of polystyrene insulation layers placed between 18-inch sand bedding layers, and covered by a 12-inch gravel surface layer. The sand and insulation layers should be placed at the start of the thawing season to avoid deformations from thawed foundation soils

- Utilize thermal and structural layer modeling to design the final layer thicknesses, and provide additional gravel thicknesses to allow for future leveling operations if climatic warming accelerates thawing of subsurface excess ice deposits

SECTION 15 - IMPLEMENTATION ACTIONS – EXPERIMENTAL FIELD TRIALS

The above section on alternative designs suggests many new methods and products to be evaluated. Of these, the following three approaches are suggested as potentially the most cost effective and easy to evaluate and implement:

15.1 GEOSYNTHETIC DRAINAGE PRODUCT APPLICATIONS

Evaluation of geonets, sheet drains and edge drain products for reducing the moisture contents and frost heaving magnitudes of silt embankments should be done by field installations in selected portions of a newly constructed silt embankments, followed by monitoring of static water levels, frost heaving, settlement, and water contents over a period of several years. Such a study is needed to determine the benefits of subsurface geonet drains or capillary cutoff layers in draining and stabilizing silt fills.

15.2 AIR COOLED EMBANKMENT SECTIONS

A significant section of a new or extended airfield embankment should be built using a 2.5- to 3.0-foot-thick layer of open graded rock, selected to be from 6 to 10 inches in size. It will allow an evaluation of the air cooling and structural benefits of the ACE concept. This study will require installation of ground temperature monitoring equipment and settlement plates. It will also allow evaluation of the handling properties and costs of using such large rock, which may require different barge loading and unloading operations.

15.3 PERIODIC COMPACTION BY VIBRATION

According to reports of how embankments were once stabilized, periodic light compaction and surface re-grading should prove useful in increasing the density and stability of silt embankment soils. However, no program of periodic testing to measure the results was apparently ever conducted. To demonstrate the benefits of this approach, one or more embankments from Phase 1 construction should be periodically compacted, and measurements of density, water content and strength should be constructed to optimize the method.

SECTION 16 - RECOMMENDED FUTURE RESEARCH

Several of the alternative design and construction methods and products discussed in Section 12 (above) will require further research before plans can be made to implement them in actual construction projects. Probably the most pressing research need is to identify the drainage potentials and strength versus moisture content relationships of the organic silt soils common to the Y-K Delta. Also, two of the most promising methods of improving embankment performance, which must receive laboratory or field testing and evaluation before specifying their inclusion in actual projects, are discussed below:

16.1 DETERMINATION OF THE ENGINEERING PROPERTIES OF SILT SOILS

Evaluation of existing and new embankments over time is needed to measure the rates of drainage of excess water by evaporation and by vertical and lateral drainage. The presence of internal water levels inside the embankments would also need to be monitored to see the influence of rain infiltration, spring melt water effects, etc. Without such information, the design for and the benefits of installing drainage systems cannot be evaluated. Also, water is probably moving up and down in such embankments throughout the year as frost action draws it up in winter and gravity pulls it down in summer. Whether water removal from wet silt embankments overlying bogs or impermeable permafrost foundations occurs primarily by lateral drainage or by surface evaporation and transpiration from vegetation will remain unknowns unless such research is done. Whether seeding of the tops of Phase I embankments aids or hinders the drying process is still another unknown to be solved by research.

16.2 STABILIZATION OF SILT SOILS WITH SODIUM SILICATES

According to the Russian Dalaeroproject report in Appendix A, use of sodium silicates (waterglass) should provide satisfactory stabilization of silty soils. Since this product has never been used in studies of stabilizers for Y-K Delta silts, and since the reactions of sodium silicate are enhanced by addition of various other chemical products, a laboratory study should be done to measure the required contents and the benefits of this type of soil stabilizer in reducing or preventing frost heave and in strengthening wet and slightly organic silt soils. Cost estimates for field use can also only be made after determining the contents and methods of treating and curing such stabilized soils. The obvious applications to road embankments would justify use of Highway Research Program funds to perform this work.

16.3 BENEFITS OF PRE-THAWING Y-K DELTA SOILS

Field trials of the effects of surface organic layer stripping and subsequent vegetation control have been done in the Fairbanks area of Alaska, but the favorable results of those tests cannot be directly applied to the Y-K Delta due to the differing soil and climatic conditions. One or two permafrost sites should be selected, stripped of their organic layer coverings prior to the thawing season, and evaluated for a period of three years to observe the changes in thaw depths, moisture contents and settlement magnitudes. This data can then be used to predict the benefits of prethawing at other Delta area sites.

16.4 SURFACE GRAVEL THICKNESS CHANGES OVER TIME

To determine the rates of gravel loss over time from existing runways, measurement of gravel layer thickness along selected older runways should be made by use of ground-penetrating radar, or possibly by a series of many small test pits. This data would provide guidance on the initial thicknesses needed to provide long-term service.

SECTION 17 - AIRPORT CONSTRUCTION CYCLE COSTING – PROJECT PHASES

The following list of stages and tasks in the life of a typical Y-K Delta airfield is provided to guide the reader through the many stages of developing, constructing, operating and rehabilitating such airports. Because of the many possible long-term outcomes and possible future changes, determining a common "airport life cycle" is not considered practical at this time. This report has therefore focused on ways of reducing the "construction cycle costs" and of extending the life of airfield embankments.

1. Planning: Airport extension to 3,300 feet or selected for relocation to new site.

2. Preliminary cost estimate by Design Section.

3. Funding source and budget set by FAA and ADOT&PF.

4. Site selection process based on input from: Geology Materials Section; Design Section and Construction Section; Planning Section and Environmental Section; Community/Village/Regional Corporation.

5. Alternative sites investigated by Geology Section.
Borrow sites investigated by Geology Section.
- Consultants used for some field studies.
- Field boring and sampling and lab testing costs.

6. Design alternatives and special features are analyzed by Materials and Geology Sections; included in Materials Report.

7. EA or EIS drafted, reviewed, approved and published.

8. Design Section develops Plans, Specifications and Estimate of Costs (PS&E). Phased construction often used.

9. Funds programmed as needed for construction.

10. Phase I contract advertised: Contractors investigate site and borrow sources, with field visits and investigations as required to submit bids.

11. First contract awarded.

12. Equipment and materials mobilized to site.

13. Embankment materials placed and shaped. May be from frozen or thawed borrow sites.

14. Contract completed for Phase I. Equipment demobilized from site.

15. Waiting period for embankment stabilization (wait) (variable).

16. Schedule approved for completion of work.

17. Materials evaluates surfacing course requirements.

18. Design prepares PS&E for Phase II contracts.

19. Phase II contract advertised.

20. Contractors prepare bids and submit.

21. Second contract awarded.

22. Equipment mobilized to site – controlled by barge access.

23. Contract executed as timing allows.

24. Equipment demobilized – timing controlled by barge access.

25. Airport opened to traffic; dust problems result in some loss of surfacing.

26. Maintenance work commences by contract/grants to Village/City for grading and snow removal.

27. Embankment thaw weakens in springtime causing closures to traffic.

28. Embankment settles due to thawing of permafrost, requiring re-grading from surfaces surrounding dips.

29. Gravel loss requires new contract to import additional gravel and/or added embankment height due to thaw-settlement from underlying permafrost thaw. Slope repairs also required.

30. Village growth creates demand for longer airfield and added pavement structure thickness to accommodate larger aircraft and loadings.

31. Paving of airfield required to reduce dust and damage to aircraft from loose surface materials, and to allow use of jets.

32. Periodic re-paving of airfield required, with upgrading of lighting systems, etc.

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APPENDIX A

RUSSIAN MINISTRY OF TRANSPORT'S STATE SERVICE OF CIVIL AVIATION
State Unitary Subsidiary Enterprise
State Design and Research Institute of Civil Aviation
DALAEROPROJECT

Design and Construction of Airfields in Northern Regions of Russia

Khabarovsk
2003

RUSSIAN MINISTRY OF TRANSPORT'S STATE SERVICE OF CIVIL AVIATION
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1. Introduction

In Russia, the airfields to be located in the areas of permafrost soils are designed and constructed based on the requirements of the normative documentation – Federal Aviation Rules (FAR), building norms and standards (the so-called SNiP, or Russian Building Code), and departmental building norms (DBN), design recommendations and manuals.

The construction of airfields in the areas of permafrost and (or) frost susceptible soils is linked to the need to provide measures for stability of the airfield structures. The cases of impermissible deformations of foundations due to settlements of permafrost soils during seasonal thaw or frost heaving with freezing followed by settlements at the time of thawing of frost susceptible soils result in the loss of stability. These deformations of soil foundations may destroy the structures or their separate elements (cracks, settlements or broken pavements, damages or inoperative lighting facilities and utilities).

The creation of required and rather stable temperature mode of base soils and special construction measures keep the stability of the structures in question during their lengthy operations. Design approaches, construction of airfields and other facilities in the areas of permafrost soils are based on the specifics of these areas, and the main characteristics of the areas are in Section 3.

2. Brief Characteristics of the Area of Construction

The area of construction is located in the central region of the State of Alaska on the shore of the Bering Sea, between the deltas of the Yukon and Kuskokwim Rivers. The area is a broad deltaic plain consisting of numerous active and inactive river channels, shallow lakes and ponds, and tundra vegetation – willow and grass.

The area is characterized by permafrost. The depth of periodic thaw of permafrost is between 2.0 and 2.5 meters (6.5-7.9 feet).

The temperature of permafrost is between 0°C and -3°C The soils primarily consisting of wet (moist) silts and fine sands are widely spread in the area. The natural moisture of soils is within the range of between 18% to 49% for sandy soils and 112% for silty organic soils and clayey silts, with organic contents between 0.7% and 11%.

Figures 1 through 6 and Tables 1 and 2 show climatic characteristics for the settlements of Emmonak and Mekoryuk, located in the northern and central parts of the area; these climatic characteristics are typical for the entire area of construction.

On the analogy of the accepted division into Road-Climatic Zones (as per normative documentation of the Russian Federation), the area is analogous to road-climatic zone I, road-climatic sub-zone 1_3, with types of terrain 2 and 3 based on the conditions of soil moisture. This classification applies to locations where soil moisture conditions are described as "moist and wet places, no surface drainage, there is a chance of oversaturation of soils in the summer time caused by surface and over-frost waters in the thawing layer of soil."

The main characteristics of soils in the frozen state and during thaw are as per Tables 1 to 3 – sand and clay-silt types of soils, the texture is between massive and layered, when frozen the soils are between low-ice to high-ice contents, the category of settlement II – V, total moisture is between 0.2 for sands and >1.1 for clay and silt soils.

Section 3 shows the scheme of zones in Russia and their main characteristics.

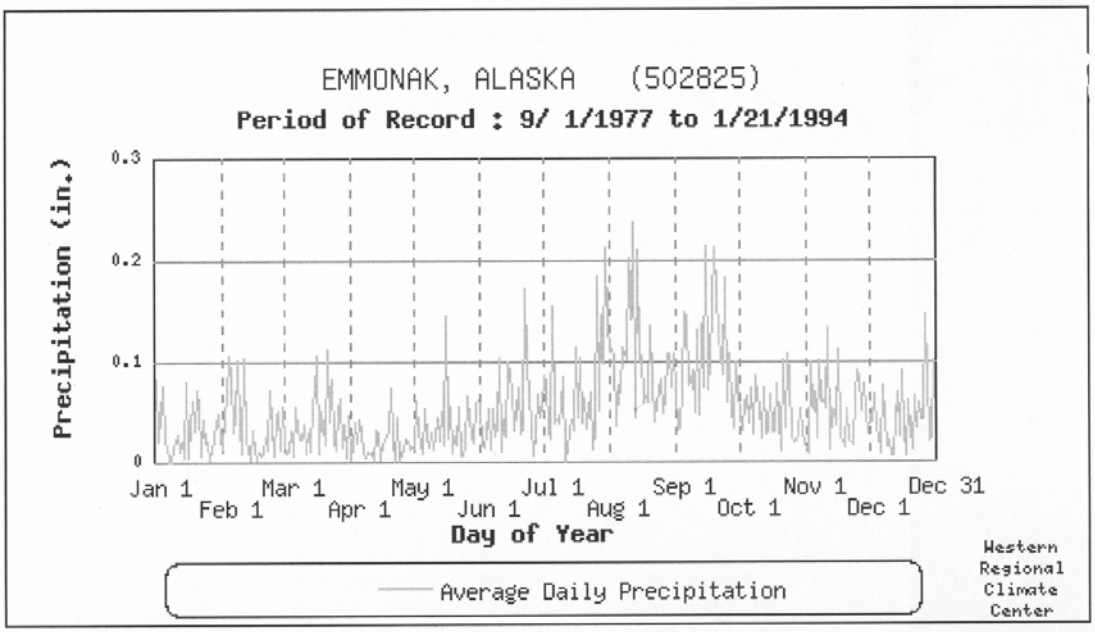
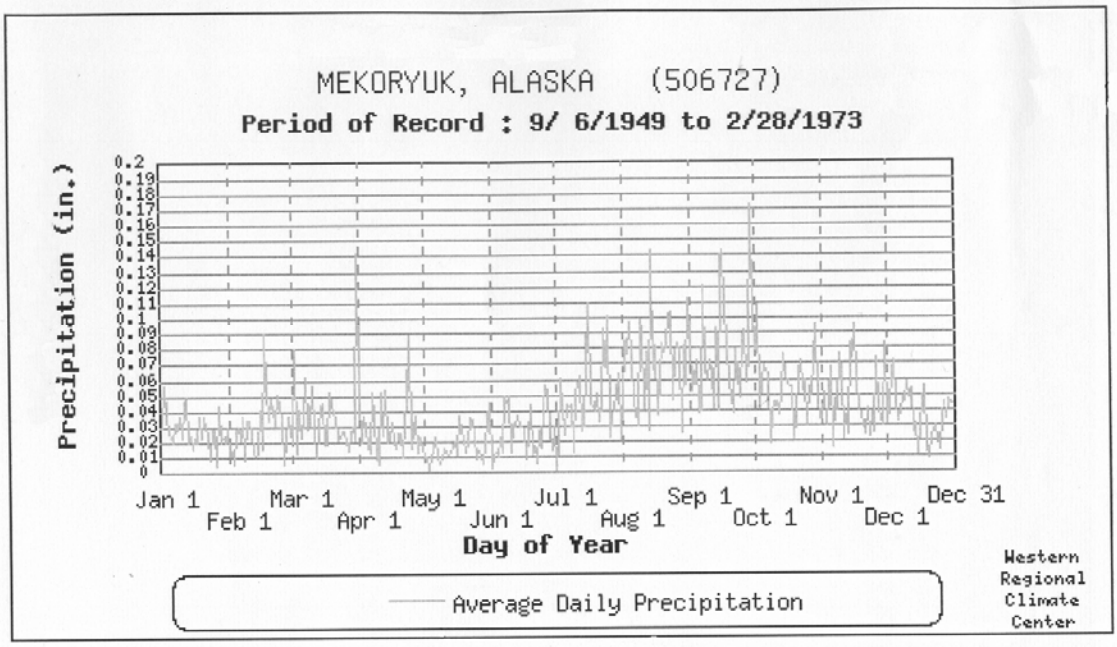


Figure 1



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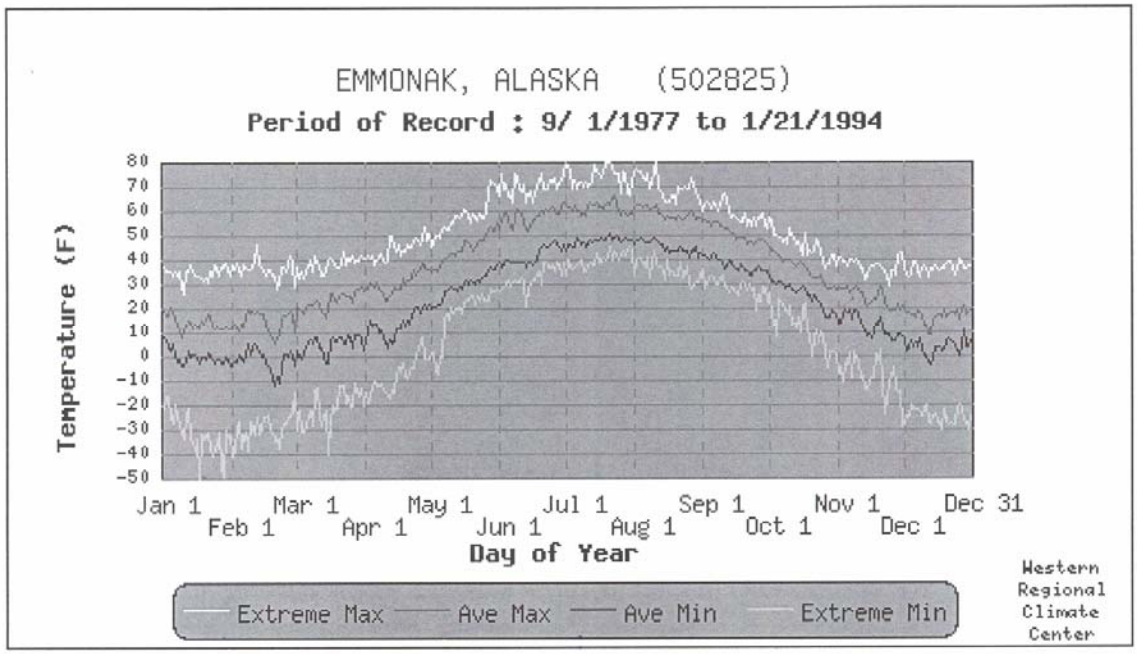

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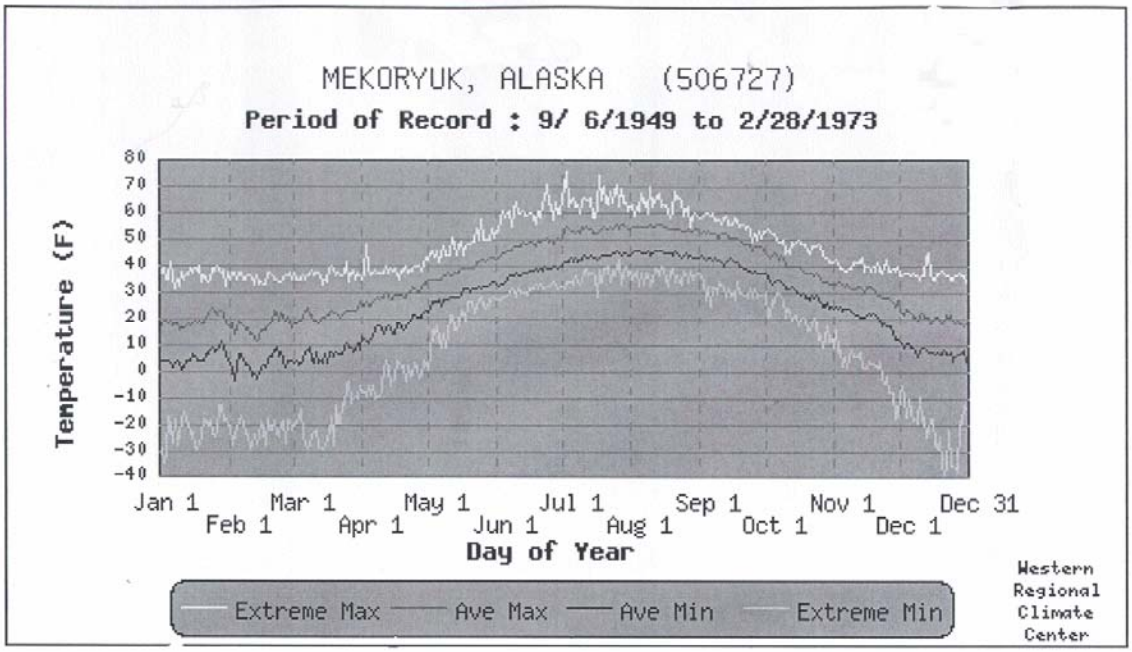

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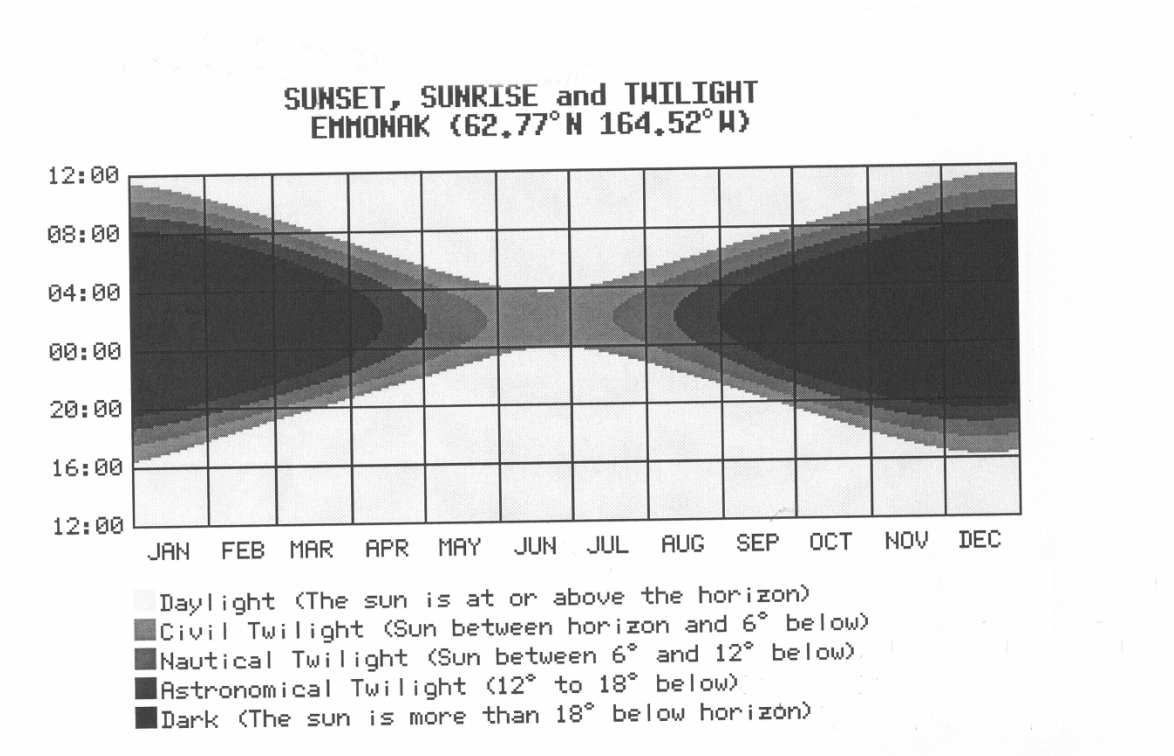

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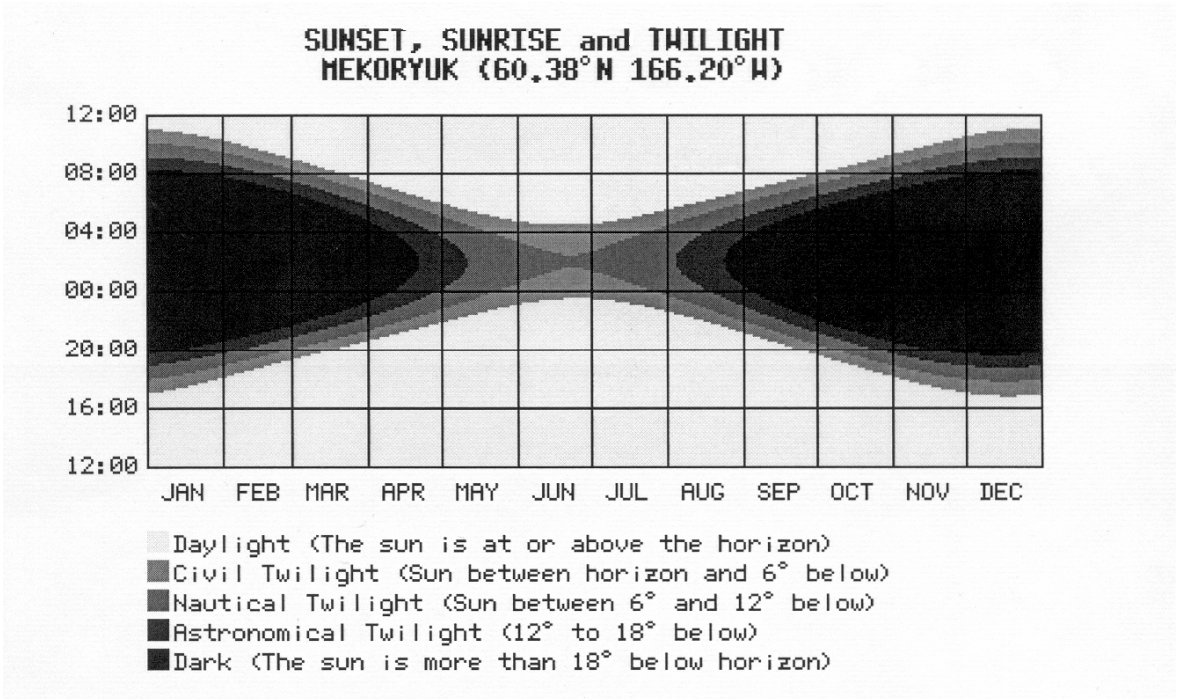

Figure 6

EMMONAK, ALASKA (502825)
Period of Record Monthly Climate Summary
Period of Record : 911/1977 to 1/21/1994

Table 1

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max, Temperature	(F)	14,9	14,3	22,9	28,9	44,3	58,5	60,7	59,3	50,7	36,0	24,5	17,2	36,0
	(C)	-9,5	-9,8	-5,1	-1,7	6,8	14,7	15,9	15,2	10,4	2,2	-4,2	-8,2	2,2
Average Min, Temperature	(F)	0,5	-1,7	4,3	11,0	29,7	41,2	47,0	45,4	37,4	24,9	12,2	4,7	21,4
	(C)	-17,5	-18,7	-15,4	-11,7	-1,3	5,1	8,3	7,4	3,0	-3,9	-11,0	-15,2	-5,9
Average Total, Precipitation (in.)		1,0	1,0	1,0	0,6	1,1	1,6	2,2	3,0	2,7	1,5	1,6	1,5	18,5
Average Total, Snowfall (in.)		10,5	7,5	9,3	3,4	1,4	0,0	0,0	0,0	0,1	5,1	16,0	12,1	65,6
Average Snow Depth (in.)		21	25	26	21	4	0	0	0	0	1	7	15	10

MEKORYUK, ALASKA (506727)
Period of Record Monthly Climate Summary
Period of Record : 9/6/1949 to 2/28/1973

Table 2

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max, Temperature	(F)	19,2	16,8	21,1	28,4	38,6	47,8	53,7	54,5	50	39	30,4	20	35
	(C)	-7,1	-8,4	-6,1	-2,0	3,7	8,8	12,1	12,5	10,0	3,9	-0,9	-6,7	1,7
Average Min, Temperature	(F)	5	2,5	6,0	16,4	29,3	37,1	43,1	44,7	40,6	30,0	20,3	7,2	23,5
	(C)	-15,0	-16,4	-14,4	-8,7	-1,5	2,8	6,2	7,1	4,8	-1,1	-6,5	-13,8	-4,7
Average Total, Precipitation (in.)		0,86	0,83	1,11	0,87	0,55	0,81	1,44	2,12	2,23	1,72	1,31	1,14	14,99
Average Total, Snowfall (in.)		0	2,9	6,8	2,6	3,1	1,7	0,0	0,0	0,7	7,4	10,7	10,0	46,0
Average Snow Depth (in.)		13	17	19	14	1	0	0	0	0	1	3	8	6

3. Road-Climatic Zoning

In normative literature the territory of the Russian Federation and the Commonwealth of the Independent States (CIS) countries is divided into five (5) Road-Climatic Zones based on climatic and geographic specifics. Figure 7 shows the location of these zones. The peculiarities of each Road-Climatic Zone are taken into account when dealing with design and technological approaches for the airports, roads and other facilities.

In the permafrost areas, classified as Road-Climatic Zone 1, there are three (3) road-climatic sub-zones based on these general features: climatic conditions, soil moisture of active (periodically thawed) layer of soils, depth of layer, method of location and temperatures of permafrost soils. Figure 8 shows the location of road-climatic sub-zones, and their main characteristics are in Table 3.

The conditions of soil moisture of base soils and frost-soil features, as shown in Table 2, dictate three (3) types of terrain for each road-climatic sub-zone, and these features are taken into consideration when developing design and technological solutions for the airfields and roads. In each type of terrain the soils of periodically thawing layer and permafrost layer have their own differences in terms of total moisture content, ice content and level of settlement when thawing, as shown in Table 3.

Characteristics of the Road-Climatic Sub-Zones

Table 3

Characteristics	Road-climatic sub-zone		
	1_1	1_2	1_3
Territories of the sub-zone. Terrain	Tundra, forest-tundra. Spotted and low-rise hills micro-terrain.	Taiga. Mountain and mountain range terrain.	Taiga, forest-steppe, steppe, coastline of the Barents Sea and the Sea of Okhotsk. Valley and downland terrain in the western part, hill and downland terrain in the eastern part.
Spread of permafrost, depth of layer, m	Solid, 100 - 500 and above	Solid, 100 - 500	Primarily insular, 25 – 200
Temperature of permafrost, °C	Between minus 1.5 - 3 and minus 12 (10 - 12 meters deep)	Between minus 1.5 - 3 and minus 7	Between 0 and minus 1.5 – 3
Depth of periodically thawing layer, m	0.4 - 2 (basically less than 1)	0.6 - 3	3
Prevailing soils	Clay, pulverescent, turf and clay	Rock, crushed stone, gravel, sand, clay	Rock, crushed stone, clay, pulverescent, turf and clay, sand in western part, crushed stone, gravel, clay – in eastern part
Average annual soil moisture content, units of moisture at the liquid limit W_T	>1	0.7 - 1	0.7 – 1

Characteristics	Road-climatic sub-zone		
	1_1	1_2	1_3
Frost processes	Frost icy peatlands in the areas of oceanic influences (north of the European part and Western Siberia, Chukotka, Kamchatka); appearances of dry, unstable and plastically frozen fine sands. High content of ices of different types at shallow depths.	Underground ices of different types, widely spread on low plains with developed thermo-karst.	Underground ices, primarily injected seasonal, and multiyear, only in river valleys.
			Sporadic thermo-karst in river valleys.
	Widely spread thermo-karst in high ice content soils, repeatedly venous and injected ices.		
Cryogenic processes	Intensive development of heaving breaks, frost spalling, solifluction, and spots.	Frost spalling, heaving icing on rivers (especially in the north-eastern part of the region)	Periodic heaving breaks, icing.

Type of Terrain Based on Moisture Conditions

Table 4

Characteristics	Type of terrain based on moisture conditions		
	1	2	3
Soil moisture content conditions	Dry places. Surface drainage; waters over permafrost do not significantly influence the moisture content of the top layers of soils.	Moist places. No surface drainage; there is a chance of oversaturation of soils in the summer time caused by surface and over-frost waters in the thawing layer of soils.	Wet places. No surface drainage; there is constant oversaturation of soils in the summer time caused by surface and over-frost waters in the thawing layer of soils.
Terrain	Rocky mounts, tufts with abrupt slopes, gravel and sand spits.	Shallow watersheds, mountains with soft slopes.	Bogs, boggy thalwegs, closed depths with bog moss and turf.
Depth of thawing layer, m	>2.5	1.0 – 2.5	<1
Type of soils	Block-in-Matrix rocks, gravel, sand, sand clay	Sand, clay, biogenic.	Clay, turf, chance of underground ices.
Soil characteristics	Massive texture, non-settling or thawed with relative moisture below $0.77W_T$	Massive and layered texture, low-icy and low-settling with relative moisture $(0.77\text{-}1)W_T$	Layered and meshy textures, icy and high-icy, settling and high-settling with relative moisture above W_T
Frost processes	Not present	Waterlogging, periodic heaving breaks	Waterlogging, multi-year heaving breaks, peatlands, thermo-karst, solifluction

Soil Characteristics

Table 5

Category of soil settling	Type of soil based on ice content and settling in periodically thawing layer and bottom permafrost layer	Relative sit at thawing and ice content as a result of ice inclusions into permafrost layer, parts per unit	Total moisture, parts per unit			
			Fine sands	Pulverescent sands, light clay sands	Sand clays, loams, clays	Peats
I	No icy contents, non-settling	0 - 0,01	<0,18	<0,20	<0,20	-
II	Low-icy, low-settling	0,01 - 0,10	0,18 - 0,25	0,20 - 0,40	0,20 - 0,40	<2
III	Icy, settling	0,10 - 0,40	>0,25	>0,40	0,40 - 1,10	2 - 12
IV	High-icy, high-settling	0,40 - 0,60	-	-	>1,10	>12
V	With large inclusions of underground ices, excessively settling	0,60 - 1,00	-	-	>1,10	>12

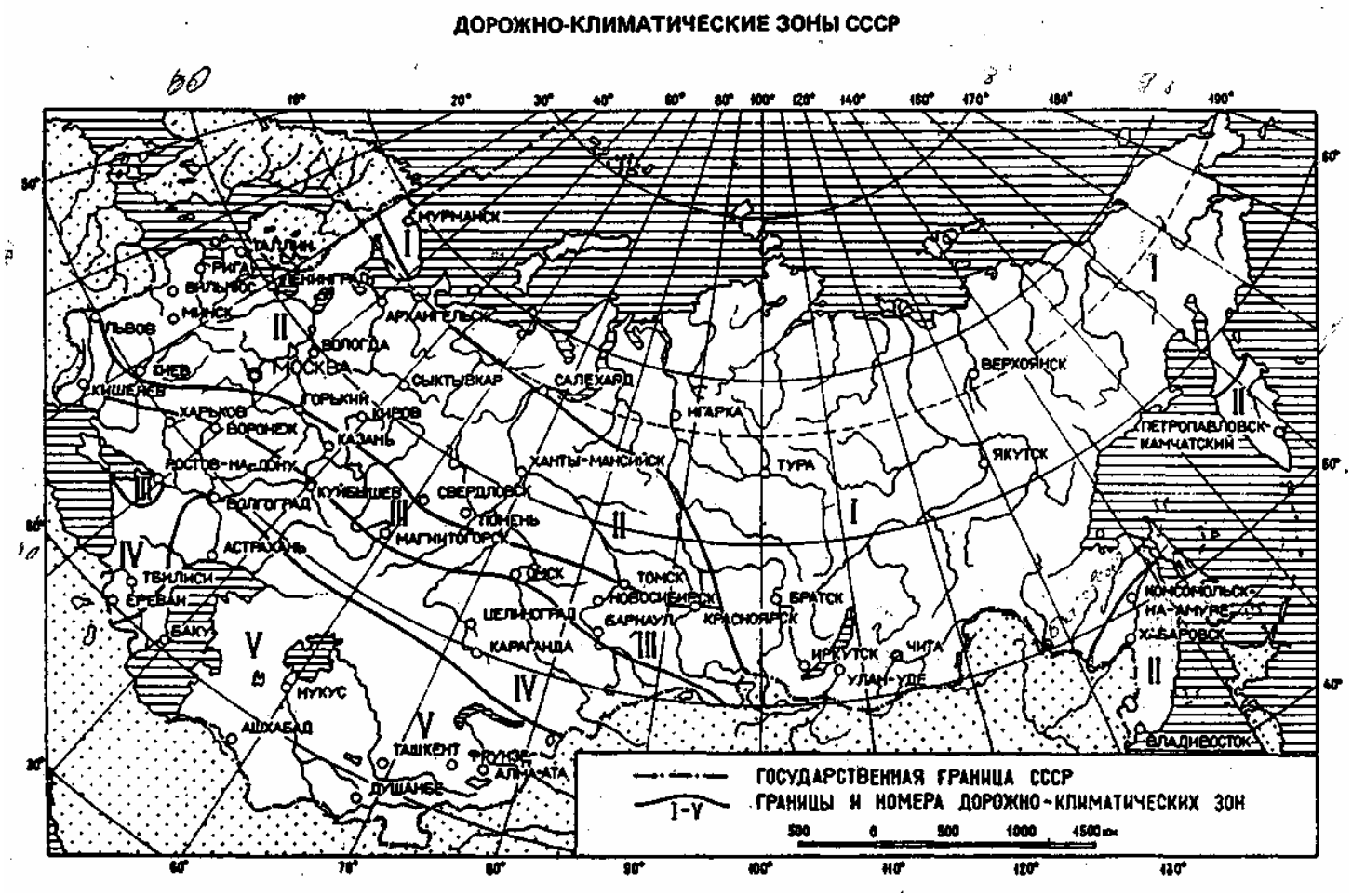

Figure 7

Road-Climatic Zones include the following geographic zones: I — tundras, forest-tundras and north-eastern part of forest zone with the presence of permafrost soils; II — forests with excessive soil moisture; III — forest-steppes with excessive soil moisture in separate years; IV — steppes with inadequate soil moisture; V — deserts and desert-steppes with dry climate and presence of salted soils.

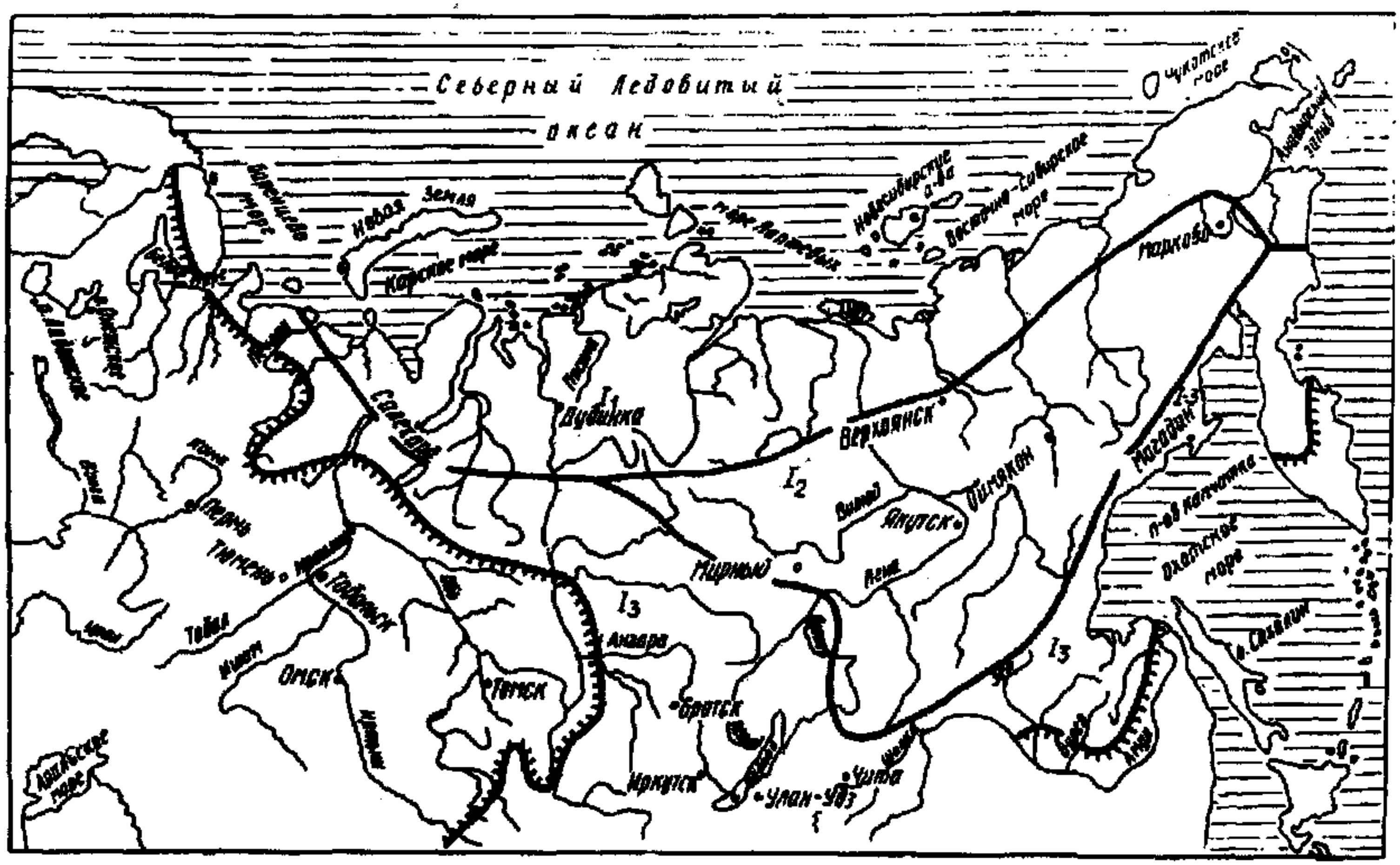

Figure 8

Schematic map of sub-zones with the presence of permafrost soils in Road-Climatic Zone I:

1_1 – northern sub-zone of low-temperature permafrost soils of solid presence; 1_2 – central sub-zone of low-temperature permafrost soils of solid presence, 1_3 – southern sub-zone of high-temperature permafrost soils of insular and partially solid presence.

4. Design and Construction of Airfields in the Areas of Permafrost

Runways and other airfield facilities, pavements, drainage and structures in the areas of permafrost are designed considering their heating and mechanical reciprocity with the soils of natural foundations, based on structural features of airfield pavements, airfield types, and engineering-geological and permafrost soil conditions of the area of construction.

When designing airfields in the areas of permafrost soils, one of the following methods of soil usage as a base airfield pavement shall be accepted.

I – permafrost soils are kept in frozen state, while soils thawing periodically to the level of airfield pavement shall be used:

a) in the frozen state during the overall period of operation of airfield pavement (**Method 1A**);
b) partially or fully thawed (**Method 1B**).

II – advance thawing of permafrost soils and removal or drying of oversaturated layers.

Methods 1A and 1B for the use of permafrost soils as a base for the airfield pavement shall be used, only if the annual temperature balance of the pavement is negative, i.e. under these conditions:

$$\sum_{i=1}^{12} t_{mp}\ \tau_i \leq 0,$$

where i - month of a year

t_{mp} – average monthly temperature °C of the pavement surface, calculated using thermotechnical calculations and based on the average monthly air temperature and average monthly solar radiation, as per requirements of the Russian SNiP (No.)

τ_i- length of month i, hours

Method 1A is applied, if natural soils of the periodically thawing layer in the thawed state do not have enough capacity or result in impermissible precipitation, whereas it is economically justified to keep the state of permafrost.

Method 1B is applied if there are soils at the base, and the deformations of these soils during periodic thaw at the design depth do not exceed the maximum permissible values for the airfields of such class/type.

Method II is applied if the annual temperature balance of the pavement is positive, and advance thawing of permafrost soils is to the level of non-settling soils during thawing.

When using base soils as per **Methods 1A** and **1B** the terrain of the airfield is graded, and the heat-insulating fill is made in such a way that the existing peat-and-moss cover is not damaged.

The longitudinal profile of runways and the height of fill shall account for the possible changes in water-and-heat mode of active layer soils and bottom permafrost soils, modes and heights of snow, and ice-thermal mode of waterways, which will likely occur as a result of development of the area and operations of building and facilities on this area and adjoining areas, creation of ditches, underground and overground utilities.

These are the main procedures providing stability of airfield structures (fills and airfield pavement) in the areas with permafrost soils:

- Design using fills;
- Fills to be made of rock, Block-In-Matrix rocks or sand soils; make use of clay soils if there is a deficiency of other types of soils;
- Use of natural and artificial heat-insulating materials for the base and body of the fill and airfield pavement;

- Use of geotextile materials for the base and body of the fill, and for the base of the airfield pavement;
- Replacement of oversaturated soils of the active layer and bottom permafrost soils with high ice content with Block-In-Matrix rocks and sand soils, respectively.

Base fill soil and materials should be used such that they restrict vertical deformations S_d during freezing or thawing at the time of using the pavement, and estimated values of which should not exceed the value of expected maximum vertical deformations S_d as shown in Table 6 as per Russian SNiP (No.) for overall time of operations of the airfield pavement.

Table 6

Airfield pavement	Maximum values for vertical deformations of subbase S_d, m, for		
	Paved runway	Main Taxiways	Aircraft stands/ parking area, main taxiways, etc.
Paved (maximum number of asphalt-concrete layers), rigid Monolithic concrete, reinforced concrete	0,02	0,03	0,04
Pre-fabricated reinforced concrete	0,03	0,04	0,06
Paved (maximum number of asphalt-concrete layers), non-rigid	0,03	0,04	0,06
Paved (minimum number of asphalt-concrete layers), non-rigid	0,04	0,05	0,08

The required thickness of heat-insulating layer is calculated based on thermotechnical calculations and on conditions that for the base designed under **Method 1A** the design thawing depth lies within the heat-insulating fill, and for the base designed under **Method 1B** the following requirement should be met:

$$S_{ft} \leq S_u,$$

where S_{ft} – value of expected deformation of heaving for periodically thawing layer of soils, defined by calculations;
S_u – maximum value of vertical deformation, as per data of Table 6. Thermotechnical calculations of the thawing depth and calculation of expected deformation of heaving S_{ft} are as per Russian SNiP (No.).

To reduce the thickness of heat-insulating fill, the layers of highly effective heat-insulating materials can be used: polymers (foam plastic), light concretes, containing porous fillers (expanded clay aggregate, agloporite, granulated particles of foam plastic etc.), ash mixes and others.

Initial data for thermotechnical calculations are:

- Accepted structure of pavement and artificial base;
- Permissible depth of periodic thaw of natural base, m;
- Thermophysical characteristics for pavement materials and artificial base materials;
- Average temperature of the surface pavement for the thaw period, calculated as an average of mean monthly temperatures of surface pavements for the warm period of year;
- Length of thawing period;
- Temperature of permafrost soils in °C at the level of annual zero amplitudes (annual zero amplitude is equal to mean annual soil temperature at the depth of 10 meters).

Thermotechnical calculations help define mean monthly temperature of pavement surface t_{mp}, annual temperature balance of pavement, based on which the method of using permafrost soils as a base for airfield pavement is defined, as well as thickness for the heat-insulating fill.

Availability of temperature values and solar radiation influence greatly the values of mean monthly temperatures of the pavement surface t_{mp} and annual temperature balance; for airfields of Class A (category of normative load, which is non-categorized, I) this availability is equal to 0.95, for airfields of Class Д (this is a reference to a Russian system of pavement classification, where the capital letters of the Russian alphabet are used: А, Б, В, Г, Д and Е; please refer to Table 16, which summarizes all of these runway classes) (category of normative load V) this value is 0.683.

These are the basic methods providing required stability of airfield structures when applying subbase under **Method II**:

- Prevailing height of the fill with the required position of the bottom of the subbase over the level of surface and soil waters;
- Use of well draining and non-frost susceptible soils for the fill, as well as of clay soils with a low moisture content;
- Use of frost protection layers made from materials that do not change their volume when freezing in a moist state;
- Use of heat-insulating materials for the airfield subbase;
- Use of reinforcing, draining and filtering interlayers made from geotextile materials.

When applying soils as a subbase under **Method II** the value of expected settlement of permafrost soils S_t, m, after their thawing is calculated as follows:

$$S_t = \sum_{i=1}^{n} \epsilon_{ti}\, t_i,$$

where: n – number of soil layers into which the thawing subbase is divided depending on the settling characteristics of the soil;
ϵ_{ti} – value of relative sit of layer i of soil;
t_i, - thickness of compressible layer i of soil under natural conditions, m.

Based on the methods of applying soils as a natural subbase for the airfields to be located in the areas near Emmonak and Mekoryuk [design of airfields of Class Д, or 2C under ICAO] it is possible to apply **Method 1A** provided there are periodically thawing layers of soil in the subbase that do not have enough bearing capacity in the thawed state or exceeding allowable settlements, and it is possible to apply **Method 1B**, if the soils of the active layer do have enough bearing capacity **and** the value of expected sit S_t, does not exceed the maximum values as per Table 6. When designing airfields of Class Г (3C under ICAO) and above, **Method II** should be applied, with the preliminary thawing of permafrost soils to the level of non-settling soils. The remedial state of subbase soils in this case should be partly thawed.

5. The Requirements for Soils Used for Subbase [Fill] Construction

In order to provide stability of the airfield facilities built in the permafrost areas on the soils used for the subbase construction, special requirements specified in Tables 7 through 11 are imposed.

Partly Thawed Clay Soils Used for Subbase Construction in Areas of All Types

Table 7

<table>
<tr><th rowspan="2">Subbase part (thickness from the airfield road subgrade, m)</th><th rowspan="2">Airfield Road Structure Type</th><th colspan="3">Soils Used for Subgrade Construction (With Silty and Clayey Particles), on the terrain of the following types</th></tr>
<tr><th>Type 1</th><th>Type 2</th><th>Type 3</th></tr>
<tr><td rowspan="2">Upper (up to 1.5)</td><td>Paved (maximum number of asphalt-concrete layers), with modified surface course.

Paved (minimum number of asphalt-concrete layers)</td><td colspan="2">Light sandy loam, light loam (not more than 35%, not more than 15%)</td><td>Light sandy loam (not more than 30%, not more than 10%)</td></tr>
<tr><td>Unpaved</td><td>Sandy loam, loam (not more than 50%, not more than 25%)</td><td colspan="2">Sandy loam, loam (not more than 50%, not more than 20%)</td></tr>
<tr><td rowspan="2">Lower (not submerged, from 1.5 through 6.0)</td><td>Paved (maximum number of asphalt-concrete layers), with modified surface course.

Paved (minimum number of asphalt-concrete layers)</td><td>Light sandy loam, light loam (not more than 35%, not more than 20%)</td><td>Light sandy loam (up to 35%, up to 15%)</td><td>Light sandy loam (not more than 35%, not more than 15%)</td></tr>
<tr><td>Unpaved</td><td colspan="2">Sandy loam, light silty loam (not more than 55%, not more than 25%)</td><td>Light sandy loam, light loam (not more than 40%, not more than 20%)</td></tr>
<tr><td rowspan="2">Lower (submerged, from 1.5 through 6.0)</td><td>Paved (maximum number of asphalt-concrete layers), with modified surface course.

Paved (minimum number of asphalt-concrete layers)</td><td colspan="3">Light sandy loam (not more than 35%, not more than 15%)</td></tr>
<tr><td>Unpaved</td><td>Light sandy loam (not more than 35%, not more than 15%)</td><td>Sandy loam, loam (up to 70%)</td><td>Light sandy loam, light loam (up to 40%, up to 20%)</td></tr>
</table>

Soil Ultimate Moisture At the Required Compaction Coefficient

Table 8

Soil	Allowable Soil Relative Moisture, Fraction of Optimum Moisture at the Required Compaction Coefficient C_c	
	1.0-0.98	0.95-0.92
Light sandy loam	0.93-1.20	0.95-1.35
Light silty loam	0.92-1.15	0.85-1.30
Heavy silty loam	0.90-1.10	0.82-1.25
Silty clay	0.90-1.05	0.85-1.15

Required Degree of Subbase Soil Compaction (Ratio of Minimum Required Density to Maximum Density At Standard Compaction)

Table 9

Soil	Compaction Coefficient of Subbase Soil		
	Airfield road structure		Unpaved part of the airfield and shoulders
	Paved (maximum number of asphalt-concrete layers)	Paved (minimum number of asphalt-concrete layers)	
Sand, sandy loam	0.98/0.95	0.95/0.95	0.90
Loam	1.00/0.95	0.98/0.95	0.95
Clay	1.00/0.98	0.98/0.95	0.95

Characteristics of Frozen Sandy Soils

Table 10

Type of frozen sandy soil as per degree of cementation with ice and ice content	Total moisture, %	Degree of frozen soil pores filled with ice and unfrozen water, ppu (parts per unit)	Porosity Coefficient	Coefficient of subsidence when thawing	Cryogenic structure	Degree of soil moisture when thawing
Loose-frozen	<3	0-0.01	0.48-0.63	0	no	air-dry
Dry-frozen	3-7	0.01-0.1	0.50-0.66	0-0.01	massive	low-moist
Stiff-frozen, low-icy	7-22	0.10-0.8	0.56-0.71	0.01-0.04	massive and stratified - reticulate	low-moist and moist
Plastic-frozen-icy	>22	>0.80	>0.71	>0.04	stratified - reticulate	water-saturated

Conditions and Methods of Sandy Soil Excavation

Table 11

Type of frozen sandy soil	Conditions of soil excavation with digging machines	Content of frozen lumps exceeding 25mm during soil excavation, %	Application conditions	Minimum compaction coefficient		Relative settlement when thawing in the fill, ppu
				when frozen	after thawing	
Loose-frozen	Without loosening	0	Without Technological Restrictions specified for partly thawed soils	0.95	0.95	0
Dry-frozen	the same	<50	Frozen lumps should not exceed 30cm. Layer-by-layer compaction with lattice or vibrating rollers	0.92	0.95	<0.05
Stiff-frozen, low-icy	With preliminary loosening performed by explosive or mechanical method	50-80	In the mixture with loose-frozen soil – in the lower fill part; content of frozen lumps of up to 30cm should not exceed 50%. Layer-by-layer compaction with lattice or vibrating rollers	0.87	0.95	<0.12
Plastic-frozen-icy	the same	>80	Only for storage pits for further thawing and drying	Not normalized		

6. Basic Subbase Configurations Used When Constructing Airfields in Permafrost Conditions

In Russia, including Far East, soils are used as natural subgrade for the airfield road structures (as per **Method 1A**) when constructing the airfields in the areas of everfrozen soils. The traditionally performed actions assuring the subbase stability and preventing the airfield road structure deformation, include:

- Construction of the heat-insulating layer [fill] out of stable non-frost susceptible and non-subsident soils (sands, SGM, crushed aggregate or pebble soils stabilized with bindings, etc.);
- Replacement of subsident or frost susceptible soils with stable soils at the depth adequate for the required heat-insulating layer height.

Such traditional actions usually require significant earthwork scope that extends construction terms and increases construction costs. This disadvantage becomes the most critical in the back North areas where stable soil delivery is very difficult and causes construction cost increase. Besides, in the areas of everfrozen soils, excavation required for soft soil replacement is not advisable due to the environmental reasons.

Below configurations of subbases constructed on the natural subgrade (**as per Methods 1A and 1B**) of the airfield road structures, are provided.

In Figure 9, it is shown a standard configuration of the subbase of stable Block-in-Matrix rocks (BIM rocks) and of partly thawed or loose-dry-frozen sandy soils for the areas of Type 3 with soils of Subsidence Categories IV-V and mandatory conservation of moss-vegetative (moss-peat) cover on the subgrade. For the soils with Subsidence Category V the slope peat padding should be provided. Height of the heat-insulating layer of stable soils is determined on the basis of thermotechnical calculations and stability analysis.

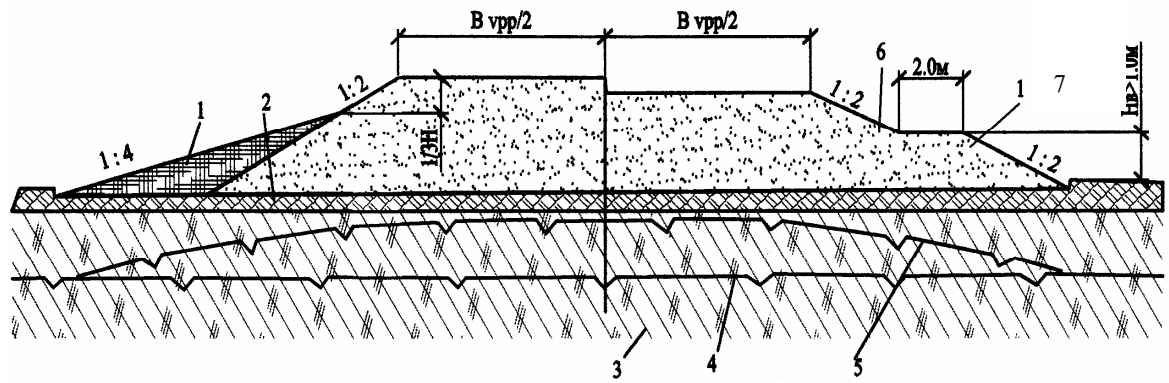

Figure 9
Cross profile of the subbase constructed in the areas with soil of Subsidence Categories IV and V:

1 – slope peat padding, 2 – moss-vegetative cover; 3 - subgrade soil; 4 - upper horizon of everfrozen soils in natural conditions; 5 – the same after the subbase construction; 6 – subbase soil; 7 – berm.

In order to decrease the subbase height in the areas of Type 3, the airfield road structure subbase is designed following the first method including construction of heat-insulation layer of natural or artificial materials (Figure 10).

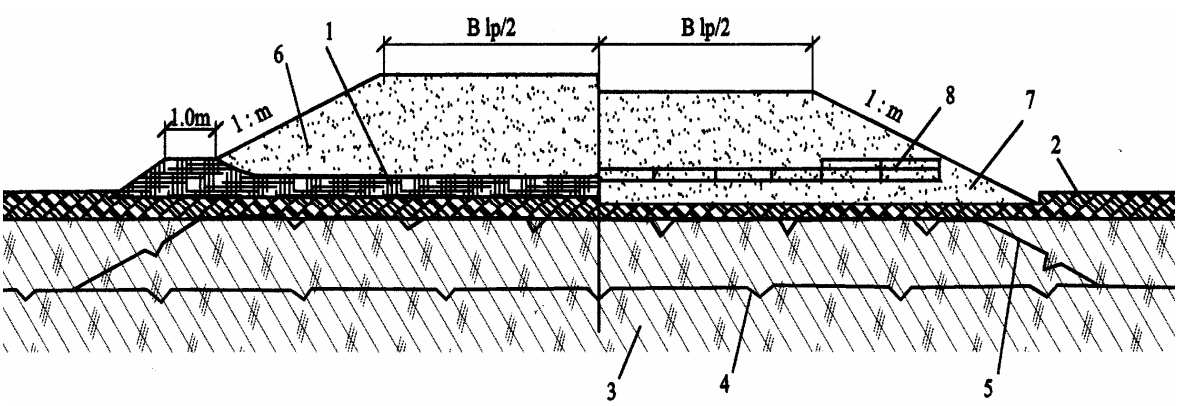

Figure 10
Cross profile of the subbase with heat-insulating layers constructed at the areas with soil of Subsidence Categories IV and V:

1 - compacted peat; 2 – moss-vegetative cover; 3 - subgrade soil; 4 - upper horizon of everfrozen soils in natural conditions; 5 – the same after the subbase construction; 6 – subbase soil; 7 - leveling layer of loose-frozen sand or fine BIM rocks; 8 -slabs of polystyrene foam (penoplex).

Floormate 500, Styrofoam, Penoplex (Russian analog of Floormate) and other foam plastics are used as artificial materials. In order to keep subgrade soil frozen, foam plastic slabs should be mostly placed at the depth of 1/3 of the subbase soil seasonal thawing depth but not higher than critical depth. Critical depth is a minimum depth where foam plastic is protected from overload [over-tension]. In order to prevent slab overloading [over-tension] when bearing design loads during construction and operation, the protective surface layer should be provided.

Minimum thickness of leveling layer (7) under the heat-insulating slabs is 0.1 meter. This layer thickness should be determined on the basis of thermotechnical calculations in accordance with existing procedure of the natural subgrade everfrozen soils use. Height of subbases designed with heat-insulating layer of foam plastic is calculated with method specified in Manual (No.).

Use of compacted peat as heat-insulating layer when constructing airfields with paved road structures are undesirable since its relative settlement when thawing is up to 0.04.

Height of fill designed with peat heat-insulating layer on the subgrade is calculated with method specified in the Russian Construction Norms (No.).

If there is shortage of peaty soils to be used for heat-insulating layer, it is allowed to design the subbases following the first method, using frozen soils (including clay soils) in the lower subbase part.

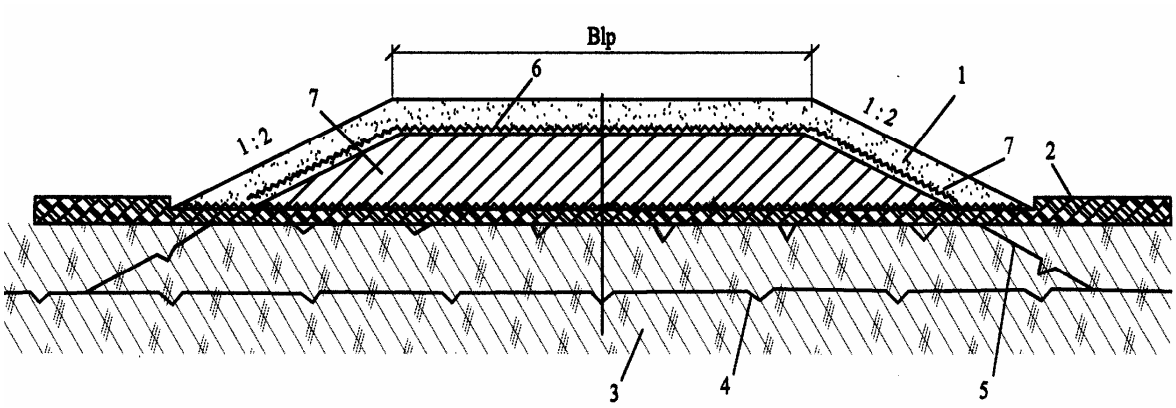

Figure 11

Cross profile of the subbase with frozen soil in the subbase lower part:
1 - sandy soil; 2 – moss-vegetative cover; 3 - subgrade soil; 4 - horizon of everfrozen soils in natural conditions; 5 – the same after the subbase construction; 6 – frozen clay soil; 7 - geotextile separating interlayer.

When constructing the airfields in the areas of everfrozen soils and using soils as natural subgrade for the airfield road structures (as per **Method II**), subgrade soft and subsident soils are replaced with stable soils up to depth of the non-subsident soils during soil thawing. These actions assure the subbase stability and prevent the airfield structures deformation. Such actions usually require significant earthwork scope that extends construction terms and increases construction costs.

When constructing the subbases on soft-soil subgrades (without replacement of soft soil under the subbase), geotextile is used as the designed structural technological interlayer for load distribution, settlement leveling and prevention of subgrade soil local squirting.

Material is placed in the subbase lower, middle and upper parts as flat interlayers, rolls and half-rolls. Interlayer operation, function and design depend on subsidence degree of the subgrade soil and subbase soil type, work season, and peculiarities of geotextile structure and characteristics.

Separating interlayer should be provided for when designing subbases for the areas with soil of Subsidence Categories II and III.

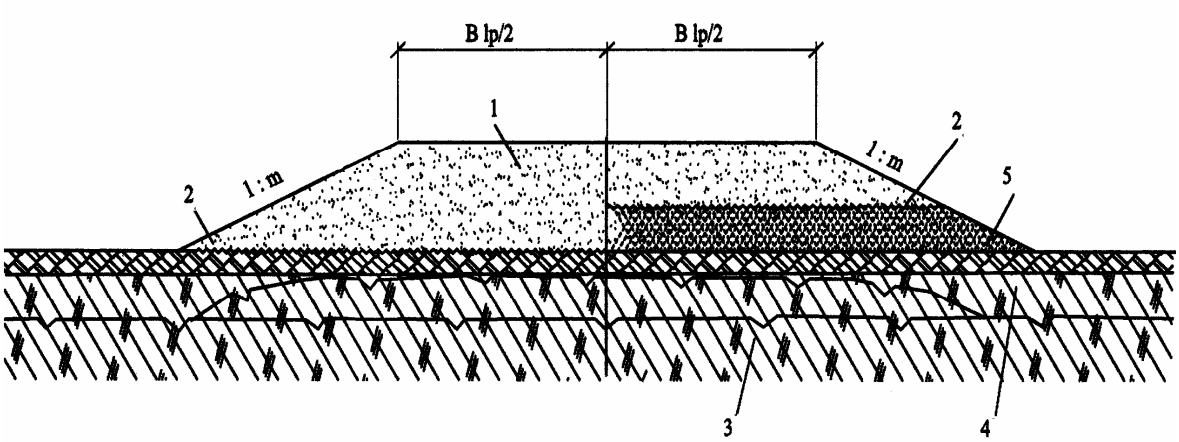

Figure 12
Cross profile of the subbase with separating geotextile interlayers:

1 – subbase soil; 2 - geotextile; 3 - horizon of permafrost soils in natural conditions; 4 – the same after the subbase construction; 5 – frozen lumpy (clay or peaty) soil in the subbase lower part.

When constructing the subbase during summer time, the geotextile interlayer is placed in the lower subbase [on the subgrade] to decrease differential settlement of the thawing subgrade soil and, at the same time, to improve support for construction machinery traffic for the subbase fill placement and compaction operation.

When constructing the subbase in winter time, the interlayer is placed between the lower layer of frozen lumpy (clay or peat) soil and middle/upper layer of dry or loose-frozen sandy soil (Figure 12). This is done to prevent penetration of the loose soil from the subbase upper layer into the lumpy soil voids, thereby decreasing differential settlement and increasing subbase drainage during summer time.

Geotextile is placed along the entire subbase width with cross slope of 4 percent and 15 to 20 cm edge extension over the slopes. Use of current geotextile and heat-insulating materials in the airfield road structure subbases allows reduction of the total earthwork scope and amount of imported stable soil, thereby reducing construction time and costs.

Figures 13 and 14 illustrate configurations of subbases constructed on natural subgrades (as per **Method II**) using geotextile and heat-insulating materials.

If annual air temperature balance is negative, in order to construct the subbase "solid core" and provide the designed bearing capacity of the airfield road structure in the areas with soft water-saturated subgrade soils (Subsidence Categories II-IV) that occur above the permafrost level, it is allowable to use frozen clay (silty) or peaty soils in the lower subbase. This provides support for the heat-insulating layer of "penoplex" insulation slabs, and reinforcing geotextile interlayer on the subgrade.

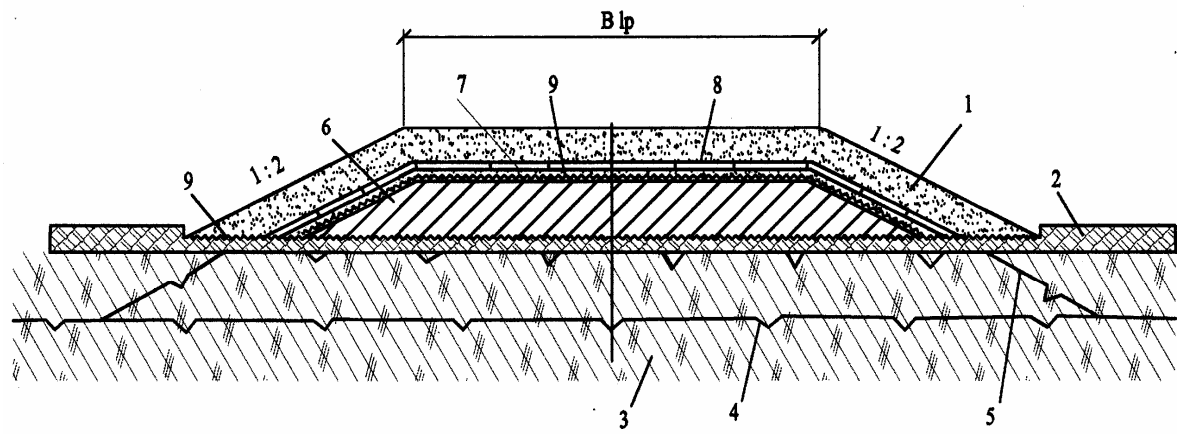

Figure 13

Cross profile of the subbase with frozen soil in the subbase lower part:

1 – sandy soil; 2 - moss-vegetative cover; 3 - subgrade soil; 4 - horizon of everfrozen soils in natural conditions; 5 – the same after the subbase construction; 6 – frozen clay soil; 7 - leveling layer of sand or fine BIM rocks; 8 - slabs of polystyrene foam (penoplex); 9 - geotextile.

The reinforcing interlayer is designed for the areas with soils of Subsidence Category III-V to improve subbase stability and prevent creep of the subbase sides, including slopes, during thawing.

In the areas with soils of Subsidence Category III, the interlayer is designed as concave half-roll. Geotextile strips are placed continuously and crosswise at the bottom of the subbase (Figure 14, left cross section). In the areas with soils of Subsidence Category IV-V, the interlayer is designed as a roll. Geotextile is placed continuously and crosswise in the lower subbase part (Figure 14, right cross section).

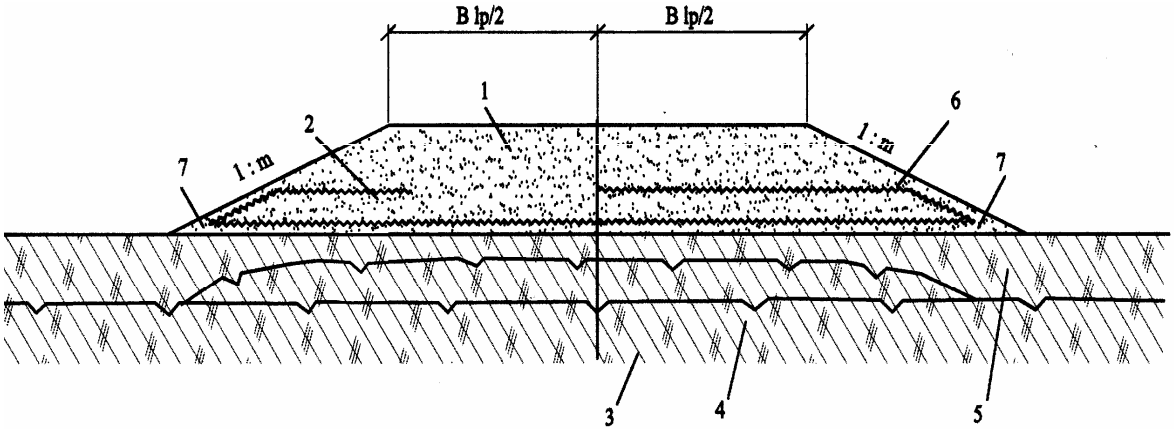

Figure 14

Cross profile of the subbase with reinforcing geotextile interlayers:
1 - subbase soil; 2 - geotextile half-roll; 3 - subgrade soil; 4 - horizon of everfrozen soils in natural conditions; 5 – the same after the subbase construction; 6 – geotextile roll; 7 – leveling layer of sand of 0.2-0.3m thickness.

When constructing separating and reinforcing interlayers of waterproofing material, the interlayer drainage restriction reduces subbase consolidation and should be calculated by decreasing the required consolidation degree by 10 percent.

7. Use of Clay (Silty) Soils in Subbase Construction

When constructing airfields in DKZ [Road-Climatic Zone] 1 and using airfield and road structures over the natural subgrade (as per **Methods 1A, 1B and II**), where there is a shortage of BIM rocks it is allowed to design subbases of partly thawed and frozen clay or silt soils.

Partly thawed clay soils used for subgrade construction should have the characteristics specified in Table 7. Clay soil moisture should not exceed the allowable moisture content at the required compaction coefficient specified in Table 8. If the moisture of partly thawed clay soils exceeds the allowable limits, it is necessary to provide for the preliminary soil drainage or to add special agents decreasing moisture content during soil fill placement. The upper part of the subbase is then constructed with sandy soils. Regardless, thickness of the subbase upper layer should be at least 0.8 meters in accordance with conditions required for the dynamic stability of the airfield structure.

When thawed, frozen clay soils should be solid, semi-solid or hardly-plastic. Such soils are used in the subbase lower part together with heat-insulating layers of peat, penoplex insulation or geotextile reinforcing layers.

Oversaturated clay soils may be used in the lower subbase if they remain frozen during the entire operation period. In such cases the subbase upper layer with thickness of not less than 0.5 meters is filled with BIM rocks or sandy soil. In this case the subbase is constructed with heat-insulating layers of peat or penoplex and reinforcing layer of geotextile (Figure 13). It is forbidden to remove or damage moss-vegetative cover on the subgrade. Subbase of oversaturated clay soils in the lower subbase part is constructed during wintertime by placing the layers of 0.25-0.3 meters as previous layer is frozen. Geotextile interlayers should be preliminarily placed for subbase load transfer, settlement leveling and prevention of subgrade soil local extrusion. Geotextile interlayer providing both separation and drainage is placed in the subbase over the upper part of clay soil layers.

8. Use of Geotextile in Airfield Construction

Geotextile interlayers may allow the reduced consumption of traditional road-construction materials required for the airfield road structure construction, reduce construction terms, power consumption during construction and repair operations, transportation costs, improve service reliability and life of the airfield road structure or its elements. All the aforesaid can be achieved using geotextile as:

- reinforcing interlayers stabilizing soil and reducing deformation;
- separating interlayers that prevent mixing of soils with different compositions and states and improve service conditions of the layers and entire structure;
- drainage interlayers providing subbase (lower or middle part) drainage and speeding up the subbase settlement. Only needle-punched materials with thickness of not less than 3.5 mm may be used;
- filter of soil particles transported with water;
- cover protecting slopes against water or wind erosion.

Geotextile should have characteristics not worse than those specified in Table 12.

Table 12

Geotextile function	Initial Modulus, H/cm	Elongation at rupture, %	Deformation Modulus, H/cm	Thickness, mm	Strength loss if bended, %	Longitudinal water permeability, m/24 hours
Reinforcing interlayer	70	100	100	4,5	10	-
Separating interlayer	40	150	30	4,5	20	-
Drainage interlayer	40	150	30	3,0	-	50
Slope cover	30	150	20	4,5	-	-
Interlayer placed under precast cement concrete	70	100	70	3,0	-	50
Interlayer of the temporary road structure	70	120	50	4,5	20	-

There are the following requirements for geotextile used as filter:

Minimum strength, H/cm	80
Water permeability	50
Stability (strength conservation)	85

As per the manufacturing procedure, geotextile may be woven and non-woven. Woven geotextile has regular structure, high strength, high elastic modulus but does not have adequate water permeability. Such materials are advised to be used as reinforcing interlayers. Stabilenka is the most common material of this type.

Characteristics of non-woven geotextile being chaotic weave of short and long fibers depend on strengthening method (fiber interconnection). Non-woven geotextile can be strengthened by mechanical, thermal or chemical methods.

Mechanically strengthened (needle-punched) non-woven synthetic materials are relatively strong, highly deformable, have good protective properties, water permeability in plane and normal direction. Their basic functions are drainage and protection, in case there are significant deformations – reinforcement (e.g. when placing on the subgrade of thin subbase of the temporary detour). Thermally strengthened non-woven geotextile materials have low deformability. They are used as filters. When chemically strengthened (bonded), geotextile characteristics depend on the binder type. Usually such materials quickly age when used and can only be used as temporary elements of the road structures. Dornote, Polyfelt are the most common materials of this type.

Apart from woven and non-woven geotextiles, geogrids of Fortrac, Polyfelt Rock PEC types are used as reinforcing interlayers. Comtrac is used as both reinforcing and drainage interlayer.

When designing as per **Method I**, subbase settlement during the airfield operation is not allowed.

When designing the airfields as per **Method II**, the reinforcing interlayer on the subgrade should be provided for in the areas with soils of Subsidence Category III-V to improve the subbase stability and prevent washout of the subbase sides including slopes during thawing.

Subbase stability is determined according to Safety Coefficient S_c, being ratio of the safe load R_{safe} complying with subbase stability conditions, to the designed load $R_{designed}$. $R_{designed}$ depends on subbase height – $h_{designed}$, soil volume weight γ_H and subbase final settlement S. S depends on the thickness of the subbase layers and the layers' settlement modulus in vertical and horizontal directions. The reinforcing interlayer takes horizontal tension stress of the lower subbase during settlement, increasing the settlement modulus in a horizontal direction resulting

in a settlement reduction. In order to prevent the subbase vertical deformation from exceeding the values specified in Table 6 during the entire operation period, elongation of the reinforcing interlayer from soil creep caused by sustained load should not exceed 1.5-2%. Stabilenka complies with all the requirements. Its elongation at break does not exceed 10%. Subbase and slope stability and settlement of the subbase constructed with reinforcing interlayers are calculated as per the methods specified in Manual No. 9.

In the areas with soils of Subsidence Category III, the interlayer is designed as concave half-roll (Figure 14). The strips are placed continuously and crosswise in the lower subbase part. For the subbase with height up to 2 meters depending on the geotextile angle of friction (j) on the subsoil, or (if no such data available) depending on the subsoil angle of internal friction, the minimum length of the half-roll "branches" on both subbase sides is assumed as per Table 13.

Table 13

j, degrees	5	10	15	20
L, m	6.0	4.2	3.4	3.0

If the soil has Subsidence Category IV-V and sub-grade soil is characterized as excessive in moisture content, to reinforce and improve the drainage parameters, the geotextile roll should be placed in the transverse direction in the sub-base bottom layer (Figure 14).

The roll height (h_{roll}) should not exceed the maximum allowable value that is subject to geotextile deformation modulus (E) (Table 14).

Table 14

E, H/cm	<100	100 - 150	>150
H_{roll}, cm	50	80	120

In order to facilitate the process of soil consolidation (to decrease the construction terms prior to base course placement), non-woven or needle-punched woven fabric, with a minimum thickness of 3.5 mm, which in compliance with the waterproof requirements, should be used. The layer should be placed in the weak soil along the whole width of the sub-base bottom course to each side with 1.0 meter overlapping. The woven fabrics should be overlapped with B coefficient, that should consider the sub-base settlement (B=0.15+0.2S, m).

At airfields with gravel or aggregate surface layers, which are characterized by low load distributing parameters, special reinforcing layer should be placed directly under the base course bottom within the width of the runway in order to improve operational characteristics. In this case, the placement of the intermediate layers is governed by additional requirements for surface layer deformation.

In order to reinforce and improve the drainage characteristics, the layers should be placed laterally across the sub-base width at the contact between sand drainage layer and underlying soil.

Soil drainage is an effective measure to improve the sub-base strength. Soil is drained using special drainage layers placed in the bottom of the sub-grade in order to facilitate the consolidation of the oversaturated soils placed over the sub-grade.

The distance between the drainage layers should be maximum 2 meters for loam and 1.5 meters for heavy loam and clay. The distance from the sub-grade surface to the upper drainage layer should meet the values specified by Table 15.

Table 15

Soil Type	Minimum distance from the sub-grade surface to the upper drainage layer H′, m, where K_w – at the rate of K_W as follows (here it shows different values for K_W in the range between 1.1 and 1.5)				
	1.1	1.2	1.3	1.4	1.5
Light loam	3.0	2.5	2.25	2.0	1.5
Heavy loam and clay, silty loam	5.5	5.0	4.35	3.5	2.5

Note: K_w - excessive moisture coefficient of sub-base soil (relation of the actual moisture to the optimum moisture).

The strength of the soil surface layer reinforced with geotextile should be calculated according to the Resolution (#).

To protect the sub-base slopes built of sandy, silty and clayey soil (if the peat soil is not available) from water and wind erosion, the geotextile layers should be secured at the sub-base shoulders and bottom (sub-grade edge), then 10-15 cm of a solar radiation protective layer made of sand or gravel-sand should be placed (Figure 15).

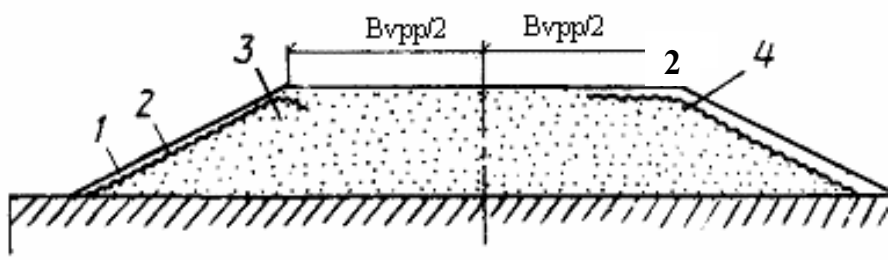

Figure 15
Transverse sub-base profile with slopes and shoulders reinforced by geotextile: 1 - 10 - 15cm protective sand layer; 2 - geotextile on the slope; 3 - sub-base soil;

9. Unpaved Runways

Unpaved runways are designed according to FAR (Federal Aviation Rules) requirements. The required runway length should be calculated according to Manual on Airfield Design (No.). The calculations should be based on the nomographic charts for the specific types of aircraft or using the correction factors, which consider the airdrome class, standard runway length, airdrome height, ambient temperature at 1 p.m. for the hottest month and unpaved runway average slope. The calculation using the correction factors should be made as for the paved runway; the result should be increased by 10%.

Subject to airport class, the basic unpaved runway parameters are represented in Table 16.

Unpaved Runway Parameters/Class of Airfield

Table 16

Runway Strip Elements	А	Б	В	Г	Д	Е
Length of unpaved runway in the conditions of MCA, m	3200	2600	1800	1300	1000	650
Runway width, m	60	45	42	35	28	21
Unpaved runway width, m	100	100	85	75	75	60
Total width of the runway strip graded area, m	160	160	140	130	110	80
Total width of runway strip, m	300	300	300	300	150	150
Maximum longitudinal slope: medium section threshold ascending descending	 0,020 0,020 0,008	 0,020 0,020 0,008	 0,020 0,020 0,008	 0,025 0,025 0,015	 0,025 0,025 0,015	 0,030 0,025 0,015
Longitudinal slope:	0,020	0,020	0,020	0,025	0,025	0,025
Vertical curve radius, m	10000	10000	10000	6000	6000	6000

Runway strip length beyond each threshold of unpaved runway should be minimum 150 meters for all airfield classes.

Unpaved runways are designed mainly for Class В, Г, Д, Е airfields to operate such fixed -wing aircrafts as AN-74, AN-24, AN-26, AN-38, AN-28, AN-2 in the areas where the construction of the paved runway is not efficient from the economical standpoint.

Unpaved runway surface course is made of aggregate or gravel mixes or soil- aggregate or soil-gravel mixes, which are composed of aggregate and clayey soil mix as 4:1. In this case, the width of the surface layer in the medium section of the soil runway is allowed to be the same as the width of the paved runway of the respective Class. Within the remaining section, the surface of the soil runway should be reinforced with turf; to place turf it is required to plant grass seeds selected for the specific region and to fertilize soil.

The thickness calculations for aggregate, soil-aggregate or soil-gravel courses should be made as for non-rigid surface courses according to the Instructions of Federal Aviation Rules (#).

10. Clay (Silty) Soil Dewatering Methods

When the moisture content of the clayey soil in the borrow pit exceeds the standard requirements, then the following methods are recommended:

- Natural soil dewatering during summer and fall;
- Soil dewatering by non-active agents;
- Soil dewatering by active agents including special chemical substances;
- Special design solutions.

Choice of the dewatering method is subject to specific climatic conditions, construction period, required agents available, economical and technical factors.

The method of natural (radiation) soil dewatering is applied when excavating the soil with excessive moisture content in the borrow pits and constructing the sub-grade provided that the climatic conditions (temperature, wind, unavailable precipitation) are non-changeable.

Natural soil dewatering includes:

- Soil dewatering in the borrow pit (e.g. stockpiled by excavator) and establishment of dried soil batch before its loading onto the trucks;
- Soil distribution in thin layers (thickness maximum 20 cm);
- Having breaks between the phases of soil placement, soil distribution and compaction.

To dewater the soil using non-active agents, ash, slag, mining wastes should be used. The moisture content ($W_д$) of such agents should be less than the optimal moisture (W_o) of the final mix.

The required relation of dry agents weight to wet soil weight (n) should be determined using the formula:

$$n = K_c = \frac{(W_o - W_д)(W_e + 1)}{(W_e - 1)(W_д + 1)}, \quad (10.1)$$

where K_c - coefficient for the mix homogeneity; K_c = 1.1 for sands and light sandy loam; K_c = 1.3 for silty and heavy silty sandy loam, light loam; K_c = 1.5 for heavy loam and clays.

To dewater the soil with excessive moisture content using dry soil (agents), it is required to mix the soil (wet and dry) on site combining soils from two different sources or alternating the layers of soil with excessive moisture content with dry material (soil) layers. The total thickness of such layers (cumulative strength) shall be determined using formula (10.1). In this case, the thickness of dry layers should be a minimum of 0.3 meters when placing on the soil with moisture coefficients of 1.1-1.15 and minimum 0.5 meters when placing on the soil with moisture coefficients of 1.25-1.3.

When dewatering the soil with active agents (unslaked lime, cement, fly ash, gypsum, dewatered cryslallic phosphoric acid, etc.), the most effective method is constructing sub-base of silty sand, sandy loam or light loam.

This method is used mainly for dewatering the soil on the top of the sub-grade.

Soils with acid reaction (pH $\leq$ 6) or with great absorption capacity (over 20-30 mg/ekv per 100 gram) should be treated with unslaked lime, fly ash, slag-cement or phosphates. For soils treated with fly ash the content of the freely soluble salts should be maximum 3% (of the soil weight) under sulfate salinization and 5% under chloride salinization.

To treat the soil with excessive moisture contents, it is recommended to use ground hydrophobic unslaked lime containing minimum 50-60% of CaO and MgO. Use of unslaked lime containing maximum 25-30% of CaO and MgO less than 25-30 % is inefficient.

When using cements to dry soil, the cements with increased content of CaO are the most effective.

Active fly ash used for soil treatment should have specific surface minimum 1600 cm^2/gram and free calcium oxide minimum 8%.

D (%), volume of the unslaked lime or fly ash (recalculated for free CaO and MgO) is subject to the content of pure CaO and MgO and material effectiveness calculated using the formula:

$$D = \frac{A \cdot 100}{Bk}, \qquad (10.2)$$

where A - required volume of CaO + MgO (Table 8.1);
B - content of free CaO + MgO in lime or fly ash, %;
k - coefficient: 1.2 - for fly ash, 1.5 - shale ash, 1- for lime.

Table 17

Soil	Volume of active fly ash, lime, % (recalculated to CaO + MgO), where K_w		
	1.2	1.4	1.6
Silty sand, sandy loam	-	0.5	1.0
Light loam	-	0.5	1.5
Heavy loam	1.0	2.0	4.0
Clay	1.5	3.0	-

Volume of Portland cement (grade 300) should be used for light loam and sand when moisture coefficient is K_w > 1,2-1,5 to 2.5%; for light loam K_w = 1,2-1,5 – 0.5 to 3%; for heavy and silty loam K_w = 1,2-1,5 to 1-5%; for clay K_w = 1,2-1,35 – 3 to 5%. When using the cement of low grades, the cement volume should be increased by 1.1-1.3 times as much.

To dewater the soil with moisture content increasing 4-6% of the optimal moisture, the construction gypsus should be used.

To improve the mechanical properties determining the adhesiveness as well as to gain the required density of clayey soil with excessive moisture content and oversaturated soil, the chemical agents with acid medium (pH $\leq$7), wastes containing chorine iron, etc. should be used (table 8.1-8.4). These agents are the most effective for the soil containing excessive montmorillonite, hydromica, kaolinite with plasticity index 7 to 30.

To dewater and to facilitate the consolidation of embankments with an excessive moisture content, it is allowable to construct the horizontal layers including geotextile layers, vertical drains as well as composite sand structures with drainage coefficient minimum 0.5.

In order to dewater the sub-grade soil, along with horizontal sand drains, in some special cases design provides for construction of the separate vertical sand drains or their combination with horizontal drain layers.

In sub-grades built of cohesive sand with excessive moisture content, vertical sand drains (cylinder or cylinder pipe configuration) should be constructed (Figure 16); drain diameter should be 0.4 to 0.6 meters.

Drain height is subject to sub-grade height, thickness values for the road cross-section and bottom draining layer.

The distances between the drains in embankments built of the cohesive soil should be 1.5 to 3 meters. The optimal distance should be calculated. We recommend the vertical drains to be constructed of homogeneous medium-grained and fine-grained sand.

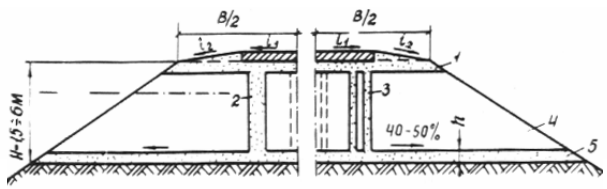

Figure 16
Schematic for sub-grade with vertical sand drains.
1 - upper drainage layer; 2 - sand drain; 3 - drain with ring cross section;
4 - sub-grade soil; 5 - bottom drainage soil;

11. Permafrost Thawing Methods

When designing and constructing the airfields to be located over permafrost soils and when using the soil as the natural sub-grade for the airfield cross-section (Principe II), we recommend the preliminary permafrost soil thawing with oversaturated layers be removed or dewatered.

Several permafrost thawing methods are used; Table 18 contains the list of them and the methods of application.

Methods of Preliminary Soil Thawing

Table 18

Thawing Method	Description	Application	Maximum Depth and Thawing Velocity
Natural	1. Snow accumulation and surface warming for winter 2. Spring snow removal to use solar radiation. 3. Cutting the topsoil and upper silty and clayey soil, surface blacking 4. Site drying	The cheapest method used for the pebble soil with drainage coefficient k> 10 and sandy loam and clayey soil with k >0.01 m/day	Up to 5-6 meters depth during 2-3 periods in the pebble soil; Two times less in sandy loam and clayey soil.
Artificial rain irrigation	1. Cutting the topsoil and upper silty and clayey soil. 2. Drainage system installation. 3. Water spraying, that is being filtrated, transfers the heat from the top to the thawing section.	Soil with drainage coefficient minimum 50 meters/day. Recommended for the sloped areas.	Up to 8 meters for the period of application.
Filtration - drainage	1. Spring snow removal 2. Cutting the topsoil 3. Drainage- irrigation ditches construction	Soil with drainage coefficient minimum 50 meters/day. Water consumption 7-13 m^3 per 1 m^3 of soil	1-1.5 meters per month; Up to 8 meters for the period of application
Wellpoints dewatering	Installation of the wellpoints and water supply with pressure head of 10-12 meters	Soil with drainage coefficient k >0,01 meters/day. Water consumption 0.2-4 m^3/day.	Soil thawing minimum up to 10 meters depth during 10 to 12 days.

Thawing Method	Description	Application	Maximum Depth and Thawing Velocity
Steam needles	1. Steam point submersion. 2. Steam supply into the soil from the boiler through the steam points.	Soil with drainage coefficient k >0,01 meters/day. Steam consumption 30-50kg/m^3	Up to 10 meters depth. Points submersion speed 0.7 to 15 m/hour. Thawed area diameter I to 1.2 meters per 4 to 8 hours of steam point operation.
Three-phase alternating current	1. Electrodes installation in line of 2-2.5 meters length; the distance between lines to be 2.5-4 meters. 2. Alternating current penetration through the soil with simulations water discharge through the electrodes. 3. Electro-osmotic compaction of thawed soil with direct current.	Clayey soil: power consumption 60-80 kW- hour/m^3	Minimum 10 meters; work period 2 to 3 months.
High voltage alternating current	1. Trenching with preliminary soil thawing with power heating (380 V). 2. Electrodes installation in the trenches; distances between electrodes to be 6 meters. 3. Backfilling with thawed soil and pouring with salted solution.	Clayey soil; recommended for the large areas; power consumption 18-25 kW-hour/m^3	Thawed depth minimum 4 meters; daily capacity to be 100 meters under 320 kW.
High-frequency current	1. Snow removal and site cleaning 2. Electrodes placement on the frozen soil surface; the distance between electrodes to be 0.6-0.8 meters. 3. Placement additional weight on the electrodes during thawing.	To be applied for not deep thawing; Power consumption 12-25 kW-hour/m^3	Thawing depth 1.0-1.2 meters; thawed soil volume per 1 hour: 1.0 meters of sand; 0.5 meters of clayey soil or loam.
Electrolytic heaters	1. Drilling wells, diameter 110-130 mm. 2. Submersion of the external and internal electrodes with electrolyte pouring. 3. Power supply to the heater (alternating current 20-30V)	Sandy and clayey soil - 0.3-0.5 kW for 1 meter of the heater.	Thawed depth - up to 15 meters; term – 40 to 50 days.
Ohmic heaters	1. Wells drilling 2. Re-bar clamps placement and backfilling with sand 3. Power supply (alternating current 20-50 V)	Sandy and clayey soil - 2.0-2.5 kW1 for 1 meter of the heater.	Thawed depth - up to 15 meters; term – 20 to 30 days.

To thaw the permafrost soil, the following methods are recommended:

- Wellpoints hydro-thawing of free-draining gravel and sandy soils with compaction by vibrating roller;
- Electrical thawing method and clayey soil compaction using electro-osmosis and wellpoint dewatering.

The method of water thawing is based on heat energy of the ascending water filtration flows. Thaw points should be submersed vertically into the soil with the distance L between them in a line; the distance between lines should be 0.87 L. Jointly with point submersion, water should be supplied and, as a result, the thawed soil cylinder is formed around the water jet. Upon the submersion to the desired depth, water injection is continued and the thawed cylinder diameter is increased over time.

To support water supply for hydro-thawing, water is usually taken from the river without artificial heating.

Upon completion of water injection, the thawed layer is drained for 2-3 days and water is pumped out from the well points (if water is discharged along the slope) or from thawed ditches in water-permeable soil (in this case water pumping is not necessary). If the thawed soil is poorly compacted, then the compaction coefficient should be increased by vibrating transferred to the soil through the needle pipes. Soil thawing is allowed under the temperatures minimum -15°C.

Electrical soil thawing requires specific electrical resistance.

Foundation soil preparation by electrical thawing should be performed in two phases. During Phase 1, soil thawing should be followed by soil compaction under dead weight loading; during Phase 2, the soil should be additionally compacted by water reduction and electro-osmosis.

During thawing, the alternating current (usually 380 V) is transferred to the soil through the perforated electrodes system; each electrode serves simultaneously as a vertical drain. Pipes used as the electrodes should be submersed into the wells or placed into the frozen soil. Electrodes should be placed in straight lines (in plan view). The distances between the electrodes in the same line should be 2 to 2.5 meters; the distances between lines should be 2.5 to 4 meters. The number of lines should be multiple to six plus one, i.e. 7, 13, 19, etc. The depth of submersion should be 1 meter less then the estimated depth of preliminary soil thawing.

Phase 2 involves combination of operation of a water suction unit with application of simultaneous direct current conduction through soil using pipe electrodes. Electrode connection schematics specify two closed electrode circuits placed along the area borders and parallel straight electrode lines inside the circuits. The electrodes of the outer circuit are the cathodes; electrodes of the inner circuit are the anodes; the marks of the inner electrode lines are alternating. At the same time the cathodes are well points for the water removal pump unit. The electro-osmotic compaction should be performed under the maximum vacuum on the water removal unit's collector pump.

The electrical method is characterized by the period of work of 2-3 months. The power source capacity per 1 m^2 of the sub-grade is 0.1-0.3 kW; power consumption per 1 m^3 of the treated soil is 60-80 kW/hour.

When thawing the permafrost soil by natural method, the soil thawing takes 2-3 years. One of the acceleration methods is full or partial prevention from soil freezing during fall-winter (temperatures below 0).

Heat exchange processes between soil (or other road construction material) and air depend on special foam surfacing made of fast-hardening foam plastic (FFP) and freezing water-air foam (foamed ice).

FFP is the universal and the most effective material of all the heat-insulating materials used in construction. Its usage can prevent, fully or partially, the freezing or overheating of soils, cement-concrete or other materials.

Foamed ice allows a decrease in the soil freezing depth especially in the areas characterized by cold continental climate, but foamed ice can not protect the soil from initial freezing impacts; foamed ice should be placed only on the initially frozen surface under negative ambient temperature (minimum –10°C).

FFP is produced in a special mixing unit (foamer) by foaming the carbamide-formaldehyde tar and foaming agent by compressed air with subsequent hardening the foam by catalyst.

Foamed ice is produced by freezing the water-air foam under low ambient air temperature. In this case, it is required to use the foaming agents, which produce the steadiest and low-decomposing foams (half-value period over 30-40 min). The steady foams are produced from the foaming agent of alkilarisulphonates (volgonate, sulfanol).

In order to improve foam serviceability during freezing period, the wide range of stabilizing agents such as organosilicon liquid (carboxilmetilcellulose CMC), water-soluble polymers, gelatin, casein, etc. should be used for water-air foams.

In order to improve serviceability of FFP, it should be placed during pre-winter period under the positive air temperature (above zero); though FFP can be even placed under the temperature below zero. If the operations are performed in marine climate characterized by occasional thawing during winter, it is required to cover the foam surface with water-proof film. In order to decrease the thickness of FFP, the iced foam should be used. In this case the thickness of FFP should be determined as for the temperature minus 10°C; if the temperature is over than 10°C, an additional layer of iced foam should be considered.

Iced foam made of water-air foam should be placed in December or January subject to the climatic zone of the construction site.

12. Activities for Soil Heaving and Settlement Prevention

Heaving caused by freezing as well as settlement caused by thawing are mainly caused by the excessive moisture content of soil in the subbase and subgrade.

As a rule, the maximum soil moisture content can be observed in spring. During spring the estimated soil parameters affects the airdrome cross-section.

The soil heaving properties should be considered, if the clayey soil has flow rate I_L, > 0 by the beginning of freezing provided that the groundwater level is observed below the estimated freezing depth, m, less than as follows:

1.0 - for fine sand;
1.5 - for silty sand, loamy sand and silty loamy sand;
2.5 - for loams, silty loams, coarse-grained soil with clayey filler;
3.0 - for clay.

Sub-grade constructed on the heaving soil should meet the following requirements:

$$s_u \geq s_f$$

where s_f - heaving uniform deformation of the sub-grade surface determined as per SNiP;
s_u - ultimate heaving vertical deformation calculated as per Table 6.

In order to meet these requirements the following parameters should be considered:

- Groundwater level decrease;
- Placement of the stable layer of the non-susceptible soil on the sub-grade; sometimes the heat-insulating materials should be used to decrease the heaving soil freezing depth;

- The activities for reducing the sub-grade soil susceptibility decrease include the soil treatment at the specific depth with chemical salts (NaCl, $CaCl_2$, $MbCl_2$, etc.), organic and mineral agents and electric-chemical treatment; all these measures are used to decrease the freezing temperature.

When designing water drainage systems for airfields in the areas of permafrost soil for decreasing the groundwater level, the following requirements should be met:

- Under continuous merging low-temperature permafrost (temperature of minus 3°C at the zero amplitudes line) only water drain systems should be designed. As a rule, drainage systems are not allowed.
- Under sporadic permafrost or continuous but high-temperature permafrost (temperature of minus 3°C and higher at the zero amplitudes line), water drains and drainage systems should be designed on the basis of respective engineering/geological and engineering/ cryopedology surveys;
- In the areas with discontinuous permafrost where the layer of seasonal frost penetration and thawing (active layer) is composed of soil with the ice contents i_i <0.4, as well as in the areas with no permafrost soils, the drainage systems are designed as for climatic zone II.
- When reinforcing the sub-base course using layers of non-susceptible materials, and in cases using heat insulation materials to decrease the frost penetration depth of frost susceptible soils, the thickness of the stabilizing course and heat insulation course should be determined on the basis of the thermal engineering design method.

When determining the frost susceptibility coefficient, the sub-base courses designed in accordance with the requirements for category IA are classified as of the Type I hydrological conditions; courses designed in accordance with the requirements for category IB and II are classified as of the Type II hydrological conditions subject to the installed water drainage; if there is no drainage provided for the melting water, the course is classified as Type III hydrological conditions.

As previously noted, the maximum seasonal soil moisture content is observed in spring as the result of transfer of the liquid and vapor moisture. When melting, oversaturated silty soils transit into yield condition and, as a result, sub-base bearing capacity is decreased and soil subsidence is observed. In addition to the above listed activities, drainage layers, geotextile layers and hydro- and vapor-insulating layers are used to decrease the soil moisture content susceptibility and increase deformation modulus.

13. Vapor and Water Insulation Courses for Airfield Construction

During operation, the airfields are subject to dynamic loads and climatic conditions. The latter causes heat exchange, mass transfer, frost penetration, and seasonal thawing to occur in the fill. Soil stability of the fill varies significantly within the year. This, in turn, changes the stability of airfield pavement. One of the most effective methods to increase stability and service life of the pavement is targeted regulation of the water-heat regime that will ensure seasonal stability of soil deformation and reliability properties based on the temperature and moisture.

The main source of soil and sub-base moistening is not only precipitation but also capillary water and transportation of easy moving water vapor (60-80%). The transport of water vapor is due to the temperature difference occurring constantly in cold seasons, and vapor thermal diffusion upward the pavement structure results in accumulation of the condensate in the lesser vapor permeable pavement structure.

Even though pavement structures constructed with use of the traditional sand, gravel and aggregate materials provide regulation of the water and heat regime by excess water drainage, they are not always effective as reliable and stable drainage layers, and can cause or facilitate water accumulation in sub-base. Moreover, even if the drainage is reliable, they significantly increase soil moisture content (W=0.74-0.9) and duration of the thaw weakened period due to increased time required for drying of the upper part of the fill. At the same time, deformations are increased and stability properties decreased by 25-35%.

Targeted water and heat regulation include estimation of the moisture parameters W_p and soil stability based on the thermal calculations of the road structural courses and the fill and use of the layers with high vapor and water resistance properties.

The examples of the vapor and water insulation are as follows:

- Compacted cohesive soil with compaction index of 1.03-1.05;
- Rolled film insulators;
- Soils stabilized with organic and mineral binding materials;
- Penoplex type materials.

Use of the compacted silty soils allows decreasing the maximum seasonal moisture of the soils by 10-15%, increasing deformation and stability parameters by 20-30%, and decreasing the thawing and remedial period, thereby reducing the thickness of the airfield structure.

Use of rolled film insulation materials does not allow transfer of the pellicular moisture and water vapor upward to the upper courses and decreases the moisture content W (0.45-0.55). Thus, the road structure designed with film insulating materials is protected from frost heaving.

Having higher heat resistance and high thermal stability, heat insulation courses with penoplex materials have low water and vapor permeability properties. Use of these materials decreases the moisture content in upper part of the fill (W=[0.45-0.55]), increases stability and deformation properties by 20-25 percent and reduces the thickness of frost penetration into the soils, also protecting the lower fill courses from heaving. Structural parameters, thickness and burial depth of the vapor and water insulating courses are designed on the basis of the heat and water regime, however the minimum distance between the structural course and insulating course should be no less that 0.9 meters, and the bottom of the insulating course should be located at least 0.2 meters away from the groundwater level.

14. Pre-fabricated Road Plates for the Airfields

Pre-fabricated pre-stressed reinforced concrete plates are manufactured at the factories and delivered to the work sites by rail road, trucks and vessels.

Our manufacturers produce four types of the road plates: PAG-14 with thickness 14 cm, PAG-18 with thickness 18 cm, PAG-20 with thickness 20 cm, and PAG-25 with thickness 25 cm. Plates length is 6 meters and their width is 2.0 meters. The plates are made of concrete of Class B btb 4,0. The reinforcement bars of Class A with diameter of 12-14 mm are used for concrete reinforcement.

For the areas with permafrost soils and soft settling soils used for sub-base construction, design of the pre-fabricated structures made of pre-stressed reinforced concrete slabs is expedient if feasibility study economical calculations justified two-phased construction of the airfield pavement structure.

Generally, PAG-14 should be used for standards loads no higher than as for Category III, PAG-18 for loads not higher than as for Category II.

Phase I includes construction of the transitional (unpaved) airfield surface course made of aggregate and gravel surface course or materials stabilized with organic or mineral binder. At Phase II, this transitional structure (subject to its condition) can be used as a sub-base for installation of the pre-fabricated reinforced concrete plates.

Pre-fabricated reinforced concrete plates are installed on the preliminary prepared artificial sub-base course. For the areas with hydrological conditions of Type II where natural sub-grade course consists of non-draining soils (clay, loam, dusty loam, dusty clay sand), it is necessary to design drainage courses made of medium and coarse sand with drainage coefficient of no less than 7m/day and thickness no less than those specified in Table 19 below.

Table 19

Natural sub-base soil	Minimum thickness of drainage course, cm, for road climatic zones as follows:			
	I	II	III	IV
Clay, loam	35	30/35	20/25	15
Loam and clay sand	60	40/50	30/35	15/20

Note: The thickness before slash is for the areas located southward the road climatic zone, the thickness after the slash is for the areas located northward the road climatic zone.

When installing artificial sub-bases composed of coarse-porous materials directly on clay and fine soils, anti-silting fillers should be installed, made of materials that do not transit into the plastic state when moistened (sand, local soil treated with binder, slag etc) or else separating geotextile layers that prevent penetration of the moistened sub-base soil in the course, porous materials. The thickness of the anti-silting filler should be no less than the size of the biggest particles of the material used, but not less than 5 cm in all cases.

When installing the pre-fabricated plates on the sub-bases of all types, except for sand, a leveling course of dry sand and cement should be placed with a thickness of 3-4 cm.

When installing plates on the sandy sub-base, it is recommended to utilize protective geo layers to increase service life of the pre-fabricated reinforced concrete plates. Geotextile layers installed under the joints of the plates will prevent sand spitting of the sand from under the plates in case of dynamic stability loss, prevent sand wash-out under the plates joints and edges. Geotextile strips with width of at least 1/2 of the plate's width should be placed under the both longitudinal and transversal joints. It is recommended to use non-woven materials with thickness of minimum 3.5 mm and drainage filter minimum 50 m/day and strength minimum 70 H/cm.

In case of the two-phased construction method, geotextile layers are installed during the second phase after soil compaction. During installation, the joints are welded to avoid longitudinal movements of the plates. When using the pre-fabricated plates for the road surfacing, it's also necessary to cut the expansion joints. The distance between the transverse joints as well as between longitudinal joints at the aprons and parking areas should not exceed the numbers specified below:

12 meters if annual amplitude of the average monthly temperature is higher than 45°C
18 meters if annual amplitude of the average monthly temperature is from 30 to 45°C
24 meters if annual amplitude of the average monthly temperature is less than 30°C

Generally, the expansion joints in the plates installed for RW and taxi ways are not cut. The extraction joints are filled with dry sand and cement mixture to the 2/3 of their depth, the rest of the space is filled with sealant.

The structure of the pre-stressed plates is shown in Figure 17.

15. Dust Control Methods

At the unpaved airfields with no sod matting, the significant amount of soil is blown off by the operating engines of the aircraft. The cohesionless soils with particles of 0.1 – 0.15 mm have the highest erosion rate. When choosing the most appropriate dust control method in each particular case, it's recommended to consider the service life of the unpaved airfield, the duration of dust control effects, and availability of the required materials and equipment for the work.

The amount of the dust can be reduced by as follows:

- Decreasing the soil impact imposed by aerodynamic and mechanical loads by constructing various man-made surfaces or sod matting;

- Maintaining the structural and moisture regime of the soil to ensure its cohesion and avoid structural and mechanical erosion;
- Treating with various binding materials to stabilize and reinforce the soil.

On the runway thresholds, which are subject to the most extensive impact from the airflow and the landing gear of the aircrafts, it's recommended to use the most accessible method such as watering (capacity 0.5-0.8 l/m2).

One more dust control method is stabilizing soil with lime that can be added either as hydrated lime or as lime milk in the following ratio 1:4 – 1:5 in the amount 3 to 5% of soil weight in the treated course. Calcium chloride can also be used with an application rate as 1 kg/m2 per each 10 cm of the treated course thickness.

At the airfield and heliports, the following materials and binders are used for dust control:
- Hygroscopic salts;
- Cellulose and paper industry waste (lignin sulfites);
- Various mineral and organic binders.

The most effective dust control materials are organic binders: bitumen, oil tar, oil, bitumen emulsion and oily bitumen binders. The approximate organic binder spreading rates are: for raw oil and oil tar is 3 l/m; for bitumen emulsion is 2-3 kg/m^2; for diluted bitumen paste is 6-8 l/ m^2; for diluted bitumen is 3 l/m; for oily bitumen binder is 3-4.5% of the amount of dehydrated sand clay and loamy sand.

The soil treatment procedure to ensure dust control includes:
- Loosening, leveling and grading of the site;
- Preparation and spreading of the binders;
- Compaction of the treated area if required;

The treated site should be leveled and graded by mobile graders, and the graded site should not have a slope more than 20º and surface dips with the depth more than 6 cm.

The thickness of the treatment should be at least 25-30 mm.

As for dust control at airfields, heliports and landing areas composed of sand, sand clay and loamy sand (Extreme North areas and Far East in particular), the most effective dust control material is oily bitumen binder that consists of bitumen, waste oil of aviation and tractor oil and dilutor in the ratio as 1:1:1. The duration of the dust control effect is no less than two years. For such purposes, the medium thickening and slow thickening bitumens or others treated to the viscosity rate of a liquid bitumen should be used.

As for the waste oils, any used oil or their mixtures with specific weight of 0.8-0.95 grams/cm³ and viscosity of C^5_{20}=25-40c with no mechanical admixtures having particles more than 1 mm can be utilized.

Kerosene, diesel fuel or other can be used as the dilutor.

To ensure penetration of the oily bitumen binder into the soil and its even spreading, it is recommended to first till the upper surface course, especially loamy sands, to a minimum depth of 10 cm.

When treating cohesionless soils, the treatment course thickness should be minimum 5 cm.

16. Gravel Barge Transportation. Handling Procedures

The procedures for loading/unloading barges when transporting bulk materials (sand and gravel) depend on availability of the docks, cargo handling devices, river depth in the dock area and draught of the barges and floating cranes.

Sand and gravel loading methods are as follows:

- By dredge when excavating the sand and gravel from the river bottom;
- By bridge crane equipped with buckets from the stockpiles of the delivered materials;
- By transporters installed at the dock areas from the stockpiles.

Sand and gravel unloading methods are as follows:

- From the river bank by cranes with buckets
- By floating cranes equipped with buckets

Sand and gravel can be unloaded from the bank if the river depth in the bank area is sufficient for barge mooring. If the depth is not sufficient, then it is recommended to use for unloading the floating cranes with shallow draft; the crane should be installed between the river bank and the barge.

When unloaded, the sand and gravel shall be stored in stockpiles at the designated areas and then transported by trucks to the work sites.

17. Soil Stabilization Methods

Presently, there are several soil stabilization methods designed for improving soils properties. They can be divided into three categories: mechanical, physicochemical and chemical. Below are the soil stabilization methods that are more acceptable in the area of the permafrost.

Mechanical Methods

Soil compaction with use of bored piles, vertical drains, explosives, vibration, hydrovibration, electrovibration methods. Compaction of loose soils resulted from the above external impact causes decrease of the porosity, consolidation of the mineral particles, squeezing of the void water and, as the result, high resistance of the compacted soil to the loads from the constructed facilities.

Water-saturated sandy soils can be drained with various drains, and electro-osmotic dewatering is used for loamy, silty and fluid soil. By decreasing water content, we change the density of the soil and improve bearing capacity. The drainage facilities are acceptable only for sandy soils and loamy sand.

The purpose of electro-osmotic dewatering is to treat the soils with direct (DC) electric current through the installation of soil electrodes. As the result, the electro-osmotic effects, electrophoretic effect and electrolysis cause exchange reaction which can be observed. The positively charged water molecules move to the cathode; negatively charged elementary particles of the soil move to the anode. The accumulated water is drained by pumps attached to the anodes. Electric dewatering is sufficient for the soils with drainage coefficient no less than 0.05 m/day. However, this effect may be temporary.

Physiochemical Methods

Electrochemical stabilization of the excessively water-saturated soils includes the combined effects of permanent electric current and stabilizing agents introduced via perforated electrodes. In addition to the effect caused by electro-osmotic treatment of the soils without introducing any chemical agents, there is a chemical reaction between soil and the introduced agent. As the result, the soil structure, chemical and mineralogical content as well as properties of the soil change significantly. New strength growth can be observed and soil stability and frost resistance properties are improved.

There are two methods of electrochemical stabilization:

- Electrical silication – treatment of the water-saturated fine sands and loamy sand as well as loess with drainage coefficient of up to 0.005m/day with direct electrical current and simultaneous introduction of sodium silicate and hardener into the soil.

- Electrolytic stabilization – simultaneous treatment of the water-saturated clay soils with drainage coefficients of less than 0.01 m/day with direct current and electrolyte (for example, calcium chloride).

The soil freezing method is used in the areas with permafrost when designing facilities as per Category I and II subject to preserving permafrost condition of the soil within the entire period of operation. For soil freezing, the wells are bored and freezing devices with circulating cold fluids are installed in the drilled wells.

Chemical methods

Chemical stabilization of the sub-bases composed of water-saturated soft unstable soil (peat soil, marshy soil, silty soil) that will be used for airfield construction can also be used as the stabilization procedure is very easy and the cost of chemical agents is very cheap.

These methods are based on pressured injection of various stabilizing mixtures and binders into the soils to change the natural properties of the soil and improve its stability. BY this means the water penetration and frost heave resistance may be improved. The significant change of soil properties caused by chemical stabilization is due to the complex chemical and physiochemical interactions between the injected agent and the soil.

Based on the type of injected agents and binders, there are the following methods of deep soil chemical stabilization:

Cementing – Injection of the cement, cement and silicate, cement and lime, cement and clay mixtures (suspensions) with admixtures or without them into the coarse-porous soil on fissured rock with the drainage coefficient of 30-50 m/day. When hardened in pores and cracks, the mixtures provides the soil stabilization.

Liming – Lime mixture or caustic floured lime (common lime or water lime) are injected in the well drilled in silty excessively water-saturated soil. Spreading through the cracks, pores and loose parts of the soil and hardening in there the lime mixture dehydrate and stabilize the soil. Floured lime after being slacked in the wells has a similar but more effective result.

Silication – Injection of silicate mixtures in low-permeable sandy and loess soils into which pores the cementing gel of silicic acid is formed. To stabilize soils with drainage coefficients from 2 to 120 m/day, the two-mixture silication method is used (sodium silicate mixture and calcium chloride mixture). To stabilize soils with drainage coefficient from 0.1 to 2 m/day, the one-mixture silication method is used (only one mixture is injected and soil itself is used as hardener).

Tarring – Stabilizing of the sandy, loamy sand and clay soils by injecting various synthetic resins with hardeners. This method is used to stabilize soils with the drainage coefficient of 0.05 m/day and higher. Carbamide, furan, phenol formaldehyde, epoxy, polyacrylamide and other types of polymeric resins and substances are used for tarring. The reinforced soil has higher stability, water resistance and other properties.

Stabilization with lignosulphonate is performed by injecting cellulose and paper industry waste (sulfite waste liquor alcohol, sulfite yeast wash etc.) with hardeners into the soil. This method is the most effective for clay soil and loamy soil with the drainage coefficient of 0.1-0.05 m/day. As the result of such stabilization, the water resistant gel is formed in soil pores that ensures stability of the soil.

Each method of deep soil stabilization has its own area of application determined firstly by the drainage coefficient and type of the treated soil, in consideration of technological procedures, pros and cons of the selected method, and cost aspects.

In addition to the deep soil stabilization, there are some methods of the surface stabilization of local soil with mineral and organic binders to construct pavement structural courses for airfields.

In both cases, deep or surface stabilization, the sub-base soil can be considered as a semi-manufactured article or raw material for producing local road construction material, which, in the first case, is used for construction of the surface courses of the airfields, and, in the second case, is used to create an anti-deformation and anti-sliding structure in the subgrade (piles, walls, layers, screens).

18. Aircraft and Load Types

The calculations for airfield pavement are made for normative loads, the categories and parameters of which are summarized in Table 20, as well as for loads from a specific aircraft type, which is projected to be operated at the airfield.

Table 20

Category of normative load for airfields	Normative load P_n per main (tentative) aircraft gear, kN (tf)	Tire internal air pressure p_B, MPa (kgf/cm^2)	Main gear
Non-Categorized	850 (85)	1.0 (10)	Four-wheel
I	700 (70)		
II	550 (55)		
III	400 (40)		
IV	300 (30)		
V	80 (8)	0,6 (6)	One-wheel
VI	50 (5)	0,4 (4)	

The distance between the tires of a four-wheel gear is taken as 70 cm between adjoining tires and 130 cm between rows of tires.

It is possible to replace normative loads of categories III and IV with the loads per one-wheel main gear and take 170 kN (17 tf) and 120 kN (12 tf), respectively, and the tire pressure for normative loads of categories V and VI to be equal 0.8 MPa (8 kgf/ cm^2).

Table 21 summarizes the application of normative loads depending on the class of airfield, approximate aircraft maximum take-off weight (MTOW) and equivalent normative load per one-wheel main gear.

Table 21

Parameters	Class of Airfield						
	А	А	Б	В	Г	Д	Е
Category of normative load	Non-Categorized	I	II	III	IV	V	VI
Normative load per tentative main gear, kN	850	700	550	400	300	80	50
Approximate aircraft maximum take-off weight (MTOW), metric tons	180	150	120	90	60	20	10
Normative load, equivalent to the one per one-wheel main gear, kN	440	350	250	170	120	100	50

Table 22 presents data for Russian aircraft based on loads and their ACNs.

Table 22

Aircraft type	Maximum permitted weight and empty weight of aircraft, kg	Load per one main gear, %	Tire pressure mPa	ACN at following pavement strength							
				Rigid pavements (B)				Non-rigid pavements (P)			
				high (A)	middle (B)	low (C)	super-low (D)	high (A)	middle (B)	low (C)	super-low (D)
IL-62M	168000/71400	47,0	1,08	43/16	52/17	62/19	71/22	50/17	57/18	67/20	83/26
IL-62	162600/66400	47,0	1,08	42/14	50/15	60/18	69/20	47/16	54/16	64/18	79/24
IL-96	231000/111500	31,7	1,08	35/15	43/16	52/19	61/23	42/17	46/18	57/20	76/26
IL-76T	171000/83800	23,5	0,588	29/10	32/13	29/15	33/14	24/9	27/10	34/12	45/16
IL-76TD	191000/87200	23,5	0,686	35/12	36/14	35/16	40/15	29/10	32/11	40/13	53/17
IL-86	216500/110700	31,2	0,932	26/14	31/15	38/17	46/20	34/16	36/17	44/19	61/23
IL-18	64500/33600	47,0	0,92	16/7	20/8	24/10	27/11	18/8	19/8	24/9	31/13
IL-114	22750/14500	47,5	0,588	11/6	12/7	13/8	14/8	9/5	11/6	13/7	15/9
TU-154	98000/53500	45,1	0,932	19/8	25/10	32/13	38/17	20/10	24/11	30/13	38/13
TU-134	47600/29350	45,6	0,834	11/7	13/8	16/9	19/10	12/7	13/8	16/9	21/12
YAK-42	56500/31800	47,0	0,88	13/6	16/7	20/9	23/10	15/7	16/8	20/9	26/11
YAK-40	16000/9700	44,0	0,39	9/6	9/6	10/6	10/6	7/4	9/5	11/7	13/8
AN-12	61000/32000	46,0	0,74	13/7	17/7	20/8	23/10	16/7	18/7	21/9	26/11
AN-24	21000/13400	46,6	0,49	9/5	10/6	11/7	12/7	7/4	9/5	11/6	14/8
AN-26	24000/15000	46,6	0,39	9/5	10/5	12/6	13/7	7/4	9/5	12/7	15/8
AN-32	27000/19000	46,7	0,49	12/8	13/9	14/9	15/10	9/6	12/8	14/9	17/11
AN-72	34500/19000	45,9	0,49	12/6	13/7	14/7	16/8	9/5	12/6	14/7	16/8
TU-204	93500/54970	45,4	1,372	23/12	27/14	32/16	37/18	25/13	28/14	33/15	43/20
AN-225	600000/254000	47,5	1,18	41/16	56/16	84/19	122/25	55/17	64/19	81/22	110/30

Aircraft type	Maximum permitted weight and empty weight of aircraft, kg	Load per one main gear, %	Tire pressure mPa	ACN at following pavement strength							
				Rigid pavements (B)				Non-rigid pavements (P)			
				high (A)	middle (B)	low (C)	super-low (D)	high (A)	middle (B)	low (C)	super-low (D)
AN-124	398000/180000	47,9	1,08	36/16	49/16	74/19	101/25	50/17	58/19	73/22	100/30
AN-22	225000/118500	45,9	0.49	25/12	27/14	27/15	37/15	28/12	36/15	43/18	61/24
AN-12	61000/32000	46,0	0,74	13/7	17/7	20/8	23/10	16/7	18/7	21/9	26/11
AN-74	34800/19000	45,9	0,49	13/7	14/7	15/8	16/8	10/5	13/6	15/7	17/8
AN-74-TK-100	36500/19000	45,9	0,49	13,6/6,6	14/7,1	16,3/7,1	17,7/8,2	11/5,4	13,6/6,5	15,5/7,5	18/8,3
AN-38	8150	45	0,5	-	6	6	-	-	-	-	6
AN-28	6500	45	0,5	-	4	4	-	-	-	-	4

19. Aircraft Maintenance

The airfield maintenance of aircraft is made according to the technological scheme of flight operations for the incoming and outgoing traffic, which is as follows:

For incoming aircraft:

- Aircraft separation in the airport approach zone
- Approach
- Landing on paved runway
- Taxiing
- Taxiing to the apron area
- Apron parking

For outgoing aircraft:

- Parking out of the apron area
- Engine start
- Taxiing
- Aircraft run and take-off
- Maneuvering in the terminal area
- Reaching the air corridor (en-route)

Aircraft maintenance at the airport is done in the following three (3) main airport zones, depending on the stage of aircraft operations:

- airfield (runway, taxiway(s)
- apron (operational maintenance service)
- parking areas and other areas of regular aircraft maintenance

Aircraft maintenance on the apron and parking areas is done according to the schedule of operational maintenance service and depending on the aircraft type. The operational aircraft maintenance service on the apron includes the following technological operations:

- installation of chocks
- installation of air intake blanks into the engines
- supply of oxygen, compressed air, water and gas
- supply of oil and fuel

- unloading and supply of chemical liquids
- visual check of airframe, powerplants, main gears, cockpit etc.
- cleaning of service cabins, passenger cabins, baggage holds
- fixing equipment malfunctions
- regular flight and pre-flight operational aircraft maintenance service

The time of operational aircraft maintenance service on the apron and parking areas depends on the aircraft type.

Both fixed and movable equipment are used for aircraft maintenance services:
- equipment to supply compressed air and fire-control liquids
- equipment to start-up engines, supply power and fuel hydraulic system of the aircraft
- equipment to supply fuel and technical liquids
- equipment for air-conditioning and heating, heating of aircraft engines
- aircraft tow
- equipment for on-loading and off-loading

In commuter airports with a small amount of freight and passenger traffic the aircraft parking areas are mainly equipped with facilities to start up aircraft engines and power supply. All other types of aircraft maintenance service are performed using movable equipment.

All parking areas are equipped with grounding units, and parking areas for aircraft of 30 metric tons and less are additionally equipped with mooring devices.

20. Spring Thaw Period and Operational Restriction During Thaw Period

Operational condition of the soil-surfaced airfields with no gravel or aggregate courses is characterized by the stability of the soil at the runway, taxiways and parking areas that depends on moisture content, grain size distribution and compaction levels, and can change significantly over the year. Cohesive clay soil and loamy soil in dry season are maintained in solid state and have high stability. When the moisture content increases, their cohesion decreases and, as the result, the resistance to the load decreases as well. These soils, when in a plastic state, are not acceptable for the operation of aircraft.

Cohesionless soils, sands and loamy sand improve their resistance to the loads when the moisture content increases to some extent; however they then lose their resistance to the loads when the full moisture capacity (saturation) is reached. When temperatures increase, these soils are rapidly dried and stability is gained within a short period of time.

As for grain size distribution, the most acceptable soils for unpaved airfields are loamy sands and clay loam. They have sufficient stability when moistened and can be used for creating and maintaining a sod surface mat.

Aircraft operation at the unpaved airfields is characterized as follows:
- Flight operations interruptions during thaw period.
- Take-off possibility during the time when the soil is excessively moistened is determined by break-away thrust of the aircraft engines.

The lower the soil stability, the deeper the tracks left by the aircraft landing gears, and sod matting can be damaged. In this case, the soil surface can hardly be leveled and repaired, especially after secondary drying and consolidation.

Flight operations interruptions in thaw periods are caused by severe moistening of the soil upper layers and soil stability decrease. Thaw periods are divided into long-term periods (spring and fall), and short-term (summer). In the Extreme North territories, thaw period can last long even in summer.

Spring thaw period starts right after the snow melts and the soil upper layer thaws. Additional moistening of the soil is due to the spring rains. The operation of the aircraft is permitted when the upper layers of the soil dries to the depth of 15-20 cm for the Class IV aircraft, and to the depth of 30-35 cm for the Class III aircraft.

To improve the operational condition of the unpaved airfields, its recommended:

- Construct solid sod matting that will allow faster drying and avoid the soil blow-off and dusting.
- Compaction of the soil to the extent that will decrease the water penetration into the soil.
- Dehydration in the areas with unfavorable hydrological conditions and terrain; protection of the airfields from storm water and run-offs from the adjacent areas.

The airfield fitness and readiness for operations is determined by comparison of its characteristics and parameters with the requirements of Flight Operations Guidelines for the particular type of aircraft.

At the airfields without sod matting, the thaw period is considered as non-operational period if RW soil stability is lower than the aircraft break-away strength; at the airfields with the sod matting, the thaw period is considered as non-operational period if RW soil stability is lower than operational stability.

21. Typical Runway Design Projects

The design of paved runways is made according to the requirements of Russian Federation's Federal Aviation Rules [1]. Based on the runway length, the civil airfields are classified as classes of А, Б, В, Г, Д and Е, and include the following main elements:

- runway strips, including paved runways and unpaved runways
- stopways, if they are planned to be used
- clearways, if they are planned to be used
- taxiways
- aprons and aircraft parking areas
- areas of special use

The required lengths of the runway and elements of the air strip are calculated according to the Manual on Design of Civil Airfields [7]. The calculations are made either as per nomograms for a specific aircraft type, or using adjustment factors that account for the class of airfield, runway length under standard conditions, airfield's elevation, outdoor air temperature at 1300 hours of the hottest month, and medium slope of the runway. Table 23 summarizes main elements of the airfields depending on the airfield classes.

Table 23

Airfield elements	Class of Airfield					
	А	Б	В	Г	Д	Е
Runway length in the conditions of MCA, m	3200	2600	1800	1300	1000	500
Runway width, m	60	45	42	35	28	21
Dirt runway width, m	95	75	75	45	45	–
Total width of the runway strip graded area, m	160	160	140	130	110	80
Distance between center lines of runway and main taxiway, m	190	190	180	180	95	90
Total width of runway strip, m	300	300	300	300	150	150
Minimum length of runway strip behind every runway end, m	150	150	150	150	120	120
Length of graded runway strip behind runway end (threshold)	75	50	50	30	30	–
Maximum longitudinal slopes: medium section threshold	 0,0125 0,008	 0,0125 0,008	 0,0125 0,008	 0,015 0,015	 0,015 0,015	 0,020 0,015
Longitudinal slope	0,020	0,020	0,020	0,025	0,025	0,025
Vertical curve radius, m	30000	20000	20000	10000	10000	6000

To secure a safe turn for a design type aircraft at runway ends and without any taxiway present, it is advisable to expand the runway. The amount of expansion is taken based on the turning radius that allows the aircraft to reach the runway center line at a minimum distance from runway end. Table 24 shows runway width in the expansion areas.

Taxiways connect the runway and the apron / parking areas. The number of taxiways is defined based on the ability of aircraft to maneuver and based on the aircraft traffic at a minimum taxiing length between the runway and other elements of the airfield.

Aircraft Classification Numbers (ACNs) for the aircraft operated at a given airfield define the minimum parameters – runway width, width of runway graded areas, radius of runway curves, distance between the runway and the obstacles and other runways.

Table 24 summarizes minimal runway parameters depending on the aircraft classification number (ACN).

Table 24

Aircraft index	Wing span, m	Main gear track (outer gear chassis), m	Runway width, m	Taxiway curve radius, m		Overall runway width with two graded areas, m
				Backing to runway or apron area	Taxiway crossings or turns	
1	Up to 24	Up to 4	7,0	10	10	10,0
2	Bt. 24 and 32	Bt. 4 and 6	10,0	20	20	13,0
3	Bt. 24 and 32	Bt. 6 and 9	13,0	30	25	16,0
4	Bt. 32 and 42	Bt. 9 and	17,0	50	40	27,0
5	Bt. 32 and 42	Bt 10,5 and	19,0	50	40	29,0
6	Bt. 42 and 65	Bt 10,5 and	22,5	60	50	40,5
7	Bt. 65 and 80	Bt 14 and 16	25,0	60	50	44,0

Airfield pavements are divided into rebuilt (capital) and light depending on the type of materials used. Rebuilt (capital) airfield pavements are sub-divided into pavements with rigid surfaces - monolithic concrete, armored concrete, reinforced concrete, pre-cast reinforced concrete, - and pavements with non-rigid surfaces – asphalt concrete.

The selection of optimum structure for the airfield pavements and artificial bases, and the selection of structural layers depend on operational loads, traffic loads and the availability of construction materials.

For artificial sub-bases the materials processed with mineral or organic primer are used - sand cement, crushed stones or gravel processed with bitumen, and also stable materials are used - crushed stones, gravels, sand-and-gravel mixture, sand.

For normative loads of Categories I-IV mainly capital pavements are made. The thickness of structural layers of airfield pavements is calculated based on the Federal Aviation Rules' manual [1], also considering operational loads, traffic intensity, the capacity of materials used and that of a sub-base.

In general, the total thickness of airfield pavements for airfields of Class A, Category I of normative loads – 120 cm, for airfields of Class Б, Category of normative loads – 100 cm, for airfields of Class B, Category III of normative loads – 90 cm, for airfields of Class Г, Category IV of normative loads – 70 cm, for airfields of Class Д, Category V of normative loads - 50 cm.

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APPENDIX B

GeoEngineers, Inc.

Alaska Remote Runway Construction Study

Literature Survey of Design and Construction Practices in Scandinavia

2004-1-21

F I N A L R E P O R T

VISTA

Forword

VISTA Utredning AS has been tasked by Geoengineers, Inc. to do a literature study of airport constructions on permafrost in the Scandinavian area. This is a study made to support the planning and construction of airports in the Yukon River delta in Alaska.

The task was originally defined to include literature surveys of relevant constructions on permafrost in the region, also including Greenland. It has been assumed that the most relevant material will be found in correspondence and project material among airport owners and developers rather than in books and other literature.

The task has later been reduced in volume, and will mostly concentrate on the most relevant example in this region, Svalbard, Longyear on Spitsbergen. This airport is owned and operated by the Norwegian state company Avinor AS, who is a subcontractor to VISTA Utredning AS on this task.

We are particularly grateful for the contributions by Mr Truls Mølmann of consultancy company Barlindhaug AS, Tromsø, Norway, by submitting reports on the thaw settlement depressions mitigation studies carried for Luftfartsverket (Avinor AS fron January 1st 2003) in the mid 1990ies.

Background material collection, interviews and report edition has been carried out by senior architect Johan Borchgrevink VISTA Utredning AS, while quality assurance has been done by senior engineer Geir Lange of Avinor AS.

Oslo, Norway January 2004.

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1 Background

1.1 Objectives

The objective with this study is to provide background material for future design and construction of airports in the Yukon delta of Alaska, USA. This and similar studies of design and construction experiences in USA, Canada and Russia particularly on constructions on frozen saturated silt, is expected to benefit choice of constructions for airports in that region.

1.2 Scope of work

After defining relevant geographical area, realizing where there are airports, contacts have been made to Scandinavian aviation experts on permafrost to challenge them to provide literature references or other experience data within defined areas.

At the same time Norwegian databases on relevant literature have been looked into, and people with certain expertise on permafrost and airport managers have been contacted.

Realizing that the main airport on Spitsbergen, Svalbard, Longyear, has a construction and maintenance history that should provide considerable useful knowledge, specific effort has been made to find sources for this experience, mostly from Norwegian airport owner organisation Avinor AS (Until December 31st 02: Luftfartsverket), and from companies supporting Luftfartsverket in their struggle to overcome the thaw settlements problems on that airport.

The report is in its reduced format not intended to give a balanced picture of all relevant permafrost constructions within the defined area, but to provide the optimum experience basis from this area considering its usefulness for future airport constructions in Alaska, mostly based on experiences from Svalbard, Longyear.

2 Permafrost in the Nordic area (geographic overview)

Scandinavia is traditionally defined as the three countries of Denmark, Norway and Sweden. To become the Nordic countries ("Norden") Finland and Iceland should be added. Included are also belonging islands like the Faroe Islands (Denmark) and Spitsbergen (Norway). It is a matter of definition to which region Greenland (Denmark, with certain autnomy) belongs.

The map (illustration 1) shows total extension of permafrost areas in the Nordic area, including Greenland. Most of this area is on Greenland and Spitsbergen. Permafrost is relatively scarce on the mainland, and continuous permafrost only in higher areas of Norway and on the borderland to Sweden. As few people live in higher areas, there are no airports built on continuous permafrost in the Nordic mainland. Elsewhere on the Nordic mainland there are no areas with permafrost, neither on the Faroe Islands nor on Iceland.

Most of Greenland is permanently covered with snow and ice, and airports of interest are all along the cost. We assume that relevant experience can be derived from airport constructions on Greenland, but it has been considered beyond the revised scope of this study.

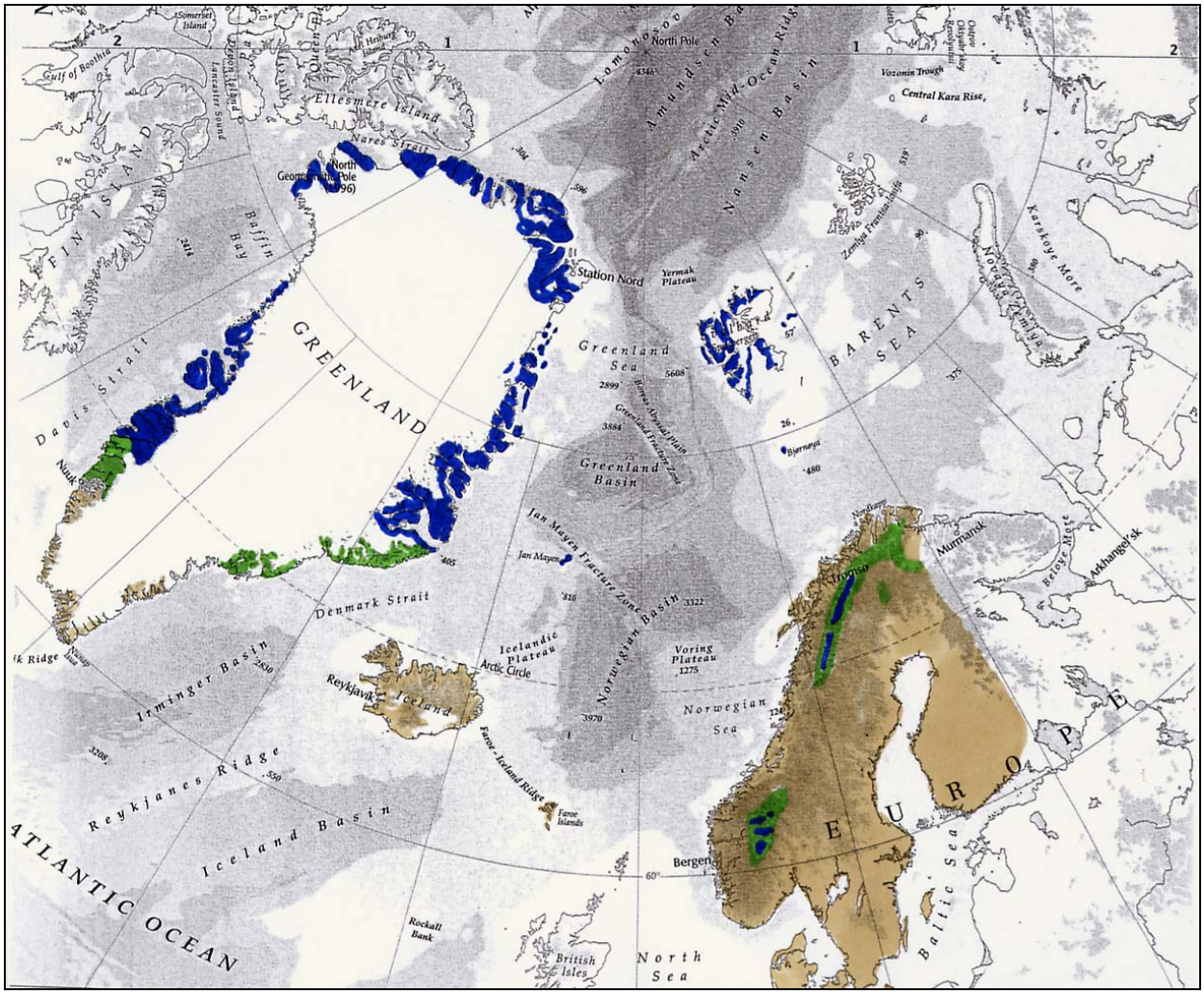


Illustration 1: Permafrost in the Nordic area.
Green: Discontinuous permafrost. Blue: Continuous permafrost. White: Ice cap or water.
Based on Times World Atlas

3 Airports experiences

3.1 Contacts made

To survey relevant literature and other material contacts have been made to Reijo Tassanen in the Finnish CAA and Nils-Erik Nyquist in the Swedish CAA, just to confirm the assumption that there is no relevant experience in either country. Mainland Denmark is definitely without any permafrost, and Greenland not included in the survey, and contacts to Copenhagen consequently not made.

The most valuable contribution to this study is without comparison project reports from Mr Truls Mølmann in consultancy company Barlindhaug AS, Tromsø, Norway, who carried out substantial research and analysis on Svalbard, Longyear jointly with EBA Engineering Consultants Ltd of Edmonton, Canada.

Information has also been collected from the Norwegian CAA, Avinor AS, Norwegian Geotechnical Institute and airport management at Jan Mayen, Svea and Ny Aalesund.

A complete list of persons contacted is given in attachment 1.

3.2 Airport overview

It has been confirmed also by our contacts that the relevant airports are to be found on Norwegian islands (and on Greenland). On Spitsbergen there are in addition to Svalbard, Longyear (see 3.3.), smaller airstrips at Ny Aalesund and at Svea. There is also an airstrip at Jan Mayen.

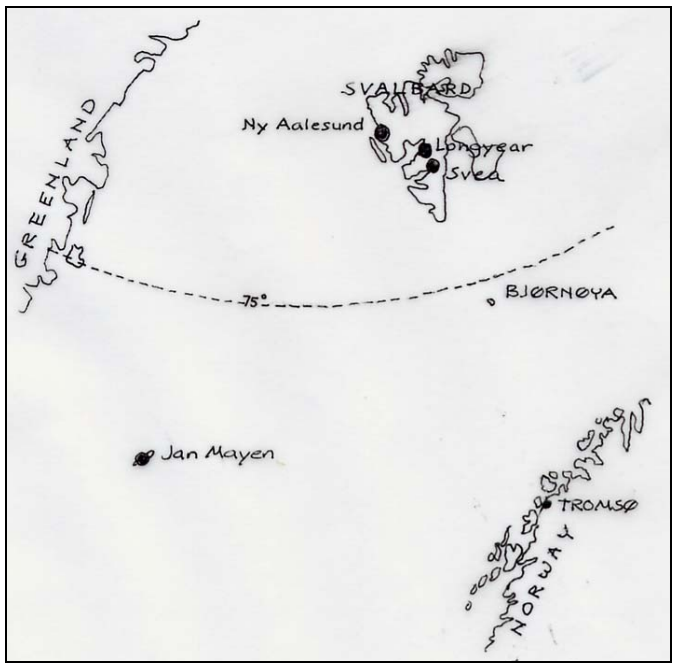


Illustration 2. Map showing location of the four airports addressed.

In the following most of the attention is given to Svalbard, Longyear, while there is also a small section outlining the conditions at Ny Aalesund, Svea and Jan Mayen.

Illustration 3.
Picture shows Hercules C-130 taking off at Jan Mayen (2277 m volcanic Beerenburg in the background. From the Jan Mayen Met station homepage).

3.3 Svalbard, Longyear

3.3.1 Basic information of airport

The airport was built in the summers 1973-75 as one of 18 so called trunk route airports in Norway. It is 2200 meters long, 45 meters wide, oriented 28-10, and equipped with a complete ILS to runway 10, while there is an offset LLZ-DME approach to runway 28. There is no surveillance system available in the area (questioned after the crash of an approaching Ukrainian aircraft in 1996, killing 141), and tower service is AFIS. See attachment 3-5

It is located just outside Longyearbyen, the main settlement in Spitsbergen. The population in Longyearbyen is approximately 1000, mostly busy with by mining and polar research.

The airport has two buildings in the terminal area: a hangar for one medium sized aircraft, and passenger terminal functions as an integrated part of that, and a utility building for maintenance, RFF and snow clearing vehicles, including some offices.

3.3.2 Aircraft types and traffic

The airport is mostly operated by major ICAO code 3 aircraft like B-737s and DC-9/MD-80s to the mainland. Smaller aircraft and helicopters serve other settlements from the airport, Russian Barentsburg, Ny Aalesund and Svea in particular.

Traffic totalled 4800 movements the first 9 months of 2003. Of these 800 were scheduled, 2300 charter and 1400 helicopters. Only 45 movements were international (Russian)

3.3.3 Ground conditions and original runway construction

The general geology in the area is tertiary rock (south of Isfjorden) of which younger parts contain coal, which has been commercially exploited for about a century.
The runway is constructed on a relatively flat coastal plain in an east-west direction. The ocean - Isfjorden – is close to the north of the runway, while south of the runway steeply sloping foothills rise to an upland plateau. These hills provide a source of surface and groundwater flow towards the runway. This water is channelled into two major drainage courses that cross beneath the runway through corrugated steel culverts. Cut-off ditches have been constructed on the uphill side of the runway to intercept runoff from the slope.

The coastal plain where the runway is situated is underlain by coarse to fine-grained soil. According to Tobiasson (1978) the soil underneath the runway ranges from being relatively dry to ice-rich, and contains ice lenses. Peat bogs, up to 0.5 m in thickness are believed to have existed at some locations along the runway; however, it is understood that the existing peat and tundra surface was removed prior to construction. Tobiasson also states that “Samples of permafrost below the runway revealed that that it contained numerous ice lenses up to 50 mm thick, but no massive ice”. It has also been reported that, in some locations beneath the runway, the soil contains about 70 % ice by volume.

The runway was constructed with approximately one-third to one-half of its area in cut and fill; the remainder of the area as an embankment fill. Fill thickness overlying the native soil varies from 1.1 to 4.0 m, depending on the location along the runway. The thinner fill sections are located within the cut and fill areas. The excavated material was used on both sides of the cut areas.

The runway was paved with 5-10 cm asphalt
Bearing capacity is presently declared to PCN-40 F/B/X/U

3.3.4 Initial problems and remedial actions

The runway has been affected by settlement depressions since the construction was completed in 1975. The sections with minimum fill are the sections that have experienced the most settlement distress. The resulting unevenness of the runway has required ongoing remedial maintenance to provide a relatively smooth runway surface. Measures used by Luftfartsverket include the construction of cut-off ditches on the uphill side of the runway, new, wider culverts to prevent water to overflow the runway when frozen pipes prevented the originally intended drainage, and painting the runway white. The white paint had insufficient effect and caused a very slippery runway when winter came, and was removed.

In 1989, 14 years after the airport was built, the runway was in poor condition and a PCI-survey concluded that a new surface layer was needed due to low temperature cracking, weathering and unevenness. It was decided to insulate the two cut areas south of the centreline after excavating additional 0.4 m in order to reduce the settlements. This action was effective, but left problems in the transition areas, suggesting that such insulation might have been carried out more extensively.

3.3.5 Site surveys 1994- 1996

After reasphalting the runway in 1993 a major study was launched in 1994.The objective of the study was to determine the cause of the settlements and propose potential rehabilitation solutions. A site investigation was conducted to address the following issues:

- assemble detailed stratigraphic information, including moisture content, salinity, grain size distributions, ice content, and bulk density
- monitor ground temperature below the runway surface, and
- examine ground water conditions.

Seven boreholes were drilled at the airport, two on the runway (EBA1 and EBA2) on the runway, four (EBA3-EBA6) south of the runway in the same area (station 1600 – 2100), and one in the west (MP1). The principal two boreholes were drilled on the runway for the purpose of assessing the stratigraphy and to install permanent ground temperature cables. The remaining four boreholes in that area were drilled along the southern uphill edge of the runway to study ground water conditions. Slotted standpipes were installed in the latter four boreholes for this purpose. See illustration 4 below.
Undisturbed samples were obtained for the first time where soil conditions were suitable using a 75mm diameter permafrost core barrel. The undisturbed samples obtained allowed the determination of ice content , particle size distribution, Atterberg limits, bulk density and salinity. See attachments 6 and 7.

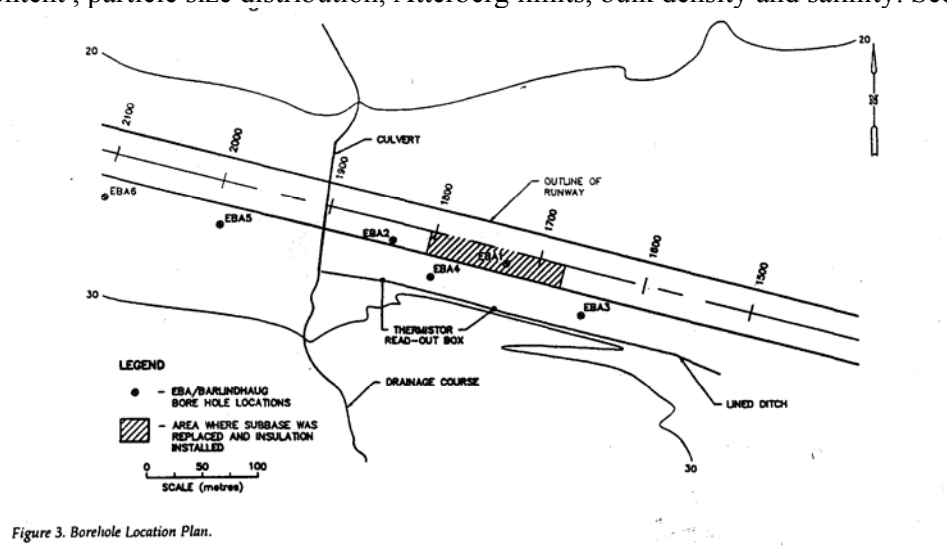


Figure 3. Borehole Location Plan.

Illustration 4. Borehole location plan. Barlindhaug/EBA, Site investigation and analysis, april 1994

Dataloggers, housed on the south side of the runway, were connected to the ground temperature cables. The first temperature data were recorded on April 28th, 1994.
Temperatures recorded through most of 1994 show significant differences between EBA1 and EBA2, see attachments 8 and 9. The annual maximum thaw front in the insulated area extends to just below the insulation and therefore does not reach the ice-rich silty clay located at 1.8m depth. The insulation installed is performing well. This is readily apparent when comparing the settlement that has occurred in the insulated and non-insulated areas.

The seasonal thaw front in the non-insulated area extends to 2.5m, well beyond the surface of the ice-rich soils found at 1.8m depth. The site investigation and temperature measurements obtained show that runway settlement is due to thawing of the ice-rich soils.

The installation of insulation has prevented thaw settlement. However, the insulation may have drawbacks as it affects the thermal gradient directly below the asphalt. The asphalt surface overlying the insulated sections may incur additional thermal cracking when compared to the non-insulated area. Differential icing of the pavement surface has resulted due to differential heat flow through the pavement structure. However, this is deemed to be a minor problem for the operation of the airport.

Since it was readily apparent that the surface settlement was caused by thawing of the ice-rich soil, it was necessary to identify the mode of heat transfer. Two possible mechanisms causing thaw were identified:

- Heat conduction from the ground surface
- Combination of heat conduction and mass heat transfer due to water sweeping underneath the runway causing enhanced thaw.

A thermal analysis was then conducted using a conductive heat transfer model. The agreement between the predicted and measured ground temperatures suggest that the model was appropriate to explain the observed behaviour, and that water flow beneath the runway did not provide a significant contribution to the thawing process.

3.3.6 Rehabilitation alternatives and recommendations

The site investigation and subsequent analysis have determined that runway settlements are due to progressive thawing of ice-rich soil. Runway settlements may be eliminated if the thaw front is prevented from reaching the ice-rich soil. The following rehabilitation alternatives have been suggested:

1. Insulation alternative

Extruded insulation (100 mm thick) already installed has prevented further thaw settlement. Extending insulation to other problem areas should therefore eliminate further settlement problems. Challenge would be transition zones between insulated and non-insulated zones.
Drawbacks: High cost and traffic disruption for at least one summer.

2. Remove and replace alternative

An alternative to insulation to keep the ice-rich permafrost frozen would be to remove it completely down to the underlying frozen gravel stratum. It is anticipated that the amount of ice-rich soil would need to be over-excavated will vary along the runway. The same drawbacks as for alternative 1 apply.

3. Raised grade alternative

Raising the runway grade by addition of thaw stable gravel, either by adding an estimated 1.5 m of stable material or combine with 50 mm extruded polystyrene placed directly on the runway and 1.0 m of

stable gravel. Less construction time is expected compared to alternatives 1 and 2, but there would be additional cost in terms of replacement of lights, navigational aids etc.

4. Painting alternative

Previous attempts to paint the runway white showed that the thaw front was reduced by an average of 0.4 m. This solution would not solve the problems associated with thaw settlement, but will rather slow the rate of thaw. There would be maintenance issues to make sure the runway remains white, and to keep acceptable friction when wet or frozen.

5. Patch/overlay alternative

This alternative means continuing what has been done in the past. Thaw settlement would be monitored, and asphalt patching/overlays would be utilized as required. Investments are less, and the runway would be taken out of service for short periods of time.

The study has determined that the thaw settlements observed on the runway are due to permafrost degradation of a layer of ice-rich soil. Finite element analysis has shown that the ground temperature distribution agrees well with the geothermal model. This indicates that the thaw settlements observed does not relate to mass heat transfer from the flow of water underneath the runway.

Luftfartsverket intended at that time to excavate and insulate (alternative 1).

3.3.7 Later actions

Since then Luftfartsverket has carried out aircraft performance studies to support the basis for further actions, and yet no major reconstruction has taken place. Patchwork (alternative 5) is still done, and alternatives 1 and 3 are still being considered.

3.4 Svea

Svea is a small mining community approximately 50 km southeast of Longyearbyen on Spitsbergen, and the airstrip belongs to mining company Store Norske Spitsbergen Grubekompani AS.
Svea airfield was completely rebuilt on an old airstrip site in 1994. It is 850 m long and 30 m wide + safety zones, and had 2066 aircraft movements in 2002, most of them to and from Longyear.
It was constructed with a thick bottom layer of rock rubble, covered with more fine grained gravel, all shipped from mainland Norway. A binding agent is mixed into the top layer.
Uphill water is drained by ditches to either runway end.
Maintenance involves fresh mainland gravel and use of a vibro roller**.** Thaw rarely causes runway to become too soft for aircraft operations.

3.5 Ny Aalesund

Ny Aalesund is another mining community approximately 100 km northwest of Longyearbyen. This airstrip is owned by mining company Kings Bay AS.
The airstrip in its present shape was rebuilt in 1996. It is 800 x 40 meters plus safety zones. In 2002 it had approximately 350 aircraft movements.
The 1996 reconstruction utilized local crushed rocks, and a top layer of gravel shipped from the mainland.

The runway is located almost on top of a ridge, and suffers little from surface water flow. By removing snow and ice carefully before surface melts a certain “freeze dry” effect is obtained, keeping the runway mostly dry and operable during summer months.

3.6 Jan Mayen

Jan Mayen is an isolated island of 373sqkm located 7100N, 800W, approximately 500 km to the north east of Iceland. It is not recorded if the ground is continuous permafrost or if there are some areas thawing completely. The airport was built by the Norwegian Ministry of Defence to serve the only settlement on the island: a meteorological station. The airstrip is 1650 meters long and is operated by C-130 Hercules (see illustration 3) and some minor aircraft. The military aircraft visits Jan Mayen six times a year. The runway has no bearing construction and the top layer consists of local volcanic sand, and lava sand is applied and compacted by use of a vibro roller to mend damage made by surface water eroding the top layer. At one stage local gravel of higher density was applied, but it was more easily eroded for instance by propeller blast, and the more fine grained sand is now back on top. Operations occasionally take place on the runway even when thaw has made the top layer soft. In such cases the depth of “slush” is measured and reported to the pilot. There are periods of time, for instance during periods of summer rain, that the runway is unsuitable for aircraft operations.

4 Attachments

1. Contact persons
2. Literature (written material)
3. AIP Norway, Longyear: Landing chart
4. AIP Norway, Longyear: ILS+DME 10
5. AIP Norway, Longyear: LLZ+DME 28
6. Borehole log EBA1
7. Borehole log EBA2
8. Ground temperature profile EBA1
9. Ground temperature profile EBA2
10. Longitudinal profile
11. Cross sections

4.1 Contact persons

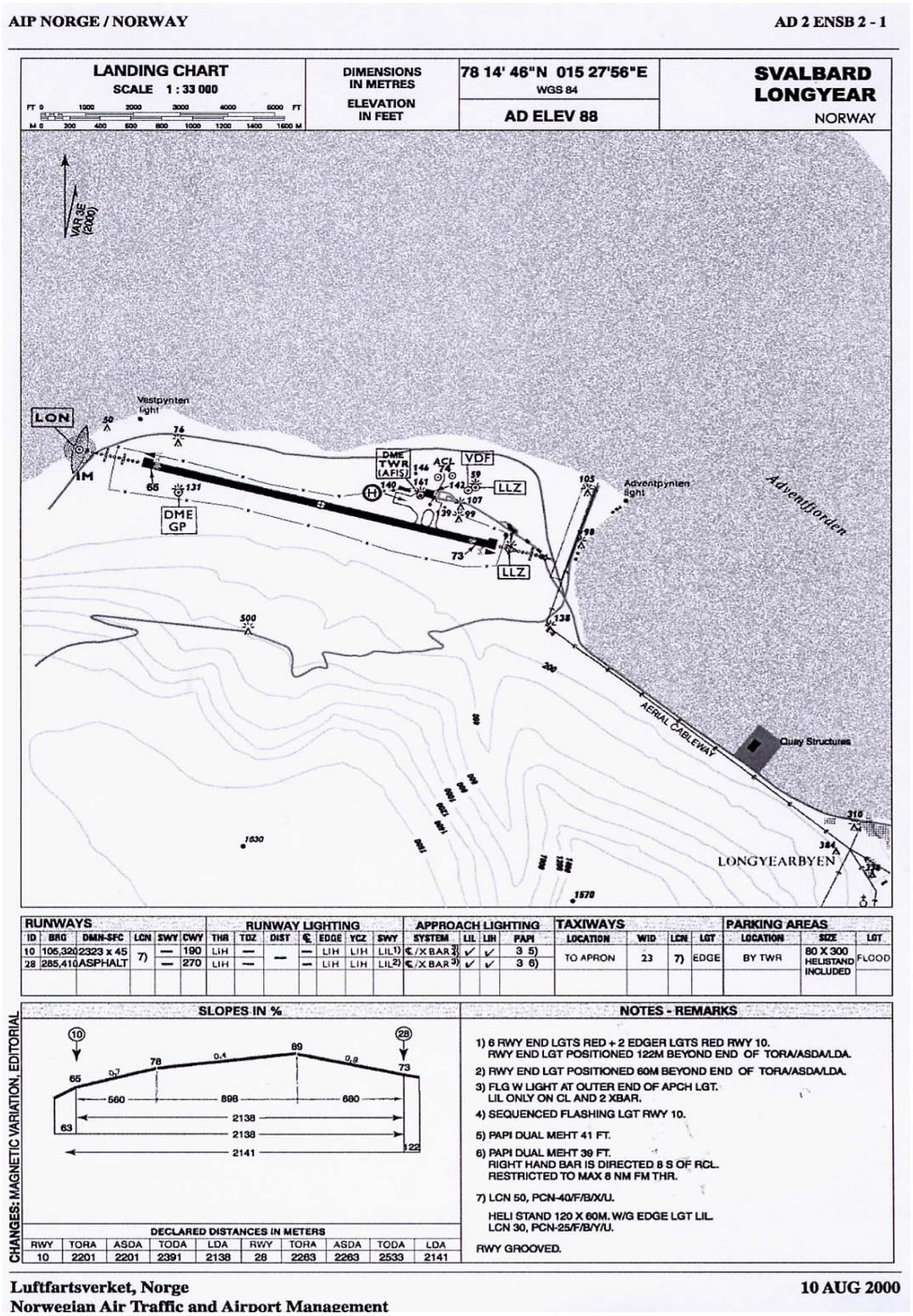
The following persons have been contacted for information:

Reijo Tassanen, Ilmailolaitos, (Finnish CAA)
Nils-Erik Nyquist, Luftfartsverket (Swedish CAA)
Truls Mølmann, Barlindhaug AS, Tromsø, Norway
Civil engineer Ørjan Nærland, Norwegian Geotechnical Institute, Oslo, Norway
Traffic analyst Øystein Tvetene, Avinor AS, Oslo Norway
Tomm A.Øwre, Airport licencing, Luftfartstilsynet (Norwegian CAA)
Airport manager Gudmund Vangberg, Store Norske Spitsbergen Grubekompani AS (Svea)
Work manager Øystein Blia, Kings Bay AS (Ny Aalesund)
Head of Electrotechnical dept. Tom Olav Johansen, Jan Mayen Met station

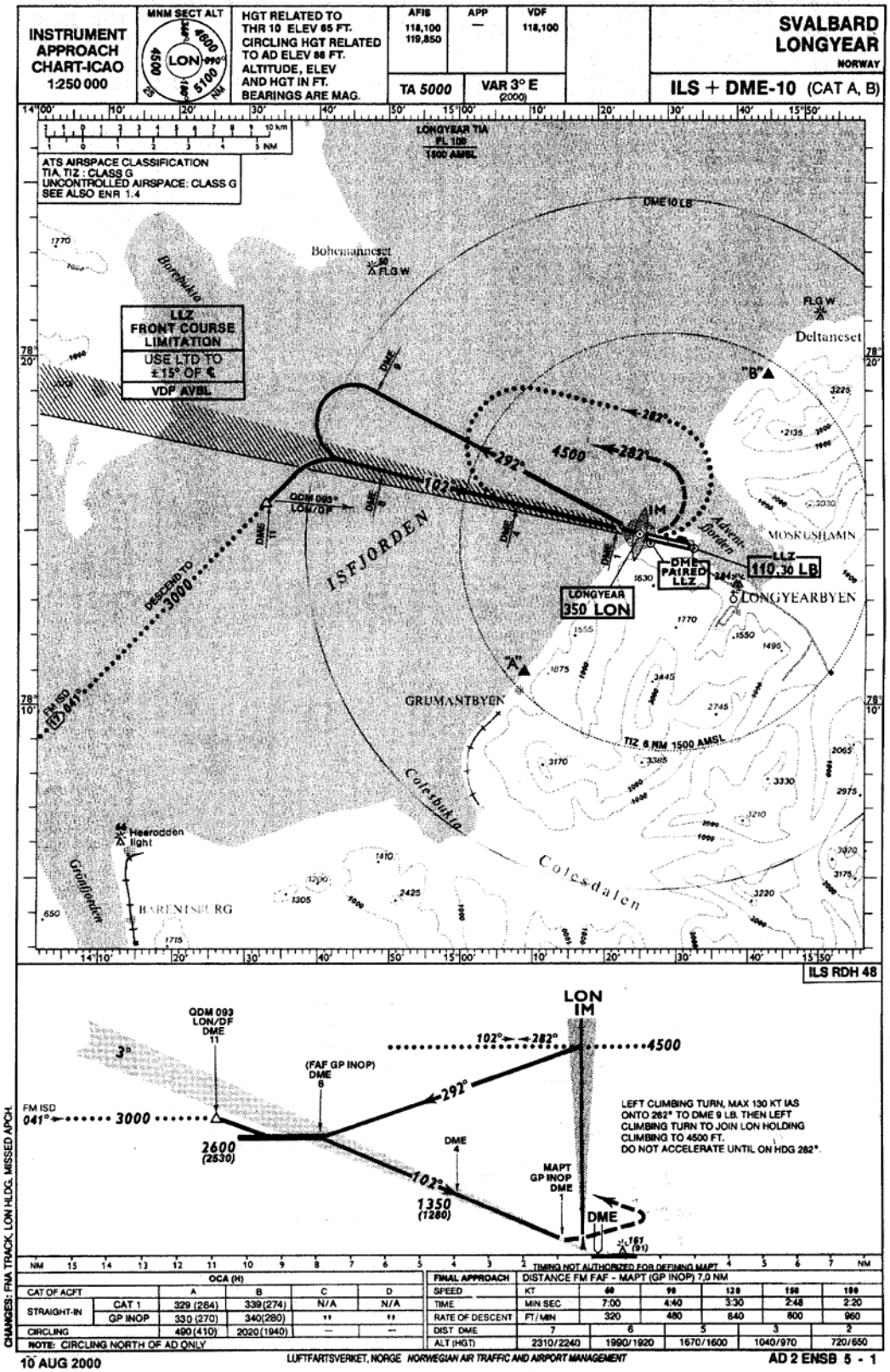
4.2 Literature (written material)

Barlindhaug and EBA (1995): Svalbard Airport. Runway distress investigation phase II
Site investigation and analysis.
Barlindhaug and EBA (1996): Svalbard Airport. Preliminary Design Report.
Barlindhaug and EBA (1998): Svalbard Airport Geotechnical Study: Engineering Methodology and Results
Presentation to the 7th International Conference on Permafrost, Yellowknife, Canada June23-27.-1998.
Avinor: AIP Norway
Norwegian CAA: Airport licences for Svea and Ny Aalesund
Jan Mayen Web home site

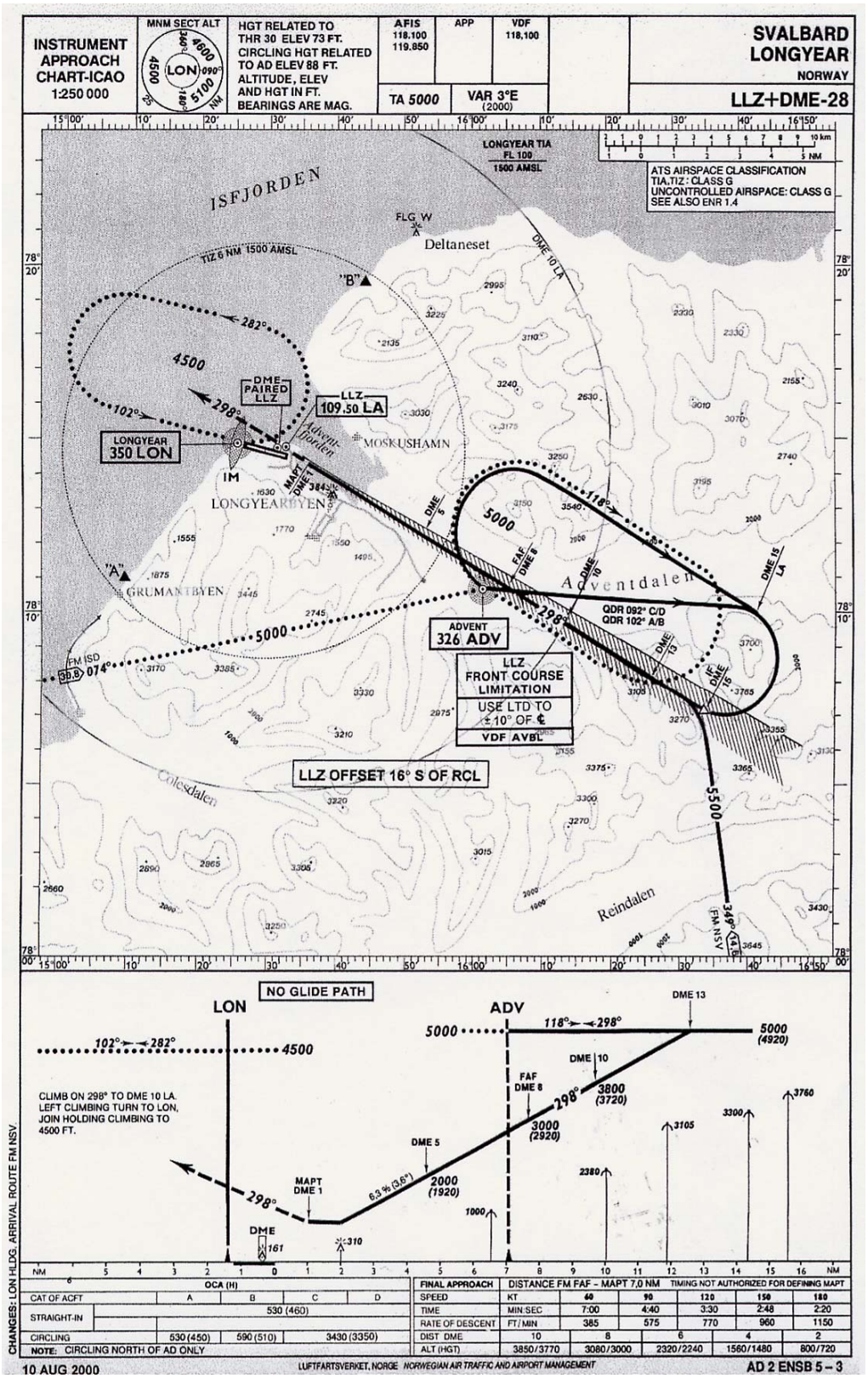
4.3 AIP Norway, Longyear: Landing chart



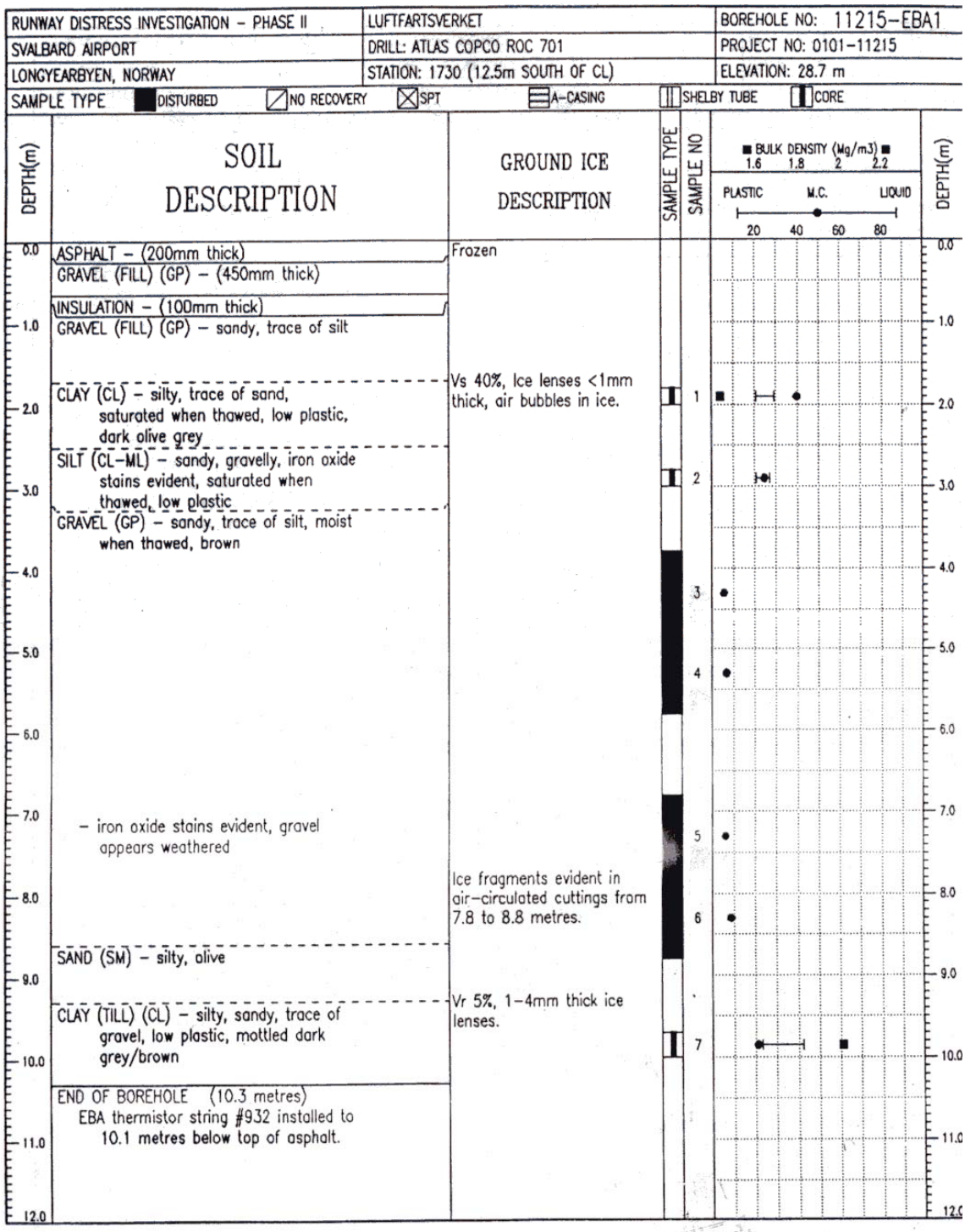
4.4 AIP Norway, Longyear: ILS+DME 10



4.5 AIP Norway, Longyear: LLZ+DME 28



4.6 Borehole log EBA1



igure 4. Borehole Log EBA1.

Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998

4.7 Borehole log EBA2

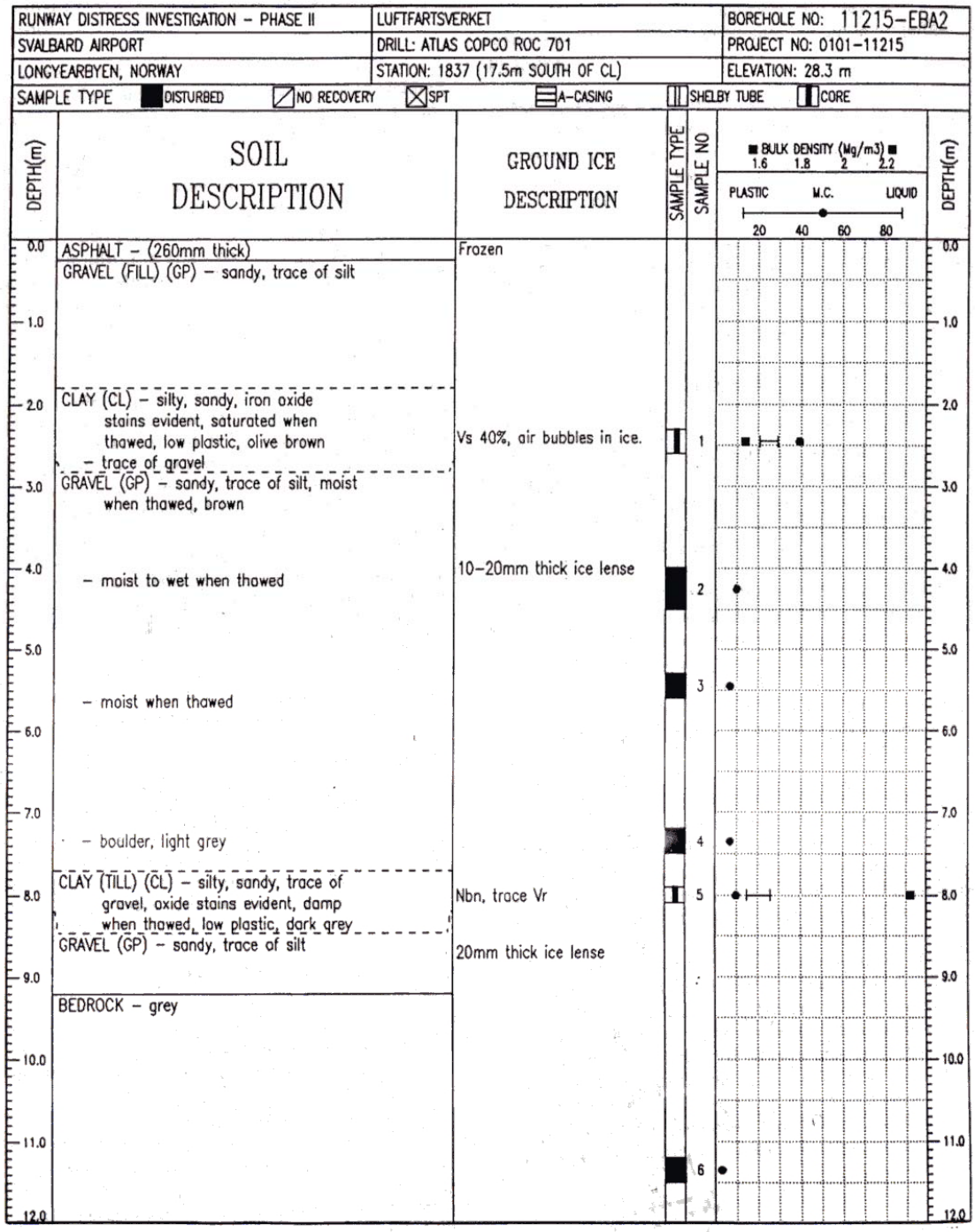
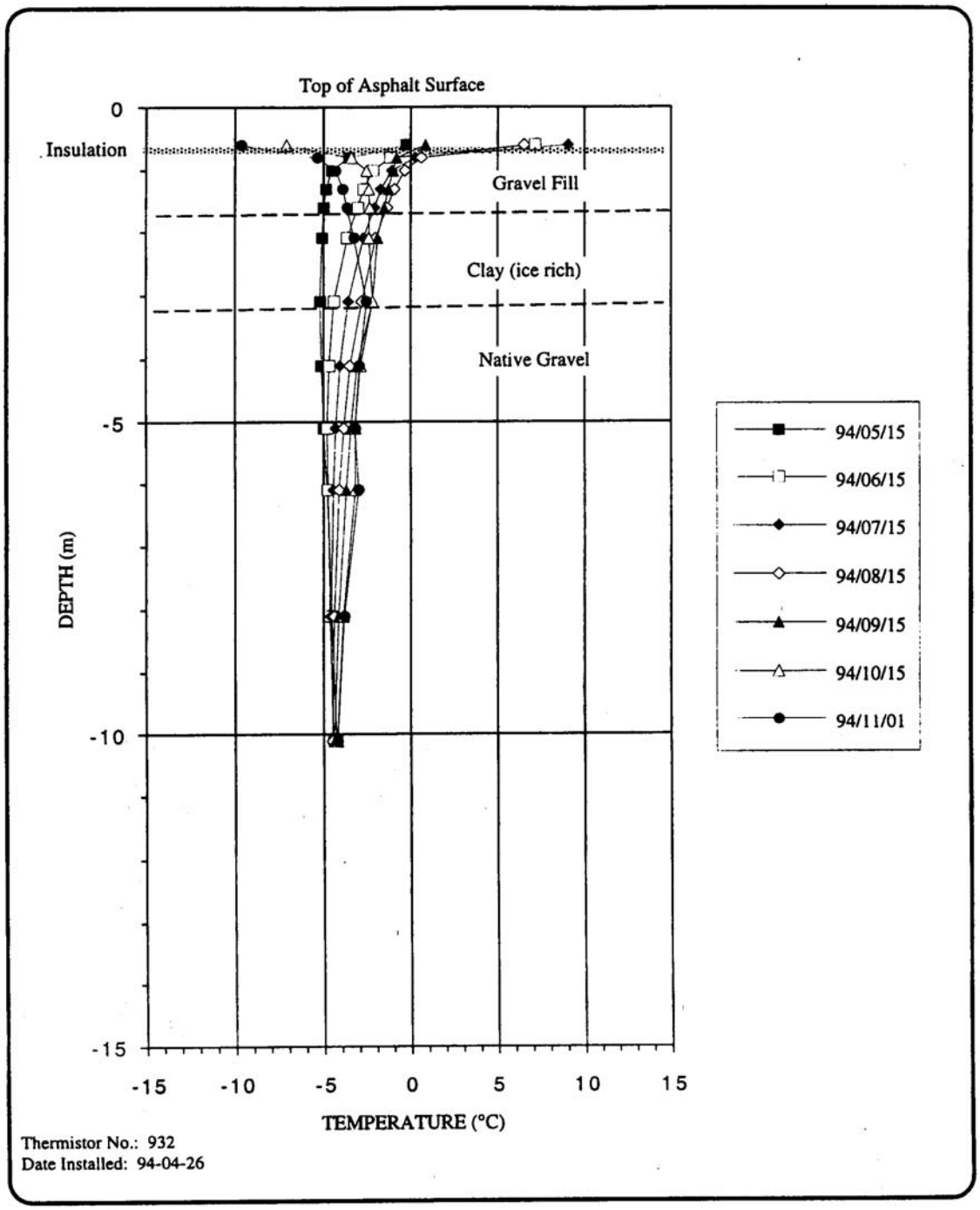


Figure 5. Borehole Log EBA2.

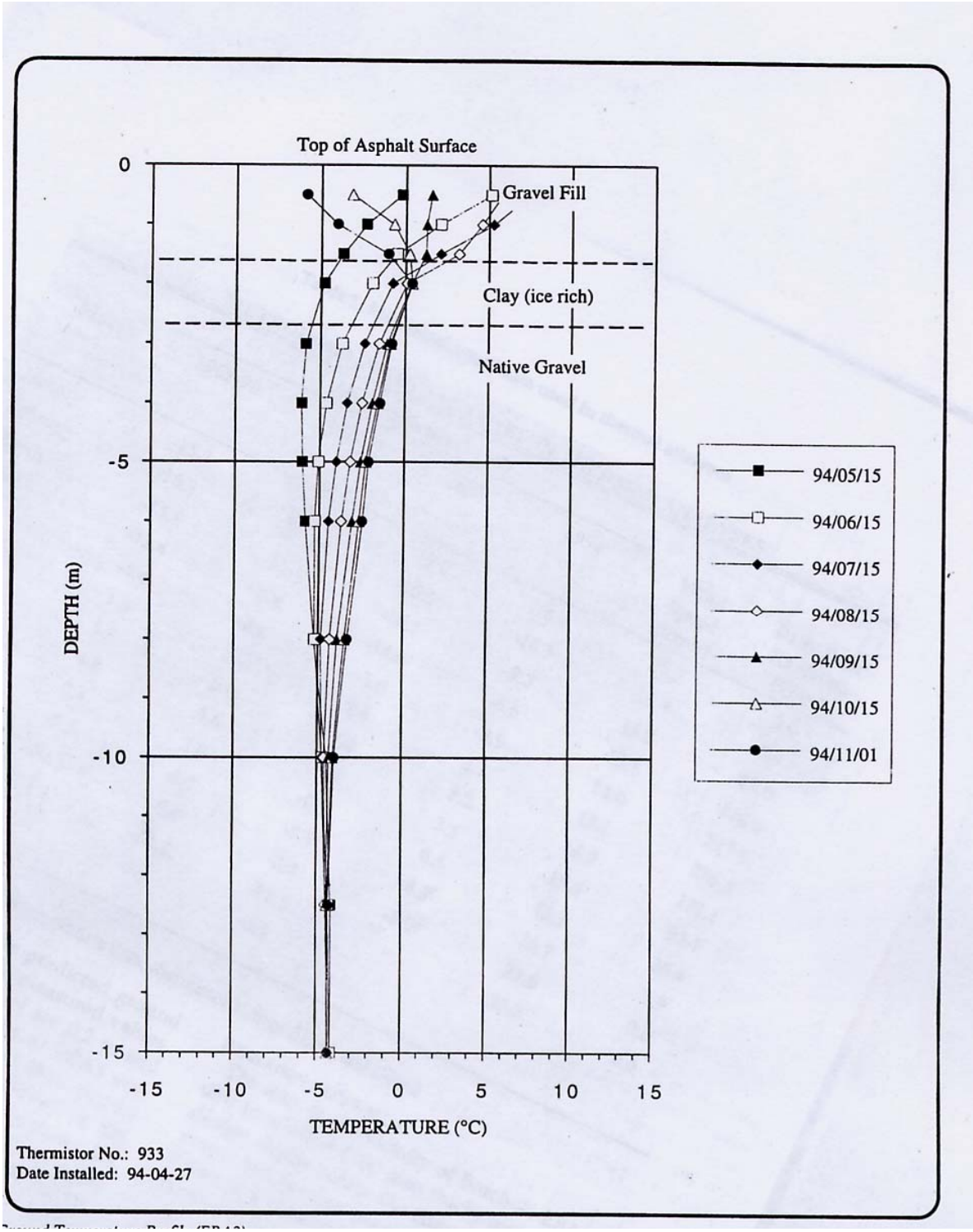
Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998

4.8 Ground temperature profile EBA1



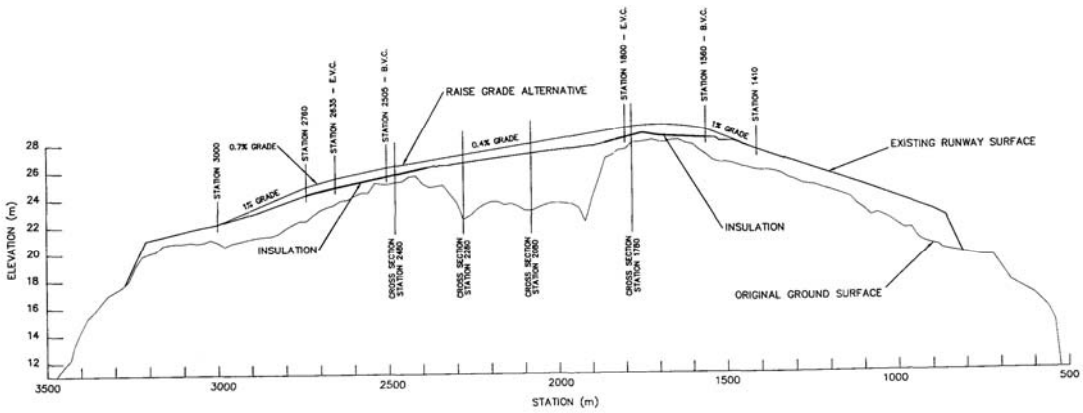
Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998

4.9 Ground temperature profile EBA2



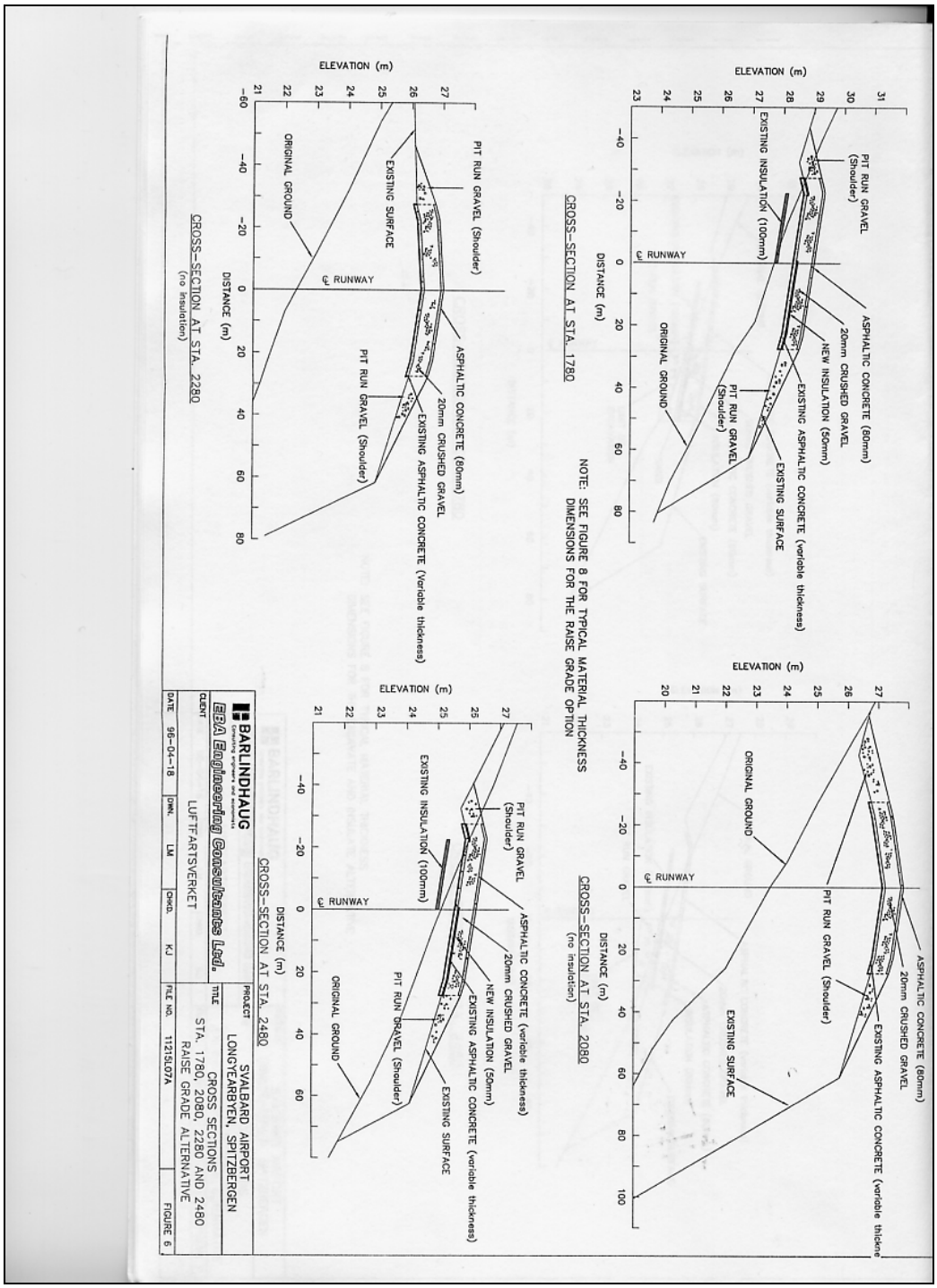
Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998

4.10 Longitudinal profile

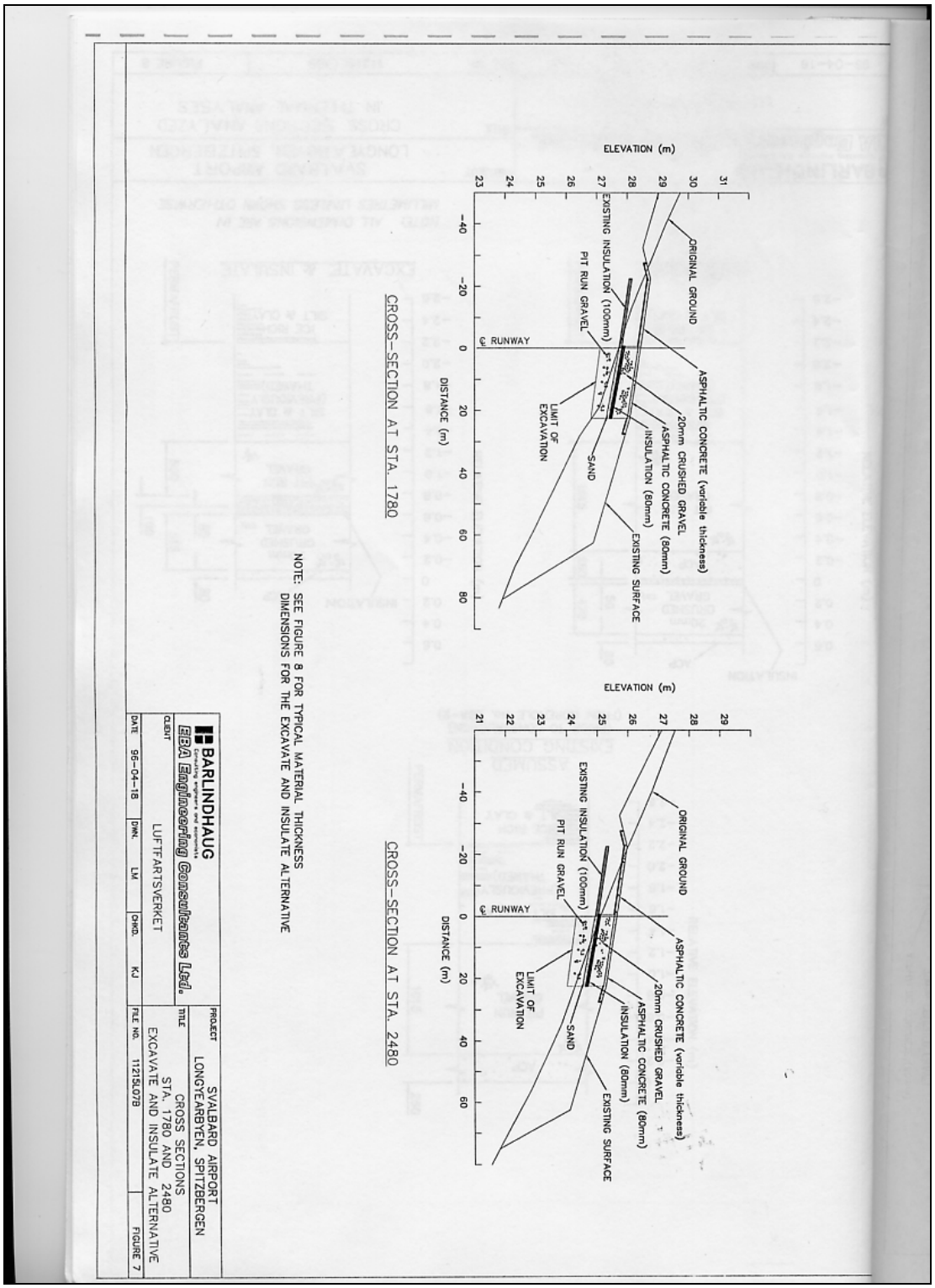


Barlindhaug/EBA: Svalbard Airport: Preliminary Design Report 1996

4.11 Cross sections



Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998



Barlindhaug/EBA: Presentation to the 7th Conference on Permafrost 1998

APPENDIX C

Information Search on Airport Design, Construction and Maintenance in Permafrost Areas in Northern Europe

Submitted to GeoEngineers, Inc.

by

Asphalt Pros
Hannele Zubeck

December 3, 2003

Introduction

GeoEngineers, Inc. tasked Hannele Zubeck representing Asphalt Pros to find out information from Finland and possibly other countries in northern Europe about airport design, construction and maintenance in arctic and sub-arctic areas. As other project teams consist of members in Norway and Russia, Asphalt Pros focused on information available in Finland and mainly written in Finnish. Other references are quoted as prompted by the subject topics.

The Finnish knowledge of airport construction in arctic and sub-arctic aerias is well summarized by Reijo Tasanen's response to acquires about the subject. As a representative of the Civil Aviation Administration of Finland he reports that they don't have any literature regarding air port structural design. Instead, they use FAA's publications. Airports in Finland are not in permafrost areas and are not designed to be immune to frost action. The structural layers and drainage are, however, designed to mitigate the frost action. Tasanen doesn't know any literature about design in permafrost areas. (Personal communication, 2003)

As there are no airports in Finland in permafrost areas, not much information was found that directly benefits the project. Experiences from road and embankment design and construction in seasonal and permafrost areas are given if they were considered relevant to the project. The information in this report is collected by interviews and from referenced literature. All the requested topic areas were considered, but for some of them, no information was readily available. The following sections summarize the reviewed resources.

Placement and use of wet or frozen silts in embankments

Silts were used in road embankments in Finland in 1930s. When placed in the active layer, they were layered with non frost susceptible materials (Finnish Road Administration, Finnra, 1997). There is no knowledge of current use of wet or frozen silts in embankments.

Semonova et al. (2003) report experiences of active layer tamping in cryolithozone. A 2500-kg pyramid shaped tamper was dropped from a crane. In plastic sands and sandy loams tamping may be effective prior to about 40 strokes, after which soil starts to squeeze out of the ground. If there is water above the permafrost table, compaction is only possible after the removal of the water. Dynamic load on water-saturated ground in closed system was completely transferred to the water, and the water-saturated soils were

incompressible. Loose sands may be compacted by spreading coarse material to the ground surface and tamping it into the sand.

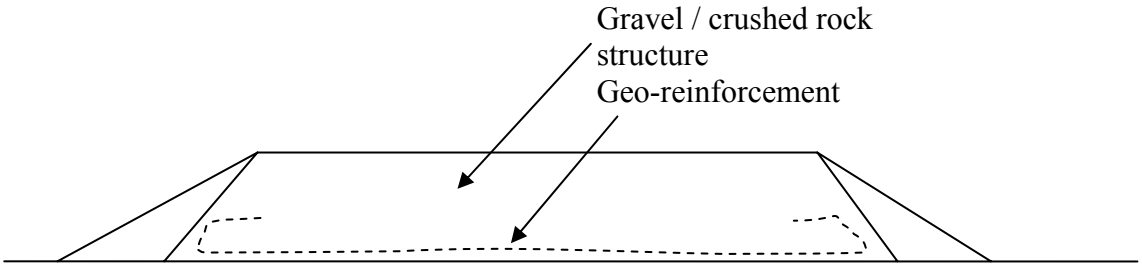
Dr. Seppo Saarelainen from the Technical Research Center of Finland suggests crushing and compacting frozen silts. Crushing decreases the thaw settlement due to reduced porosity. A report in Swedish has been ordered about the subject written in the Technical University of Luleå.

Geotextile reinforcement of embankments; types used, burial depths, and design methods

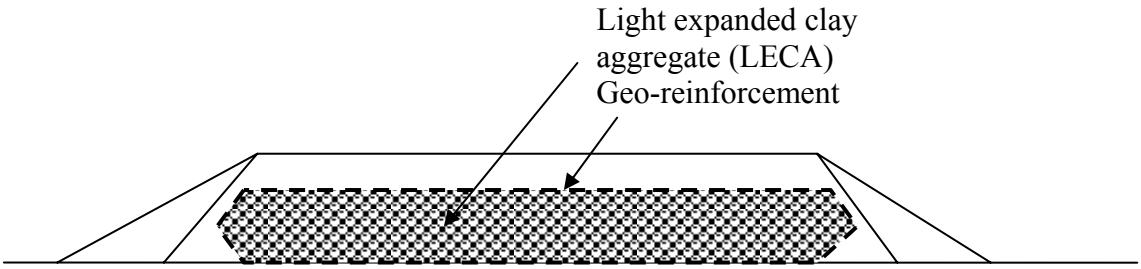
Aalto et al. (1998) have written a book "Synteettiset Geovahvisteet, Suunnittelu ja Rakentaminen" or "Synthetic Geo-reinforcements, Design and Construction." It is based on literature review, laboratory tests, modeling and full scale in-situ test construction in Finland. The following conclusions deal with the cold environment:

- Polyethylene and polypropylene are the recommended polymers for cold environment, except when used with hot asphalt mixture when polyamides or polyester need to be used. Polyamides and polyesters are also recommended for long time loading (design life ≥ 60 years).
- Applications for road and airfield structures used in Finland are given in Figure 1. Reinforcement for gravel surfaced temporary road is designed using Giroud & Noiray (1981) method that considers traffic, undrained shear strength (c_u or CBR) and allowable rut depth. Aalto et al. also accept design methods from reliable manufacturers of geo-reinforcements (Aalto does not define reliable manufacturers). The standard axle load is 80 kN, the road structure is assumed to be homogeneous and strong enough for the possible failure to occur in the subgrade or in the geo-reinforcement between the structure and the subgrade. The method also assumes that the subgrade fails undrained, the geo-reinforcement's anchoring is adequate, and that the traffic uses same tracks. The method does not consider spring thaw weakening, but it is assumed that the geo-reinforcement improves the bearing capacity when compared to structure without reinforcement. A correction coefficient can be calculated for other than 80 N axle loads. Frost protection need to be considered separately.
- Geo-reinforced embankment structures on soft soils used in Finland are given in Figure 2. They are designed using method described by Jewell (1988). There are no special considerations for cold climate. Recommendations for burial depths are not given. An example calculation uses 300 mm from the road surface for a situation presented in the top structure of Figure 2.

Steel nets or webs have been routinely used in Finland to mitigate cracking and uneven thaw settlement. Best results have been obtained by placing the steel web reinforcement in the middle of the base course. (personal communication with Seppo Saarelainen). More information and construction recommendations are available if there is interest to this technique.



Clayey or peaty subgrade



Clayey or peaty subgrade

Figure 1. Alternative geo-reinforced structures for road and airfield structures used in Finland (Aalto et al. 1998).

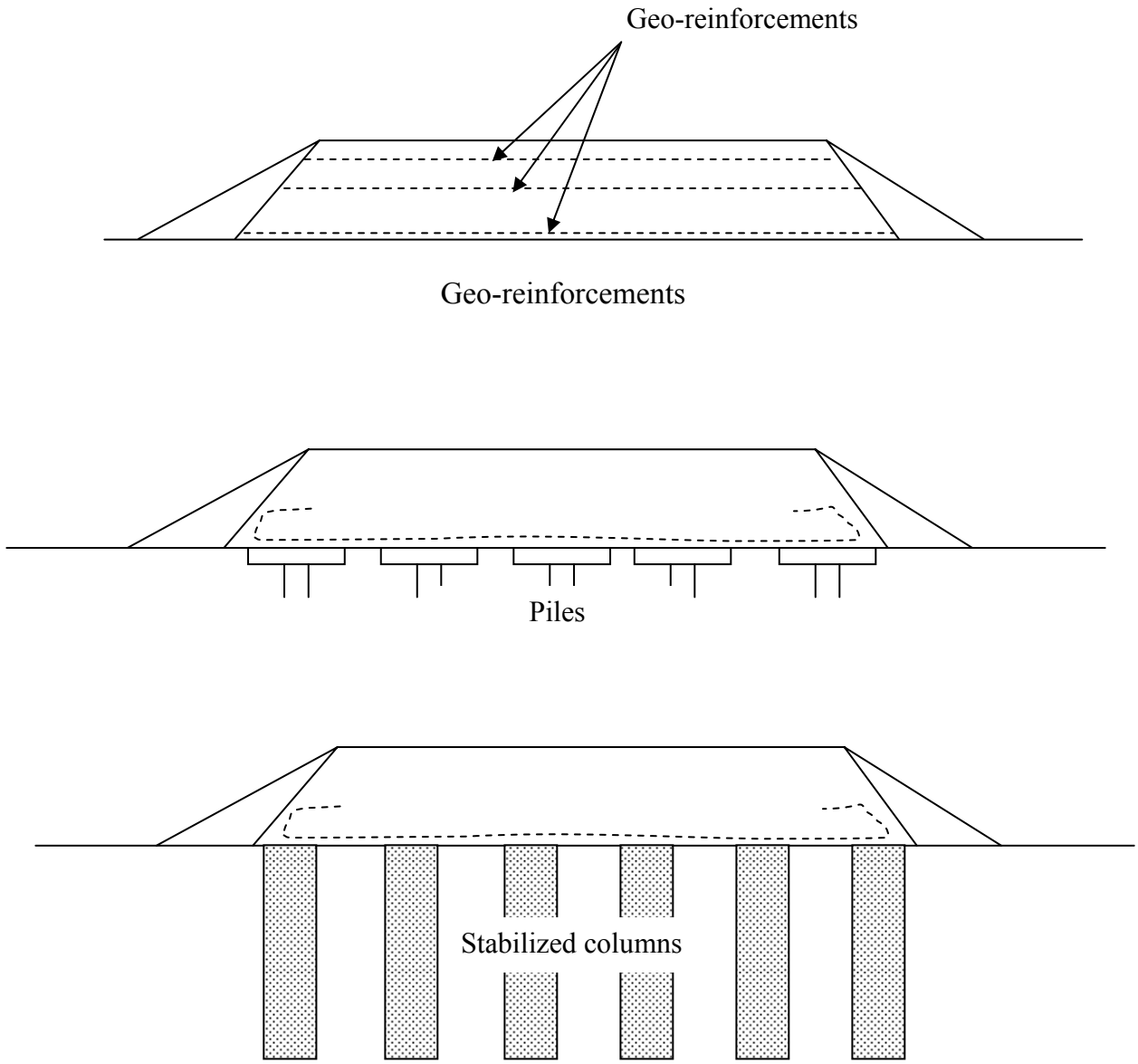


Figure 2. Use of geo-reinforcement in embankments on soft subgrades

Timber mats have been used in road construction. They are not so common anymore due to the availability of cheaper reinforcing materials. A mat can be constructed using evergreen trunks (branches are removed) with a minimum diameter of 100 mm. The trees are placed in two layers on a level surface side by side or using a maximum distance of 0.5 m. The trees in the two layers form 90 – 120° angle with each other. The trees must be at least 2 m long and adjacent joints need to be avoided. Where the trees cross, they need to be wedged or saddled so that they support each other. Every second crossing need to be fastened with bolts or similar. (RIL 1995)

Unpaved runway structural design methods

Finland uses FAA's design methods (Personal communication with Tasanen, 2003).

Drainage methods for organic silty soils

Vertical wick drains, typically geocomposites, are used in road construction in Finland. It is not sure if wick drains work for organic silts (Personal communication with Hartikainen, 2003). RIL 156 (1995) states that it is important to monitor the settlement and sometimes pore water pressures. If an overburden is required, it needs to be placed in summer when the silt is completely thawed.

Frost heave and thaw settlement mitigation methods

Transition zones between frost susceptible and non frost susceptible materials are used in Finnish embankment construction (RIL 156 1995) to level out differential frost heave and differences in spring time bearing capacities. The transition zones are wedges made out of non frost susceptible material. The depth is designed using recommendations given by the road authority. E.g. the Finnish Road Administration specifies wedge depths from 1.5 m in Southern Finland to 2.2 m in Northern Finland. The length of the zone is determined with the magnitude of the predicted frost heave and allowable change in longitudinal grade. The length of the wedge varies between 3 to 50 m. Wedges are also necessary at culverts and pipes in the road structure. The bottom of the wedge needs to be drained if water will flow into it. The compaction of the wedge needs to meet the requirements for the upper layer.

Differential frost heave has been mitigated on existing roads with placing a steel net and 200-mm thick layer of crushed rock on the top of it. Based on field experience, the softest

locations during the spring thaw were remedied using this method (Personal communication with Seppo Saarelainen).

Insulation usage

Frost protection in Finland is also conducted using insulation (RIL 156 1995). Board insulation or light expanded clay aggregate (LECA) are the materials used. The thickness of the material is designed based on the freezing index and local conditions. If board insulation is used, it needs to be done in one layer, as water may collect between the layers and increase the heat conductivity. The boards are placed on a sand bed of 50 to 100 mm. A plastic membrane on the top decreases the wetting of the insulation boards. The boards need to be covered daily during construction with a minimum of 0.2 m gravel layer. The edge boards and every fifth board should be attached to the ground with wooden nails. The embedment depth from the wearing course should be at least 0.7 m to avoid early freezing of the surface. Transition zone between insulated and non insulated area is built gradually by reducing the insulation thickness until it is 20 mm.

LECA gravel is placed on the top of a sand layer or a separation geotextile (RIL 156 1995). A layer of LECA is spread, leveled out and compacted using a light weight dozer with tracks. The slopes need to be protected with a minimum layer of 0.5 to 1 m friction soil. A separation geosynthetic (textile or a membrane) need to be placed on the top of the LECA layer. A granular soil layer is then placed on the top of the geosynthetic. The thickness of the layer needs to be at least 0.2 m. It needs to be compacted with light weight equipment. After this regular earthwork equipment may drive on the surface. The final layer thickness on the top of the LECA layer needs to be at least 400 to 600 mm depending on the type and volume of the traffic. A transition zone needs to be constructed by decreasing the thickness of the LECA layer gradually until it is 200 mm.

Peat layers have also been used successfully. They also need to be covered with a sufficient layer of high quality aggregate.

An arctic road construction project was conducted in Finland by Saarela (1993, 2002). Test sections were constructed in 1986-1987 on discontinuous permafrost areas in Kilpisjärvi, Northern Finland. They were monitored in 1990s and inspected in 2000 and 2001. Average annual temperature in the location is -2.5°C and the air freezing index about 42,000 h°C.

Insulated test sections were constructed to test suitability of different materials to mitigate differential frost heave. Sections contained 1) frost susceptible material, 2) slightly frost

susceptible material or 3) peat that was isolated from non frost susceptible materials with a membrane or board insulation. The structures were designed so that the largest frost heave in 10 years would be equal or less than 30 – 70 mm. The conclusions and recommendations from the project state that the frost heave was limited to 50 mm once in 10 years, except for the peat section, were the frost heave was 50 – 100 mm. However, it was concluded that the increased frost heave in the peat section was due to the high existing water content in the peat, not due to frost heave in the subgrade. The slightly frost susceptible gracial till, LECA and polystyrene proved to be good insulators, considering their thermal and mechanical properties. The peat however, experienced more rutting than other sections, a proof that the section was not designed to be stiff enough. (Saarelainen 1993, 2002)

One of the sections in Kilpisjärvi was constructed on palsa permafrost, where the goal was to reduce thaw settlement of the road subgrade. The existing road had settled 1.8 m with a rate of 70 to 80mm per year. The rehabilitated test section was built with a 100-mm thick polystyrene board insulation that was placed in the sub base (700 mm) from the road surface. The old pavement was removed and the new materials were placed on the old base course. The sides of the road embankment were insulated with 0.3 – 0.5-m thick peat layer. The section was paved with an oil-gravel containing light colored aggregate.

The new structure with the insulation and relatively light surface reduced the thaw settlement down to 10 to 30 mm per year. The pavement was overlaid with a darker oil-gravel layer in 1990, which accelerated the settlement rate to a maximum of 50 mm/a. (Saarelainen 1993, 2002)

Use of pre-fabricated runway/taxiway or apron surfacing mats

Surfacing mats have not been used in Finland. USACRREL has been investigating surfacing mats, e.g. geocells filled with sand.

In the permafrost areas of the former Soviet Union, reinforced 2 m by 3 m concrete blocks with polyurethane insulation layer in the bottom have been used as a surface layer on test roads (Räty, 1985). The subgrade under the embankment stayed frozen during the whole summer.

Dust control methods

Kaarela (2003) states that water would be a good solution for dust mitigation, but it evaporates too soon, and therefore salts and different organic products are used. Calcium chloride is the most common agent used in Finland. The Finnra uses about 28 000 to 30 000 tons calcium chloride annually. Organic dust mitigation agents include asphalt emulsion and other petroleum based products, lignin sulfite, polymer emulsions, vegetable oils, tall oil products, molasses, enzymes and surfactants. In the Nordic Countries, about 17 000 tons of lignin sulfite, a by-product from sulfite cellulose manufacturing, is used annually.

Chemical stabilization methods for silt and organic soils

Lime is used to stabilize silt, clay and silt rich glacial tills in Finland (RIL 156 1995). Both CaO and $Ca(OH)_2$ have been used. The stabilized layer is ripped off with a blade or dozer, mixed with rotating blades, leveled with a blade and compacted with a pneumatic roller. If the soil is extremely soft, the work is done in two phases. First the lime is spread out (e.g. with a hose from a truck). The next day, the area is harder and more lime is spread with regular equipment. The water content should be close to optimum. The compaction should be conducted as fast as possible after the mixing of the lime.

Saarelainen (personal communication, 2003) thinks that portland cement stabilization works also with silts as long as the reaction temperature is kept above 0°C.

Spring thaw concerns and use of load restrictions during thaw

Finnish airports don't use load restrictions during thaw. However, there are load restrictions on the road system. New recommendations (Saarenketo and Perälä 2003) classify the roads in three categories: Class 0 = no load restrictions are needed or allowed, Class 1 = the need for load restrictions is determined annually based on the thaw weakening prediction, and Class 2 = load restrictions are used annually when needed. The recommended load restriction model considers observed thaw damages and the importance of the road to local economy. The load restrictions should start when the thaw has penetrated 150 mm into the road structure. The removal of the restriction would be determined based on either

- locally with water content and temperature instrumentation. The restriction ends when the thaw front has penetrated 800 mm depth.
- the thaw weakening is monitored with falling weight deflectometers.

- decrease in frost heave is monitored e.g. with levels. The restriction is removed when the frost heave is smaller than 80 mm.

Seppo Saarelainen (personal communication, 2003) thinks that thaw period needs to be predicted annually with weather data. The criteria should be related to number of axle loads causing allowable rut depth on unpaved surfaces.

Typical runway designs (size, length, width and thickness)

The most northern airports in Finland are in Enontekiö, Ivalo and Kittilä. The Enontekiö airport has one runway that is 2,000 m long and 45 m wide. The Ivalo airport has two runways, 2,500 m and 1,720 m long. The only runway of Kittilä airport is 2,500 m long. (http://www.ilmailulaitos.com/)

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Personal communications (2003):

- Reijo Tasanen from Civil Aviation Administration of Finland, the Project Manager for the Third Runway Project at the Helsinki-Vantaa airport in Finland.
- Dr. Seppo Saarelainen, VTT, Technical Research Center of Finland

Other personal communications, not referenced in the text (2003):

- Tech. Lic. Kauko Kujala from University of Oulu
- Dr. Jorma Hartikainen, from Tampere University of Technology
- Dr. Pauli Kolisoja from Tampere University of Technology

APPENDIX D

Yukon-Kuskokwim Delta Airports

Airport Narrative & Construction Review

A twin-engine Piper Navajo is unloaded at a rural airport. This scene is typical of aviation in
much of the Southwest Alaska study area.

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C. Anchorage, Alaska
Percy Frisby, President & Chief Executive Officer

For: GeoEngineers, Inc.
Alaska Department of Transportation & Public Facilities

February 2004

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I. Introduction

Arctic Pacific Enterprises, LLC is a subcontractor to GeoEngineers, Inc., the prime contractor for the Airport Life-Cycle Costs – Yukon-Kuskokwim Delta project. This project is funded by the Alaska Department of Transportation and Public Facilities (DOT/PF).

The purpose of the Airport Life-Cycle Costs – Yukon-Kuskokwim Delta project is to evaluate current construction practices and cost effective engineering approaches for the Yukon-Kuskokwim Delta region. Life cycle costs cover all expenses encountered over the useful life of the airport from initial scooping through design and construction to operation and long-term maintenance of airport infrastructure.

II. Airport Construction

Alaska is dependent on aviation to a far greater degree than the Lower 48 states. According to the Federal Aviation Administration (FAA) there are a total of 671 private and public airports in Alaska ranging from international airports to short private strips (FAA 2003). The State of Alaska, in particular the Department of Transportation and Public Facilities (DOT/PF), has a large stake in rural Alaska airports and airport facilities. This is because the State owns and is responsible for 257 of the 282 publicly-owned, public use airports in Alaska. This figure includes 175 gravel airstrips, 41 paved strips and 41 seaplane bases. Of the total, 106 airports have runway lengths of less than 3,000 feet (31 of these are less than 2,000 feet).

Part of the mission of DOT/PF is to provide for safe and adequate airports and airstrips in rural Alaska. As part of that mission, the department is engaged in a very active program of constructing new airports and upgrading existing ones in rural Alaska.

The desired minimum standard runway at state-owned airports is 3,300 feet in length, 75 feet wide and is lighted where safe and practical to do so. This is based on a 3,200 foot FAA minimum standard for runways that are capable of handling instrument landings, plus an additional 100 feet to accommodate different elevation and temperature variables around the state (DOT/PF, March 2003).

The FAA is expending considerable funds on aviation-related facilities in Alaska, much of it through its Airport Improvement Program (AIP). The AIP provides 93.75% funding for eligible public airport development in Alaska. The airport sponsor provides the remaining 6.25%. The AIP is financed from the federal Airport and Airway User Trust Fund which, in turn, is funded primarily from a 10% tax on domestic air fares (DOT/PF, 2003). The AIP budget for Alaska in FY 2002

was $145 million, and in FY 2003 it was $180 million. The anticipated FY 2004 AIP budget also is expected to be approximately $180 million (FAA 2003).

Currently, constructing a new airport in the Y-K Delta region of rural Alaska is a very expensive proposition, requiring millions of dollars and up to a decade to complete, according to DOT&PF project records. Normal airport project components include soils testing, environmental and archaeological assessments, engineering and design, the bid and public notice process as well as logistics, mobilization, shipping and actual construction.

These normal hurdles facing the construction of infrastructure in rural areas are compounded by the fact that there are virtually no gravel resources in Southwest Alaska (DOT/PF, 2003). Gravel is an important component of constructing airports to serve small rural communities. Gravel airstrips are the norm rather than the exception. Gravel strips need regular maintenance to stay in good condition. Few rural airports, with the exception of regional hubs, have paved airstrips. Although gravel is required in significant quantities for paved airstrips just as it is for unpaved strips, the gavel requirements for maintenance of the paved strips are significantly less (DOT/PF, 2003).

Airport construction costs and time requirements for airport construction in Southwest Alaska are driven by the fact that constructing a general aviation airport in this region often takes many years to complete. This is due to a lack of available quality local material for embankments. These airports are normally constructed as phased projects with the first phase involving construction of an embankment made of locally available ice-rich silts and sand. The embankment is allowed to drain, consolidate and gain strength over several years before the final placement of imported material and installation of runway and taxiway lighting.

When other typical components of airport construction are added, it is understandable how it can take five to 10 years to complete a project. Such projects often cost more than $10 million due to the phasing and imported materials costs, according to DOT&PF construction records.

Role of Arctic Pacific Enterprises, LLC

Arctic Pacific Enterprises, LLC, in its subcontract with GeoEngineers, was assigned the task of obtaining information on the airport lifecycle and related concerns from 14 representative communities in Southwest Alaska. According to the FAA's Alaskan Region Airport Improvement Plan (AIP) Program (FY 1982-FY 2002), airport projects either have been recently completed (7 communities) or are currently underway (6 communities) for all but one of the communities (Nunapitchuk).

The communities were contacted beginning in September 2003. It was recognized at the onset that contacting rural leaders concerning the life cycle

cost project would be time consuming. Rural Alaskans are very mobile and very focused in their actions. Many local leaders were engaged in subsistence activities (finishing salmon fishing; then hunting) at the time and many were in travel status for fall meetings. Fall can be called the "meeting season" for rural Alaska. The Alaska Federation of Natives has its annual conference in Anchorage in October and many Native Regional and Non-Profit Regional corporations and village corporations also hold their annual meetings during this period. Federal agencies, notably the Bureau of Indian Affairs, also conduct large-scale meetings specific to rural communities and their residents during this time.

Methodology:

The first phase of Arctic Pacific's work effort focused on the 14 communities involved and included the following elements:

1. Arctic Pacific developed a community questionnaire to gather current information, opinions and recommendations from local leaders concerning airport construction, use and maintenance.
2. The questionnaires were transmitted either by facsimile or e-mail to the governing bodies in each of the 14 communities. Each community was contracted by telephone before the questionnaires were sent. They were sent to the Mayor's office in those communities with a municipal government and to the tribal president in those communities governed by a BIA-recognized Indian Reorganization Act (IRA) or Traditional councils.
3. The questionnaire was discussed with the appropriate community leader to assist in the completion. All 14 communities participated.
4. The results were compiled and analyzed for common threads and potential areas of additional research. The results were then written up in this report for GeoEngineers, Inc. The effort required numerous follow-up calls to ensure the questionnaires were returned in a timely fashion.

In the second phase, which ran concurrently with Phase 1, Arctic Pacific focused on the other entities which make regular use the 14 rural airports.

1. Questionnaires were developed for: a). air carriers which serve the communities; b). barge services which transport airport construction related materials including gravel; c). other state, federal and local agencies which use the airports; and d). contractors who are constructing or have constructed airports in the region. A copy of each questionnaire is attached in Appendix A. Comments and information developed through the Community questionnaire were used to fine tune the questionnaires and the participants lists of other entities to be contacted in this phase.
2. The questionnaires were transmitted to the relevant agencies and entities; and discussed with them. The results were compiled and written up in reports similar to that done for Phase 1.

In the third phase, Arctic Pacific wrote an overall report summarizing the work and listing suggestions for decreasing construction costs of and the amount of

time involved in building new or upgraded rural airports in Southwest Alaska, and ongoing maintenance costs.

In conjunction with developing direct community contacts and information, Arctic Pacific Enterprises, LLC also conducted a search of the available literature for each community's airport. Information acquired included: the FAA Airport Master Record for each community (Appendix B); the FAA Alaska Region Airport Improvement Program Record FY 1982 – FY 2002 for each community (Appendix C); and a Compilation of DOT/PF Bids for Recent Airport Construction Projects (Appendix D).

III. Demographics

For the purposes of this report, the area under consideration includes the Wade Hampton and Bethel Census Districts. The area also can be described as those lands within Calista Corporation, which is the Alaska Native Claims Settlement Act for-profit regional corporation for Southwest Alaska, and the Association of Village Council Presidents (AVCP), which is the Native non-profit regional association for the same area.

The communities involved in the study are:

- Alakanuk,
- Atmautluak,
- Chefornak,
- Chevak,
- Eek,
- Emmonak,
- Kipnuk,
- Kotlik,
- Kwethluk,
- Napakiak,
- Napaskiak,
- Nunam Iqua,
- Nunapitchuk and
- Tuntutuliak.

Arctic Pacific personnel – during previous dealings in the region – have visited each of the villages on several occasions and have acquaintances in all 14.

The region generally is within the service area of the Yukon Kuskokwim Health Corporation (YKHC), which is a regional health care provider. YKHC operates a regional acute care hospital in Bethel as well as health care clinics in most of the 48 active villages in the region (YKHC Website, November 2003).

The region also is served by four state-funded Regional Educational Attendance Areas (REAA's) in the region, which include:

- the Lower Yukon School District, headquartered in Mountain Village, with 12 school facilities in 11 communities including the study communities of Alakanuk, Emmonak, Kotlik and Nunam Iqua;
- the Lower Kuskokwim School District, headquartered in Bethel, with 28 school facilities in 22 communities including the study communities of Atmautluak, Chefornak, Eek, Kipnuk, Kwethluk, Nunapitchuk, Napakiak, Napaskiak and Tuntutuliak;
- the Kashunamiut School District, which is headquartered and has facilities in the study community of Chevak.

- the Kuspuk School District, headquartered in Aniak, with 11 school facilities in eight communities but none of the study communities; and,
- the Yupiit School District, headquartered in Akiachak, with schools in three communities but none of the study communities.

Several communities in the study group also host significant levels of seasonal activity by federal and state agencies – typically concerned with resource management, especially fish and game.

Finally, all 14 communities receive their mail via air. This is different from the Lower 48 states where U.S. Postal regulations governing first class mail typically rely on rail and road service. There are no roads or railroads connecting the 14 study group communities with other villages in the area or to the regional hub in Bethel or the sub-regional hubs such as Emmonak, Saint Mary's, Hooper Bay and Aniak. This also is true of virtually all rural Alaska communities that are not on the highway system. Air delivery of mail, therefore, is the default service in rural Alaska. This is an important distinction because mail delivery is a very important revenue source for the air carriers which serve rural Alaska communities.

It is important to recognize the organizations listed above because their activities account for a very significant portion of local airport use. It would be inaccurate and a disservice to the communities and the construction efforts by DOT&PF to assume that airport use is focused just on the delivery of goods to, and provision of transportation services for, local residents.

Importance of Aviation:

Travel by air is the predominant year-round mode of transportation for all of the study communities. Overland travel in summer is limited by muskeg terrain and a lack of established trails that can be used by vehicles larger than all terrain vehicles (ATVs). Thus, over land travel to and from nearby villages is generally limited to winter and the use of snow machines. Skiffs, such as those shown at right at Nunam Iqua, are widely used for summer seasonal river and coastal transportation in Southwest Alaska.

Of the 14 study group communities, three are governed by tribal councils and 11 are governed by municipal governments. The three tribes are organized as Traditional Councils in contrast to IRA (Indian Reorganization Act of 1935) councils. There are differences between the two designations, but not of a level

to warrant further examination for the Airport Life-Cycle Costs – Yukon-Kuskokwim Delta project. Of primary concern with respect to the project is the fact that tribes and tribal councils cannot level taxes to pay for services such as airport construction, maintenance and operations and/or repairs and renovations.

All of the 11 municipalities are recognized as Second Class cities by the State of Alaska and function under the Alaska Municipal Code, Title 29, of the Alaska Statutes. Although the municipal government may be the primary governing body for these communities, tribal councils play a significant role.

There are two types of general law cities provided for by the Alaska Constitution: first class and second class. Second class cities are the most common form of municipal government in rural Alaska (Alaska Municipal Officials Directory, 2003). The definition of, and process for becoming, a Second Class city as presented in the Directory of Municipal Officials provides that "communities with at least 25 registered voters can petition the State to incorporate as a second-class city in order to provide services and facilities to their residents. Alaska statutes require second-class cities to conduct regular city council meetings, codify city ordinances and establish local election procedures. The major of a second-class city is elected by and from the council and may vote on all matters. Second class cities may levy a property tax only if it is approved by the voters and at a level no higher than 5 mills, except that the limit does not apply to millage levied to pay off bonds."

The ability to raise funds through taxation is further limited for rural Alaska communities in that, in many instances, the lands utilized by Native residents are Native allotments. These allotments are held in trust for their respective owners by the Bureau of Indian Affairs and cannot be taxed.

The conclusion to this brief discussion on taxation is that most rural Alaska communities, for a number of reasons, are not in a position to raise significant amounts of capital. This places a much greater reliance on the State for the provision of many services that are provided by local governments in the rest of the United States.

The vast majority of community residents are Central Yupik Eskimos, most of whom practice a subsistence lifestyle (Krauss, 1982). This region of Alaska is unique in that a significant portion of adults still speak their original tongue. Children typically are raised with Yupik as their first language, learning English in public schools. Populations range from 164 in Nunam Iqua to 854 in Chevak (State Demographer, 2002 estimate).

Table 1

Community	Government	School District	Population
Alakanuk	2nd Class City	Lower Yukon School District	659
Atmautluak	Tribal	Lower Kuskokwim School District	291
Chefornak	2nd Class City	Lower Kuskokwim School District	419
Chevak	2nd Class City	Kashunamiut School District	854
Eek	2nd Class City	Lower Kuskokwim School District	291
Emmonak	2nd Class City	Lower Yukon School District	745
Kipnuk	Tribal	Lower Kuskokwim School District	644
Kotlik	2nd Class City	Lower Yukon School District	633
Kwethluk	2nd Class City	Lower Kuskokwim School District	730
Napakiak	2nd Class City	Lower Kuskokwim School District	351
Napaskiak	2nd Class City	Lower Kuskokwim School District	408
Nunam Iqua	2nd Class City	Lower Yukon School District	204
Nunapitchuk	2nd Class City	Lower Kuskokwim School District	512
Tuntutuliak	Tribal	Lower Kuskokwim School District	377

Sources: State of Alaska, Department of Community and Economic Development, Division of Community Advocacy, 2003; and State of Alaska, Department of Labor and Workforce Development, State Demographer, 2002.

Community sketches:

Each community involved in the study has its own unique characteristics which must be considered in the overall context of constructing airports in Southwest Alaska. The following a very brief community sketches of information relevant to airport construction and long-term airport maintenance and operations. This discussion is based on information contained in the State of Alaska Community Profiles Database.

Alakanuk is located at the east entrance of Alakanuk Pass, the major southern channel of the Yukon River, 15 miles from the Bering Sea. It is part of the Yukon Delta National Wildlife Refuge and lies 8 miles southwest of Emmonak, approximately 162 air miles northwest of Bethel. It is the longest village on the lower Yukon – the development stretches over a three-mile area along Alakanuk Pass. The climate of Alakanuk is sub-arctic, annually averaging 60 inches of snowfall and 19 inches of total precipitation. Temperatures range from between a -25 to 79 degrees. Heavy winds are frequent during the fall and winter. The Yukon River is used as an ice road during freeze-up, from November through May. The photograph above left is of the Alakanuk School.

Alakanuk is a Yupik Eskimo village based on commercial fishing and subsistence. It experiences a seasonal economy with 76 residents holding commercial fishing permits. Many have gill net permits. Set net fishermen sell

their salmon to Seattle fish buyers. Poor fish returns since 1998 have significantly affected the community. Government employment and retail businesses provide limited year-round employment. Many residents travel to Emmonak to shop and attend social events and basketball tournaments.

A State-owned 2,200-foot long by 55-foot wide gravel airstrip is available. An airport relocation project, due to erosion of the existing airstrip, is underway. According to a community official, air carriers providing scheduled service to Alakanuk include Grant Aviation and Hageland Aviation Services Inc.

Alakanuk is easily accessible from the Yukon River and Bering Sea by barge and riverboat. Most passengers and mail arrive by air. There are no roads connecting Alakanuk with other population centers in the region, but ice roads are used in winter. Snow machines and boats are used for local travel.

Atmautluak lies on the west bank of the Pitmiktakik River in the Yukon-Kuskokwim delta, 20 miles northwest of Bethel. The area averages 16 inches of precipitation, with snowfall of 50 inches. Summer temperatures range from 62 to 42; winter temperatures 19 to -2 degrees.

Atmautluak is a traditional Yupik Eskimo village with a subsistence lifestyle. Yupiks have inhabited this region for thousands of years due to the area's rich resources. The school, retail businesses and the village government provide cash income to supplement the subsistence lifestyle. Thirty-one residents hold commercial fishing permits. Poor fish returns since 1997 have significantly affected the community.

The old State-owned airstrip was 2,000-feet. Major improvements to the runway, taxiway and apron were recently completed. According to a tribal official, air carriers providing scheduled service to Atmautluak include Grant Aviation and Hageland Aviation Services Inc.

Locals use skiffs in the summer to travel to Bethel and other area villages, and snow machines, all-terrain vehicles (ATVs) and dog sleds are used in the winter. A winter trail exists to Nunapitchuk (7.0 miles).

Chefornak is located on the south bank of the Kinia River, at its junction with the Keguk River, in the Yukon-Kuskokwim Delta. The village lies within the Clarence Rhode National Wildlife Refuge, established for migratory waterfowl protection. Chefornak is 98 air miles southwest of Bethel and 490 miles southwest of Anchorage. Chefornak is located in a marine climate. Precipitation averages 22 inches, with 43 inches of snowfall annually. Summer temperatures range from 41 to 57 degrees, winter temperatures range 6 to 24.

A traditional Yupik community, Chefornak residents practice a subsistence lifestyle with commercial fishing. Other than government positions, most

employment in Chefornak is seasonal, supplemented by subsistence activities. Twenty-seven residents hold commercial fishing permits for herring roe and salmon fisheries. Coastal Villages Seafood, Inc., processes halibut and salmon in Chefornak. Trapping is also a source of income.

A State-owned 2,500-foot gravel airstrip provides chartered and private air access year-round, and a seaplane base is available. A new airport is currently under development. Air carriers providing scheduled service to Chefornak include Grant Aviation, Hageland Aviation Services Inc. and Era Aviation Inc.

Although there are no docking facilities at this time, a number of fishing boats and skiffs are used for local travel. Snow machines are relied upon during the winter. Winter trails are marked to Kipnuk (20 miles) and Kasigluk (83 miles).

Chevak is located on the north bank of the Niglikfak River, 17 miles east of Hooper Bay in the Yukon-Kuskokwim Delta. Chevak has a maritime climate. Its location near the Bering Sea makes it subject to heavy winds and rain. Temperatures range from -25 to 79. Snowfall averages 60 inches per year. Freeze-up occurs at the end of October; break-up occurs in June.

Eskimos have inhabited the region for thousands of years. Chevak is a Cupik Eskimo village. Commercial fishing and subsistence activities are an important part of the local culture.

Employment in Chevak is at its peak in the summer months and declines to a few full-time positions during winter. Construction projects and BLM fire fighting provide summer employment. Eighteen residents hold commercial fishing permits. Incomes are supplemented by subsistence activities and handicrafts. Salmon, seal, walrus, clams and waterfowl are harvested. Chevak, along with Hooper Bay to the west, are acclaimed worldwide for bird watching opportunities. Although visitors from around the globe visit the communities during prime bird watching times, a concerted effort to develop this visitor opportunity has not been aggressively pursued.

A State-owned 2,610-foot gravel airstrip is available, although heavy winds and rain can preclude air access. A relocation of the airport was recently completed. Float planes can land on Chevak Lake/Ninglikfak River. According to a community official, air carriers providing scheduled service to Chevak include Grant Aviation, Hageland Aviation Services Inc., Era Aviation Inc., Larry's Flying Service, Alaska Transportation Services and Arctic Circle Air.

There are no docking facilities, however, a barge landing is available for cargo off-loading. A community official said a new dock is planned for construction in 2004. Skiffs are used for local travel on the river in the summer, and snow machines are used in the winter. Winter trails exist to Scammon Bay (25 miles), Hooper Bay (20 miles) and Newtok (50 miles).

Eek lies on the south bank of the Eek River, 12 miles east of the mouth of the Kuskokwim River. It is 35 air miles south of Bethel in the Yukon-Kuskokwim Delta, and 420 miles west of Anchorage. Eek is located in a marine climate. Precipitation averages 22 inches, with 43 inches of snowfall annually. Summer temperatures average 41 to 57; winter temperatures average 6 to 24.

Eek is a traditional Yupik Eskimo village with a subsistence lifestyle, fully 80%-90% of the diet consists of salmon. All five Pacific salmon species spawn in the Eek River. Eek's economy is primarily subsistence- and commercial fishing-based. A few full-time positions are available at the school, City, and village office. All families participate in subsistence fishing, and 44 residents hold commercial fishing permits. Poor fish returns and prices in recent years have significantly affected the economy.

A State-owned 1,400-foot sand and gravel airstrip provides chartered and private air access. A relocation of the airport is currently under development. A seaplane base is also available on the Eek River. According to a community official, air carriers providing scheduled service to Eek include Grant Aviation, Hageland Aviation Services Inc., Era Aviation Inc., Inland Aviation Services Inc., and Bellair Inc.

Fishing boats, skiffs and snow machines are used for local transportation to Bethel and other villages. There is a one-mile gravel road in the City. Winter trails are marked to Quinhagak (39 miles), Eek Island (15 miles) and the Kwethluk River (45 miles) Barges deliver fuel and supplies during the summer months. A dock is available.

Emmonak is located at the mouth of the Yukon River, 10 miles from the Bering Sea, on the north bank of Kwiguk Pass. It lies 120 air miles northwest of Bethel and 490 air miles from Anchorage, in the Yukon Delta National Wildlife Refuge. A maritime climate predominates in Emmonak. Temperatures range from -25 to 79. Precipitation is 19 inches per year, while snowfall is 50 to 60 inches per year. Freeze-up occurs during October; break-up occurs in June.

Due to increasing flooding and erosion, the village was relocated in 1964-65. Emmonak is a Yupik Eskimo village involved in commercial fishing, processing and subsistence activities. The City experiences a seasonal economy as a center for commercial fishing, purchasing and processing on the lower Yukon River. Yukon Delta Fish Marketing Co-op and Bering Sea Fisheries process and export salmon from Emmonak. About 100 residents hold commercial fishing permits. Subsistence activities, trapping and public assistance support income. The majority of the community travels to fish camps during the summer months to dry salmon for winter use. Moose, beluga whale, seal and waterfowl are also utilized.

Emmonak relies on air and water transportation. A State-owned 4,400-foot gravel airstrip was recently constructed and is operational. Some airport improvements remain to be completed. According to a community official, air carriers providing regular and scheduled service to Emmonak include Grant Aviation, Hageland Aviation Services Inc., Northern Air Cargo, Larry's Flying Service and Everts Air Cargo.

There are no connecting roads, but winter trails to Kotlik, Alakanuk and Sheldon Point are used by snow machines. Skiffs and ATVs are using during the summer for local transportation.

Kipnuk is located on the west bank of the Kugkaktlik River in the Yukon-Kuskokwim Delta, 85 air miles southwest of Bethel. It lies four miles inland from the Bering Sea coast. The community is located in a marine climate. Precipitation averages 22 inches, with 43 inches of snowfall annually. Summer temperatures range from 41 to 57, winter temperatures are 6 to 24.

Yupik Eskimos have inhabited the region for thousands of years. Kipnuk is a traditional Yupik community, maintaining a subsistence lifestyle. Commercial fishing is an important income source. Most employment in Kipnuk is in seasonal activities such as commercial fishing and construction. Subsistence activities are a major component of the Kipnuk lifestyle, and 97 residents hold commercial fishing permits. Coastal Villages Seafood, Inc., processes halibut and salmon in Kipnuk. Income is also obtained by trapping. The community is also interested in an arts and crafts marketing cooperative.

Kipnuk has a State-owned 2,120-foot gravel airstrip, with scheduled air taxi service five times each day. Charter services are also available. A seaplane base is also available. A relocation of the airport is currently under development. According to a community official, air carriers providing scheduled service to Kipnuk include Grant Aviation, Era Aviation Inc., and Hageland Aviation Services Inc.

Boats and skiffs are used by residents for local travel during the summer, with snow machines in the winter. Winter trails exist to Tuntutuliak (77 miles), Chefornak (20 miles) and Kwigillingok (35 miles) Although there is no dock, barges from Bethel deliver cargo each summer. It is a local priority to construct docking facilities.

Kotlik is located on the east bank of the Kotlik Slough, 35 miles northeast of Emmonak in the Yukon-Kuskokwim Delta. It lies 165 air miles northwest of Bethel, and 460 miles from Anchorage. The climate of Kotlik is sub-arctic. Temperatures range between -50 and 87. There is an average of 60 inches of snowfall, with a total of 16 inches of precipitation annually. High winds and poor visibility are common during fall and winter. Norton Sound and the Yukon are ice-

free from mid-June through October. The photograph at left is of a boardwalk in Kotlik. It is typical of boardwalks found in Southwest Alaska.

Due to its location with easy access by large riverboats and barges, Kotlik is one of the larger ports and commercial centers of the lower Yukon River. It is a Yupik village with a fishing, trapping and subsistence lifestyle. Kotlik has a seasonal economy. Fishing and fish processing are the primary income generators, and 79 residents hold commercial fishing permits. The community is interested in developing a local seafood processing facility, and an arts and crafts project. Kotlik's residents rely heavily on subsistence foods, and many families have fish camps on the Yukon River. Salmon, moose, beluga whale and seal are harvested. Income is also derived from trapping.

Air transportation of passengers, cargo and mail is provided via the State-owned 4,400-foot gravel airstrip which was recently completed. Air carriers providing scheduled service to Kotlik include Grant Aviation and Hageland Aviation Services Inc.

There is no road access, although Kotlik is easily accessible by barge. The river is used by the 50 or so commercial and private boats owned by residents.

Kwethluk is a Yupik community located 12 air miles east of Bethel on the Kwethluk River at its junction with the Kuskokwim. The village is the second largest along the Lower Kuskokwim River, following Bethel. Kwethluk's precipitation averages 16 inches, with snowfall of 50 inches. Summer temperatures average from 62 to 42; winter averages are 19 to -2. Extremes have been recorded from 86 to -46. The Kuskokwim is typically ice-free from June through October.

Archaeological evidence from a nearby site indicates this area has been occupied since prehistoric times. Kwethluk is a predominantly Yupik community with a subsistence lifestyle. The largest employers are the school district, village corporation, store and health clinic. Sixty-one residents hold commercial fishing permits. Subsistence activities play a central role in the lifestyle; salmon, moose and caribou are the staples of the diet. Seal meat and seal oil are obtained in trade with coastal relatives and neighbors. Most families travel to fish camps each summer.

Kwethluk is dependent on air transportation for year-round movement of freight and passengers. A State-owned 1,750-foot gravel airstrip and seaplane base are available. A relocation of the airport is currently under development. According to a community official, air carriers providing scheduled service to Kwethluk include Grant Aviation and Hageland Aviation Services Inc.

Barge services deliver cargo during the summer. There are no docking facilities. Snow machines, ATVs, and skiffs are used for local travel, and the River becomes an ice road during winter. Winter trails are marked to Eek (45 miles), Three Step Mountain (55 miles) and Columbia Creek (49 miles).

Napakiak is on the north bank of the Kuskokwim River, 15 miles southwest of Bethel. It is located on an island between the Kuskokwim River and Johnson's Slough. It lies 407 miles west of Anchorage. Napakiak is influenced by storms in the Bering Sea and also by inland continental weather. Average annual precipitation is 16 inches, with 50 inches of snowfall. Summer high temperatures average 59 to 62, winter highs average 11 to 19. Extremes from 86 to -46 have been recorded.

Yupik Eskimos have lived in this region since 1,000 A.D. The city is predominantly Yupik with a fishing and subsistence lifestyle. Napakiak's primary employers include the school and local, state, and federal governments. Seasonal commercial fishing, construction projects, trapping and crafts also provide income. Forty-three residents hold commercial fishing permits, primarily for herring roe and salmon net fisheries. Subsistence foods provide an estimated 50% of the local diet. Most families have fish camps. Salmon, waterfowl, moose, bear and seals provide meat.

The first airstrip was completed in 1973. A State-owned 2,150-foot gravel runway and seaplane landing area provide air transportation for passengers, mail and cargo. The runway recently underway major reconstruction. Air carriers providing scheduled service to Napakiak include Grant Aviation and Hageland Aviation Services Inc.

Barges from Bethel deliver goods during the summer. There are no docking facilities. The river is an important means of transportation in summer; the Kuskokwim is a major thoroughfare. In winter the river becomes an ice road to surrounding villages. A winter trail is marked to Bethel (1.1 miles) The community has long favored construction of a 9-mile road to Bethel.

Napaskiak is located on the east bank of the Kuskokwim River, along the Napaskiak Slough, 7 miles southeast of Bethel. Napaskiak is strongly influenced by storms and patterns in the Bering Sea and also by inland continental weather. Average annual precipitation is 16 inches, with 50 inches of snowfall. Summer temperatures range from 42 to 62, winter temperatures are -2 to 19.

Napaskiak is a traditional Yupik community dependent upon fishing and subsistence activities. The school, local businesses and some commercial fishing provide employment with 39 residents holding commercial fishing permits for salmon drift netting. Subsistence activities are a part of the culture and supplement cash earnings. At right is an aerial view of Napaskiak.

A State-owned 3,000-foot gravel airstrip and seaplane landing area west of the village provides charter and general aviation access year-round. According to a community official, Grant Aviation and Hageland Aviation Services Inc. provide scheduled service to Napaskiak.

Although there are no docking facilities, many residents have fishing boats, and skiffs are used in the summer for subsistence fishing and travel to Bethel and nearby villages. Snow machines and ATVs are used in winter. Barges, including a hovercraft, also deliver goods.

Nunam Iqua (formerly known as Sheldon Point) is on a south fork of the Yukon River, about 9 miles south of Alakanuk and 18 miles southwest of Emmonak on the Yukon-Kuskokwim Delta. It lies 500 miles northwest of Anchorage. The climate is maritime, averaging 60 inches of snowfall with a total of 18 inches of precipitation per year. Temperatures range from -25 to 78. Heavy winds in the fall and winter often limit accessibility. The Bering Sea is ice-free from mid-June through October.

Commercial fishing and subsistence activities are the means of support for this Yupik village. Commercial fishing is the economic foundation of the community and 24 residents hold commercial fishing permits. There are a few year-round positions with government organizations and the private sector. Subsistence activities and trapping supplement income. Salmon, beluga whale, seal, moose, and waterfowl are harvested.

Nunam Iqua has easy access by boat and barge. It has a State-owned, City-operated 3,015-foot gravel airstrip which was recently completed. Air carriers providing scheduled service to Nunam Iqua are Hageland Aviation Services Inc. and Grant Aviation. Float plane landing areas are available at Kwemeluk Pass and Swan Lake. In the winter snow machines serve as the primary mode of inter-village transportation.

Nunapitchuk is located on the both banks of the Johnson River, 22 miles northwest of Bethel in the Yukon-Kuskokwim Delta. The area averages 16 inches of precipitation, with snowfall of 50 inches. Summer temperatures range from 62 to 42; winter temperatures run from 19 to -2.

This is a Yupik village. Residents rely on subsistence and commercial fishing. The school, local businesses and the City provide most employment in Nunapitchuk. Commercial fishing and subsistence activities are a focal point of the culture, and 58 residents hold commercial fishing permits for salmon and herring roe net fisheries and roe on kelp. The photograph above is of the Nunapitchuk school.

A State-owned 2,040-foot airstrip provides chartered or private air access year-round. A new dock, small boat harbor, and seaplane landing area are available on the Johnson River. According to a community official, air carriers providing scheduled service to Nunapitchuk include Grant Aviation and Hageland Aviation Services Inc. Snow machines, ATVs and dog sleds are used in winter months. Winter trails exist to Atmautluak (7 miles) and Akula Heights (2.5 miles).

Tuntutuliak is on the Qinaq River, approximately 3 miles from its confluence with the Kuskokwim River, about 40 miles from the Bering Sea coast. It lies 40 miles southwest of Bethel and 440 miles west of Anchorage. Tuntutuliak's summer temperatures average from 42 to 62, winter temperatures average -2 to 19. Extremes have been recorded from 86 to -46. Annual precipitation averages 16 inches, with snowfall of 50 inches.

This is a Yupik village with a fishing and subsistence lifestyle. Salmon and seal are important food sources. Employment by the school, services, commercial fishing and fish processing provides most of the income. Trapping, basket weaving, skin-sewn products and other Native handicrafts also provide cash. Subsistence foods comprise a majority of the diet. About one-half of families go to fish camp each summer and 51 residents hold commercial fishing permits for salmon net and herring roe fisheries.

Tuntutuliak relies heavily on air transportation for passengers, mail and cargo service. A project to relocate the airport was recently completed. The old runway was 1,800-feet long. A public seaplane base on the Qinaq River also is available. Hageland Aviation Services Inc. and Grant Aviation provide scheduled service to Tuntutuliak.

Barge services deliver goods approximately six times a year. Boats and snow machines are used for local travel. Winter trails are marked to Kipnuk (77 miles), Toundra (60 miles) and Kongiganak (29 miles).

Airport Information:

Current information and aerial maps are available on each of the study community airports from the Federal Aviation Administration. Representative, annotated aerial maps are included in Appendix E. The appendix contains at least one FAA aerial map per community. The FAA, in most cases, has multiple aerial maps for each community in Alaska which can be accessed from its Fairbanks District Office website.

IV. Air Service in the Study Area

Regulatory Regime:
The air carriers serving small rural Alaska communities, including the study area, are primarily what are known as Part 135 Commuter and On-Demand Operators. These carriers operate under Federal Aviation Rules as published in the U.S. Code of Federal Regulations. The specific reference is: CFR Title 14 – Aeronautics and Space; Chapter I – Federal Aviation Administration, Department of Transportation; Subchapter G – Air Carriers and Operators for Compensation or Hire: Certification and Operations; Part 119 – Certification: Air carrier and commercial operators; and Part 135 – Operating Requirements: Commuter and on-demand operators and rules governing persons on board such aircraft.

According to Part 119.3 Definitions, *Commuter operation* means any scheduled operation conducted by any person operating one of the following types of aircraft with a frequency of operations of at least 5 round trips per week on at least one route between two or more points according to published flight schedules:

(1) Airplanes, other than turbojet powered airplanes, having a maximum passenger-seat configuration of 9 seats or less, excluding each crewmember seat, and a maximum payload capacity of 7,500 pounds or less; or

(2) Rotorcraft.

On-demand operation means any operation for compensation or hire that is one of the following:

(1) Passenger-carrying operations conducted as a public charter under part 380 of this title or any operations in which the departure time, departure location, and arrival location are specifically negotiated with the customer or the customer's representative that are any of the following types of operations:

(i) Common carriage operations conducted with airplanes, including turbojet-powered airplanes, having a passenger seat configuration of 30 seats or fewer, excluding each crewmember seat, and a payload capacity of 7,500 pounds or less, except that operations using a specific airplane that is also used in domestic or flag operations and that is so listed in the operations specification as required by § 119.49(a)(4) for those operations are considered supplemental operations;

(ii) Non-common or private carriage operations conducted with airplanes having a passenger-seat configuration of less than 20 seats, excluding each crewmember seat, and a payload capacity of less than 6,000 pounds; or

(iii) Any rotorcraft operation.

(2) Scheduled passenger-carrying operations conducted with one of the following types of aircraft with a frequency of operations of less than 5 round trips per week on at least one route between two or more points according to the published flight schedules:

(i) Airplanes, other than turbojet powered airplanes, having a maximum passenger-seat configuration of 9 seats or less, excluding each crewmember seat, and a maximum payload capacity of 7,500 pounds or less; or

(ii) Rotorcraft.

(3) All-cargo operations conducted with airplanes having a payload capacity of 7,500 pounds or less, or with rotorcraft.

Air Carriers:

Of the many air carriers in Alaska, four Part 135 air carriers serve all of the 14 communities in the study group on a scheduled basis. One carrier provides scheduled passenger and cargo service to five of the study communities. Of the four that serve all 14, two are cargo-only and two offer passenger service as well as cargo. It should be noted that with the exception of Emmonak, a sub-regional hub, the other communities receive cargo service on a non-scheduled, delivery and/or on-call basis. Above is a photo of a single-engine Village Air Cargo Cessna 207. The photo is posted at VAC's website.

All of the air carriers contract with the U.S. postal Service to deliver mail. A great number of other airlines based throughout the state offer charter services to the communities as well, notably Larry's Flying Service which is based out of Fairbanks. At right is photo of a twin-engine Grant Aviation Piper Navajo found at the company's website.

The air carriers are what are known as fixed base operators (FBOs). These carriers utilize primarily single-engine aircraft such as the Cessna 172, Cessna 180, Cessna 206, Cessna 207, Cessna Caravan 208, Cessna 209, and Piper Cherokee 6 as well as twin-engine aircraft such as the Cessna 402 and 406, King Air 200, Piper Navajo, CASA 212 (cargo) and DeHavilland Twin Otter. At left is a photo of a Grant Aviation single-engine Cessna 208 Caravan.

The air carriers referenced above are:

- Grant Aviation, which has its headquarters in Anchorage and hub operations in Bethel, Emmonak, Dillingham, Kotzebue and Nome. The airlines serves 54 communities, as of October 2003, including all 14 of the

study communities. Grant Aviation focuses on passenger service but also provides cargo service (Grant Aviation Website). At right is a photo of a Grant Aviation twin-engine King Air.

- Hageland Aviation Services Inc. also has its corporate offices in Anchorage. Hub operations are located in Aniak, Barrow, Bethel, Emmonak, Dillingham (cargo only), Kotzebue, Nome, Saint Mary's and Unalakleet. The airline serves 105 communities as of October 2003, including all 14 of the study communities. Hageland provides primarily passenger services. It is the largest airline providing scheduled services in rural Alaska (Hageland Aviation Services Website).

- Arctic Transportation Services is headquartered in Anchorage with hubs in Akiak, Bethel, Emmonak, Kotzebue, Nome, Saint Mary's and Unalakleet. It formerly was known as Ryan Air. The airline focuses on cargo service and mail delivery. ATS provides scheduled service from its hubs to 70 communities as of October 2003, including all 14 of the study communities (ATS Website). At right is photo of an Alaska Transportation Services twin-engine Cessna 402 which is posted at its website.

- Village Air Cargo was formerly known as Camai Air. Village Air Cargo is headquartered in Anchorage with hubs in Bethel and Kotzebue. The airline provides scheduled service from its hubs to 57 communities as of October 2003, including all 14 of the study communities (VAC Website). At right is a photo of a twin-engine Village Air Cargo CASA 212 which is posted at its website.

- Era Aviation Inc. is headquartered in Anchorage with a hub in Bethel which serves 17 communities as of October 2003, including five of the study communities (ERA Website).

Service Parameters:

All of the airports in the 14 study communities were constructed by, and are owned by, the State of Alaska. There is a private strip at one community. Maintenance work typically is contracted out to a local resident. DOT/PF provides

equipment (usually a grader), fuel and fuel storage and a storage building all of which are usually located at the airport.

All the 14 study communities are served by what the Federal Aviation Administration terms as "public use" airports as compared with "certificated" airports. Certificated airports are known as Part 139 (Title 49, USC 44706, Part 139) airports. These are airports that serve scheduled and unscheduled air carrier aircraft with more than 30 seats or that the FAA Administrator requires to have a certificate. Alaska has 33 Part 139 airports which serve the state's largest cities, regional hubs, military installations and several major resource development areas including the Red Dog Mine, North Slope oil fields and the trans-Alaska oil pipeline. None of the 14 study community airports are certificated. The Bethel regional airport is the only Part 139 airport in the study region.

Flight activities to and from the study community airports are conducted under visual flight rules (VFR). None of the airports at the study communities are equipped for instrument landings. This means that no operations conducted at these airports can be made under instrument flight rules (IFR). Short periods of daylight during the winter and long periods of daylight during summer months are directly reflected in the hours of service available and the seasonal frequency of flights at these airports.

Few airports in the 14 communities, outside of sub-regionals such as Emmonak, offer fuel service. Efforts by DOT/PF to construct or upgrade airports to a length of 3,300 feet enable service by heavier aircraft such as the DC-6 and the four-engine Hercules (military C-130s). These longer runways also meet minimum standards for IFR landings should the runway be so equipped.

Airport Construction Status:
New airports have recently been constructed or existing airports have been upgraded by DOT&PF in the following communities:

- Atmautluak (project closed September 2002)
- Chevak (project closed March 1999)
- Kotlik (project closed September 2000)
- Napakiak (project closed September 2002)
- Napaskiak (project closed September 1995)
- Nunam Iqua (project closed September 2002)
- Tuntutuliak (project closed September 2002)

Construction of new or upgraded airports is underway by DOT&PF in:

- Alakanuk (funding obligated May 2002)
- Chefornak (funding obligated September 2002)
- Eek (funding obligated September 2002)

- Emmonak (funding obligated September 2001)
- Kipnuk (funding obligated September 2000)
- Kwethluk (funding obligated September 2001)

The community of Nunapitchuk has no airport projects either recently completed/upgraded, underway or planned.

A cursory review was conducted of the DOT/PF bid solicitation and the apparent low bid in five of the 12 study communities (Appendix C). The communities involved were Atmautluak, Chefornak, Eek, Kipnuk and Kwethluk. The results are shown in the following table.

Table 2

Community	DOT Estimate	Low Bidder
Atmautluak	$2,919,225	$3,082,800
Chefornak	$4,557,250	$6,156,250
Eek	$4,994,910	$5,662,231
Kipnuk	$3,880,800	$3,759,710
Kwethluk	$5,892,745	$6,182,381

Sources: Federal Aviation Administration, Alaska Region Airport AIP Program, FY 1982-FY 2002, March 24, 2003.
State of Alaska, Department of Transportation & Public Facilities, Compilation of Bids: Atmautluak, August 16, 2003; Chefornak, July 24, 2002; Eek, August 8, 2002; Kipnuk, March 27, 2001; and Kwethluk September 18, 2001.

V. Community Questionnaire Analysis

The following discussion is based upon information received from those village officials that returned the Community Questionnaire.

Air Service:
Air service to the study communities varies based on community size and on the season. Larger communities, especially a sub-regional hub such as Emmonak, typically receive more flights than do smaller communities. Air carrier schedules show flights also are more numerous during the long daylight hours of summer than they are during winter. Air carriers typically operate under two schedules – one for summer and one for winter. According to these schedules, service ranges from a minimum of three days per week during winter months up to two flights per day – including weekends – during summer months. All of the five carriers discussed earlier maintain web sites which include current schedules.

All of the five air carriers that service most or all of the study communities have a local agent in each community. In some cases where competition is not an issue, the agent may work for more than one air carrier. It is the duty of the agent to meet the plane to pick up freight and mail from an incoming flight and to bring freight and mail for outgoing flights. Passengers are usually left to their own devices to get to and from the airport because few communities have taxi services. However, the traits of courtesy and sharing that are an historical part of Yupik culture (Langdon 1993) usually means that anyone needing a ride to town or assistance with freight will get it. Ground travel to and from airports in the small communities is predominantly by ATV or snow machine in winter with an occasional compact pickup truck.

Airport Maintenance:
Rural airport projects include the following components; the airstrip with approaches, a taxiway and parking apron, a building to house maintenance equipment (a road grader), a small tank farm for diesel fuel and a road from the airport to the community. The projects are constructed by the Department of Transportation and Public Facilities through a competitive bid process. The funding is primarily from the Federal Aviation Administration with a State of Alaska/airport sponsor match.

Airport maintenance is the responsibility of the State of Alaska as owner of the airports in each of the study communities. State-owned airports in this region are managed from the DOT/PF office in Bethel. The actual work of maintaining the airport, including snow plowing, is carried out by an individual under contract to DOT/PF. Maintenance contracts are based upon the lowest qualified bidder for the work. Airport maintenance usually is performed by a local individual.

Community officials generally rated airport maintenance as adequate and "excellent" in a few cases. Of greatest concern is the speed with which the maintenance personnel respond to a snow fall. Air carriers serving the airstrips generally believe that snowplowing right after a storm does not receive the emphasis that it deserves. Runway snow drifts due to cross winds also can present problems.

Residents generally are quite pleased with the results in those communities which have recently received new or reconstructed airports. The new airstrips are longer, wider and more stable than the airstrips they replaced. Several concerns were given to cross wind problems and the fact that the new airport in one case is located a considerable distance from the community. All of the 14 study airports, as well as virtually all of the other airports in Southwest Alaska, must be shut down for up to a week in the spring because of muddy and soft airstrip condition brought on by break-up and seasonal rains.

Special conditions such as the flooding and erosion that affected all of the airports prior to construction of new or rehabilitated airports have been mitigated, largely because of new construction techniques and efforts to locate the airstrips out of or above the flood plain.

Weather:
All study airports are characterized by flat terrain, cloudy and windy conditions, and limited navigation aids. There are no FAA Flight Service Stations (FSS) located in the study region. FSSs nearest the study area are located at Cold Bay, Dillingham, Iliamna and McGrath. The nearest FAA Automated Fight Service Station (AFSS) is located at the Kenai airport. FAA has a federal contract tower at Bethel. Local weather conditions at the 14 study communities are reported to the FAA by automated information gathering systems.

Communities in the study area, from a logistics and weather standpoint, comprise three clusters: a). the Bethel Cluster which includes Atmautluak, Nunapitchuk, Kwethluk, Napakiak and Napaskiak; b). the Emmonak cluster which includes Emmonak as well as Alakanuk, Kotlik and Nunam Iqua; and, c). the Kuskokwim Bay cluster of Chefornak, Eek, Kipnuk and Tuntutuliak.

Weather conditions for the entire regional are often extrapolated from reports on Bethel and vicinity conditions. Although Bethel is the transportation hub for the entire region, air carriers state the Bethel area has its own "mini-weather system" which does not accurately reflect flying conditions in the rest of the region. They state weather conditions outside of Bethel and vicinity typically are worse than that reported for Bethel. These statements were confirmed by a spokesman for the National weather Service. Emmonak cluster communities are influenced more by Norton Sound weather conditions while the Flat terrain, cloudy, windy conditions. Limited navigation aids. Kuskokwim Bay cluster reflect Bering Sea weather conditions.

Local weather conditions at the 14 study communities are reported to the FAA by automated information gathering systems. Pilots typically rely on their community agents and "PIREPS" (pilot reports on weather from other pilots flying in the area) for updated weather conditions.

Airport Construction:

Local officials in communities where airports were constructed or upgraded were generally pleased with the conduct of the contractor involved. Local hire was utilized and local equipment that was leased by the contractor was generally returned to its original or better condition. Roads, river landing areas and other local terrain impacted by the construction work also were returned to their original condition or improved. In one instance, the airport construction contractor improved the local dock during the construction process.

Barge service:

All communities receive barge service at least once a year, and usually two or more times a year during ice-free periods. None of the 14 study communities are located on the coast although several are located within a few miles of the coast. Freeze-up for all communities in the study region begins by late October. The river systems are frozen over through May with break-up occurring in June, according to the Environmental Atlas of Alaska..

Communities located on the coast, the Yukon River up to Fort Yukon and the Kuskokwim River to McGrath may receive from six to 10 freight deliveries a season. For those communities located on the Yukon River, most scheduled barge service originates from Nenana, southwest of Fairbanks on the Tanana River. Fuel shipments also are made from a large tank farm located downriver and up the Norton Sound coast at Saint Michael. Ocean going barges from the Pacific Northwest unload freight at Bethel (see photo at right) where it is transferred to smaller barges for freight service up the Kuskokwim River and its tributaries. The limit of upriver barge service on the Kuskokwim River is McGrath.

Barge service is an important component of the transportation system in rural Alaska because the delivery of bulk freight is predominantly done by barge and generally is limited to the ice-free months of summer. The photograph above provides examples of the various types of freight delivered along the Yukon and Kuskokwim Rivers during summer and early fall.

A typical Southwest Alaska village will receive a shipment of fuel in the spring to refill empty tanks and another shipment in the fall to top off the tanks for winter. The gravel fill material required for airports and building pads also is barged in from other areas because of a lack of such resources in Southwest Alaska.

The photo at left shows a small fuel barge docked at the village of Atmautluak in preparation for offloading fuel to the community's bulk fuel tank farm.

Shipment of fuel by aircraft is usually, but not always, more expensive than barge service in this region. Air shipments of fuel are frequent, however, because of emergencies, colder than normal winters and the fact that payment for fuel delivery is cash-up-front. Volatile fuel prices and the village's cash position can mean the village does not receive as much fuel as needed for the entire winter. If this is the case, a shipment of fuel by air is often necessary before the end of winter and prior to the beginning of spring barge deliveries. The photo at right shows a Northern Air Cargo DC-6 fuel hauler at the Bethel airport.

Most communities have a specified or preferred landing area but few have a dock or improved landing area. Eek and Chevak, for example, have a dock. Napaskiak has an improved landing area near the airport. Napaskiak receives hovercraft service from Bethel. All study communities expressed an interest in a new or improved dock/landing area. The City of Emmonak is actively attempting to develop a Port of Emmonak with a storage yard. Community officials also expressed a desire for more frequent barge service but added they realized that such service is market driven and not likely to increase unless the market demand also increases.

Local ground transportation:
As noted, local access to the airport is provided primarily by a gravel road constructed as part of the overall airport project. Gravel roads, boardwalks, summer ATV trails and winter snow machine trails provide access within the communities.

Fill material:
Locally available fill generally is silt and sand. Gravel typically must be imported by barge, in some cases, from quite distant sources. The cost of fill material was generally either unknown by local officials or set by the Regional Native Corporation. The regional corporations own the subsurface estate – including gravel and other fill material – to lands they have selected and the subsurface state of lands selected by Village Corporation under the Alaska Native Claims Settlement Act (ANCSA) of 1971. For the study area, the Native Regional corporation is Calista Corporation which has its headquarters offices in Anchorage.

With a few exceptions, Native Regional Corporations are the only private entities in Alaska that own the subsurface estate of their lands. In Alaska unlike most of the Lower 48 states, private parties generally do not own the subsurface estate (often referred to as mineral rights) of their lands. Those rights have been retained by the State of Alaska.

An official at Emmonak, which has access to sand and silt for fill, stated the cost to excavate the fill was $15 per cubic yard (27 cubic feet). The cost to mine and place the fill was $32/cubic yard. The cost to mine rock was $49/yard. Crushing and placing the crushed rock added another $15 per yard.

It has been suggested that regional stockpiles of fill material may help reduce the cost to construct and maintain airports in this region. Community participants liked the idea of regional fill stockpiles. For the lower Yukon River, for example, the preferred stockpile site was Emmonak. There reportedly is a fill source located between Emmonak and Alakanuk. Emmonak also has a source of fill with the old airport. Concerns were voiced from several community leaders for the potential for pilferage.

According to the December 2003 issue of Alaska Economic Trends, published by the Alaska Department of Labor and Workforce Development, glaciers can be a source of sand and gravel. Alaska's glaciers have and continue to produce a high grade of sand and gravel, according to the article. Most are near coasts which facilitates transportation. Unfortunately, none of the potential glacial gravel deposits are located in or near Southwest Alaska. However, given the fact that gravel for construction use in rural Alaska often is imported from considerable distances (including from the Lower 48 States), this potential glacial resource may merit more consideration.

Mining also may provide a potential source of fill material. Alaska has a number of active hard-rock and coal mines as well as a number of new mines in the development stage, including the proposed Donlin Creek gold and silver mine located in the eastern portion of the study area. Calista Corporation holds the mineral rights and is actively developing the mine with its partner, NovaGold Resources.

These mines typically are open-pit operations which entail the removal of considerable overburden, including sand and gravel. While the organic portions of the overburden are typically retained for revegetation efforts, it may be worthwhile to assess the possibility of stockpiling mined sand and gravel for future use elsewhere in the region. Donlin Creek, for example, is located relatively near the Kuskokwim River. This portion of the river up to McGrath is accessible by barge. A similar scenario may be possible with Northern Dynasty's Pebble gold and copper prospect near Lake Iliamna.

Transportation Corridors:
Historic transportation corridors exist between neighboring communities as noted in the community sketches. There are also instances of such trails being recorded under the former Federal Revised Statute 2477. However, for all practical purposes, these corridors are used only during winter time and are not suited for speedy transport of individuals to and from villages or for the transportation of freight. Given a resurgence in interest of constructing rural roads where practical and economically feasible, it may be worth the effort to research and catalog these corridors for future reference. An example of such a corridor within the study area is an historic trail which runs from the Upper and Lower Kalskag/Aniak area on the Kuskokwim River north to the former village of Paimiut on the Yukon River.

Aside from the above applications, local community officials noted the use of the Kuskokwim and the Yukon Rivers as virtual highways for boat travel during the summer. The rivers also are used by snow machines, and in some cases trucks and automobiles, when the rivers are frozen over during winter. Use of the iced-over rivers during winter can prove dangerous. Nearly every year, there are reports of vehicles from snow machines to automobiles falling through the ice, often with fatalities involved.

The final section of the report contains sub-reports on information provided in the Air carriers, Water transportation (barges), Agencies and Airport contractors questionnaires.

VI. Air Carrier Questionnaire Analysis

The air carriers serving the study area which returned completed questionnaires are very supportive of the State of Alaska's airport improvements program and its attempts to enhance maintenance. Although, they say there is room for improvement, they also state that the rural airport system in Southwest Alaska is greatly improved over conditions existing only a few years ago. Many of the air carrier responses were similar to the responses from community officials which were discussed above. There is no need to repeat those responses here.

The carriers generally favor an airstrip from 3,000 feet to 4,000 feet long, 100 feet wide and typically oriented Northeast/Southwest to accommodate prevailing winds.

Erosion:
Airport erosion, which remains a problem with airports yet to be upgraded in the region, is generally not a problem with the new or reconstructed airstrips. Most of the new strips, however, are characterized by soft spots during spring break-up. This factor can close an airstrip from two or three days to a week or more. During break-up, carriers can occasionally access these airstrips in the morning hours before the frozen strip has a chance to thaw. This is a case-by-case, day-by-day decision.

Maintenance:
Maintenance is variable with each airstrip. In general, the air carriers do not believe the airports are being maintained to FAA standards. The chief complaint is that maintenance personnel have not been properly trained in operating the equipment used to maintain the strip. They also state there appears to be no incentive for local maintenance employees to promptly plow the strip after a snowfall significant enough to affect air operations.

Airstrip equipment:
Most of the airports have landing lights and locator beacons. While this equipment is generally in working order, the carriers expressed a concern that – as with snow plowing – there seemed to be no impetus to repair damaged or inoperative systems in a timely fashion.

Fill materials:
Pilots are knowledgeable about the terrain over which they fly. The carriers were aware of a fill source between Emmonak and Alakanuk. They also suggested Saint Lawrence Island and the Quinhagak region as other potential sources. The area around Platinum which is named after the metal which was mined in the region for many years, also may be a source of gravel fill. Air carriers supported regional gravel stockpiles and suggested that such stockpiles be placed in the vicinity of the airport for use to rehabilitate airstrips and fill in potholes.

The recommendations offered by air carriers generally track their concerns;

- Require airstrips to be constructed to minimum of 4,000 feet with lighting.
- Utilize trained equipment operators to maintain airstrips, taxiways, ramps and roads on a regular basis to minimize potholes, soft spots, etc.
- Runways, ramps and taxiways should be plowed after each snowfall.
- Wind socks should be illuminated for night operations.
- Ramps need tie-downs.
- Perform regular maintenance checks and repairs on airport landing lights and locator beacons.

The carriers also are interested in the potential for using the Global Positioning System (GPS) in making aircraft Instrument Flight Rules (IFR) landing approaches at rural airports. This recommendation may bear fruit. The FAA and DOT/PF are working jointly on a project to investigate the use of the GPS system for shooting approaches. This is part of an overall project to upgrade and enhance navigation and landing/takeoff services in Alaska, particularly rural Alaska (Storm, FAA 2003).

One carrier suggested that airport construction project include a transfer station facility at the airport. This would be used to place mail and other small cargo items to protect them from inclement weather. The transfer station should be a bare bones approach and not require utility services such as heat or lights.

Ironically, lengthening airstrips may also increase short-term capital costs for some rural air carriers. The carriers utilize aircraft suitable for the airports which they serve. If an airstrip is significantly lengthened, the carrier may have to upgrade its fleet to remain competitive. Specifically, one carrier stated that longer runways have given the Casa 212 – a twin engine, turboprop aircraft with a useful payload of 5,400 pounds – a completive advantage over the Shorts Sky Vans which had been used on shorter airstrips. The same effect can be seen with passenger aircraft where small, single engine aircraft such as the Cessna 172 and 206 can be displaced by larger aircraft such as the single-engine turboprop Cessna 208 and/or a number of light, twin-engine models.

VII. Water Transportation Questionnaire

Generally speaking, barges deliver most of the cargo destined for rural Alaska. With but few exceptions, virtually all rural communities in Alaska are located on a navigable river or coast. According to State demographic statistics, more than 80% of all Alaska residents live within 50 miles of the coast. The only notable exception is the Fairbanks North Star Borough.

The variety of cargo delivered to rural Alaska is substantial. It is easier to list commodities that are not barged such as perishable foodstuffs than those that are. From heavy equipment and construction materials to snow machines and village store non-perishables and dry goods – they all travel by barge under ordinary circumstances.

Equipment:
The size barges used directly reflects river depths and conditions. According to one barge company, the size of barges working the Yukon and Kuskokwim rivers include 120 feet by 28.7 feet, 150 feet by 38.5 feet, 150 feet by 50 feet, and 175 feet by 44.7 feet. Tonnage capacities range from 14 tons to 336 tons. Vessel drafts ranges from 3 feet to 6.5 feet.

Bulk commodities:
Most rural communities rely on diesel fuel for space heating and to power their electrical generation system. The diesel generation system and school facilities are the largest consumers of bulk fuel in a village (Alaska Energy Authority Database, 2000). Bulk fuel tank farms in rural communities are an order of magnitude greater than similar road-accessible communities because of the need to store a winter's worth of fuel. A village of 200 may have fuel storage capacity well over 150,000 gallons. Bulk fuel deliveries are a significant part of rural barge deliveries. Fuels transported by barge include #1 diesel, #2 diesel, gasoline, aviation gas, JP8 (jet fuel for military installations) and propane bottles.

General purpose barge companies – companies that haul both general cargo and fuel – do not get into the business of fuel pricing because of the volatility of the international oil market. As a spokesperson for Yutana Barge Lines, LLC said with respect to fuel deliveries, "we are a fuel and freight transportation company hired by other companies at their prices." The same statement applies to the transportation of gravel and other fill materials as noted below.

Barges are the primary carrier of gravel fill material. Prices are typically given on a per ton basis; however, mobilization, difficulty in loading, navigation and delivery risks also are considered. One company stated that, historically, it has priced its gravel delivery cost at $30 per ton assuming a one-way distance of 80 miles (160 miles round trip). These prices do not include the cost to mine the gravel or place it on the construction site after it has been unloaded from the barge at its destination.

Local marine infrastructure:
Most Alaska rural coastal and riverine communities do not have developed docking facilities or landing areas. In some instances, barges do not even make landfall, but off load freight from offshore making use of portable, pontoon-like bridge apparatuses or lightering. Landing areas may change from year to year based on changes in water depths and shifting sand bars. As a result, communities do not assess landing fees. However, a number of communities have expressed a desire to upgrade landing areas and/or construct a dock where possible. The barge carriers recommended hard-facing the barge landing area, slip and/or staging areas with gravel fill.

Fill material:
Barge companies acknowledged existing gravel sources in the Birch Creek, Platinum, Nome, Saint Michael and Saint Mary's areas. They also added Russian Mission and Galena as regions which also may be able to supply gravel fill. They recommended stockpiling fill for lower Yukon River projects near the Saint Mary's dock and at other communities after securing local permission.

Platinum, not surprisingly named after the precious metal that had been mined in the region for many years, should be considered further as a possible source of fill material. The community, according to its community profile published by the State of Alaska, is a major source of gravel for communities in the immediate area. Platinum was established shortly after traces of platinum were discovered in 1926. Between 1927 and 1934, several small placer mines operated on creeks in the area. About 3,000 troy ounces of platinum were mined over that period, with a value of about $48 per ounce.

A major strike occurred in October of 1936, which brought a stampede of prospectors for the metal, often referred to as "white gold." The claims proved to be too deep for hand mining methods and were bought out by two companies. The largest, Goodnews Mining Co., eventually acquired title to over 150 claims. In 1937 a large dredge was built at the mining site, about 10 miles from the village of Platinum. By 1975, 545,000 ounces of platinum had been mined at the site. The community was incorporated as a Second Class City in 1975.

The mine was later sold to Hanson Properties, which estimated reserves of more than 500,000 ounces. It ceased operations in 1990. Given the mining development in the region, it would be worthwhile to assess and document quantities of existing gravel and tailings piles.

VIII. Agency Questionnaire

There are a number of State, Federal and other agencies which make regular use of the airport facilities in the 14 study communities. These include health organizations, the school system, as well as government social services and resource management organizations.

The Yukon Kuskokwim Health Corporation is responsible for providing health services to Native Alaskans within the region. YKHC operates a large hospital and medical clinic complex in Bethel and also staffs and operates rural health clinics in each of the region's occupied villages. As part of their mission they make use of local airports for a variety of tasks including:

- Medical evacuation (Medivac) of seriously ill or injured persons to the Bethel Regional Hospital or to the Alaska Native Medical Center in Anchorage.
- Transporting supplies and provisions to the clinics.
- Transporting transient medical personnel to and from the villages. This is a circuit rider approach where a dentist, for example, will visit each village one or two times a year and spend a number of days in the community providing dental services.
- Transporting local health aides from the village to Bethel or Anchorage for advanced training, meetings, etc.

As discussed above, regional school districts are responsible for providing educational services in the villages. As part of their work, they make use of local aviation facilities to:

- Transport maintenance personnel, equipment and materials to and from the villages for routine and emergency maintenance and repairs.
- Transport educational staff to and from the villages for training, meetings, etc.
- Transport students involved in school activities such as basketball, track and cultural activities.
- Assist in supervising the construction of new educational facilities.

Social services such as the Headstart Program, Indian Child Welfare Act program, and others also staff offices in these communities. A number of State and Federal agencies maintain personnel in rural communities on a seasonal basis. These agencies include the U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game, among others.

IX. Contractor Questionnaire

Airport construction contractors are dealt with as a separate part of the overall GeoEngineers Inc. report. The results of the Contractor Questionnaire are included in that section and will not be repeated here; however, a few general comments are in order.

There is support for innovative design considerations including:

- Soil stabilization for surface treatment of silts or sands;
- Use of open graded crushed rock to create an air cooled embankment (ACE) section, and thereby preserve permafrost soils; and,
- Use of wood chip layers or fills to increase strength or provide additional subsurface insulation.

Contractors prefer to use gravel as opposed to local silts and sand even if the gravel must be imported from a remote location.

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Appendix A: Study Questionnaires

1. Community Questionnaire
2. Air Carrier Questionnaire
3. Water Transportation (Barge) Questionnaire
4. Agency Questionnaire
5. Airport Contractor Questionnaire

Since its introduction in Alaska in the 1980s, the Cessna Caravan C208 has become a workhorse in rural Alaska.

Community Questionnaire

Community: _____ Govt: City or Tribe Date: _____
(Circle One)

Contact Name/Title: _____ Contact #: _____

Airport: 1st constructed in _____ Rebuilt in _____ New in: _____
Master plan started/completed: _____ New construction scheduled: _____
(Circle One)

If construction is recent, was local hire utilized? Yes No
(Circle One)

A. Air carrier service:
Carriers that serve the community, local agent, frequency of flights:

Name of Carrier	Local agent	Frequency
1.		
2.		
3.		
4.		
5.		

Who performs maintenance on the airport/air strip? _____
Phone Number: ___(907)_____

Do you consider maintenance to be adequate. If not, what do you suggest?

_____
_____
_____

Concerns and comments (Strip is good, strip too short, too narrow, soft, etc.):

_____
_____
_____

Comment on any aircraft accidents apparently caused by or related to the condition of the runway.

_____
_____
_____

Are there any special conditions that affect your airstrip (flooding, silt surface turns to mud, erosion, settlement, heaving, cracking etc.)?

_____
_____
_____

Impact of climate: Are there times of the year when the airport cannot be used due to break-up or freeze-up? Yes or No. If so, when are they?
(Circle One)

_____

_____

What is your overall opinion on the construction contractor and the work?

_____

_____

_____

Was equipment or infrastructure used for the work returned to its original condition (example: dock used to land materials, was torn up and not repaired or vice versa: contractor did extra work)?

_____

_____

_____

B. Barge service
Barge companies that serve the community, local agent and frequency.

Name of Carrier	Local agent	Frequency
1.		
2.		
3.		
4.		
5.		

Does the community have a dock or improved landing area? Describe.

_____

_____

_____

Concerns and comments on barge service:

_____

_____

_____

E. Local ground transportation:
Are your local roads primarily: roads, boardwalks, trails, snow machine trails?

_____

What kind of access to airport: road, boardwalk, trail, snow machine trails?

_____

C. Fill material:
Is fill material available in your area?

Location	Type (gravel, sand, silt)	Owner
1.		
2.		
3.		
4.		
5.		

To your knowledge, what types of fill were used for the airstrip, apron and taxiway?
□ Gravel, □ Sand/silt, □ Basalt, □ Other _____

What entity owned the fill material(s) used for the project?:
□ Native Corporation, □ State, □ Federal, □ Other _____

How much does fill material/gravel cost? This is total cost, including owner royalty as well as the cost to mine, transport and place the gravel. $_____ per cubic yard (alternatively any costs you may have: At pit, offloaded at the dock, placed at the airport etc.)

_____

_____

Is there a location(s) where regional gravel stockpiles could be located? What are your views of regional stockpiles?

_____

_____

Other comments:

_____

_____

_____

D. Transportation Corridors:
Do you have land transportation routes between your community and other communities and what kind (road, winter trail, etc.)

_____

_____

What are the historic transportation corridors in the area around your community and/or between other communities? (this can be river, trail, RS 2477, etc.)

_____

_____

Air Carrier Questionnaire

Carrier:		**Date:**
Contact:		**Phone:**
Address:		**Fax:**

Communities served and local agents: There are 14 communities in the study group. Please check the ones you serve and provide the name of your local agent/number, if available:

	Community	**Agent**	**Phone #**
	Alakanuk		
	Chefornak		
	Eek		
	Kipnuk		
	Kwethluk		
	Napaskiak		
	Nunam Iqua*		

*formerly known as Sheldon Point

	Community	**Agent**	**Phone #**
	Atmautluak		
	Chevak		
	Emmonak		
	Kotlik		
	Napakiak		
	Nunapitchuk		
	Tuntutuliak		

Others: _____

Air Carriers

Type of carrier (Part 121, Part 135, FBOs, charter): _____

_____

Types of aircraft utilized: _____

Aircraft future upgrades (if strip were longer, for example): _____

_____

Old roads/trails: _____

Other: _____

Your views on the airport

Appropriate length, width, orientation: _____

_____

Condition (soft spots?): _____

_____

Erosion/vegetation: _____

_____

Local services (aviation gas, aircraft maintenance): _____

_____

Other strong points, weak points: _____

_____

Have you experienced aircraft accidents and/or minor or major damage due to strip conditions such as roughness, soft surfaces, rutting, frost heaves or settlement areas due to permafrost thaw? _____

Weather and climate: do you experience any of the following at any of the survey airports? Please describe briefly:

Accessibility (how often is the strip unusable due to spring thaw softness/winter freeze-up and water ponding?): _____

_____

_____

Seasonal differences (wind changes, drifting, etc.): _____

_____

Special conditions (flooding, silt turns to mud, etc.): _____

_____

How would you compare weather at the airstrips with that of Bethel at the same time of year? _____

_____

Airstrip maintenance

Graded and snow plowed as appropriate? Comments: _____

_____

Overall adequacy: _____

_____

Landing lights operational all the time?: _____

_____

Locator beacon operational?: _____

_____

Gravel sources

Are your aware of gravel/fill sources in your service area? If so, what are the location(s) (Birch Creek, Platinum, Nome, Saint Mary's, Saint Michael, etc.): _____

_____

Type (river gravel bar, gravel pit, quarry [rock crushing], silt/sand, resources outside immediate area/region, etc.): _____

_____

Do you know who owns the gravel? □ Yes □ No

□ Native Corporation, □ State, □ Federal, □ Other

Owner name _____

Are there opportunities for stockpiling at regional locations in your service area: _____

_____

Water Transport Questionnaire

Carrier:		**Date:**
Contact:		**Phone:**
Address:		**Fax:**

Communities served and local agents: There are 14 communities in the study group. Please check the ones you serve and provide the name of your local agent/number, if available:

√	**Community**	**Agent**	**Phone #**
	Alakanuk		
	Chefornak		
	Eek		
	Kipnuk		
	Kwethluk		
	Napaskiak		
	Nunam Iqua*		

√	**Community**	**Agent**	**Phone #**
	Atmautluak		
	Chevak		
	Emmonak		
	Kotlik		
	Napakiak		
	Nunapitchuk		
	Tuntutuliak		

*formerly known as Sheldon Point

A. Your services:

What size(s) of barges do you use? _____

_____

_____

What are your delivery frequencies? _____

_____

_____

What are the typical types and sizes of equipment/materials that you transport?

_____

_____

_____

Do you transport bulk products such as gravel or fill material? □ Yes □ No
If so, what is the typical transportation cost per cubic yard per mile (if you quote prices in a different format, please describe). _____

_____

_____

_____

Do you transport fuel? If so, what types: □ Gasoline □ #1 Diesel
□ #2 Diesel □ Aviation Gas □ Other _____

Fuel costs are too volatile to ask for specific prices; however, what format do you use for pricing fuel deliveries? _____

_____

_____

B. Deliveries (typical dates)

Season's first delivery: _____ Season's last delivery _____

Break-up begins: _____ Freeze-up begins _____

What off-loading infrastructure is typically available (check all that apply):

□ Dock □ Designated shore location

□ Best available at time of delivery □ Other _____

_____

_____

Are there any special conditions such as high or low water, or flooding, etc., that affect delivery positively or negatively or which force you to limit the size of shipments? _____

_____

_____

C. Dock/landing area maintenance

To your knowledge, what level of maintenance is performed on offloading areas (including dock if available) _____

_____

_____

What would be your recommendations with respect to the establishment and/or maintenance of offloading sites? _____

_____

_____

D. Gravel: Are you aware of fill material sites in the local or regional area?

□ Yes □ No

Location(s) and size if known (Birch Creek, Platinum, Nome, Saint Mary's, Saint Michael, for example): _____

_____

_____

Type: gravel bar, gravel pit, quarry (rock crushing), silt/sand, basalt, other:

_____

_____

_____

Transport cost per cubic yard per mile (if you quote prices in a different format, please describe): _____
_____
_____

Are you aware of any possible sites for stockpiling fill material within your service area? _____
_____
_____

E. What distinguishes your company from other water-borne transportation services? _____
_____
_____

Agency Questionnaire

Agency:		**Date:**
Contact:		**Phone:**
Address:		**Fax:**

Communities served and office locations: There are 14 communities in the study group. Please check the ones for which you provide services or where you have operations. If you maintain an office in community (year-round or seasonal), please provide the name of your local agent and telephone number, if available:

√	**Community**	**Agent**	**Phone #**
	Alakanuk		
	Chefornak		
	Eek		
	Kipnuk		
	Kwethluk		
	Napaskiak		
	Nunam Iqua*		

√	**Community**	**Agent**	**Phone #**
	Atmautluak		
	Chevak		
	Emmonak		
	Kotlik		
	Napakiak		
	Nunapitchuk		
	Tuntutuliak		

*formerly known as Sheldon Point

A. Agency: Please check the box which best describes your agency:

□ State, □ Federal, □ Native, □ Other

B. Services: Please check the box(es) which best describe the services and/or duties your agency performs:

□ Resource Management □ Health □ Regulatory □ Education
□ Public Safety □ Military □ Construction □ Housing
□ Social Services □ Other _____

_____

C. Primary use made of airstrip by agency (check all that apply)

□ People transportation
□ Cargo transportation
□ U.S. Mail/Gold Streak, "Penpak," Federal Express/UPS, etc.
□ Agency also makes use of barge service.
□ Agency also makes use of ice roads and/or frozen rivers during winter.
□ Other _____

_____

D. In your assessment, are the rural airports you utilize:

□ Generally of appropriate length and width and properly surfaced.
□ Existing airport needs to be upgraded with respect to the above.
□ A new airport is needed.

E. Airstrip maintenance

Graded and snow plowed as appropriate? Comments: _____

_____

_____

Overall maintenance adequacy: _____

_____

_____

In your experience, have the landing lights been operational all the time?:

_____

_____

In your, experience, has the locator beacon been operational at all times?:

_____

_____

F. Do weather, climate or other factors unduly affect your ability to land at and depart from communities? If so, how and to what degree of severity? If your remarks concern individual communities, please identify them with your response.

Accessibility due to break-up/freeze-up situations: _____

_____

_____

Special conditions (flooding, silt turns to mud with spring/fall rains, etc.)

_____

_____

Other: _____

_____

_____

_____

Overall, what is your assessment of airport maintenance?_____

_____

_____

G. Gravel: Are you aware of fill material sites in the local or regional area?

□ Yes □ No

Location(s) and size if known (Birch Creek, Platinum, Nome, Saint Mary's, Saint Michael, for example): _____

_____

_____

Do you know who owns the gravel? □ Yes □ No. If so, please complete:
□ Native Corporation, □ State, □ Federal, Owner name _____

Type: gravel bar, gravel pit, quarry (rock crushing), silt/sand, basalt: _____
_____
_____

Opportunities for stockpiling at regional locations: _____
_____
_____

Contractor Questionnaire

Company:		**Date:**
Contact: Name		**Phone:**
e-mail Address:		**Fax:**

Airports studied:
There are 14 airfields in our investigation of Airport Life-cycle costs and performance. Please check the ones for which you provided significant work related to the project construction contracts which built these airports. Duties include on-site project engineering, inspections, change order approvals or overall responsibility for projects in the Y-K delta region.

√	**Airport**	**Years in which work was done**	**Duties**
	Alakanuk		
	Chefornak		
	Eek		
	Kipnuk		
	Kwethluk		
	Napaskiak		
	Nunam Iqua*		

√	**Airport**	**Years in which work was done**	**Duties**
	Atmautluak		
	Chevak		
	Emmonak		
	Kotlik		
	Napakiak		
	Nunapitchuk		
	Tuntutuliak		

*formerly known as Sheldon Point

A. Please check the box which best describes your job assignment:
□ Contract management □ Materials □ Inspection □ Program Management

B. Responsibilities : Please check the box(es) which describe the duties you perform:
□ Field testing and inspection □ Contract Change Order development
□ FAA contact coordination □ Change Order Acceptance
□ Final reviews and approvals □ Other _____
_____

C. Project Plans: Do you review the Contract Plans and Specifications and provide input prior to final plan approvals?

□ Yes □ No

D. Budget Records. This project requires information on prior costs, going back as far as 20 years if possible. To examine the Life-Cycle costs of these Y-K Delta airports, we will need to know the costs of prior construction and engineering work related to these airfields. Do you have such records? How can they be obtained?

How long are records retained _____
Who/how/Where accessed _____

E. Design Features. Certain non-standard design features have been used on these remote airports in attempts to control costs and / or preserve permafrost by retarding thawing of the underlying soils. Check the features on which you have had specific involvement in supervising construction involving their use. (For each such use, list the above airports where you had construction experience – This is needed because of the multiple project contracts at some sites).

□ [1] Frozen silt borrow embankments;
Where_____ Years_____

□ [2] Stripping of vegetation to pre-thaw foundation soils.
Where_____ Years_____

□ [3] Polystyrene foam insulation layers;
Where_____ Years_____

□ [4] Geosynthetics at bottom of embankment;
Where_____ Years_____

□ [5] Geosynthetics for crack reduction on shoulders and slopes;
Where_____ Years_____

□ [6] Geosynthetics for subsurface drainage of excess moisture;
Where_____ Years_____

□ [7] Geosynthetic grids for reinforcement of base course;
Where_____ Years_____

□ [8] Geosynthetics for separation of embankment/base course soils:
Where_____ Years_____

F. Innovative Design Features Considered: In our investigation we are to develop recommendations for new and innovative design features or ways of operating, based on recommendations and experience from other areas of the

North. Which of the following features do you consider to have merit and would like to see tested in field experimental trials.

- ☐ [9] Subdrain pipes for drainage of excess moisture:
- ☐ [10] Surface treatments for Dust Control;
- ☐ [11] Soil stabilization for surface treatment of silts or sands;
- ☐ [12] Uses of prefabricated mats for temporary surfacing of pit access roads and/or permanent apron or runway surfacings.
- ☐ [13] Installation of near horizontal thermosyphons beneath embankments to preserve permafrost foundation soils
- ☐ [14] Use of open graded crushed rock to create an Air Cooled Embankment (ACE) section, and thereby preserve permafrost soils
- ☐ [15] Use of wood chip layers or fills to increase strength or provide additional subsurface insulation

Features I feel justify more study (from the above list): _____

_____

Comments: _____

_____

_____

Recommendations for other new design features: _____

_____

_____

G. Embankment materials used are most commonly the local organic silts. If thawed and frozen sources are both available due to the common occurrence of discontinuous permafrost, which is to be preferred from the standpoint of economics and ease of construction? (Thawed sites are typically in wet pits)

☐ Frozen borrow sites ☐ Thawed borrow sites

Why? _____

_____

Construction timing is often critical to embankment construction. Should this be left to the contractor's option to reduce costs, or is setting the timing of the work by specification the best approach?

☐ by contractor ☐ by specification

H. **Silt embankments** are very susceptible to erosion and gully formation which often must be repaired during construction, What method do you recommend for such gully repairs;

□ Silt placement and re-compaction □ gravel fill placement □_ geotextiles combined with silt fill □ geotextiles combined with gravel fill □ Other:

_____

_____

I. **Embankments** constructed of frozen soils and /or on ice rich permafrost are known to settle and develop shoulder cracking over time. Geosynthetics are specified at times to control such cracking. Is there a suitable method of correcting shoulder cracks on an active construction project.

□ No □ Yes Explain: _____

_____

_____

J. **Unpaved airport surfacing layers** (pavement structures) placed over silt embankment materials are commonly built with the thinnest possible layer of crushed gravel, sometimes separated from the silt by use of a separation geotextile. Silt embankment materials, however, are frequently too wet to support the equipment used to place and compact the gravel. What specifications and design procedure do you recommend for analyzing the strength of silt embankments before or during construction? Should equipment size and weight specifications be used to assure constructability?

□ density testing □ proof rolling □ penetration DCP testing □ Restrict equipment

Comments and recommendations:

_____

_____

_____

K. **Summer weather** may prove too wet to allow drying of wet silts used in embankments. How is this best dealt with in the Construction phase?

_____

_____

_____

L. **Reducing construction costs** may help to reduce the life-cycle costs of the Y-K delta airports. Certain questions are being posed to contractors related to their work. Your comments are desired on the following questions:

- Are seasonal construction requirements adequate? Is there sufficient flexibility to allow lowest bids to be made? Comments: _____

  _____

  _____

- Are compaction requirements realistic or do they cause major cost increases which might be avoided? Comments: _____
  _____
  _____

- Should seasonal construction timing be specified to avoid the perception that soils can be worked when they cannot be, due to excessively soft and wet conditions, or should timing decisions be left to the contractor? Comments: _____
  _____
- _____

- Would avoiding the use of local silt soils by specifying the use of known, high-quality remote borrow sites for embankments help to simplify construction and result in a better end-product?
- Comments: _____
  _____
  _____

- Would more use of geotextile layers in embankments improve the constructability or simply hinder progress? Comments: _____
  _____
  _____

- Should equipment size specifications be used to avoid problems caused by excessively large equipment, or should this be left to the contractor? Comments: _____
  _____
  _____

Closing Comments / Ideas on reducing the life cycle costs of Y-K Delta Airports:
_____
_____
_____

Appendix B: FAA Master Airport Records

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: ALAKANUK
> 2 AIRPORT NAME: ALAKANUK
3 CBD TO AIRPORT (NM): 01 SW
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: AUK
5 COUNTY: WADE HAMPTON AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50024.1*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: ST OF AK DOTPF NORTHERN RGN
> 12 ADDRESS: 2301 PEGGER ROAD
FAIRBANKS, AK 99709
> 13 PHONE NR: 907-443-3444
> 14 MANAGER: HARRY JOHNSON
> 15 ADDRESS: BOX 192
UNALAKLEET, AK 99684
> 16 PHONE NR: 907-624-3261
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 62-40-48.159N ESTIMATED
20 ARPT LONG: 164-39-35.731W
21 ARPT ELEV: 10 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:
CARGO

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: RDO-CTL
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	3
91 MULTI ENG:	0
92 JET:	0
TOTAL:	3
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,000
103 G A LOCAL:	300
104 G A ITNRNT:	500
105 MILITARY:	0
TOTAL:	1,800

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		18/36
> 31 LENGTH:		2,200
> 32 WIDTH:		55
> 33 SURF TYPE-COND:		GRVL-G
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)
> 51 DISPLACED THR	/
> 52 CTLG OBSTN	/
> 53 OBSTN MARKED/LGTD	/
> 54 HGT ABOVE RWY END	/
> 55 DIST FROM RWY END	/
> 56 CNTRLN OFFSET	/
57 OBSTN CLNC SLOPE	50:1 / 50:1
58 CLOSE-IN OBSTN	N / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 042 RWY 18 MKD WITH REFLECTIVE CONES & THLD PANELS; SOME THLD PANELS DAMAGED.
A 081 ACTIVATE MIRL RY 18/36 & ROTG BCN - CTAF.
A 110-01 RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.
A 110-02 RY AND APRON FLOODS IN SPRING.
A 110-03 S SAFETY AREA SOFT & GRASSY.

111 INSPECTOR: (F)
112 LAST INSP: 06/17/1997
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

AUK Alakanuk Airport
Alakanuk, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: AUK
Lat/Long: 62-40-48.159N / 164-39-35.731W
62-40.80265N / 164-39.59552W
62.6800442 / -164.6599253
(estimated)
Elevation: 10 ft. / 3 m (estimated)
Variation: 17E (1985)
From city: 1 mile SW of ALAKANUK, AK

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: ENM (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: yes
Lights: RDO-CTL
ACTIVATE MIRL RY 18/36 & ROTG BCN - CTAF.
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX AWOS-3 at ENM (8 nm NE): 135.35 (907-949-1014)

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:03	12:03
Sunrise	05:42	13:42
Sunset	00:08	08:08
Evening civil twilight	01:47	09:47

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
ENMr200/7.8	EMMONAK VOR/DME	117.80	17E

METAR

PAEM 211915Z AUTO 32008KT 230V360 OVC070 06/02 A3010 RMK AO1

Airport Services

Airframe service: NONE
Powerplant service: NONE

Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 18/36

Dimensions: 2200 x 55 ft. / 671 x 17 m
Surface: gravel, in good condition
Runway edge lights: medium intensity
Runway edge markings: MKD WITH REFLECTIVE CONES & THLD PANELS; SOME THLD PANELS DAMAGED.

	RUNWAY 18	RUNWAY 36
Traffic pattern:	left	left

Airport Operational Statistics

Aircraft based on the field: 3
Single engine airplanes: 3

Aircraft operations: avg 34/week
56% air taxi
28% transient general aviation
17% local general aviation

Additional Remarks

- RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.
- RY AND APRON FLOODS IN SPRING.

- S SAFETY AREA SOFT & GRASSY.

Businesses, Services and Facilities On or Near Alakanuk Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Alakanuk Airport

- www.alaska.faa.gov/...
- www.alaska.faa.gov/...
- www.alaska.faa.gov/...
- www.alaska.faa.gov/...
- www.alaska.faa.gov/...

ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: ATMAUTLUAK
> 2 AIRPORT NAME: ATMAUTLUAK
3 CBD TO AIRPORT (NM): 00 SW
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: 4A2
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50044.*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: ST OF AK DOT/PF CENTRAL REG
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L.J. DAVIS
> 15 ADDRESS: PO BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-52-00.284N ESTIMATED
20 ARPT LONG: 162-16-23.300W
21 ARPT ELEV: 17 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR: YES
84 SEGMENTED CIRCLE: NONE
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	0
103 G A LOCAL:	0
104 G A ITNRNT:	0
105 MILITARY:	0
TOTAL:	0

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		15/33
> 31 LENGTH:		2,000
> 32 WIDTH:		25
> 33 SURF TYPE-COND:		GRAVEL-P
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V)	A(V)
> 51 DISPLACED THR		
> 52 CTLG OBSTN	BERM	
> 53 OBSTN MARKED/LGTD		
> 54 HGT ABOVE RWY END	12	
> 55 DIST FROM RWY END	150	
> 56 CNTRLN OFFSET	0B	
57 OBSTN CLNC SLOPE	12:1	50:1
58 CLOSE-IN OBSTN	N	Y

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 031 RWY 15/33 HAS SOFT TUNDRA ON ALL SIDES SURROUNDING RY.
A 033 RWY 15/33 FIRST 650 FT OF RY 33 ROUGH W/DIPS.
A 042 RWY 15 /33 MARKED WITH REFLECTIVE MARKERS & CONES.
A 058 RWY 33 SAND PILES TO 30 FT, 300 FT L AND PARALLEL TO RY 33. 30 FT POLE, 70 FT S, 150 FT L OF RY 33 THLD.
A 110-01 CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
A 110-02 RY EDGES AND SAFETY AREAS SOFT.
A 110-03 SAND PILE 50 FT HIGH WEST SIDE RY 15/33 MID-FIELD.
A 110-04 UPSLOPING TERRAIN AT 5% GRADE TO 20 FT ABOVE RUNWAY ELEVATION ON NW END OF RY 15/33.
A 110-05 15 FT BERM 150 FT OFF END OF RY 15.

111 INSPECTOR: (S)
112 LAST INSP: 07/11/2002
113 LAST INFO REQ: 09/25/1980

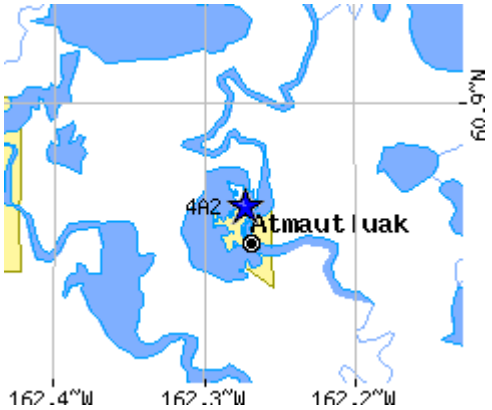
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

4A2 Atmautluak Airport
Atmautluak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: 4A2
Lat/Long: 60-52-00.284N / 162-16-23.300W
60-52.00473N / 162-16.38833W
60.8667456 / -162.2731389
(estimated)
Elevation: 17 ft. / 5 m (estimated)
Variation: 18E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: yes
Segmented circle: no
Beacon: unknown

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX ASOS at BET (14 nm E): PHONE 907-543-5475

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:34	12:34
Sunrise	05:51	13:51
Sunset	23:41	07:41
Evening civil twilight	00:57	08:57

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr272/14.0	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
OSCARVILLE	272/12.6	251	19E	OSE --- ... .
BETHEL	269/13.9	344	19E	ET . -

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 15/33

Dimensions: 2000 x 25 ft. / 610 x 8 m
HAS SOFT TUNDRA ON ALL SIDES SURROUNDING RY.
Surface: gravel, in poor condition
FIRST 650 FT OF RY 33 ROUGH W/DIPS.
Runway edge markings: /33 MARKED WITH REFLECTIVE MARKERS & CONES.

	RUNWAY 15	RUNWAY 33
Traffic pattern:	left	left
Obstructions:	12 ft. berm, 150 ft. from runway, 12:1 slope to clear	none SAND PILES TO 30 FT, 300 FT L AND PARALLEL TO RY 33. 30 FT POLE, 70 FT S, 150 FT L OF RY 33 THLD.

Additional Remarks

- CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
- RY EDGES AND SAFETY AREAS SOFT.

- SAND PILE 50 FT HIGH WEST SIDE RY 15/33 MID-FIELD.

- UPSLOPING TERRAIN AT 5% GRADE TO 20 FT ABOVE RUNWAY ELEVATION ON NW END OF RY 15/33.
- 15 FT BERM 150 FT OFF END OF RY 15.

Businesses, Services and Facilities On or Near Atmautluak Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Atmautluak Airport

www.alaska.faa.gov/...
www.alaska.faa.gov/...
www.alaska.faa.gov/...
www.alaska.faa.gov/...
ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: CHEFORNAK
> 2 AIRPORT NAME: CHEFORNAK
3 CBD TO AIRPORT (NM): 00 E
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: CFK
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50095.12*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF ALASKA DOTPF
> 12 ADDRESS: POUCH 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L. J. DAVIS
> 15 ADDRESS: BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-08-57.212N ESTIMATED
20 ARPT LONG: 164-17-08.277W
21 ARPT ELEV: 40 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING:
25 NPIAS/FED AGREEMENTS:N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: C
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE:
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT:
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,000
103 G A LOCAL:	0
104 G A ITNRNT:	500
105 MILITARY:	0
TOTAL:	1,500

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	16/34	
> 31 LENGTH:	2,500	
> 32 WIDTH:	35	
> 33 SURF TYPE-COND:	GRVL-DIRT-P	
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED	
> 42 RWY MARK TYPE-COND	NONE -	NONE -
> 43 VGSI		
44 THR CROSSING HGT		
45 VISUAL GLIDE ANGLE		
> 46 CNTRLN-TDZ	N - N	N - N
> 47 RVR-RVV	- N	- N
> 48 REIL	N	N
> 49 APCH LIGHTS		

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V)	A(V)
> 51 DISPLACED THR		
> 52 CTLG OBSTN		
> 53 OBSTN MARKED/LGTD		
> 54 HGT ABOVE RWY END		
> 55 DIST FROM RWY END		
> 56 CNTRLN OFFSET		
57 OBSTN CLNC SLOPE	50:1	50:1
58 CLOSE-IN OBSTN	N	N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	
> 61 TAKE OFF DIST AVBL (TODA)	
> 62 ACLT STOP DIST AVBL (ASDA)	
> 63 LNDG DIST AVBL (LDA)	

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 021 SEAPLANE BASE ELEVATION: 5 FT MSL.
A 033 RWY 16/34 RY 16/34 SURFACE VARIATIONS DIPS DUE TO FROST HEAVING/THAWING.
A 083 WINDSOCK LIGHT OTS INDEFLY.
A 110-01 BIRDS ON & INVOF ARPT.
A 110-02 GRAVEL TURN AROUNDS MIDWAY BOTH ENDS USABLE.
A 110-03 FLOAT AVBL FOR PARKING. NO BEACHING FACILITIES. REEF ADJ NW OF FLOAT.
A 110-04 RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
A 110-05 RY 34 HAS 8 INCH DIP IN CNTRLN 100 FT FM APCH THLD.

111 INSPECTOR: (S)
112 LAST INSP: 07/10/2002
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

PACK Chefornak Airport
Chefornak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: CFK
Lat/Long: 60-08-57.212N / 164-17-08.277W
60-08.95353N / 164-17.13795W
60.1492256 / -164.2856325
(estimated)
Elevation: 40 ft. / 12 m (estimated)
SEAPLANE BASE ELEVATION: 5 FT MSL.
Variation: 17E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: MYU (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted, WINDSOCK LIGHT OTS INDEFLY.
Segmented circle: no
Lights: DUSK-DAWN
Beacon: white (unlighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:54	12:54
Sunrise	06:05	14:05
Sunset	23:42	07:42
Evening civil twilight	00:53	08:53

Airport Communications

CTAF: 122.7
WX AWOS-3 at IIK (15 nm SE): 118.325 (907-896-5510)

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
IIKr312/14.5	KIPNUK VOR/DME	115.90	17E

Airport Services

Runway Information

Runway 16/34

Dimensions:	2500 x 35 ft. / 762 x 11 m	
Surface:	gravel/dirt, in poor condition RY 16/34 SURFACE VARIATIONS DIPS DUE TO FROST HEAVING/THAWING.	
Runway edge lights:	medium intensity	
	RUNWAY 16	**RUNWAY 34**
Traffic pattern:	left	left
Markings:	none	none
Runway end identifier lights:	no	no

Airport Operational Statistics

Aircraft operations: avg 29/week
67% air taxi
33% transient general aviation

Additional Remarks

- BIRDS ON & INVOF ARPT.

- GRAVEL TURN AROUNDS MIDWAY BOTH ENDS USABLE.

- FLOAT AVBL FOR PARKING. NO BEACHING FACILITIES. REEF ADJ NW OF FLOAT.
- RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
- RY 34 HAS 8 INCH DIP IN CNTRLN 100 FT FM APCH THLD.

Businesses, Services and Facilities On or Near Chefornak Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Chefornak Airport

www.alaska.faa.gov/...
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: CHEVAK
> 2 AIRPORT NAME: CHEVAK
3 CBD TO AIRPORT (NM): 01 N
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: VAK
5 COUNTY: WADE HAMPTON AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50096.22*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOTPF CENTRAL RGN
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L. J. DAVIS
> 15 ADDRESS: 2016 AIRPORT ROAD
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 61-32-01.089N ESTIMATED
20 ARPT LONG: 165-35-01.436W
21 ARPT ELEV: 75 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS:N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: C
> 81 ARPT LGT SKED: RDO-CTL
> 82 UNICOM: 122.800
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: NONE
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,800
103 G A LOCAL:	0
104 G A ITNRNT:	300
105 MILITARY:	0
TOTAL:	2,100

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	14/32	18W/36W
> 31 LENGTH:	2,610	2,000
> 32 WIDTH:	40	400
> 33 SURF TYPE-COND:	GRVL-F	WATER
> 34 SURF TREATMENT:		
35 GROSS WT: SW		
36 (IN THSDS) DW		
37 DTW		
38 DDTW		

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED	
> 42 RWY MARK TYPE-COND	NONE - / NONE -	- / -
> 43 VGSI	/	/
44 THR CROSSING HGT	/	/
45 VISUAL GLIDE ANGLE	/	/
> 46 CNTRLN-TDZ	N - N / N - N	- / -
> 47 RVR-RVV	- N / - N	- / -
> 48 REIL	N / N	/
> 49 APCH LIGHTS	/	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)	/
> 51 DISPLACED THR	/	/
> 52 CTLG OBSTN	/ ROAD	/
> 53 OBSTN MARKED/LGTD	/	/
> 54 HGT ABOVE RWY END	/ 10	/
> 55 DIST FROM RWY END	/ 160	/
> 56 CNTRLN OFFSET	/ 0B	/
57 OBSTN CLNC SLOPE	50:1 / 16:1	50:1 / 50:1
58 CLOSE-IN OBSTN	N / N	N / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/	/
> 61 TAKE OFF DIST AVBL (TODA)	/	/
> 62 ACLT STOP DIST AVBL (ASDA)	/	/
> 63 LNDG DIST AVBL (LDA)	/	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 033 RWY 14/32 LOOSE GRVL ON SFC. SHOULDERS SOFT.
A 040 RWY 14/32 NSTD PVT LGTS.
A 042 RWY 14 /32 MKD WITH REFLECTIVE CONES & THR PANELS.
A 080 NSTD WHITE FLASHING ROTG BCN.
A 081 ACTVT MIRL RY 14/32; NSTD ROTG BCN - CTAF.
A 110-01 STRONG CROSS WIND AT THIS LCTN.
A 110-02 SPB LANDING AREA IN NINGIKFAF RIVER; NO FLOAT OR DOCKING FACILITIES.
A 110-03 RY IS TROUGH SHAPED LOW IN CENTER & HIGH AT BOTH ENDS.
A 110-04 CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.

111 INSPECTOR: (F)
112 LAST INSP: 06/13/1997
113 LAST INFO REQ:

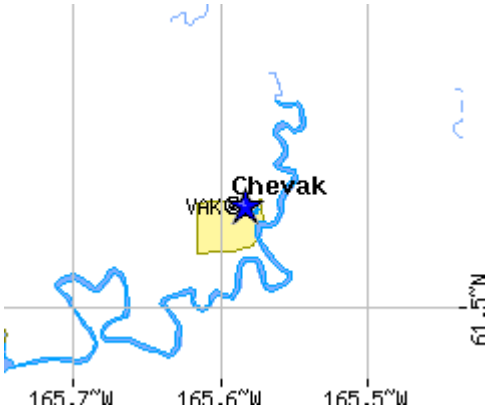
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

VAK Chevak Airport
Chevak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: VAK
Lat/Long: 61-32-01.089N / 165-35-01.436W
61-32.01815N / 165-35.02393W
61.5336358 / -165.5837322
(estimated)
Elevation: 75 ft. / 23 m (estimated)
Variation: 13E (2005)
From city: 1 mile N of CHEVAK, AK

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: HPB (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: no
Lights: RDO-CTL
ACTVT MIRL RY 14/32; NSTD ROTG BCN - CTAF.
Beacon: white (unlighted land airport)
NSTD WHITE FLASHING ROTG BCN.

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 123.0
UNICOM: 122.8
WX AWOS-3 at HPB (16 nm W): 135.10 (907-758-4211)

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:35	12:35
Sunrise	05:58	13:58
Sunset	00:00	08:00
Evening civil twilight	01:23	09:23

METAR

PAHP 211915Z 06008KT 9SM CLR 12/01 A3012 RMK AO1
PACZ 211915Z AUTO 07009KT 10SM SCT050 10/M02 A3010

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
HPBr070/15.8	HOOPER BAY VOR/DME	115.20	16E

NDB name	Hdg/Dist	Freq	Var	ID

CAPE ROMANZOF 129/18.9 4 16E CZF -.-. --.. ..-.

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 14/32

Dimensions: 2610 x 40 ft. / 796 x 12 m
Surface: gravel, in fair condition
LOOSE GRVL ON SFC. SHOULDERS SOFT.
Runway edge lights: medium intensity
NSTD PVT LGTS.
Runway edge markings: /32 MKD WITH REFLECTIVE CONES & THR PANELS.

	RUNWAY 14	RUNWAY 32
Traffic pattern:	left	left
Markings:	none	none
Runway end identifier lights:	no	no
Obstructions:	none	10 ft. road, 160 ft. from runway, 16:1 slope to clear

Runway 18W/36W

Dimensions: 2000 x 400 ft. / 610 x 122 m
Surface: water

	RUNWAY 18W	RUNWAY 36W
Traffic pattern:	left	left

Airport Operational Statistics

Aircraft operations: avg 40/week
86% air taxi
14% transient general aviation

Additional Remarks

- STRONG CROSS WIND AT THIS LCTN.

- SPB LANDING AREA IN NINGIKFAF RIVER; NO FLOAT OR DOCKING FACILITIES.
- RY IS TROUGH SHAPED LOW IN CENTER & HIGH AT BOTH ENDS.
- CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.

Businesses, Services and Facilities On or Near Chevak Airport

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: EEK
> 2 AIRPORT NAME: EEK
3 CBD TO AIRPORT (NM): 01 E
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: EEK
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50177.*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOTPF CENTRAL RGN
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L. J. DAVIS
> 15 ADDRESS: BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-12-57.255N ESTIMATED
20 ARPT LONG: 162-00-20.193W
21 ARPT ELEV: 40 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR: YES
84 SEGMENTED CIRCLE: NONE
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	0
103 G A LOCAL:	0
104 G A ITNRNT:	0
105 MILITARY:	0
TOTAL:	0

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		17/35
> 31 LENGTH:		1,420
> 32 WIDTH:		35
> 33 SURF TYPE-COND:		GRVL-P
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)
> 51 DISPLACED THR	/
> 52 CTLG OBSTN	/
> 53 OBSTN MARKED/LGTD	/
> 54 HGT ABOVE RWY END	/
> 55 DIST FROM RWY END	/
> 56 CNTRLN OFFSET	/
57 OBSTN CLNC SLOPE	50:1 / 50:1
58 CLOSE-IN OBSTN	N / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 030	RWY 17/35 SLOPES UPHILL 3% TO THE N.
A 033	RWY 17/35 SHALLOW RUTS & DIPS ENTIRE LENGTH; PONDING & SOFT SFC AFTER RAIN.
A 042	RWY 17 /35 CONES WITH REFLECTORS ALONG RY EDGE & THLD; THLD CONES ON RY 35 MISSING.
A 110-01	THR RYS 17 & 35 LCTD AT RIVERS EDGE AND LAKE EDGE.
A 110-02	CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
A 110-03	RY 35 FIRST 100 FT VERY SOFT GRVL.
A 110-04	RY 17/35 SAFETY AREAS BOTH ENDS VERY SOFT.

111 INSPECTOR: (S)
112 LAST INSP: 07/14/2002
113 LAST INFO REQ:

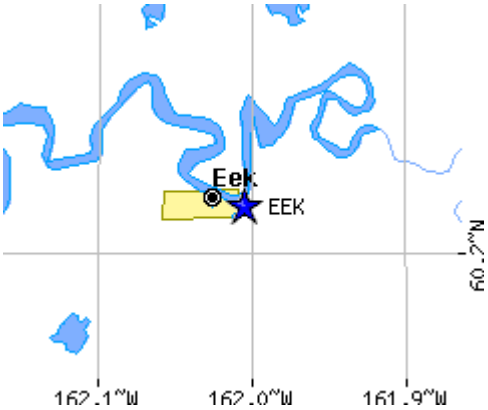
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

EEK Eek Airport
Eek, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: EEK
Lat/Long: 60-12-57.255N / 162-00-20.193W
60-12.95425N / 162-00.33655W
60.2159042 / -162.0056092
(estimated)
Elevation: 40 ft. / 12 m (estimated)
Variation: 18E (1985)
From city: 1 mile E of EEK, AK

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: yes
Segmented circle: no
Beacon: unknown

Airport Communications

CTAF: 122.8

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr170/34.6	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
OSCARVILLE	167/34.7	251	19E	OSE --- ... .

Airport Services

Airframe service: NONE

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:44	12:44
Sunrise	05:55	13:55
Sunset	23:34	07:34
Evening civil twilight	00:45	08:45

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 17/35

Dimensions: 1420 x 35 ft. / 433 x 11 m
Surface: gravel, in poor condition
SHALLOW RUTS & DIPS ENTIRE LENGTH; PONDING & SOFT SFC AFTER RAIN.
Runway edge markings: /35 CONES WITH REFLECTORS ALONG RY EDGE & THLD; THLD CONES ON RY 35 MISSING.
Operational restrictions: SLOPES UPHILL 3% TO THE N.

	RUNWAY 17	RUNWAY 35
Traffic pattern:	left	left

Additional Remarks

- THR RYS 17 & 35 LCTD AT RIVERS EDGE AND LAKE EDGE.

- CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
- RY 35 FIRST 100 FT VERY SOFT GRVL.

- RY 17/35 SAFETY AREAS BOTH ENDS VERY SOFT.

Businesses, Services and Facilities On or Near Eek Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Eek Airport

www.alaska.faa.gov/...
www.alaska.faa.gov/...
ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: EMMONAK
> 2 AIRPORT NAME: EMMONAK
3 CBD TO AIRPORT (NM): 00 E
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: ENM
5 COUNTY: WADE HAMPTON AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50198.61*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: ST OF AK DOTPF NORTHERN RGN
> 12 ADDRESS: 2301 PEGGER ROAD
FAIRBANKS, AK 99709
> 13 PHONE NR: 907-443-3444
> 14 MANAGER: HARRY JOHNSON
> 15 ADDRESS: BOX 192
UNALAKLEET, AK 99684
> 16 PHONE NR: 907-624-3261
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 62-47-06.671N ESTIMATED
20 ARPT LONG: 164-29-27.766W
21 ARPT ELEV: 14 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: NGY
26 FAR 139 INDEX:

SERVICES

> 70 FUEL: 100
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	8
91 MULTI ENG:	1
92 JET:	0
TOTAL:	9
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	5,000
103 G A LOCAL:	1,000
104 G A ITNRNT:	7,000
105 MILITARY:	0
TOTAL:	13,000

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	16/34	
> 31 LENGTH:	4,400	
> 32 WIDTH:	75	
> 33 SURF TYPE-COND:	GRAVEL-G	
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED	
> 42 RWY MARK TYPE-COND	- / -	
> 43 VGSI	V2L / V2L	
44 THR CROSSING HGT	/ 35	
45 VISUAL GLIDE ANGLE	3.00 / 3.00	
> 46 CNTRLN-TDZ	- / -	
> 47 RVR-RVV	- / -	
> 48 REIL	/	
> 49 APCH LIGHTS	/	

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)	
> 51 DISPLACED THR	/	
> 52 CTLG OBSTN	/	
> 53 OBSTN MARKED/LGTD	/	
> 54 HGT ABOVE RWY END	/	
> 55 DIST FROM RWY END	/	
> 56 CNTRLN OFFSET	/	
57 OBSTN CLNC SLOPE	50:1 / 50:1	
58 CLOSE-IN OBSTN	N / N	

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 031 RWY 16/34 SAFETY AREA LENGTH 5000 FT; SAFETY AREA ROUGH BOTH RY ENDS.
A 033 RWY 16/34 SHALLOW; RUTS & DIPS ENTIRE LENGTH OF RY.
A 042 RWY 16 THLDS MKD WITH THLD PANELS; PANELS DAMAGED.
A 042 RWY 34 THLD PANELS SET BELOW RY GRADE.
A 081 ACTVT MIRL RY 16/34 & VASI RYS 16 & 34 - CTAF.
A 084 SEGMENTED CIRCLE IN BAD REPAIR.
A 110-01 WX REPORTS UNAVBL.
A 110-02 RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.

111 INSPECTOR: (F)
112 LAST INSP: 06/12/1997
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

PAEM Emmonak Airport
Emmonak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: ENM
Lat/Long: 62-47-06.671N / 164-29-27.766W
62-47.11118N / 164-29.46277W
62.7851864 / -164.4910461
(estimated)
Elevation: 14 ft. / 4 m (estimated)
Variation: 17E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: ENM (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: yes
SEGMENTED CIRCLE IN BAD REPAIR.
Lights: DUSK-DAWN
ACTVT MIRL RY 16/34 & VASI RYS 16 & 34 - CTAF.
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX AWOS-3: 135.35 (907-949-1014)

- APCH/DEP SVC PRVDD BY ANCHORAGE ARTCC ON FREQS 132.5/226.8 (CAPE RAMONZOF RCAG).

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	03:59	11:59
Sunrise	05:40	13:40
Sunset	00:09	08:09
Evening civil twilight	01:50	09:50

METAR

PAEM 211915Z AUTO 32008KT 230V360 OVC070 06/02 A3010 RMK AO1

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
ENM at field	EMMONAK VOR/DME	117.80	17E

Airport Services

Fuel available: 100

Runway Information

Runway 16/34

Dimensions:	4400 x 75 ft. / 1341 x 23 m SAFETY AREA LENGTH 5000 FT; SAFETY AREA ROUGH BOTH RY ENDS.
Surface:	gravel, in good condition SHALLOW; RUTS & DIPS ENTIRE LENGTH OF RY.
Runway edge lights:	medium intensity
Runway edge markings:	THLDS MKD WITH THLD PANELS; PANELS DAMAGED. THLD PANELS SET BELOW RY GRADE.

	RUNWAY 16	**RUNWAY 34**
Latitude:	62-47.46750N	62-46.74700N
Longitude:	164-29.51250W	164-29.41167W
Elevation:	14.3 ft.	14.3 ft.
Traffic pattern:	left	left
Visual slope indicator:	2-box VASI on left (3.00 degrees glide path)	2-box VASI on left (3.00 degrees glide path)

Airport Operational Statistics

Aircraft based on the field: 9	Aircraft operations: avg 36/day
Single engine airplanes: 8	54% transient general aviation
Multi engine airplanes: 1	38% air taxi
	8% local general aviation

Additional Remarks

- WX REPORTS UNAVBL.

- RY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.

Businesses, Services and Facilities On or Near Emmonak Airport

Business Name	Contact	Services	Brand	100LL	Comments
Grant Aviation		fuel, charters	unknown	$2.85 As of 10-Aug-1998	add

ADD A BUSINESS UPDATE PRICES

Other Pages about Emmonak Airport

- www.alaska.faa.gov/...
- www.alaska.faa.gov/...
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- www.alaska.faa.gov/...
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- www.alaska.faa.gov/...

ADD A LINK

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: KIPNUK
> 2 AIRPORT NAME: KIPNUK
3 CBD TO AIRPORT (NM): 00 SE
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: IIK
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50416.31*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOT/PF CNTRL REG
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L. J. DAVIS
> 15 ADDRESS: BOX 505
BETHEL, AK 99762
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 59-55-58.624N ESTIMATED
20 ARPT LONG: 164-01-49.847W
21 ARPT ELEV: 11 SURVEYED
22 ACREAGE:
> 23 RIGHT TRAFFIC: 33
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: NGY
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED: RDO-CTL
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: NONE
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	6,000
102 AIR TAXI:	200
103 G A LOCAL:	0
104 G A ITNRNT:	800
105 MILITARY:	0
TOTAL:	7,000

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		15/33
> 31 LENGTH:		2,120
> 32 WIDTH:		35
> 33 SURF TYPE-COND:		GRAVEL-G
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)
> 51 DISPLACED THR	/
> 52 CTLG OBSTN	/
> 53 OBSTN MARKED/LGTD	/
> 54 HGT ABOVE RWY END	/
> 55 DIST FROM RWY END	/
> 56 CNTRLN OFFSET	/
57 OBSTN CLNC SLOPE	50:1 / 50:1
58 CLOSE-IN OBSTN	Y / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 042 RWY 15 /33 MKD WITH THR PANELS.
A 058 RWY 15 20 FT AWOS ANT ON APRON 200 FT R OF RY 15 THLD.
A 081 ACTVT MIRL RY 15/33 - CTAF
A 083 WINDSOCK AT S END OF ARPT DAMAGED; NOT FUNCTIONING PROPERLY.
A 110-01 CAUTION--FREQ CROSSWINDS.
A 110-02 EROSION IN SAFETY AREA OUTSIDE GRVL RY. RY SLOPES OFF TO TUNDRA SHARPLY.
A 110-03 CAUTION--HEAVY BIRD ACTIVITY NEAR RUNWAYS.
A 110-04 CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
A 110-05 VOR/DME LCTD 2000 FT N OF RY 15 200 FT L OF CNTRLN.

111 INSPECTOR: (S)
112 LAST INSP: 07/10/2002
113 LAST INFO REQ:

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: KIPNUK
> 2 AIRPORT NAME: KIPNUK
3 CBD TO AIRPORT (NM): 00 SE
4 STATE: AK
6 REGION/ADO: AAL
LOC ID: IIK
5 COUNTY: BETHEL
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50416.31*A

GENERAL

10 OWNERSHIP:
> 11 OWNER:
> 12 ADDRESS:

> 13 PHONE NR:
> 14 MANAGER:
> 15 ADDRESS:

> 16 PHONE NR:
> 17 ATTENDANCE SCHEDULE:
MONTHS DAYS HOURS

18 AIRPORT USE:
19 ARPT LAT:
20 ARPT LONG:
21 ARPT ELEV:
22 ACREAGE:
> 23 RIGHT TRAFFIC:
> 24 NON-COMM LANDING:
25 NPIAS/FED AGREEMENTS:
26 FAR 139 INDEX:

RUNWAY DATA

> 30 RUNWAY IDENT:
> 31 LENGTH:
> 32 WIDTH:
> 33 SURF TYPE-COND:
> 34 SURF
35 GROSS WT: SW
36 (IN THSDS) DW
37 DTW
38 DDTW

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:
> 42 RWY MARK TYPE-COND
> 43 VGSI
44 THR CROSSING HGT
45 VISUAL GLIDE ANGLE
> 46 CNTRLN-TDZ
> 47 RVR-RVV
> 48 REIL
> 49 APCH LIGHTS

OBSTRUCTION DATA

50 FAR 77 CATEGORY
> 51 DISPLACED THR
> 52 CTLG OBSTN
> 53 OBSTN MARKED/LGTD
> 54 HGT ABOVE RWY END
> 55 DIST FROM RWY END
> 56 CNTRLN OFFSET
57 OBSTN CLNC SLOPE
58 CLOSE-IN OBSTN

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL
> 61 TAKE OFF DIST AVBL (TODA)
> 62 ACLT STOP DIST AVBL (ASDA)
> 63 LNDG DIST AVBL (LDA)

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR:
84 SEGMENTED CIRCLE:
85 CONTROL TWR:
86 FSS:
87 FSS ON ARPT:
88 FSS PHONE NR:
89 TOLL FREE NR:

BASED AIRCRAFT

90 SINGLE ENG:
91 MULTI ENG:
92 JET:
TOTAL:
93 HELICOPTERS:
94 GLIDERS:
95 MILITARY:
96 ULTRA-LIGHT:

OPERATIONS

100 AIR CARRIER:
101 COMMUTER:
102 AIR TAXI:
103 G A LOCAL:
104 G A ITNRNT:
105 MILITARY:
TOTAL:

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 110-06 TWR 30 FT AGL UNLIT 300 FT NNE.

111 INSPECTOR: (S)
112 LAST INSP: 07/10/2002
113 LAST INFO REQ:

FAA Form 5010-1 (5-91) SUPERSEDES PREVIOUS

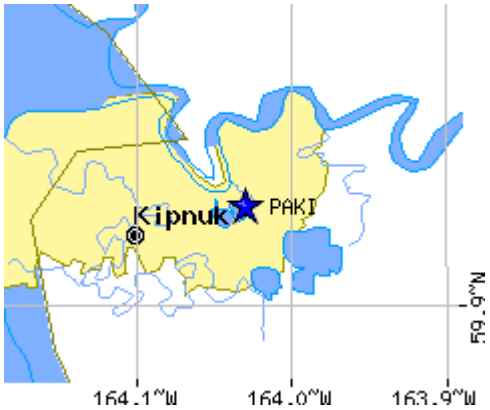
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

PAKI Kipnuk Airport
Kipnuk, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: IIK
Lat/Long: 59-55-58.624N / 164-01-49.847W
59-55.97707N / 164-01.83078W
59.9329511 / -164.0305131
(estimated)
Elevation: 11 ft. / 3.4 m (surveyed)
Variation: 17E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: MYU (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted, WINDSOCK AT S END OF ARPT DAMAGED; NOT FUNCTIONING PROPERLY.
Segmented circle: no
Lights: RDO-CTL
ACTVT MIRL RY 15/33 - CTAF
Beacon: unknown

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.7
WX AWOS-3: 118.325 (907-896-5510)

- APCH/DEP SERVICE PROVIDED BY ANCHORAGE ARTCC ON FREQ 125.2/372.0 (BETHEL RCAG).

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:56	12:56
Sunrise	06:06	14:06
Sunset	23:40	07:40
Evening civil twilight	00:49	08:49

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
IIK at field	KIPNUK VOR/DME	115.90	17E

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 15/33

Dimensions: 2120 x 35 ft. / 646 x 11 m
Surface: gravel, in good condition
Runway edge lights: medium intensity
Runway edge markings: /33 MKD WITH THR PANELS.

	RUNWAY 15	RUNWAY 33
Latitude:	59-56.14618N	59-55.80797N
Longitude:	164-01.91578W	164-01.74577W
Elevation:	9.7 ft.	8.4 ft.
Traffic pattern:	left	right
Touchdown point:	yes, no lights	yes, no lights

Airport Operational Statistics

Aircraft operations: avg 134/week
86% commercial
11% transient general aviation
3% air taxi

Additional Remarks

- CAUTION--FREQ CROSSWINDS.
- EROSION IN SAFETY AREA OUTSIDE GRVL RY. RY SLOPES OFF TO TUNDRA SHARPLY.
- CAUTION--HEAVY BIRD ACTIVITY NEAR RUNWAYS.
- CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
- VOR/DME LCTD 2000 FT N OF RY 15 200 FT L OF CNTRLN.
- TWR 30 FT AGL UNLIT 300 FT NNE.

A58-15 20 FT AWOS ANT ON APRON 200 FT R OF RY 15 THLD.

Businesses, Services and Facilities On or Near Kipnuk Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Kipnuk Airport

www.webcamlocator.com/...

ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: KOTLIK
> 2 AIRPORT NAME: KOTLIK
3 CBD TO AIRPORT (NM): 01 W
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: 2A9
5 COUNTY: WADE HAMPTON AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50427.61*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK/N REG
> 12 ADDRESS: 2301 PEGER RD
FAIRBANKS, AK 99709
> 13 PHONE NR: 907-624-3261
> 14 MANAGER: HARRY JOHNSON
> 15 ADDRESS: BOX 192
UNALAKLEET, AK 99684
> 16 PHONE NR: 907-443-3444
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 63-01-50.100N ESTIMATED
20 ARPT LONG: 163-31-57.500W
21 ARPT ELEV: 15 ESTIMATED
22 ACREAGE: 185
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING:
25 NPIAS/FED AGREEMENTS:NGY
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE: TIE
76 OTHER SERVICES:
CARGO

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT:
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,400
103 G A LOCAL:	0
104 G A ITNRNT:	400
105 MILITARY:	0
TOTAL:	1,800

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		01/19
> 31 LENGTH:		4,422
> 32 WIDTH:		100
> 33 SURF TYPE-COND:		GRVL
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(NP) / A(NP)
> 51 DISPLACED THR	/
> 52 CTLG OBSTN	/
> 53 OBSTN MARKED/LGTD	/
> 54 HGT ABOVE RWY END	/
> 55 DIST FROM RWY END	/
> 56 CNTRLN OFFSET	/
57 OBSTN CLNC SLOPE	:1 / :1
58 CLOSE-IN OBSTN	N / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 030 RWY 01/19 RY DEVELOPS SOFT SPOTS IN CENTER DURING BREAKUP & HEAVY RAINS.
A 042 RWY 01 RY 01/19 MKD WITH REFLECTIVE CONES.
A 081 ACTVT MIRL RY 01/19 - CTAF
A 110 THIS AIRPORT HAS BEEN SURVEYED BY THE NATIONAL GEODETIC SURVEY.
A 110-01 RY COND NOT MONITORED , RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.
A 110-02 OLD RY WEST OF TOWN - CLOSED.

111 INSPECTOR: (N)
112 LAST INSP:
113 LAST INFO REQ: 09/30/1999

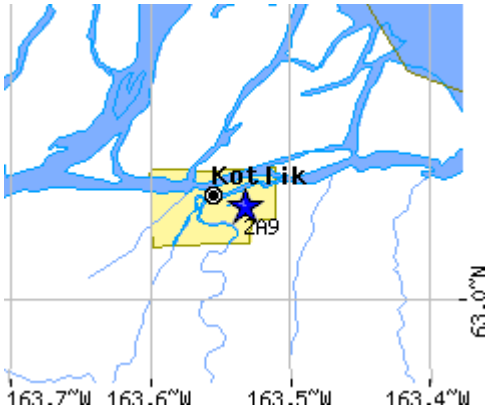
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

2A9 Kotlik/New Airport
Kotlik, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: 2A9
Lat/Long: 63-01-50.100N / 163-31-57.500W
63-01.83500N / 163-31.95833W
63.0305833 / -163.5326389
(estimated)
Elevation: 15 ft. / 5 m (estimated)
Variation: 17E (1995)
From city: 1 mile W of KOTLIK, AK

Airport Operations

Airport use: Open to the public
Activation date: 10/1999
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: ENM (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: yes
Lights: DUSK-DAWN
ACTVT MIRL RY 01/19 - CTAF
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
ENMr043/30.0	EMMONAK VOR/DME	117.80	17E

Airport Services

Parking: tiedowns

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	03:47	11:47
Sunrise	05:34	13:34
Sunset	00:08	08:08
Evening civil twilight	01:55	09:55

METAR

PAEM 211915Z AUTO 32008KT 230V360 OVC070 06/02 A3010 RMK AO1

Runway Information

Runway 1/19

Dimensions:	4422 x 100 ft. / 1348 x 30 m
Surface:	gravel
Runway edge lights:	medium intensity
Runway edge markings:	RY 01/19 MKD WITH REFLECTIVE CONES.
Operational restrictions:	RY DEVELOPS SOFT SPOTS IN CENTER DURING BREAKUP & HEAVY RAINS.

	RUNWAY 1	RUNWAY 19
Latitude:	63-01.52808N	63-02.14062N
Longitude:	163-32.38580W	163-31.52940W
Elevation:	7.7 ft.	8.5 ft.
Traffic pattern:	left	left
Runway heading:	015 magnetic, 032 true	195 magnetic, 212 true

Airport Operational Statistics

Aircraft operations: avg 34/week
78% air taxi
22% transient general aviation

Additional Remarks

- RY COND NOT MONITORED , RECOMMEND VISUAL INSPECTION PRIOR TO LANDING.
- OLD RY WEST OF TOWN - CLOSED.

Businesses, Services and Facilities On or Near Kotlik/New Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Kotlik/New Airport

ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: KWETHLUK
> 2 AIRPORT NAME: KWETHLUK
3 CBD TO AIRPORT (NM): 00 S
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: KWT
5 COUNTY: BETHEL AK
7 SECT AERO CHT: MC GRATH
FAA SITE NR: 50438.5*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOT/PF CENT REG
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L.J. DAVIS
> 15 ADDRESS: PO BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:
MONTHS DAYS HOURS
UNATNDD

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-48-15.307N ESTIMATED
20 ARPT LONG: 161-26-43.260W
21 ARPT ELEV: 28 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:
CARGO

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR: YES
84 SEGMENTED CIRCLE: NONE
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	450
103 G A LOCAL:	0
104 G A ITNRNT:	100
105 MILITARY:	0
TOTAL:	550

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	06/24	07W/25W
> 31 LENGTH:	1,750	5,000
> 32 WIDTH:	35	500
> 33 SURF TYPE-COND:	GRVL-G	WATER
> 34 SURF TREATMENT:		
35 GROSS WT: SW		
36 (IN THSDS) DW		
37 DTW		
38 DDTW		
LIGHTING/APCH AIDS		
> 40 EDGE INTENSITY:		
> 42 RWY MARK TYPE-COND	- / -	- / -
> 43 VGSI	/	/
44 THR CROSSING HGT	/	/
45 VISUAL GLIDE ANGLE	/	/
> 46 CNTRLN-TDZ	- / -	- / -
> 47 RVR-RVV	- / -	- / -
> 48 REIL	/	/
> 49 APCH LIGHTS	/	/
OBSTRUCTION DATA		
50 FAR 77 CATEGORY	A(V) / A(V)	/
> 51 DISPLACED THR	/	/
> 52 CTLG OBSTN	TREE / PLINE	/
> 53 OBSTN MARKED/LGTD	/	/
> 54 HGT ABOVE RWY END	10 / 40	/
> 55 DIST FROM RWY END	200 / 1,750	/
> 56 CNTRLN OFFSET	50R / 300R	/
57 OBSTN CLNC SLOPE	20:1 / 43:1	50:1 / 50:1
58 CLOSE-IN OBSTN	N / N	N / N
DECLARED DISTANCES		
> 60 TAKE OFF RUN AVBL (TORA)	/	/
> 61 TAKE OFF DIST AVBL (TODA)	/	/
> 62 ACLT STOP DIST AVBL (ASDA)	/	/
> 63 LNDG DIST AVBL (LDA)	/	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 042 RWY 06 /24 MKD WITH REFLECTIVE CONES & PANELS. CONES ARE NOT ALIGNED IN A STRAIGHT LINE.
A 110-01 RY SOFT DURING SPRING BREAKUP.
A 110-02 RY COND NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
A 110-03 BRUSH & TREES TO 15' WITHIN 75' EACH SIDE OF RY CENTERLINE.
A 110-04 FREQUENT PEDESTRIAN & ATV TRAFFIC ON ROAD 200 FT N OF RY.

111 INSPECTOR: (F)
112 LAST INSP: 06/09/1997
113 LAST INFO REQ:

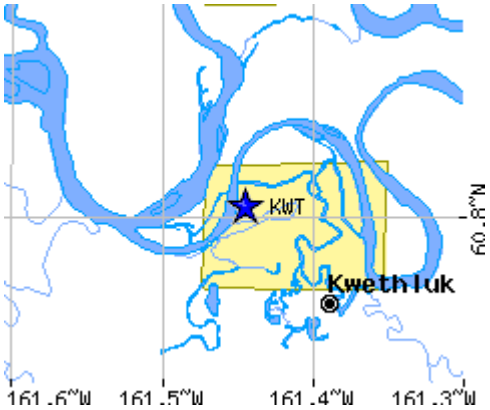
AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

KWT Kwethluk Airport
Kwethluk, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: KWT
Lat/Long: 60-48-15.307N / 161-26-43.260W
60-48.25512N / 161-26.72100W
60.8042519 / -161.4453500
(estimated)
Elevation: 28 ft. / 9 m (estimated)
Variation: 19E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: MC GRATH CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: yes
Segmented circle: no
Beacon: unknown

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX ASOS at BET (12 nm W): PHONE 907-543-5475

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:32	12:32
Sunrise	05:48	13:48
Sunset	23:37	07:37
Evening civil twilight	00:53	08:53

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr065/11.2	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
BETHEL	069/11.0	344	19E	ET . -
OSCARVILLE	067/12.5	251	19E	OSE --- ... .

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 7W/25W

Dimensions: 5000 x 500 ft. / 1524 x 152 m
Surface: water

	RUNWAY 7W	RUNWAY 25W
Traffic pattern:	left	left

Runway 6/24

Dimensions: 1750 x 35 ft. / 533 x 11 m
Surface: gravel, in good condition
Runway edge markings: /24 MKD WITH REFLECTIVE CONES & PANELS. CONES ARE NOT ALIGNED IN A STRAIGHT LINE.

	RUNWAY 6	RUNWAY 24
Traffic pattern:	left	left
Obstructions:	10 ft. tree, 200 ft. from runway, 50 ft. right of centerline, 20:1 slope to clear	40 ft. pline, 1750 ft. from runway, 300 ft. right of centerline, 43:1 slope to clear

Airport Operational Statistics

Aircraft operations: avg 46/month
82% air taxi
18% transient general aviation

Additional Remarks

- RY SOFT DURING SPRING BREAKUP.

- RY COND NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.
- BRUSH & TREES TO 15' WITHIN 75' EACH SIDE OF RY CENTERLINE.
- FREQUENT PEDESTRIAN & ATV TRAFFIC ON ROAD 200 FT N OF RY.

Businesses, Services and Facilities On or Near Kwethluk Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Kwethluk Airport

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www.alaska.faa.gov/...

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: NAPAKIAK
> 2 AIRPORT NAME: NAPAKIAK
3 CBD TO AIRPORT (NM): 00 W
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: WNA
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50520.01*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOT/PF CENTRL REG
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-266-1735
> 14 MANAGER: L.J. DAVIS
> 15 ADDRESS: PO BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-41-25.200N ESTIMATED
20 ARPT LONG: 161-58-42.600W
21 ARPT ELEV: 20 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: RDO-CTL
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,000
103 G A LOCAL:	0
104 G A ITNRNT:	500
105 MILITARY:	0
TOTAL:	1,500

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		16/34
> 31 LENGTH:		3,269
> 32 WIDTH:		60
> 33 SURF TYPE-COND:		GRAVEL-F
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V) / A(V)
> 51 DISPLACED THR	/
> 52 CTLG OBSTN	BRUSH / BRUSH
> 53 OBSTN MARKED/LGTD	/
> 54 HGT ABOVE RWY END	15 / 5
> 55 DIST FROM RWY END	150 / 150
> 56 CNTRLN OFFSET	60L / 50L
57 OBSTN CLNC SLOPE	10:1 / 30:1
58 CLOSE-IN OBSTN	N / N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 081 ACTVT ROTG BCN - CTAF
A 081 ACTVT MIRL RY 16/34 - CTAF.
A 110 THIS AIRPORT HAS BEEN SURVEYED BY THE NATIONAL GEODETIC SURVEY.
A 110-01 SPB OPER IN RIVER; JOHNSON SLOUGH UNUSABLE.
A 110-05 CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.

111 INSPECTOR: (S)
112 LAST INSP: 07/11/2002
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

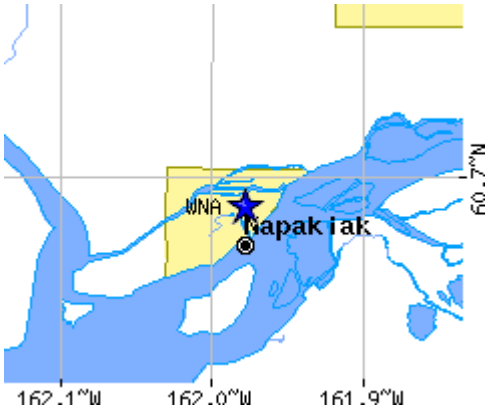
WNA Napakiak Airport
Napakiak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: WNA
Lat/Long: 60-41-25.200N / 161-58-42.600W
60-41.42000N / 161-58.71000W
60.6903333 / -161.9785000
(estimated)
Elevation: 20 ft. / 6 m (estimated)
Variation: 18E (1985)



Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: yes
Lights: RDO-CTL
ACTVT ROTG BCN - CTAF
ACTVT MIRL RY 16/34 - CTAF.
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX ASOS at BET (7 nm NE): PHONE 907-543-5475

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:36	12:36
Sunrise	05:51	13:51
Sunset	23:38	07:38
Evening civil twilight	00:53	08:53

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr200/7.3	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
OSCARVILLE	188/6.8	251	19E	OSE --- . . . .
BETHEL	197/7.9	344	19E	ET . -

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 16/34

Dimensions: 3269 x 60 ft. / 996 x 18 m
Surface: gravel, in fair condition
Runway edge lights: medium intensity

	RUNWAY 16	RUNWAY 34
Latitude:	60-41.68735N	60-41.15245N
Longitude:	161-58.75148W	161-58.66768W
Elevation:	13.4 ft.	13.0 ft.
Traffic pattern:	left	left
Runway heading:	158 magnetic, 176 true	338 magnetic, 356 true
Obstructions:	15 ft. brush, 150 ft. from runway, 60 ft. left of centerline, 10:1 slope to clear	5 ft. brush, 150 ft. from runway, 50 ft. left of centerline, 30:1 slope to clear

Airport Operational Statistics

Aircraft operations: avg 29/week
67% air taxi
33% transient general aviation

Additional Remarks

- SPB OPER IN RIVER; JOHNSON SLOUGH UNUSABLE.

- CAUTION: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USING.

Businesses, Services and Facilities On or Near Napakiak Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Napakiak Airport

www.alaska.faa.gov/...
www.alaska.faa.gov/...
ADD A LINK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: NAPASKIAK
> 2 AIRPORT NAME: NAPASKIAK
3 CBD TO AIRPORT (NM): 01 SW
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: PKA
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50520.18*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOTPF/CE REGION
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L.J. DAVIS
> 15 ADDRESS: BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:
MONTHS DAYS HOURS
UNATNDD

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-42-10.500N ESTIMATED
20 ARPT LONG: 161-46-41.900W
21 ARPT ELEV: 24 SURVEYED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: NGY
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	1
91 MULTI ENG:	0
92 JET:	0
TOTAL:	1
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	500
103 G A LOCAL:	0
104 G A ITNRNT:	300
105 MILITARY:	0
TOTAL:	800

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	02/20	09W/27W
> 31 LENGTH:	3,000	15,000
> 32 WIDTH:	60	2,000
> 33 SURF TYPE-COND:	GRVL-G	WATER
> 34 SURF TREATMENT:		
35 GROSS WT: SW		
36 (IN THSDS) DW		
37 DTW		
38 DDTW		
LIGHTING/APCH AIDS		
> 40 EDGE INTENSITY:	MED	
> 42 RWY MARK TYPE-COND	- / -	- / -
> 43 VGSI	/	/
44 THR CROSSING HGT	/	/
45 VISUAL GLIDE ANGLE	/	/
> 46 CNTRLN-TDZ	- / -	- / -
> 47 RVR-RVV	- / -	- / -
> 48 REIL	/	/
> 49 APCH LIGHTS	/	/
OBSTRUCTION DATA		
50 FAR 77 CATEGORY	A(V) / A(V)	/
> 51 DISPLACED THR	/	/
> 52 CTLG OBSTN	TREE / BRUSH	/
> 53 OBSTN MARKED/LGTD	/	/
> 54 HGT ABOVE RWY END	32 / 30	/
> 55 DIST FROM RWY END	800 / 800	/
> 56 CNTRLN OFFSET	125L / 20L	/
57 OBSTN CLNC SLOPE	25:1 / 26:1	:1 / :1
58 CLOSE-IN OBSTN	N / N	N / N
DECLARED DISTANCES		
> 60 TAKE OFF RUN AVBL (TORA)	/	/
> 61 TAKE OFF DIST AVBL (TODA)	/	/
> 62 ACLT STOP DIST AVBL (ASDA)	/	/
> 63 LNDG DIST AVBL (LDA)	/	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 081 ACTVT MIRL RY 02/20 - CTAF.
A 110 THIS AIRPORT HAS BEEN SURVEYED BY THE NATIONAL GEODETIC SURVEY.
A 110-01 WATCH FOR NETS & BOATS IN RIVER; AREA IN FRONT OF VILLAGE UNUSABLE FOR FLOAT PLANES.
A 110-02 RWY 02/20 FLOODS IN SPRING.
A 110-03 RY 02/20 CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USE.
A 110-04 PILOTS ARE REQUESTED TO SELF-ANNOUNCE ON CTAF BEFORE TAXIING ON THE RWY FOR DEPARTURE, LEAVING THE RWY AND WITHIN 5 NM OF THE AIRPORT WHEN APPROACHING TO LAND.

111 INSPECTOR: (F)
112 LAST INSP: 06/09/1997
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

PKA Napaskiak Airport
Napaskiak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: PKA
Lat/Long: 60-42-10.500N / 161-46-41.900W
60-42.17500N / 161-46.69833W
60.7029167 / -161.7783056
(estimated)
Elevation: 24 ft. / 7 m (estimated)
Variation: 18E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted
Segmented circle: yes
Lights: DUSK-DAWN
ACTVT MIRL RY 01/19 - CTAF.
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX ASOS at BET (5 nm N): PHONE 907-543-5475

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:35	12:35
Sunrise	05:50	13:50
Sunset	23:37	07:37
Evening civil twilight	00:52	08:52

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr146/5.1	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
BETHEL	148/5.8	344	19E	ET . -
OSCARVILLE	133/6.0	251	19E	OSE --- ... .

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Airframe service: NONE
Powerplant service: NONE
Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 9W/27W

Dimensions: 15000 x 2000 ft. / 4572 x 610 m
Surface: water

	RUNWAY 9W	RUNWAY 27W
Elevation:	10.0 ft.	10.0 ft.
Traffic pattern:	left	left

Runway 1/19

Dimensions: 3021 x 60 ft. / 921 x 18 m
Surface: gravel, in good condition
Runway edge lights: medium intensity

	RUNWAY 1	RUNWAY 19
Traffic pattern:	left	left
Runway heading:	012 magnetic, 030 true	192 magnetic, 210 true
Obstructions:	32 ft. tree, 800 ft. from runway, 125 ft. left of centerline, 25:1 slope to clear	30 ft. brush, 800 ft. from runway, 20 ft. left of centerline, 26:1 slope to clear

Airport Operational Statistics

Aircraft based on the field: 1
Single engine airplanes: 1

Aircraft operations: avg 67/month
62% air taxi
38% transient general aviation

Additional Remarks

- WATCH FOR NETS & BOATS IN RIVER; AREA IN FRONT OF VILLAGE UNUSABLE FOR FLOAT PLANES.
- RWY 01/19 FLOODS IN SPRING.

- RY 01/19 CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USE.

Businesses, Services and Facilities On or Near Napaskiak Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Napaskiak Airport

www.alaska.faa.gov/...
www.alaska.faa.gov/...

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: SHELDON POINT
> 2 AIRPORT NAME: SHELDON POINT
3 CBD TO AIRPORT (NM): 00 NE
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: SXP
5 COUNTY: WADE HAMPTON AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50698.71*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: ST OF AK DOTPF NORTHERN RGN
> 12 ADDRESS: 2301 PEGER ROAD
FAIRBANKS, AK 99709
> 13 PHONE NR: 907-443-3444
> 14 MANAGER: HARRY JOHNSON
> 15 ADDRESS: BOX 192
UNALAKLEET, AK 99684
> 16 PHONE NR: 907-624-3261
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 62-31-14.000N ESTIMATED
20 ARPT LONG: 164-50-52.000W
21 ARPT ELEV: 12 ESTIMATED
22 ACREAGE: 120
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN: NONE
> 74 BULK OXYGEN: NONE
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: CG
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	400
103 G A LOCAL:	40
104 G A ITNRNT:	280
105 MILITARY:	0
TOTAL:	720

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	01/19	09W/27W	18W/36W
> 31 LENGTH:	3,015	15,000	15,000
> 32 WIDTH:	60	2,000	2,000
> 33 SURF TYPE-COND:	GRAVEL-G	WATER	WATER
> 34 SURF TREATMENT:			
35 GROSS WT: SW			
36 (IN THSDS) DW			
37 DTW			
38 DDTW			
LIGHTING/APCH AIDS			
> 40 EDGE INTENSITY:	MED		
> 42 RWY MARK TYPE-COND	- / -	- / -	- / -
> 43 VGSI	/	/	/
44 THR CROSSING HGT	/	/	/
45 VISUAL GLIDE ANGLE	/	/	/
> 46 CNTRLN-TDZ	- / -	- / -	- / -
> 47 RVR-RVV	- / -	- / -	- / -
> 48 REIL	/	/	/
> 49 APCH LIGHTS	/	/	/
OBSTRUCTION DATA			
50 FAR 77 CATEGORY	A(V) / A(V)	/	/
> 51 DISPLACED THR	/	/	/
> 52 CTLG OBSTN	/	/	/
> 53 OBSTN MARKED/LGTD	/	/	/
> 54 HGT ABOVE RWY END	/	/	/
> 55 DIST FROM RWY END	/	/	/
> 56 CNTRLN OFFSET	/	/	/
57 OBSTN CLNC SLOPE	50:1 / 50:1	:1 / :1	:1 / :1
58 CLOSE-IN OBSTN	N / N	N / N	N / N
DECLARED DISTANCES			
> 60 TAKE OFF RUN AVBL (TORA)	/	/	/
> 61 TAKE OFF DIST AVBL (TODA)	/	/	/
> 62 ACLT STOP DIST AVBL (ASDA)	/	/	/
> 63 LNDG DIST AVBL (LDA)	/	/	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 021 SEAPLANE BASE ELEVATION: 0 FT MSL.
A 030 RWY 01/19 RY 01/19 CONDITIONS NOT MONITORED; VISUAL INSPECTION RECOMMENDED PRIOR TO LANDING.
A 030 RWY 09W/27W & 18W/36W LAND ALL DIRECTIONS IN RIVER ADJACENT TO VILLAGE; FREQUENT STRONG CROSS WINDS IN THIS AREA.
A 031 RWY 01/19 SOFT SPOTS MAY DEVELOPE DURING RAINY PERIODS & SPRING BREK-UP.
A 081 ACTVT MIRL RY 01/19 - CTAF.
A 083 WINDSOCK FADED.

111 INSPECTOR: (F)
112 LAST INSP: 06/17/1997
113 LAST INFO REQ: 09/27/1980

FAA Form 5010-1 (5-91) SUPERSEDES PREVIOUS

AIRNAV.COM

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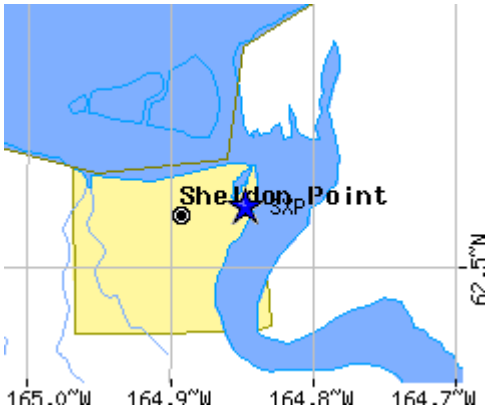
SXP Sheldon Point Airport
Sheldon Point, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: SXP
Lat/Long: 62-31-14.000N / 164-50-52.000W
62-31.23333N / 164-50.86667W
62.5205556 / -164.8477778
(estimated)
Elevation: 12 ft. / 4 m (estimated)
SEAPLANE BASE ELEVATION: 0 FT MSL.
Variation: 17E (1985)

Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: ENM (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted, WINDSOCK FADED.
Segmented circle: yes
Lights: DUSK-DAWN
ACTVT MIRL RY 01/19 - CTAF.
Beacon: white-green (lighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX AWOS-3 at ENM (19 nm NE): 135.35 (907-949-1014)

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:09	12:09
Sunrise	05:45	13:45
Sunset	00:07	08:07
Evening civil twilight	01:43	09:43

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
ENMr195/18.6	EMMONAK VOR/DME	117.80	17E

METAR

PAEM 211915Z AUTO 32008KT 230V360 OVC070 06/02 A3010 RMK AO1

Airport Services

Airframe service: NONE
Powerplant service: NONE

Bottled oxygen: NONE
Bulk oxygen: NONE

Runway Information

Runway 9W/27W

Dimensions: 15000 x 2000 ft. / 4572 x 610 m
Surface: water
Operational restrictions: & 18W/36W LAND ALL DIRECTIONS IN RIVER ADJACENT TO VILLAGE; FREQUENT STRONG CROSS WINDS IN THIS AREA.

	RUNWAY 9W	RUNWAY 27W
Elevation:	0.0 ft.	0.0 ft.
Traffic pattern:	left	left

Runway 18W/36W

Dimensions: 15000 x 2000 ft. / 4572 x 610 m
Surface: water

	RUNWAY 18W	RUNWAY 36W
Elevation:	0.0 ft.	0.0 ft.
Traffic pattern:	left	left

Runway 1/19

Dimensions: 3015 x 60 ft. / 919 x 18 m
SOFT SPOTS MAY DEVELOPE DURING RAINY PERIODS & SPRING BREK-UP.
Surface: gravel, in good condition
Runway edge lights: medium intensity
Operational restrictions: RY 01/19 CONDITIONS NOT MONITORED; VISUAL INSPECTION RECOMMENDED PRIOR TO LANDING.

	RUNWAY 1	RUNWAY 19
Traffic pattern:	left	left

Airport Operational Statistics

Aircraft operations: avg 60/month
56% air taxi
39% transient general aviation
6% local general aviation

Businesses, Services and Facilities On or Near Sheldon Point Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Sheldon Point Airport

- www.alaska.faa.gov/...
- www.alaska.faa.gov/...
- www.alaska.faa.gov/...

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: NUNAPITCHUK
> 2 AIRPORT NAME: NUNAPITCHUK
3 CBD TO AIRPORT (NM): 00 E
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: 16A
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50552.1*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF AK DOTPF
> 12 ADDRESS: POUCH 196900
ANCHORAGE, AK 99516-6900
> 13 PHONE NR: 907-269-0747
> 14 MANAGER: L. J. DAVIS
> 15 ADDRESS: BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907-543-2495
> 17 ATTENDANCE SCHEDULE:
MONTHS DAYS HOURS
UNATNDD

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-54-20.982N ESTIMATED
20 ARPT LONG: 162-26-20.817W
21 ARPT ELEV: 12 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING:
25 NPIAS/FED AGREEMENTS:N
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:
CARGO

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR: YES
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT:
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	0
91 MULTI ENG:	0
92 JET:	0
TOTAL:	0
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	500
103 G A LOCAL:	0
104 G A ITNRNT:	500
105 MILITARY:	0
TOTAL:	1,000

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:	18/36	NE/SW
> 31 LENGTH:	2,040	3,000
> 32 WIDTH:	60	300
> 33 SURF TYPE-COND:	GRVL-F	WATER
> 34 SURF TREATMENT:		
35 GROSS WT: SW		
36 (IN THSDS) DW		
37 DTW		
38 DDTW		
LIGHTING/APCH AIDS		
> 40 EDGE INTENSITY:		
> 42 RWY MARK TYPE-COND	- / -	- / -
> 43 VGSI	/	/
44 THR CROSSING HGT	/	/
45 VISUAL GLIDE ANGLE	/	/
> 46 CNTRLN-TDZ	- / -	- / -
> 47 RVR-RVV	- / -	- / -
> 48 REIL	/	/
> 49 APCH LIGHTS	/	/
OBSTRUCTION DATA		
50 FAR 77 CATEGORY	A(V) / A(V)	/
> 51 DISPLACED THR	/	/
> 52 CTLG OBSTN	/	/
> 53 OBSTN MARKED/LGTD	/	/
> 54 HGT ABOVE RWY END	/	/
> 55 DIST FROM RWY END	/	/
> 56 CNTRLN OFFSET	/	/
57 OBSTN CLNC SLOPE	50:1 / 50:1	:1 / :1
58 CLOSE-IN OBSTN	N / N	N / N
DECLARED DISTANCES		
> 60 TAKE OFF RUN AVBL (TORA)	/	/
> 61 TAKE OFF DIST AVBL (TODA)	/	/
> 62 ACLT STOP DIST AVBL (ASDA)	/	/
> 63 LNDG DIST AVBL (LDA)	/	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 042 RWY 18 /36 RY EDGES & THLDS MKD BY 30 INCH RED CONES WITH REFLECTIVE COLLARS; THLD MKRS SET BELOW RY GRADE.
A 110-01 RY COND NOT MONTRD - RCMD VISUAL INSP PRIOR TO USE.
A 110-02 SMALL FLOAT IN RIVER USED FOR LOADING & OFF-LOADING LCTD IN VILLAGE ACRS THR RIVER FM THE ARPT.
A 110-03 DIPS & SINKHOLES ALONG RY EDGES.

111 INSPECTOR: (S)
112 LAST INSP: 08/02/2002
113 LAST INFO REQ: 02/19/1988

AIRNAV.COM

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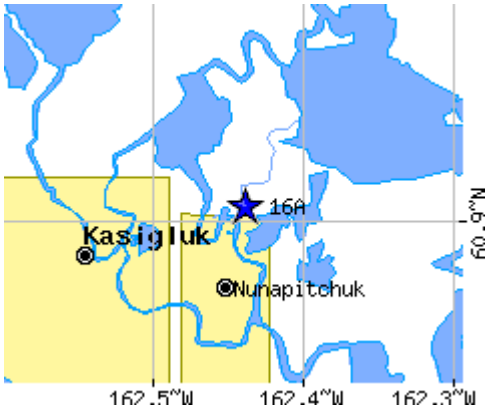
16A Nunapitchuk Airport
Nunapitchuk, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes



Location

FAA Identifier: 16A
Lat/Long: 60-54-20.982N / 162-26-20.817W
60-54.34970N / 162-26.34695W
60.9058283 / -162.4391158
(estimated)
Elevation: 12 ft. / 4 m (estimated)
Variation: 18E (1985)

Airport Operations

Airport use: Open to the public
Activation date: 01/1988
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: yes
Segmented circle: yes
Beacon: unknown

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.9
WX ASOS at BET (19 nm SE): PHONE 907-543-5475

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:34	12:34
Sunrise	05:51	13:51
Sunset	23:42	07:42
Evening civil twilight	00:58	08:58

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr273/19.4	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
OSCARVILLE	274/17.9	251	19E	OSE --- . . . .

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Runway Information

Runway NE/SW

Dimensions: 3000 x 300 ft. / 914 x 91 m
Surface: water

	RUNWAY NE	RUNWAY SW
Traffic pattern:	left	left

Runway 18/36

Dimensions: 2040 x 60 ft. / 622 x 18 m
Surface: gravel, in fair condition
Runway edge markings: /36 RY EDGES & THLDS MKD BY 30 INCH RED CONES WITH REFLECTIVE COLLARS; THLD MKRS SET BELOW RY GRADE.

	RUNWAY 18	RUNWAY 36
Traffic pattern:	left	left

Airport Operational Statistics

Aircraft operations: avg 83/month
50% transient general aviation
50% air taxi

Additional Remarks

- RY COND NOT MONTRD - RCMD VISUAL INSP PRIOR TO USE.

- SMALL FLOAT IN RIVER USED FOR LOADING & OFF-LOADING LCTD IN VILLAGE ACRS THR RIVER FM THE ARPT.
- DIPS & SINKHOLES ALONG RY EDGES.

Businesses, Services and Facilities On or Near Nunapitchuk Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Nunapitchuk Airport

www.alaska.faa.gov/...
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: TUNTUTULIAK
> 2 AIRPORT NAME: TUNTUTULIAK
3 CBD TO AIRPORT (NM): 01 S
4 STATE: AK
6 REGION/ADO: AAL/NONE
LOC ID: A61
5 COUNTY: BETHEL AK
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50772.6*A

GENERAL

10 OWNERSHIP: PUBLIC
> 11 OWNER: STATE OF ALASKA DOT/PF C REG
> 12 ADDRESS: PO BOX 196900
ANCHORAGE, AK 99519-6900
> 13 PHONE NR: 907-266-1767
> 14 MANAGER: L.J. DAVIS
> 15 ADDRESS: PO BOX 505
BETHEL, AK 99559
> 16 PHONE NR: 907 543-2495
> 17 ATTENDANCE SCHEDULE:

MONTHS	DAYS	HOURS
UNATNDD		

18 AIRPORT USE: PUBLIC
19 ARPT LAT: 60-20-07.244N ESTIMATED
20 ARPT LONG: 162-40-01.234W
21 ARPT ELEV: 16 ESTIMATED
22 ACREAGE:
> 23 RIGHT TRAFFIC: NO
> 24 NON-COMM LANDING: NO
25 NPIAS/FED AGREEMENTS: NGY
26 FAR 139 INDEX:

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS: NONE
> 72 PWR PLANT RPRS: NONE
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN: C
> 81 ARPT LGT SKED: DUSK-DAWN
> 82 UNICOM:
> 83 WIND INDICATOR: YES-L
84 SEGMENTED CIRCLE: YES
85 CONTROL TWR: NONE
86 FSS: KENAI
87 FSS ON ARPT: NO
88 FSS PHONE NR: 800-478-3576
89 TOLL FREE NR: 1-800-WX-BRIEF

BASED AIRCRAFT

90 SINGLE ENG:	1
91 MULTI ENG:	0
92 JET:	0
TOTAL:	1
93 HELICOPTERS:	0
94 GLIDERS:	0
95 MILITARY:	0
96 ULTRA-LIGHT:	0

OPERATIONS

100 AIR CARRIER:	0
101 COMMUTER:	0
102 AIR TAXI:	1,800
103 G A LOCAL:	150
104 G A ITNRNT:	500
105 MILITARY:	0
TOTAL:	2,450

OPERATIONS FOR
MOS ENDING

RUNWAY DATA

> 30 RUNWAY IDENT:		02/20
> 31 LENGTH:		1,772
> 32 WIDTH:		28
> 33 SURF TYPE-COND:		GRVL-P
> 34 SURF TREATMENT:		
35 GROSS WT:	SW	
36 (IN THSDS)	DW	
37	DTW	
38	DDTW	

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:	MED
> 42 RWY MARK TYPE-COND	- / -
> 43 VGSI	/
44 THR CROSSING HGT	/
45 VISUAL GLIDE ANGLE	/
> 46 CNTRLN-TDZ	- / -
> 47 RVR-RVV	- / -
> 48 REIL	/
> 49 APCH LIGHTS	/

OBSTRUCTION DATA

50 FAR 77 CATEGORY	A(V)	A(V)
> 51 DISPLACED THR		/
> 52 CTLG OBSTN		/ TREES
> 53 OBSTN MARKED/LGTD		/
> 54 HGT ABOVE RWY END		/ 26
> 55 DIST FROM RWY END		/ 750
> 56 CNTRLN OFFSET		/ 0B
57 OBSTN CLNC SLOPE	50:1	28:1
58 CLOSE-IN OBSTN	N	N

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL (TORA)	/
> 61 TAKE OFF DIST AVBL (TODA)	/
> 62 ACLT STOP DIST AVBL (ASDA)	/
> 63 LNDG DIST AVBL (LDA)	/

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:

A 031 RWY 02/20 RY 02/20 REMEASURED.
A 033 RWY 02/20 DIPS & RUTS TO 4 INCHES DEEP.
A 040 RWY 02/20 RY & TWY LIGHTS ARE HIGHER THAN STANDARD INTST.
A 042 RWY 02 /20 MKD WITH CONES & REFLECTIVE THR PANELS.
A 081 ACTVT MIRL RY 02/20 - 122.900.
A 083 WIND SOCK LGTS INOP.
A 110-01 NORTH END SAFETY AREA 70 FT FROM RIVER BLUFF EDGE; RY 02 SAFETY AREA 20 FT FROM RIVER EDGE.
A 110-02 CTN: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USE.
A 110-04 RY AND RAMP SOFT DURING BREAKUP AND HEAVY RAINS.

111 INSPECTOR: (F)
112 LAST INSP: 06/10/1997
113 LAST INFO REQ:

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRPORT MASTER RECORD

PRINT DATE: 03/03/2004
AFD EFF 02/19/2004
Form Approved OMB 2120-0015

> 1 ASSOC CITY: TUNTUTULIAK
> 2 AIRPORT NAME: TUNTUTULIAK
3 CBD TO AIRPORT (NM): 01 S
4 STATE: AK
6 REGION/ADO: AAL
LOC ID: A61
5 COUNTY: BETHEL
7 SECT AERO CHT: BETHEL
FAA SITE NR: 50772.6*A

GENERAL

10 OWNERSHIP:
> 11 OWNER:
> 12 ADDRESS:

> 13 PHONE NR:
> 14 MANAGER:
> 15 ADDRESS:

> 16 PHONE NR:
> 17 ATTENDANCE SCHEDULE:
MONTHS DAYS HOURS

18 AIRPORT USE:
19 ARPT LAT:
20 ARPT LONG:
21 ARPT ELEV:
22 ACREAGE:
> 23 RIGHT TRAFFIC:
> 24 NON-COMM LANDING:
25 NPIAS/FED AGREEMENTS:
26 FAR 139 INDEX:

RUNWAY DATA

> 30 RUNWAY IDENT:
> 31 LENGTH:
> 32 WIDTH:
> 33 SURF TYPE-COND:
> 34 SURF
35 GROSS WT: SW
36 (IN THSDS) DW
37 DTW
38 DDTW

LIGHTING/APCH AIDS

> 40 EDGE INTENSITY:
> 42 RWY MARK TYPE-COND
> 43 VGSI
44 THR CROSSING HGT
45 VISUAL GLIDE ANGLE
> 46 CNTRLN-TDZ
> 47 RVR-RVV
> 48 REIL
> 49 APCH LIGHTS

OBSTRUCTION DATA

50 FAR 77 CATEGORY
> 51 DISPLACED THR
> 52 CTLG OBSTN
> 53 OBSTN MARKED/LGTD
> 54 HGT ABOVE RWY END
> 55 DIST FROM RWY END
> 56 CNTRLN OFFSET
57 OBSTN CLNC SLOPE
58 CLOSE-IN OBSTN

DECLARED DISTANCES

> 60 TAKE OFF RUN AVBL
> 61 TAKE OFF DIST AVBL (TODA)
> 62 ACLT STOP DIST AVBL (ASDA)
> 63 LNDG DIST AVBL (LDA)

SERVICES

> 70 FUEL:
> 71 AIRFRAME RPRS:
> 72 PWR PLANT RPRS:
> 73 BOTTLE OXYGEN:
> 74 BULK OXYGEN:
75 TSNT STORAGE:
76 OTHER SERVICES:

FACILITIES

> 80 ARPT BCN:
> 81 ARPT LGT SKED:
> 82 UNICOM:
> 83 WIND INDICATOR:
84 SEGMENTED CIRCLE:
85 CONTROL TWR:
86 FSS:
87 FSS ON ARPT:
88 FSS PHONE NR:
89 TOLL FREE NR:

BASED AIRCRAFT

90 SINGLE ENG:
91 MULTI ENG:
92 JET:
TOTAL:
93 HELICOPTERS:
94 GLIDERS:
95 MILITARY:
96 ULTRA-LIGHT:

OPERATIONS

100 AIR CARRIER:
101 COMMUTER:
102 AIR TAXI:
103 G A LOCAL:
104 G A ITNRNT:
105 MILITARY:
TOTAL:

(>) ARPT MGR PLEASE ADVISE FSS IN ITEM 86 WHEN CHANGES OCCUR TO ITEMS PRECEDED BY >

110 REMARKS:
A 110-05 BECAUSE OF FROST HEAVES RY & TWY LGTS ARE 36 INCHES HIGH.
A 110-06 PILOTS ARE REQUESTED TO SELF-ANNOUNCE ON CTAF BEFORE TAXIING ON THE RWY FOR DEPARTURE, LEAVING THE RWY AND WITHIN 5 NM OF THE AIRPORT WHEN APPROACHING TO LAND.

111 INSPECTOR: (F)
112 LAST INSP: 06/10/1997
113 LAST INFO REQ:

AIRNAV.COM

Airports | Navaids | Airspace Fixes | Aviation Fuel

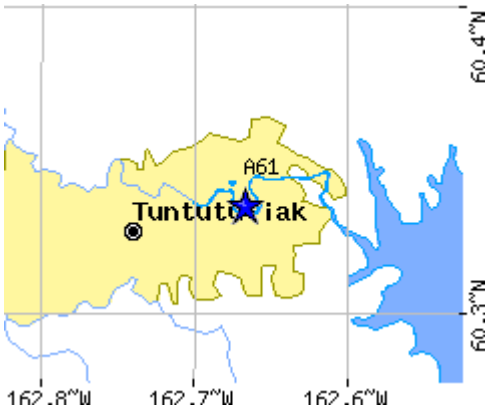
A61 Tuntutuliak Airport
Tuntutuliak, Alaska, USA

FAA INFORMATION EFFECTIVE 15 MAY 2003

Loc | Ops | Rwys | Biz | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: A61
Lat/Long: 60-20-07.244N / 162-40-01.234W
60-20.12073N / 162-40.02057W
60.3353456 / -162.6670094
(estimated)
Elevation: 16 ft. / 5 m (estimated)
Variation: 18E (1985)
From city: 1 mile S of TUNTUTULIAK, AK



Airport Operations

Airport use: Open to the public
Sectional chart: BETHEL CLICK TO BUY IT NOW
Control tower: no
ARTCC: ANCHORAGE CENTER
FSS: KENAI FLIGHT SERVICE STATION [1-800-WX-BRIEF]
NOTAMs facility: BET (NOTAM-D service available)
Attendance: UNATNDD
Wind indicator: lighted, WIND SOCK LGTS INOP.
Segmented circle: yes
Lights: DUSK-DAWN
ACTVT MIRL RY 02/20 - 122.900.
Beacon: white (unlighted land airport)

No photo available

If you have an aerial photo of this airport that you would like to share with other users of AirNav.com, click here to send us your photo.

Airport Communications

CTAF: 122.7

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
BETr204/36.7	BETHEL VORTAC	114.10	19E

NDB name	Hdg/Dist	Freq	Var	ID
OSCARVILLE	202/36.0	251	19E	OSE --- . . . .

Sunrise and sunset

Times for 21-May-2003

	Local (UTC-8)	Zulu (UTC)
Morning civil twilight	04:45	12:45
Sunrise	05:57	13:57
Sunset	23:38	07:38
Evening civil twilight	00:50	08:50

METAR

PABE 211853Z 06010KT 10SM SCT070 SCT220 12/04 A3006 RMK AO2 SLP182 T01220044

Airport Services

Airframe service: NONE
Powerplant service: NONE

Runway Information

Runway 2/20

Dimensions:	1800 x 43 ft. / 549 x 13 m	
Surface:	gravel, in poor condition DIPS & RUTS TO 4 INCHES DEEP.	
Runway edge lights:	medium intensity RY & TWY LIGHTS ARE HIGHER THAN STANDARD INTST.	
Runway edge markings:	/20 MKD WITH CONES & REFLECTIVE THR PANELS.	
	RUNWAY 2	**RUNWAY 20**
Traffic pattern:	left	left
Obstructions:	none	26 ft. trees, 750 ft. from runway, 28:1 slope to clear

Airport Operational Statistics

Aircraft based on the field: 1
Single engine airplanes: 1

Aircraft operations: avg 47/week
73% air taxi
20% transient general aviation
6% local general aviation

Additional Remarks

- NORTH END SAFETY AREA 70 FT FROM RIVER BLUFF EDGE; RY 02 SAFETY AREA 20 FT FROM RIVER EDGE.
- CTN: RWY CONDITION NOT MONITORED; RECOMMEND VISUAL INSPECTION PRIOR TO USE.
- RY AND RAMP SOFT DURING BREAKUP AND HEAVY RAINS.

- BECAUSE OF FROST HEAVES RY & TWY LGTS ARE 36 INCHES HIGH.

Businesses, Services and Facilities On or Near Tuntutuliak Airport

Business Name	Contact	Services	Comments

ADD A BUSINESS

Other Pages about Tuntutuliak Airport

www.alaska.faa.gov/...
www.alaska.faa.gov/...

ADD A LINK

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Appendix C: FAA Alaska Region AIP

Airport Improvement Program Record FY 1982 – FY 2002 for each community

Alaskan Region Airport AIP Program
FY 1982 - FY 2002

		Obligated:	Closed:	Entitlement	Discretionary	TOTAL
Alakanuk						
Alakanuk (AUK)						
3-02-0332-001-1988	Extend Runway (ST RW IM)	20-JUL-88	09-AUG-93	$1,572,129	$307,543	$1,879,672
	Improve Airport Drainage (ST OT IM)	20-JUL-88	09-AUG-93	$70,000	$0	$70,000
	Improve Access Road (OT GT AC)	20-JUL-88	09-AUG-93	$100,000	$0	$100,000
	Improve Snow Removal Equipment Building (ST BD SN)	20-JUL-88	09-AUG-93	$70,000	$0	$70,000
	Acquire Snow Removal Equipment (ST EQ SN)	20-JUL-88	09-AUG-93	$78,125	$0	$78,125
	Install Runway Lighting (ST RW LI)	20-JUL-88	09-AUG-93	$111,000	$0	$111,000
	Construct Apron (ST AP CO)	20-JUL-88	09-AUG-93	$30,000	$0	$30,000
	Construct Taxiway (ST TW CO)	20-JUL-88	09-AUG-93	$40,000	$0	$40,000
3-02-0332-002-1996	Conduct Airport Master Plan Study (PL PL MA)	12-SEP-96	20-SEP-00	$295,925	$0	$295,925
				$2,367,179	$307,543	$2,674,722
Alakanuk (Proposed CM) ( )						
3-02-0440-001-2002	Construct New Airport (ST NA CO)	20-MAY-02		$6,152,380	$0	$6,152,380
				$6,152,380	$0	$6,152,380
Atmautluak						
Atmautluak (4A2)						
3-02-0379-001-1998	Improve Snow Removal Equipment Building (ST BD SN)	28-SEP-98	24-SEP-02	$200,000	$0	$200,000
	Extend Runway (ST RW IM)	28-SEP-98	24-SEP-02	$3,946,480	$0	$3,946,480
3-02-0379-002-2002	Construct Snow Removal Equipment Building (ST BD SN)	12-SEP-02		$400,000	$0	$400,000
	Extend Runway (ST RW IM)	12-SEP-02		$900,000	$0	$900,000
	Rehabilitate Runway (RE RW IM)	12-SEP-02		$0	$2,100,000	$2,100,000
				$5,446,480	$2,100,000	$7,546,480
Chefornak						
Chefornak (Proposed CM) ( )						
3-02-0442-001-2002	Construct New Airport (ST NA CO)	12-SEP-02		$7,527,390	$0	$7,527,390
				$7,527,390	$0	$7,527,390
Chevak						
Chevak (VAK)						
3-02-0052-001-1999	Construct New Airport (ST NA CO)	25-MAR-99		$5,963,980	$0	$5,963,980
	Improve Snow Removal Equipment Building (ST BD SN)	25-MAR-99		$500,000	$0	$500,000
				$6,463,980	$0	$6,463,980

		Obligated:	Closed:	Entitlement	Discretionary	TOTAL

Eek

Eek (EEK)

3-02-0085-001-1993	Conduct Airport Master Plan Study (PL PL MA)	05-AUG-93	09-MAY-00	$233,933	$0	$233,933
3-02-0085-002-1998	Construct New Airport (ST NA CO)	27-AUG-98	24-SEP-02	$2,832,014	$0	$2,832,014
3-02-0085-003-2002	Construct New Airport (ST NA CO)	17-SEP-02		$2,194,100	$3,957,900	$6,152,000
	Construct Snow Removal Equipment Building (ST BD SN)	17-SEP-02		$352,100	$0	$352,100
				$5,612,147	$3,957,900	$9,570,047

Emmonak

Emmonak (ENM)

3-02-0397-001-1983	Construct Taxiway (ST TW CO)	21-SEP-83	25-SEP-89	$724,259	$0	$724,259
	Improve Access Road (OT GT AC)	21-SEP-83	25-SEP-89	$357,208	$0	$357,208
	Construct Apron (ST AP CO)	21-SEP-83	25-SEP-89	$994,467	$0	$994,467
	Improve Snow Removal Equipment Building (ST BD SN)	21-SEP-83	25-SEP-89	$198,131	$0	$198,131
	Construct Runway (ST RW CO)	21-SEP-83	25-SEP-89	$3,806,409	$609,000	$4,415,409
	Acquire Land for Development (ST LA DV)	21-SEP-83	25-SEP-89	$9,526	$0	$9,526
3-02-0397-002-2001	Improve Runway Safety Area (ST RW SF)	12-SEP-01		$0	$1,560,604	$1,560,604
	Rehabilitate Runway (RE RW IM)	12-SEP-01		$1,400,000	$2,600,000	$4,000,000
	Extend Taxiway (ST TW IM)	12-SEP-01		$772,956	$0	$772,956
	Expand Apron (ST AP IM)	12-SEP-01		$709,772	$0	$709,772
				$8,972,728	$4,769,604	$13,742,332

Kipnuk

Kipnuk (IIK)

3-02-0150-001-1996	Conduct Airport Master Plan Study (PL PL MA)	22-AUG-96	01-AUG-00	$295,305	$0	$295,305
3-02-0150-002-2000	Construct New Airport (ST NA CO)	12-SEP-00		$4,650,000	$0	$4,650,000
				$4,945,305	$0	$4,945,305

Kotlik

Kotlik (KOT)

3-02-0159-001-1993	Conduct Airport Master Plan Study (PL PL MA)	13-SEP-93	24-OCT-98	$253,633	$0	$253,633
3-02-0159-002-1995	Rehabilitate Taxiway (RE TW IM)	26-SEP-95	20-SEP-00	$187,500	$0	$187,500
	Improve Access Road (OT GT AC)	26-SEP-95	20-SEP-00	$20,000	$0	$20,000
	Rehabilitate Apron (RE AP IM)	26-SEP-95	20-SEP-00	$187,500	$0	$187,500
	Rehabilitate Runway (RE RW IM)	26-SEP-95	20-SEP-00	$6,804,062	$0	$6,804,062
	Improve Snow Removal Equipment Building (ST BD SN)	26-SEP-95	20-SEP-00	$218,750	$0	$218,750
3-02-0159-003-1997	Acquire Snow Removal Equipment (ST EQ SN)	13-JUN-97	20-JUL-00	$178,125	$13,745	$191,870
				$7,849,570	$13,745	$7,863,315

Kwethluk

Kwethluk (KWT)

3-02-0164-001-1996	Conduct Airport Master Plan Study (PL PL MA)	22-AUG-96	06-SEP-00	$275,191	$0	$275,191
3-02-0435-001-2001	Improve Snow Removal Equipment Building (ST BD SN)	25-SEP-01		$280,000	$0	$280,000
	Construct New Airport (ST NA CO)	25-SEP-01		$5,256,000	$0	$5,256,000
				$5,811,191	$0	$5,811,191

		Obligated:	Closed:	Entitlement	Discretionary	TOTAL

Napakiak

Napakiak (WNA)

3-02-0188-001-1998	Install Perimeter Fencing (ST EQ SE)	28-MAY-98	27-SEP-02	$75,000	$0	$75,000
	Extend Runway (ST RW IM)	28-MAY-98	27-SEP-02	$454,975	$300,000	$754,975
	Improve Snow Removal Equipment Building (ST BD SN)	28-MAY-98	27-SEP-02	$250,000	$0	$250,000
	Rehabilitate Runway (RE RW IM)	28-MAY-98	27-SEP-02	$317,575	$1,700,000	$2,017,575
				$1,097,550	$2,000,000	$3,097,550

Napaskiak

Napaskiak (PKA)

3-02-0189-001-1991	Acquire Land for Development (ST LA DV)	05-SEP-91	13-OCT-94	$109,709	$0	$109,709
3-02-0189-002-1991	Rehabilitate Runway (RE RW IM)	27-AUG-91	19-SEP-95	$1,186,606	$0	$1,186,606
	Construct Apron (ST AP CO)	27-AUG-91	19-SEP-95	$217,845	$0	$217,845
	Acquire Snow Removal Equipment (ST EQ SN)	27-AUG-91	19-SEP-95	$125,104	$0	$125,104
	Improve Access Road (OT GT AC)	27-AUG-91	19-SEP-95	$53,566	$0	$53,566
	Construct Taxiway (ST TW CO)	27-AUG-91	19-SEP-95	$26,156	$0	$26,156
	Install Runway Lighting (ST RW LI)	27-AUG-91	19-SEP-95	$229,176	$0	$229,176
	Improve Snow Removal Equipment Building (ST BD SN)	27-AUG-91	19-SEP-95	$128,390	$0	$128,390
				$2,076,552	$0	$2,076,552

Sheldon Point

Sheldon Point (SXP)

3-02-0262-001-1993	Acquire Snow Removal Equipment (ST EQ SN)	09-SEP-93	14-JUL-99	$130,000	$0	$130,000
	Extend Runway (ST RW IM)	09-SEP-93	14-JUL-99	$80,000	$0	$80,000
	Rehabilitate Taxiway (RE TW IM)	09-SEP-93	14-JUL-99	$30,000	$0	$30,000
	Acquire Land for Development (ST LA DV)	09-SEP-93	14-JUL-99	$360,000	$0	$360,000
	Improve Access Road (OT GT AC)	09-SEP-93	14-JUL-99	$250,000	$0	$250,000
	Improve Runway Safety Area (ST RW SF)	09-SEP-93	14-JUL-99	$1,350,573	$209,085	$1,559,658
	Construct Apron (ST AP CO)	09-SEP-93	14-JUL-99	$220,000	$0	$220,000
	Improve Snow Removal Equipment Building (ST BD SN)	09-SEP-93	14-JUL-99	$115,000	$0	$115,000
3-02-0262-002-1994	Acquire Snow Removal Equipment (ST EQ SN)	29-JUN-94	05-JAN-99	$75,000	$0	$75,000
	Improve Snow Removal Equipment Building (ST BD SN)	29-JUN-94	05-JAN-99	$429,296	$15,830	$445,126
3-02-0262-003-1999	Extend Runway (ST RW IM)	22-MAR-99	26-SEP-02	$1,342,559	$247,105	$1,589,664
	Construct Apron (ST AP CO)	22-MAR-99	26-SEP-02	$415,000	$0	$415,000
	Construct Taxiway (ST TW CO)	22-MAR-99	26-SEP-02	$250,000	$0	$250,000
				$5,047,428	$472,020	$5,519,448

Tuntutuliak

Tuntutuliak (A61)

3-02-0303-001-1998	Construct New Airport (ST NA CO)	28-SEP-98	27-SEP-02	$4,206,000	$992	$4,206,992
				$4,206,000	$992	$4,206,992

Appendix D: Bid Compilation on Recent Airport Construction

STATE OF ALASKA
Dept. Of Transportation
and Public Facilities

Project No. AIP 3-02-0379-02/55226
Project Name: Atmautluak Airport Reconstruction-Phase II
Location: Atmautluak, AK

Opened At: 4111 Aviation Ave. Anchorage, Alaska 99502
Opened By: Sharon L. Smith, P.E., Chief of Contracts
Date: August 14, 2002

Compiled by BH _____ Checked by JM _____

Certified True & Correct

_____ _____
Sharon L. Smith, P.E. Date
Chief of Contracts Section, Central Region

COMPILATION OF BIDS

No.	Item	Unit	Engineers Estimate Unit Price	Engineers Estimate Approx. Qty	Engineers Estimate Amount	Knik Construction Company, Inc. 6441 South Airpark Place Anchorage, AK 99502 Unit Price	Knik Amount	QAP 240 W. 68th Avenue Anchorage, AK 99518 Unit Price	QAP Amount	Bering Pacific Construction 1399 W. 34th Street Anchorage, AK 99503 Unit Price	Bering Pacific Amount
			DBE Goals: 3.7%								
D-701a	Corrugated pipe, 24 Inch	LF	$50.00	80	$4,000.00	$115.00	$9,200.00	$100.00	$8,000.00	$75.00	$6,000.00
G-100a	Mobilization and Demobilization	LS	$350,000.00	All Req'd	$350,000.00	LS	$495,000.00	LS	$950,000.00	LS	$580,000.00
G-130a	Field Office	LS	$15,000.00	All Req'd	$15,000.00	LS	$18,000.00	LS	$16,000.00	LS	$15,000.00
G-130b	Field Laboratory	LS	$10,000.00	All Req'd	$10,000.00	LS	$12,000.00	LS	$16,000.00	LS	$7,500.00
G-131a	Engineering Transportation (Truck)	Ea	$10,000.00	1	$10,000.00	$14,000.00	$14,000.00	$12,000.00	$12,000.00	$15,000.00	$15,000.00
G-131b	Engineering Transportation (ATV)	Ea	$10,000.00	1	$10,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00
G-135a	Construction Surveying by the Contractor	LS	$30,000.00	All Req'd	$30,000.00	LS	$70,000.00	LS	$70,000.00	LS	$90,000.00
G-135b	Conditional Survey Party	hour	$200.00	24	$4,800.00	$240.00	$5,760.00	$300.00	$7,200.00	$225.00	$5,400.00
G-135c	Monuments by the Contractor	LS	$3,000.00	All Req'd	$3,000.00	LS	$4,500.00	LS	$4,000.00	LS	$3,000.00
L-100b	Regulator, L-828	Ea	$7,500.00	1	$7,500.00	$11,000.00	$11,000.00	$9,500.00	$9,500.00	$7,000.00	$7,000.00
L-100d	Medium Intensity Runway Edge and Threshold Light, L-861 and L-861E	Ea	$950.00	44	$41,800.00	$600.00	$26,400.00	$500.00	$22,000.00	$850.00	$37,400.00
L-100e	Taxiway Edge Light, L-861T	Ea	$900.00	14	$12,600.00	$600.00	$8,400.00	$500.00	$7,000.00	$850.00	$11,900.00
L-100p	Handhole, L-867 - Size B	Ea	$600.00	9	$5,400.00	$400.00	$3,600.00	$350.00	$3,150.00	$500.00	$4,500.00
L100q	Junction Box, Type II	Ea	$900.00	2	$1,800.00	$450.00	$900.00	$200.00	$400.00	$800.00	$1,600.00
L-101b	Rotating Beacon, Medium Intensity, L-801A	Ea	$10,000.00	1	$10,000.00	$9,500.00	$9,500.00	$8,500.00	$8,500.00	$7,000.00	$7,000.00
L-107a	8-Foot Lighted Wind Cone, in place	Ea	$7,000.00	1	$7,000.00	$9,500.00	$9,500.00	$6,500.00	$6,500.00	$6,500.00	$6,500.00
L-107c	8-Foot Unlighted Wind Cone, in place	Ea	$5,200.00	1	$5,200.00	$5,000.00	$5,000.00	$5,500.00	$5,500.00	$3,000.00	$3,000.00

Contractor

Nuvuk Construction, LLC
5300 A Street
Anchorage, AK 99518
BB $4,228,176.50
AA1 $330,000.00

Southwest Alaska Contractors, Inc.
1225 E. International Airport Rd., Ste. 105
Anchorage, AK 99518
BB $4,433,775.00
AA1 $ 375,000.00

LSH Constructors, JV
P. O. Box 233929
Anchorage, AK 99523
BB $4,445,125.00
AA1 $275,000.00

Kelly-Ryan Inc.
2404 Boyer Avenue East
Seattle, WA 98112
BB $5,061,355.00
AA1 $387,000.00

Project No. AIP 3-02-0379-0202/55226		Engineers Estimate				Knik Construction Company, Inc.		QAP		Bering Pacific Construction	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
L-108b	Underground Cable #8 AWG, Copper, 5KV FAA Type "C", L-824	LS	$21,000.00	All Req'd	$21,000.00	LS	$10,000.00	LS	$9,000.00	LS	$22,000.00
L-108d	#6 Bare Copper Ground Conductor	LS	$12,000.00	All Req'd	$12,000.00	LS	$3,000.00	LS	$3,000.00	LS	$10,000.00
L-108g	Ground Rod	Ea	$150.00	9	$1,350.00	$45.00	$405.00	$40.00	$360.00	$250.00	$2,250.00
L-109c	Electrical Enclosure and Foundation in Place	Ea	$20,000.00	1	$20,000.00	$30,000.00	$30,000.00	$15,000.00	$15,000.00	$15,000.00	$15,000.00
L-109d	Installation of Electrical Equipment in New or Existing Structure	Ea	$25,000.00	1	$25,000.00	$20,000.00	$20,000.00	$17,000.00	$17,000.00	$23,000.00	$23,000.00
L-110h	2-Inch PE Conduit	LS	$55,000.00	All Req'd	$55,000.00	LS	$40,000.00	LS	$35,000.00	LS	$60,000.00
L-110q	3-Inch PE Conduit	LS	$1,600.00	All Req'd	$1,600.00	LS	$2,000.00	LS	$1,000.00	LS	$12,000.00
P-152a	Unclassified Excavation	CY	$4.00	120,000	$480,000.00	$4.50	$540,000.00	$5.00	$600,000.00	$6.50	$780,000.00
P-157a	Erosion and Pollution Control Administration	LS	$5,000.00	All Req'd	$5,000.00	LS	$6,000.00	LS	$5,000.00	LS	$6,000.00
P-157b	Temporary Erosion and Pollution Control	CS	$10,000.00	All Req'd	$10,000.00	CS	$10,000.00	CS	$10,000.00	CS	$10,000.00
P-165a	Removal and Disposal of Existing Structures	LS	$5,000.00	All Req'd	$5,000.00	LS	$35,000.00	LS	$5,000.00	LS	$15,000.00
P-208a	Crushed Aggregate Surface Course	CY	$100.00	12,800	$1,280,000.00	$90.00	$1,152,000.00	$110.00	$1,408,000.00	$130.00	$1,664,000.00
P-208e	Crushed Aggregate Surface Course Stockpile	CY	$100.00	100	$10,000.00	$85.00	$8,500.00	$100.00	$10,000.00	$135.00	$13,500.00
P-640b	Segmented Circle (Panel Type)	LS	$25,000.00	All Req'd	$25,000.00	LS	$30,000.00	LS	$22,000.00	LS	$24,000.00
P-650a	Soil Anchor Tie-Down	Set	$450.00	3	$1,350.00	$550.00	$1,650.00	$1,000.00	$3,000.00	$300.00	$900.00
P-660b	Reflective Markers-Type II	Ea	$75.00	58	$4,350.00	$50.00	$2,900.00	$100.00	$5,800.00	$40.00	$2,320.00
P-660c	Reflective Markers-Type III	Ea	$60.00	20	$1,200.00	$65.00	$1,300.00	$100.00	$2,000.00	$70.00	$1,400.00
P-661a	Standard Sign	SF	$50.00	20.5	$1,025.00	$120.00	$2,460.00	$100.00	$2,050.00	$100.00	$2,050.00
P-680a	Geotextile Fence, Sediment Control	LF	$5.00	5,000	$25,000.00	$2.50	$12,500.00	$5.00	$25,000.00	$5.00	$25,000.00

Project No. AIP 3-02-0379-0202/55226		Engineers Estimate				Knik Construction Company, Inc.		QAP		Bering Pacific Construction	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
P-681a	Geotextile, Separation	SY	$2.50	3,000	$7,500.00	$1.50	$4,500.00	$2.00	$6,000.00	$3.50	$10,500.00
S-142c	Equipment Storage Building (Steel Skid)	Ea	$250,000.00	1	$250,000.00	$350,000.00	$350,000.00	$250,000.00	$250,000.00	$325,000.00	$325,000.00
S-142d	Roof Access Ladder and Rotating Beacon Platform	Ea	$15,000.00	1	$15,000.00	$17,000.00	$17,000.00	$13,000.00	$13,000.00	$12,000.00	$12,000.00
S-142e	Crane Beam	Ea	$5,000.00	1	$5,000.00	$5,000.00	$5,000.00	$6,000.00	$6,000.00	$4,500.00	$4,500.00
S-142f	Heating System	Ea	$10,000.00	1	$10,000.00	$14,000.00	$14,000.00	$15,000.00	$15,000.00	$12,000.00	$12,000.00
S-143a	Fuel Tank (1000 gal)	Ea	$15,000.00	2	$30,000.00	$13,000.00	$26,000.00	$14,000.00	$28,000.00	$9,000.00	$18,000.00
S-143b	Fuel (2000 gal)	LS	$6,000.00	All Req'd	$6,000.00	LS	$7,000.00	LS	$3,000.00	LS	$5,000.00
S-143d	Electric Dispensing System	Ea	$15,000.00	1	$15,000.00	$3,700.00	$3,700.00	$3,200.00	$3,200.00	$3,000.00	$3,000.00
T-901b	Seeding	lb	$50.00	400	$20,000.00	$80.00	$32,000.00	$30.00	$12,000.00	$70.00	$28,000.00
T-908b	Mulching	lb	$3.00	16,250	$48,750.00	$0.50	$8,125.00	$1.00	$16,250.00	$1.00	$16,250.00
	Basic Bid				$2,919,225.00		$3,082,800.00		$3,681,410.00		$3,928,470.00
	Atmautluak Airport Reconstruction-Phase II-Additive Alternate #1-Equipment Storage Building (Steel Skid)										
S-142c	Equipment Storage Building (Steel Skid)	Ea	$240,000.00	1	$240,000.00	$350,000.00	$350,000.00	$275,000.00	$275,000.00	$325,000.00	$325,000.00
	Additive Alternate #1				$240,000.00		$350,000.00		$275,000.00		$325,000.00

STATE OF ALASKA
Dept. Of Transportation
and Public Facilities

Project No. AIP 3-02-0442-0102/51826
Project Name: Chefornak Airport Relocation
Location: Chefornak, AK

Opened At: 4111 Aviation Ave. Anchorage, Alaska 99502
Opened By: Sharon L. Smith, P.E., Chief of Contracts
Date: July 17, 2002
Compiled by BH _____ Checked by JM _____

Certified True & Correct
_____ _____
Sharon L. Smith, P.E. Date
Chief of Contracts Section, Central Region

REVISED

COMPILATION OF BIDS

		Engineers Estimate				Knik Construction Company, Inc. 6441 South Airpark Place Anchorage, AK 99502		Brice Incorporated P. O. Box 70668 Fairbanks, AK 99707		Osborne Construction Company P. O. Box 97010 Kirkland, WA 98083	
		DBE Goals: 2.6%									
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
P-152f	Embankment	m3	$8.00	492,300	$3,938,400.00	$10.50	$5,169,150.00	$11.40	$5,612,220.00	$11.00	$5,415,300.00
P-157a	Erosion and Pollution Control Administration	LS	$5,000.00	All Req'd	$5,000.00	LS	$5,000.00	LS	$3,897.00	LS	$3,000.00
P-157b	Temporary Erosion and Pollution Control	CS	$5,000.00	All Req'd	$5,000.00	CS	$5,000.00	CS	$5,000.00	CS	$5,000.00
P-671a	Runway Closure Marker	Ea	$500.00	3	$1,500.00	$1,500.00	$4,500.00	$1,776.00	$5,328.00	$3,000.00	$9,000.00
P-671b	Taxiway Closure Marker	Ea	$350.00	1	$350.00	$1,200.00	$1,200.00	$1,545.00	$1,545.00	$3,000.00	$3,000.00
P-680a	Geotextile Fence, Sediment Control	m	$12.00	6,700	$80,400.00	$6.00	$40,200.00	$11.11	$74,437.00	$15.00	$100,500.00
T-901b	Seeding	kg	$44.00	1,370	$60,280.00	$60.00	$82,200.00	$82.55	$113,093.50	$65.00	$89,050.00
G-100a	Mobilization and Demobilization	LS	$400,000.00	All Req'd	$400,000.00	LS	$740,000.00	LS	$830,770.00	LS	$1,099,110.00
G-130a	Field Office	LS	$10,000.00	All Req'd	$10,000.00	LS	$20,000.00	LS	$17,377.00	LS	$20,000.00
G-131a	Engineering Transportation (TRUCK)	Ea	$10,000.00	1	$10,000.00	$15,000.00	$15,000.00	$17,377.00	$17,377.00	$30,000.00	$30,000.00
G-131b	Engineering Transportation (ATV)	Ea	$10,000.00	1	$10,000.00	$8,000.00	$8,000.00	$7,944.00	$7,944.00	$2,000.00	$2,000.00
G-131c	Engineering Transportation (Snowmachine)	Ea	$10,000.00	1	$10,000.00	$8,000.00	$8,000.00	$7,944.00	$7,944.00	$2,000.00	$2,000.00
G-135a	Construction Surveying by the Contractor	LS	$25,000.00	All Req'd	$25,000.00	LS	$55,000.00	LS	$53,411.00	LS	$62,000.00
G-135b	Conditional Survey Party	hour	$110.00	12	$1,320.00	$250.00	$3,000.00	$230.00	$2,760.00	$420.00	$5,040.00
	Total Basic Bid				$4,557,250.00		$6,156,250.00		$6,753,103.50		$6,845,000.00

Contractor

LSH Constructors, J/V
P. O. Box 233929
Anchorage, AK 99523
$7,163,300.00

Kelly-Ryan, Inc.
2404 Boyer Avenue East
Seattle, WA 98112
$7,308,310.00

Nuvuk Construction, LLC
5300 A Street
Anchorage, AK 99518
$9,648,690.00

QAP
240 W. 68th Avenue
Anchorage, AK 99518
$4,244,700.00
WITHDRAWN

STATE OF ALASKA
Dept. Of Transportation
and Public Facilities

Project No. AIP 3-02-0085-0302/54851
Project Name: Eek Airport Relocation, Stage II
Location: Eek, AK

Opened At: 4111 Aviation Ave. Anchorage, Alaska 99502
Opened By: Sharon L. Smith, P.E., Chief of Contracts
Date: July 31, 2002
Compiled by BH _____ Checked by JM _____

Certified True & Correct
_____ _____
Sharon L. Smith, P.E. Date
Chief of Contracts Section, Central Region

COMPILATION OF BIDS

No.	Item	Unit	Engineers Estimate Unit Price	Approx. Qty	Engineers Estimate Amount	LSH Constructors, JV, P. O. Box 233929, Anchorage, AK 99523 Unit Price	Amount	Knik Construction Company, Inc., 6441 South Airpark Place, Anchorage, AK 99502 Unit Price	Amount	Southwest Alaska Contractors, Inc., 1225 E. Int'l Airport Rd., Ste. 105, Anchorage, AK 99518 Unit Price	Amount
			DBE Goals: 8.9%								
D-701a	CMP Pipe, 42 Inch	LF	$100.00	195	$19,500.00	$140.00	$27,300.00	$150.00	$29,250.00	$90.00	$17,550.00
G-100a	Mobilization and Demobilization	LS	$400,000.00	All Req'd	$400,000.00	LS	$350,000.00	LS	$590,000.00	LS	$510,000.00
G-130a	Field Office	LS	$20,000.00	All Req'd	$20,000.00	LS	$13,500.00	LS	$20,000.00	LS	$40,000.00
G-131a	Engineering Transportation (Truck)	Ea	$20,000.00	1	$20,000.00	$16,000.00	$16,000.00	$13,000.00	$13,000.00	$22,000.00	$22,000.00
G-131b	Engineering Transportation (ATV)	Ea	$8,000.00	1	$8,000.00	$5,000.00	$5,000.00	$8,000.00	$8,000.00	$6,500.00	$6,500.00
G-131c	Engineering Transportation (Snowmachine)	Ea	$6,000.00	1	$6,000.00	$3,750.00	$3,750.00	$7,000.00	$7,000.00	$6,500.00	$6,500.00
G135a	Construction Surveying by the Contractor	LS	$40,000.00	All Req'd	$40,000.00	LS	$92,000.00	LS	$75,000.00	LS	$88,000.00
G-135b	Conditional Survey Party	HR	$200.00	20	$4,000.00	$260.00	$5,200.00	$250.00	$5,000.00	$165.00	$3,300.00
G-135c	Monuments by the Contractor	LS	$4,000.00	All Req'd	$4,000.00	LS	$4,375.00	LS	$6,000.00	LS	$5,500.00
L-100b	Regulator, L-828	Ea	$7,500.00	1	$7,500.00	$9,000.00	$9,000.00	$4,500.00	$4,500.00	$5,000.00	$5,000.00
L-100d	Medium Intensity Runway Edge and Threshold Light, L-861 and L-861E	Ea	$950.00	44	$41,800.00	$1,200.00	$52,800.00	$900.00	$39,600.00	$850.00	$37,400.00
L-100e	Taxiway Edge Light, L-861T	Ea	$900.00	16	$14,400.00	$1,200.00	$19,200.00	$900.00	$14,400.00	$850.00	$13,600.00
L-100p	Handhole, L-867, Size B	Ea	$600.00	20	$12,000.00	$800.00	$16,000.00	$300.00	$6,000.00	$280.00	$5,600.00
L100q	Junction Box, Type II	Ea	$900.00	5	$4,500.00	$500.00	$2,500.00	$880.00	$4,400.00	$800.00	$4,000.00
L-101b	Rotating Beacon-Medium Intensity, L-801A	Ea	$10,000.00	1	$10,000.00	$10,000.00	$10,000.00	$7,000.00	$7,000.00	$6,500.00	$6,500.00
L-107a	8-Foot Lighted Wind Cone, In Place	Ea	$7,000.00	1	$7,000.00	$11,500.00	$11,500.00	$8,800.00	$8,800.00	$8,000.00	$8,000.00
L-107c	8-Foot Unlighted Wind Cone, In Place	Ea	$6,000.00	1	$6,000.00	$7,300.00	$7,300.00	$3,700.00	$3,700.00	$4,000.00	$4,000.00

Contractor

QAP
240 W. 68th Avenue
Anchorage, AK 99518
$6,982,620.00

Bering Pacific Construction
1399 W. 34th Street
Anchorage, AK 99503
$7,769,213.00

Kelly-Ryan, Inc.
2404 Boyer Avenue East
Seattle, WA 98112
$7,896,430.00

Nuvuk Construction, LLC
5300 A Street
Anchorage, AK 99518
$7,921,777.50

Project No. AIP 3-02-0085-0302/54851		Engineers Estimate				LSH Constructors, JV		Knik Construction Company, Inc.		Southwest Alaska Contractors, Inc.	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
L-108b	Underground Cable #8 AWG, Copper, 5kV FAA Type "C", L-824	LS	$21,000.00	All Req'd	$21,000.00	LS	$19,750.00	LS	$19,000.00	LS	$20,000.00
L-108d	#6 Bare Copper Ground Conductor	LS	$12,000.00	All Req'd	$12,000.00	LS	$7,800.00	LS	$7,000.00	LS	$7,000.00
L-108g	Ground Rod	Ea	$150.00	8	$1,200.00	$100.00	$800.00	$110.00	$880.00	$100.00	$800.00
L-109c	Electrical Enclosure and Foundation in Place	Ea	$25,000.00	1	$25,000.00	$26,750.00	$26,750.00	$23,000.00	$23,000.00	$21,000.00	$21,000.00
L-109d	Installation of Electrical Equipment in New or Existing Structure	Ea	$20,000.00	1	$20,000.00	$31,500.00	$31,500.00	$18,000.00	$18,000.00	$16,000.00	$16,000.00
L-110h	2 Inch PE Conduit	LS	$55,000.00	All Req'd	$55,000.00	LS	$95,000.00	LS	$65,000.00	LS	$110,000.00
L-110q	3 Inch PE Conduit	LS	$14,400.00	All Req'd	$14,400.00	LS	$8,500.00	LS	$4,400.00	LS	$4,000.00
P-152a	Unclassified Excavation	CY	$5.00	3,000	$15,000.00	$10.00	$30,000.00	$8.00	$24,000.00	$20.00	$60,000.00
P-152f	Embankment	CY	$6.00	7,500	$45,000.00	$8.00	$60,000.00	$20.00	$150,000.00	$35.00	$262,500.00
P-154a	Subbase Course	CY	$50.00	36,600	$1,830,000.00	$61.00	$2,232,600.00	$70.00	$2,562,000.00	$66.00	$2,415,600.00
P-157a	Erosion and Pollution Control Administration	LS	$5,000.00	All Req'd	$5,000.00	LS	$8,000.00	LS	$4,500.00	LS	$15,000.00
P-157b	Temporary Erosion and Pollution Control	CS	$10,000.00	All Req'd	$10,000.00	CS	$10,000.00	CS	$10,000.00	CS	$10,000.00
P-186b	Sandbag	Ea	$8.00	2,000	$16,000.00	$5.00	$10,000.00	$9.00	$18,000.00	$25.00	$50,000.00
P-208a	Crushed Aggregate Surface Course	CY	$80.00	14,400	$1,152,000.00	$82.00	$1,180,800.00	$92.00	$1,324,800.00	$98.00	$1,411,200.00
P-208e	Crushed Aggregate Surface Course (Stockpile)	CY	$75.00	100	$7,500.00	$70.00	$7,000.00	$90.00	$9,000.00	$105.00	$10,500.00
P-640b	Segmented Circle (Panel-Type)	LS	$30,000.00	All Req'd	$30,000.00	LS	$27,500.00	LS	$30,000.00	LS	$30,000.00
P-650a	Soil Anchor Tie-Down	Set	$400.00	4	$1,600.00	$300.00	$1,200.00	$400.00	$1,600.00	$650.00	$2,600.00
P-660b	Reflective Markers, Type II	Ea	$75.00	60	$4,500.00	$60.00	$3,600.00	$45.00	$2,700.00	$60.00	$3,600.00
P-660c	Reflective Markers, Type III	Ea	$75.00	20	$1,500.00	$73.00	$1,460.00	$40.00	$800.00	$75.00	$1,500.00

Project No. AIP 3-02-0085-0302/54851		Engineers Estimate				LSH Constructors, JV		Knik Construction Company, Inc.		Southwest Alaska Contractors, Inc.	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
P-661a	Standard Sign	SF	$100.00	51.1	$5,110.00	$110.00	$5,621.00	$50.00	$2,555.00	$120.00	$6,132.00
P-671a	Runway Closure Marker	Ea	$1,000.00	2	$2,000.00	$1,150.00	$2,300.00	$2,000.00	$4,000.00	$2,500.00	$5,000.00
P-680a	Geotextile Fence, Sediment Control	LF	$8.00	3,000	$24,000.00	$5.00	$15,000.00	$2.50	$7,500.00	$8.00	$24,000.00
P-681a	Geotextile, Separation	SY	$1.20	72,500	$87,000.00	$1.50	$108,750.00	$1.20	$87,000.00	$3.00	$217,500.00
P-681c	Geogrid	SY	$4.00	71,900	$287,600.00	$3.75	$269,625.00	$3.90	$280,410.00	$5.00	$359,500.00
S-142c	Equipment Storage Building (Steel Skid)	Ea	$275,000.00	2	$550,000.00	$340,000.00	$680,000.00	$350,000.00	$700,000.00	$300,000.00	$600,000.00
S-142d	Roof Access Ladder and Rotating Beacon Platform	Ea	$20,000.00	1	$20,000.00	$10,000.00	$10,000.00	$17,000.00	$17,000.00	$16,000.00	$16,000.00
S-142e	Crane Beam	Ea	$20,000.00	1	$20,000.00	$7,200.00	$7,200.00	$4,600.00	$4,600.00	$4,200.00	$4,200.00
S-142f	Heating System	Ea	$20,000.00	1	$20,000.00	$42,000.00	$42,000.00	$13,500.00	$13,500.00	$12,500.00	$12,500.00
S-143a	Fuel Tank (1,000 gallons)	Ea	$8,000.00	2	$16,000.00	$14,800.00	$29,600.00	$12,000.00	$24,000.00	$8,000.00	$16,000.00
S-143b	Fuel	LS	$8,000.00	All Req'd	$8,000.00	LS	$5,200.00	LS	$4,500.00	LS	$5,500.00
S-143c	Manual Dispensing System	Ea	$5,000.00	1	$5,000.00	$675.00	$675.00	$200.00	$200.00	$550.00	$550.00
S-143d	Electric Dispensing System	Ea	$10,000.00	1	$10,000.00	$2,250.00	$2,250.00	$1,500.00	$1,500.00	$2,500.00	$2,500.00
T-901a	Seeding	Acre	$2,000.00	9	$18,000.00	$4,325.00	$38,925.00	$1,800.00	$16,200.00	$1,000.00	$9,000.00
T-908a	Mulching	SY	$0.70	44,000	$30,800.00	$0.85	$37,400.00	$0.20	$8,800.00	$1.50	$66,000.00
	Total Basic Bid				$4,994,910.00		$5,662,231.00		$6,288,095.00		$6,579,132.00

STATE OF ALASKA
Dept. Of Transportation
and Public Facilities

Project No. AIP 3-02-0150-02/53658
Project Name: Kipnuk Airport Relocation-Phase I
Location: Kipnuk, AK

Opened At: 4111 Aviation Ave. Anchorage, Alaska 99502
Opened By: Robert H. Wilson, P.E., Chief of Contracts
Date: March 21, 2001
Compiled by BH _____ Checked by JM _____

Certified True & Correct
_____ _____
Robert H. Wilson, P.E. Date
Chief Contracts Section, Central Region

COMPILATION OF BIDS

No.	Item	Unit	Engineers Estimate Unit Price	Approx. Qty	Engineers Estimate Amount	Bering Pacific Construction, 10505 NE 38th Place, Kirkland, WA 98033 Unit Price	Amount	QAP, 240 W. 68th Avenue, Anchorage, AK 99518 Unit Price	Amount	Brice Incorporated, P. O. Box 70668, Fairbanks, AK 99707 Unit Price	Amount
			DBE Goals: 6.3%								
D-701a	Corrugated PE Pipe, 1050mm Dia.	m	$200.00	260	$52,000.00	$200.00	$52,000.00	$300.00	$78,000.00	$394.00	$102,440.00
G-100	Mobilization and Demobilization	LS	$350,000.00	All Req'd	$350,000.00	LS	$750,000.00	LS	$1,300,000.00	LS	$380,000.00
G-120	DBE Adjustment	CS	$0.00	All Req'd	$0.00	CS	$0.00	CS	$0.00	CS	$0.00
G-130a	Engineer's Field Office	LS	$10,000.00	All Req'd	$10,000.00	LS	$10,000.00	LS	$1,000.00	LS	$15,000.00
G-131	Engineering Transportation	LS	$20,000.00	All Req'd	$20,000.00	LS	$15,000.00	LS	$25,000.00	LS	$15,000.00
G-135a	Construction Surveying by the Contractor	LS	$25,000.00	All Req'd	$25,000.00	LS	$100,000.00	LS	$60,000.00	LS	$25,000.00
G-135b	Three Person Survey Party	hour	$150.00	16	$2,400.00	$250.00	$4,000.00	$220.00	$3,520.00	$200.00	$3,200.00
G-135c	Monuments by the Contractor	LS	$1,000.00	All Req'd	$1,000.00	LS	$1,500.00	LS	$1,000.00	LS	$1,000.00
P-152h	Borrow Embankment	m3	$7.00	376,000	$2,632,000.00	$5.66	$2,128,160.00	$6.00	$2,256,000.00	$8.90	$3,346,400.00
P-156a	Erosion and Pollution Control Administration	LS	$4,000.00	All Req'd	$4,000.00	LS	$3,000.00	LS	$8,000.00	LS	$5,000.00
P-156b	Erosion and Pollution Control	CS	$0.00	All Req'd	$0.00	CS	$0.00	CS	$0.00	CS	$0.00
P-156c	Erosion and Pollution Control Adjustment	CS	$0.00	All Req'd	$0.00	CS	$0.00	CS	$0.00	CS	$0.00
P-190	Geotextile Fence, Sediment Control	m	$5.00	2,800	$14,000.00	$14.00	$39,200.00	$10.00	$28,000.00	$10.00	$28,000.00
P-191	Geotextile Floating Curtain, Sediment Control	m	$25.00	400	$10,000.00	$72.00	$28,800.00	$60.00	$24,000.00	$75.00	$30,000.00
S-150a	Boardwalk	m	$300.00	600	$180,000.00	$400.00	$240,000.00	$400.00	$240,000.00	$650.00	$390,000.00
S-150b	Bridge	LS	$80,000.00	All Req'd	$80,000.00	LS	$40,000.00	LS	$82,000.00	LS	$100,000.00
T-901b	Seeding	kg	$60.00	650	$39,000.00	$40.00	$26,000.00	$60.00	$39,000.00	$40.00	$26,000.00

Contractor

LSH Constructors JV
P. O. Box 233929
Anchorage, AK 99523
Basic Bid: $4,591,860.00
AA#1: $364,000.00
Total Basic Bid: $4,955,860.00

Goodfellow Brothers, Inc.
11710 S. Gambell Street
Anchorage, AK 99515
Basic Bid: $4,665,700.00
AA#1: $312,000.00
Total Basic Bid: $4,977,700.00

Tamsher Construction, Inc.
P. O. Box 878990
Wasilla, AK 99687
Basic Bid: $5,343,412.30
AA#1: $560,560.00
Total Basic Bid: $ 5,903,972.30

Knik Construction Company, Inc.
6441 South Airpark Place
Anchorage, AK 99502
Basic Bid: $7,054,750.00
AA#1: $468,000.00
Total Basic Bid: $7,522,750.00

BIDWITHDRAWN

Project No. AIP 3-02-0150-02/53658		Engineers Estimate				Bering Pacific Construction		QAP		Brice Incorporated	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
T-901d	Fertilizing	kg	$6.00	9,600	$57,600.00	$2.00	$19,200.00	$2.00	$19,200.00	$3.50	$33,600.00
T-908c	Mulching	kg	$2.00	19,900	$39,800.00	$1.50	$29,850.00	$1.00	$19,900.00	$2.00	$39,800.00
	Basic Bid				$3,516,800.00		$3,486,710.00		$4,184,620.00		$4,540,440.00
	Kipnuk Airport Relocation-Phase I Additive Alternate #1 Increase Depth of Borrow Embankment										
P-152h.1	Borrow Embankment	m3	$7.00	52,000	$364,000.00	$5.25	$273,000.00	$5.00	$260,000.00	$5.88	$305,760.00
	Additive Alternate #1				$364,000.00		$273,000.00		$260,000.00		$305,760.00
	Basic Bid				$3,516,800.00		$3,486,710.00		$4,184,620.00		$4,540,440.00
	Additive Alternate #1				$364,000.00		$273,000.00		$260,000.00		$305,760.00
	Total Bid				$3,880,800.00		$3,759,710.00		$4,444,620.00		$4,846,200.00

BID WITHDRAWN

STATE OF ALASKA
Dept. Of Transportation
and Public Facilities

Project No. AIP 3-02-0435-0101/53872
STP-0001(210)/54297
Project Name: Kwethluk Airport Relocation
and Access Road

Location: Kwethluk, AK
Engineers Estimate

Opened At: 4111 Aviation Ave. Anchorage, Alaska 99502
Opened By: Robert H. Wilson, P.E., Chief of Contracts
Date: September 14, 2001

Compiled by JL _____ Checked by JM _____

Certified True & Correct

_____ _____
Robert H. Wilson, P.E. Date
Chief Contracts Section, Central Region

COMPILATION OF BIDS

DBE Goals: 6.3%

No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
						Southwest Alaska Contractors, Inc. 1399 W. 34th Street, Suite 202 Anchorage, AK 99503		QAP 240 W. 68th Avenue Anchorage, AK 99518		LSH Constructors, JV P.O. Box 233929 Anchorage, AK 99523-3929	
	Schedule A										
G-100	Mobilization and Demobilization	LS	$600,000.00	All Req'd	$600,000.00	LS	$700,000.00	LS	$500,000.00	LS	$475,000.00
G-130a	Field Office	LS	$20,000.00	All Req'd	$20,000.00	LS	$22,000.00	LS	$20,000.00	LS	$24,000.00
G-130b	Field Laboratory	LS	$20,000.00	All Req'd	$20,000.00	LS	$25,000.00	LS	$16,000.00	LS	$25,000.00
G-130d	Meal	Ea	$12.00	1000	$12,000.00	$40.00	$40,000.00	$10.00	$10,000.00	$14.50	$14,500.00
G-130e	Lodging	Ea	$75.00	300	$22,500.00	$55.00	$16,500.00	$50.00	$15,000.00	$72.00	$21,600.00
G-131a	Engineering Transportation (truck)	Ea	$7,000.00	1	$7,000.00	$24,000.00	$24,000.00	$16,000.00	$16,000.00	$20,000.00	$20,000.00
G-131b	Engineering Transportation (snowmachine)	Ea	$2,000.00	1	$2,000.00	$8,000.00	$8,000.00	$6,000.00	$6,000.00	$5,000.00	$5,000.00
G-131c	Engineering Transportation (ATV)	Ea	$2,000.00	1	$2,000.00	$8,000.00	$8,000.00	$6,000.00	$6,000.00	$5,000.00	$5,000.00
G-700	Traffic Maintenance	CS	$12,000.00	All Req'd	$12,000.00	CS	$12,000.00	CS	$12,000.00	CS	$12,000.00
P-152k	Haul Road Construction, Removal and Restoration	LS	$20,000.00	All Req'd	$20,000.00	LS	$185,000.00	LS	$530,000.00	LS	$200,000.00
P-157a	Erosion and Pollution Control Administration	LS	$2,000.00	All Req'd	$2,000.00	LS	$12,000.00	LS	$5,000.00	LS	$6,000.00
P-157b	Erosion and Pollution Control	CS	$5,000.00	All Req'd	$5,000.00	CS	$5,000.00	CS	$5,000.00	CS	$5,000.00
P-680	Geotextile Fence, Sediment Control	m	$15.00	1777	$26,655.00	$23.00	$40,871.00	$11.00	$19,547.00	$14.50	$25,766.50
	Schedule A SubTotal				$751,155.00		$1,098,371.00		$1,160,547.00		$838,866.50

Contractor

Tamsher Construction, Inc.
P.O. Box 878990
Wasilla, AK 99687
$7,741,372.80

Brice Incorporated
P.O. Box 70668
Fairbanks, AK 99707
$8,017,970.00

Knik Construction Co., Inc.
6441 SouthAirpark Place
Anchorage, AK 99502
$8,467,069.00

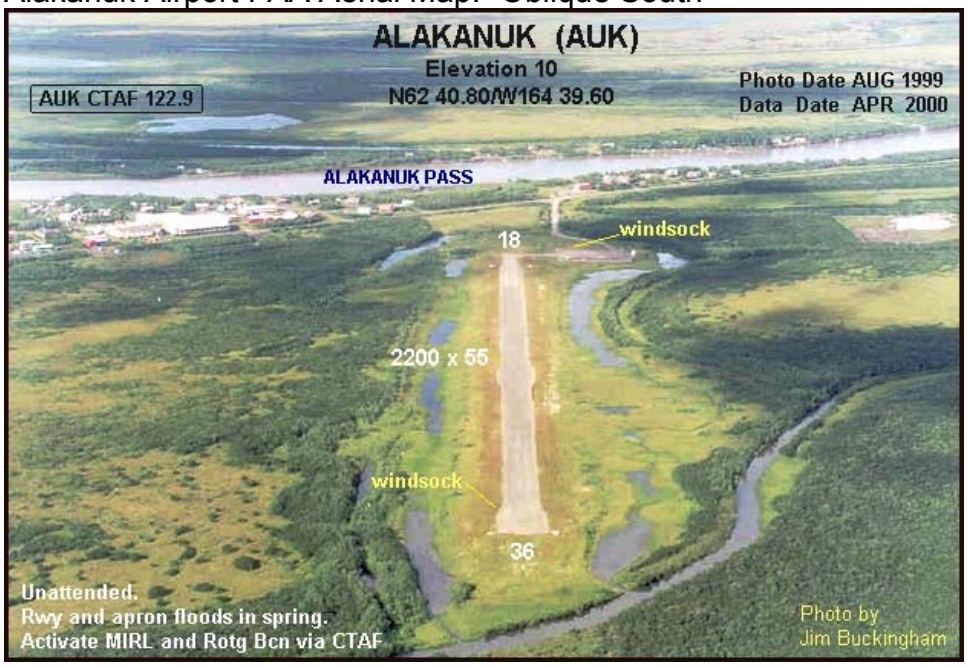
Project No. AIP 3-02-0435-0101/53872 & STP-0001(210)/54297		Engineers Estimate				Southwest Alaska Contractors, Inc.		QAP		LSH Constructors, JV	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Schedule B-Project 53872 Airport Relocation										
G-135a	Construction Surveying by the Contractor	LS	$25,340.00	All Req'd	$25,340.00	LS	$100,000.00	LS	$30,000.00	LS	$139,000.00
G-135b	Three Person Survey Party	hour	$250.00	6	$1,500.00	$200.00	$1,200.00	$200.00	$1,200.00	$300.00	$1,800.00
G-135c	Monuments by the Contractor	Ea	$500.00	7	$3,500.00	$200.00	$1,400.00	$300.00	$2,100.00	$300.00	$2,100.00
L-100d	Medium Intensity Runway Edge and Threshold Light, L-861 & L-861E	Ea	$600.00	44	$26,400.00	$950.00	$41,800.00	$1,000.00	$44,000.00	$1,270.00	$55,880.00
L-100e	Taxiway Edge Light, L-861T	Ea	$600.00	14	$8,400.00	$900.00	$12,600.00	$1,000.00	$14,000.00	$1,270.00	$17,780.00
L-100f	Handhole, L-867 Size B	Ea	$400.00	9	$3,600.00	$600.00	$5,400.00	$650.00	$5,850.00	$630.00	$5,670.00
L-101b	Rotating Beacon, Medium Intensity, L-802A	Ea	$7,500.00	1	$7,500.00	$6,500.00	$6,500.00	$6,000.00	$6,000.00	$11,100.00	$11,100.00
L-107a	2.5 m Lighted Wind Cone	Ea	$7,000.00	1	$7,000.00	$6,500.00	$6,500.00	$5,000.00	$5,000.00	$10,000.00	$10,000.00
L-107c	2.5 m Unlighted Wind Cone	Ea	$5,000.00	1	$5,000.00	$4,500.00	$4,500.00	$4,000.00	$4,000.00	$7,000.00	$7,000.00
L-108b	Underground Cable, #8 AWG, Copper, 5kV, Type "B", L-824	LS	$20,000.00	All Req'd	$20,000.00	LS	$12,000.00	LS	$11,000.00	LS	$31,500.00
L-108d	#6 Bare Copper Ground Conductor	LS	$12,500.00	All Req'd	$12,500.00	LS	$8,000.00	LS	$7,000.00	LS	$15,800.00
L-108g	Ground Rod	Ea	$150.00	10	$1,500.00	$150.00	$1,500.00	$150.00	$1,500.00	$550.00	$5,500.00
L-109c	Electrical Enclosure and Foundation in Place	Ea	$7,000.00	1	$7,000.00	$24,000.00	$24,000.00	$22,000.00	$22,000.00	$19,000.00	$19,000.00
L-109d	Installation of Electrical Equipment in New or Existing Structure	Ea	$40,000.00	1	$40,000.00	$22,000.00	$22,000.00	$15,000.00	$15,000.00	$35,000.00	$35,000.00
L-110h	50 mm PE Conduit	LS	$40,000.00	All Req'd	$40,000.00	LS	$75,000.00	LS	$70,000.00	LS	$95,000.00
P-151b	Clearing	LS	$29,500.00	All Req'd	$29,500.00	LS	$100,000.00	LS	$400,000.00	LS	$73,000.00
P-152a	Unclassified Excavation	m3	$5.00	43,000	$215,000.00	$4.00	$172,000.00	$6.00	$258,000.00	$5.75	$247,250.00
P-152h	Borrow Embankment (Type 1)	m3	$8.00	240,000	$1,920,000.00	$5.60	$1,344,000.00	$8.00	$1,920,000.00	$7.10	$1,704,000.00

Project No. AIP 3-02-0435-0101/53872 & STP-0001(210)/54297		Engineers Estimate				Southwest Alaska Contractors, Inc.		QAP		LSH Constructors, JV	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
P-208b	Aggregate Surface Course	m3	$90.00	11000	$990,000.00	$95.00	$1,045,000.00	$80.00	$880,000.00	$115.00	$1,265,000.00
P-208c	Aggregate Surface Course Stockpile	m3	$90.00	100	$9,000.00	$95.00	$9,500.00	$70.00	$7,000.00	$110.00	$11,000.00
P-640b	Segmented Circle (Panel-Type)	Each	$25,000.00	1	$25,000.00	$30,000.00	$30,000.00	$22,000.00	$22,000.00	$34,000.00	$34,000.00
P-650a	Soil Anchor Tiedown	Set	$600.00	6	$3,600.00	$360.00	$2,160.00	$200.00	$1,200.00	$210.00	$1,260.00
P-660b	Reflective Marker, Type II	Ea	$40.00	58	$2,320.00	$40.00	$2,320.00	$40.00	$2,320.00	$49.00	$2,842.00
P-660c	Reflective Markers, Type III	Ea	$100.00	20	$2,000.00	$60.00	$1,200.00	$40.00	$800.00	$68.00	$1,360.00
P-670a	Standard Signs	m2	$200.00	1.56	$312.00	$1,050.00	$1,638.00	$1,000.00	$1,560.00	$975.00	$1,521.00
P-671	Runway Closure Marker	Ea	$1,500.00	3	$4,500.00	$1,000.00	$3,000.00	$440.00	$1,320.00	$1,200.00	$3,600.00
P-681b	Geotextile, Reinforcement	m2	$2.00	83,000	$166,000.00	$2.00	$166,000.00	$1.00	$83,000.00	$2.40	$199,200.00
S-142b	Equipment Storage Building (Steel Floor)	LS	$220,000.00	All Req'd	$220,000.00	LS	$310,000.00	LS	$200,000.00	LS	$410,000.00
S-143a	Fuel Tank (3800 Liter)	Ea	$10,000.00	2	$20,000.00	$10,000.00	$20,000.00	$8,000.00	$16,000.00	$20,500.00	$41,000.00
S-143b	Fuel	LS	$7,000.00	All Req'd	$7,000.00	LS	$5,000.00	LS	$4,000.00	LS	$7,000.00
T-901b	Seeding	kg	$120.00	120	$14,400.00	$78.00	$9,360.00	$230.00	$27,600.00	$165.00	$19,800.00
T-905a	Topsoiling	m2	$1.00	20100	$20,100.00	$2.70	$54,270.00	$0.90	$18,090.00	$5.00	$100,500.00
T-908a	Mulching	m2	$2.00	20100	$40,200.00	$1.15	$23,115.00	$1.00	$20,100.00	$1.30	$26,130.00
	Schedule B SubTotal				$3,898,172.00		$3,620,963.00		$4,101,640.00		$4,600,593.00

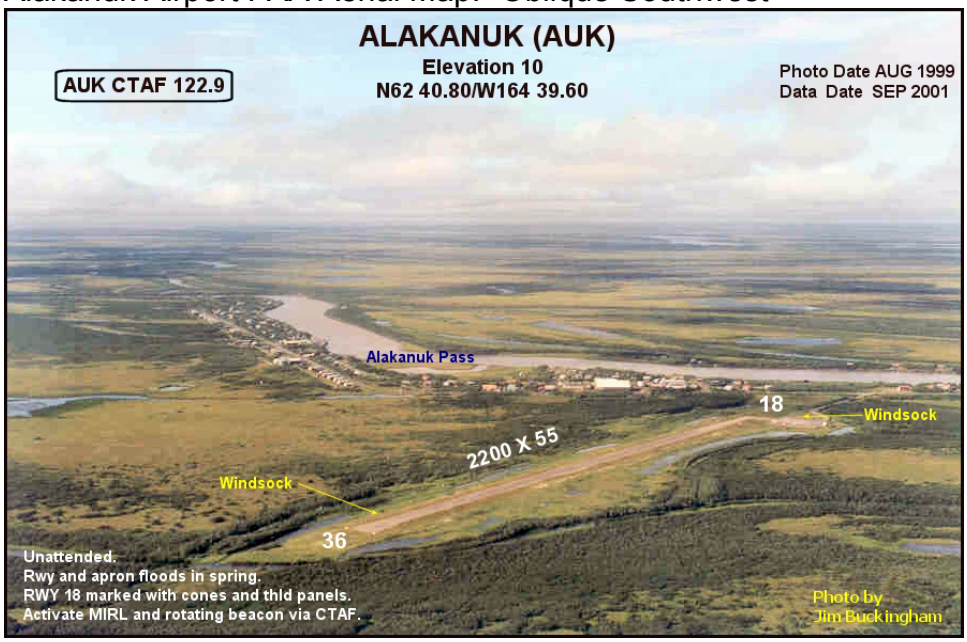
Project No. AIP 3-02-0435-0101/53872 & STP-0001(210)/54297		Engineers Estimate				Southwest Alaska Contractors, Inc.		QAP		LSH Constructors, JV	
No.	Item	Unit	Unit Price	Approx. Qty	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Schedule C-Proj. 54297, Airport Access Rd.										
D-701a(1)	Corrugated PE Pipe 1050 mm w/ End Section	m	$250.00	170	$42,500.00	$400.00	$68,000.00	$400.00	$68,000.00	$250.00	$42,500.00
D-701a(2)	Corrugated PE Pipe, 900 mm w/ End Sections	m	$250.00	120	$30,000.00	$350.00	$42,000.00	$300.00	$36,000.00	$185.00	$22,200.00
G-135a	Construction Surveying by the Contractor	LS	$25,250.00	All Req'd	$25,250.00	LS	$30,000.00	LS	$22,000.00	LS	$51,000.00
G-135b	Three Person Survey Party	hour	$250.00	6	$1,500.00	$200.00	$1,200.00	$200.00	$1,200.00	$325.00	$1,950.00
G-135c	Monuments by the Contractor	Ea	$500.00	12	$6,000.00	$200.00	$2,400.00	$300.00	$3,600.00	$400.00	$4,800.00
P-151b	Clearing	LS	$9,500.00	All Req'd	$9,500.00	LS	$90,000.00	LS	$100,000.00	LS	$20,000.00
P-152h	Borrow Embankment (Type I)	m3	$9.00	37,500	$337,500.00	$10.00	$375,000.00	$8.00	$300,000.00	$7.00	$262,500.00
P-152j	Borrow Embankment (Type 2)	m3	$60.00	4,000	$240,000.00	$65.00	$260,000.00	$80.00	$320,000.00	$7.00	$28,000.00
P-180a	Riprap, Class I	m3	$75.00	800	$60,000.00	$150.00	$120,000.00	$100.00	$80,000.00	$250.00	$200,000.00
P-208b	Aggregate Surface Course	m3	$97.00	2750	$266,750.00	$95.00	$261,250.00	$80.00	$220,000.00	$115.00	$316,250.00
P-670a	Standard Signs	m2	$200.00	4.34	$868.00	$800.00	$3,472.00	$1,000.00	$4,340.00	$1,000.00	$4,340.00
P-681b	Geotextile, Reinforcement	m2	$2.50	43,460	$108,650.00	$2.00	$86,920.00	$1.00	$43,460.00	$2.40	$104,304.00
P-684	Geotextile, Floating Cutain, Sediment Control	m	$100.00	150	$15,000.00	$40.00	$6,000.00	$150.00	$22,500.00	$385.00	$57,750.00
T-901b	Seeding	kg	$120.00	150	$18,000.00	$78.00	$11,700.00	$180.00	$27,000.00	$145.00	$21,750.00
T-905a	Topsoiling	m2	$1.00	27300	$27,300.00	$2.70	$73,710.00	$1.00	$27,300.00	$5.00	$136,500.00
T-908a	Mulching	m2	$2.00	27300	$54,600.00	$1.15	$31,395.00	$1.00	$27,300.00	$1.50	$40,950.00
	Schedule C SubTotal				$1,243,418.00		$1,463,047.00		$1,302,700.00		$1,314,794.00
	Schedule A SubTotal				$751,155.00		$1,098,371.00		$1,160,547.00		$838,866.50
	Schedule B SubTotal				$3,898,172.00		$3,620,963.00		$4,101,640.00		$4,600,593.00
	Schedule C SubTotal				$1,243,418.00		$1,463,047.00		$1,302,700.00		$1,314,794.00
	Total Basic Bid				$5,892,745.00		$6,182,381.00		$6,564,887.00		$6,754,253.50

Appendix E: FAA Aerial Airport Maps

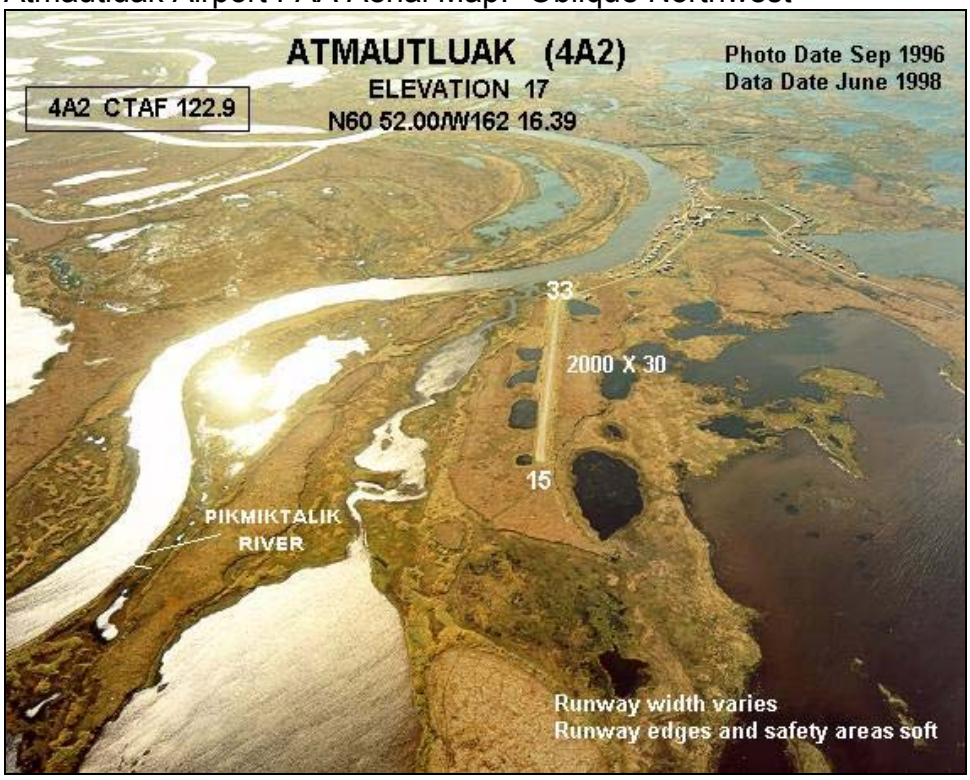
Alakanuk Airport FAA Aerial Map: “Oblique South”



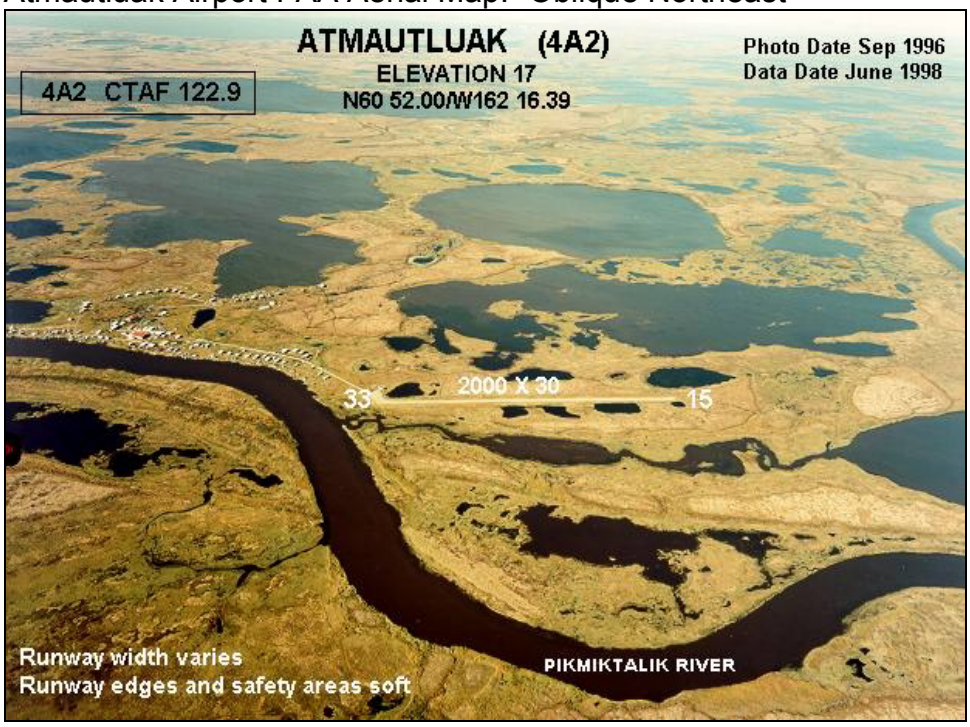
Alakanuk Airport FAA Aerial Map: “Oblique Southwest”



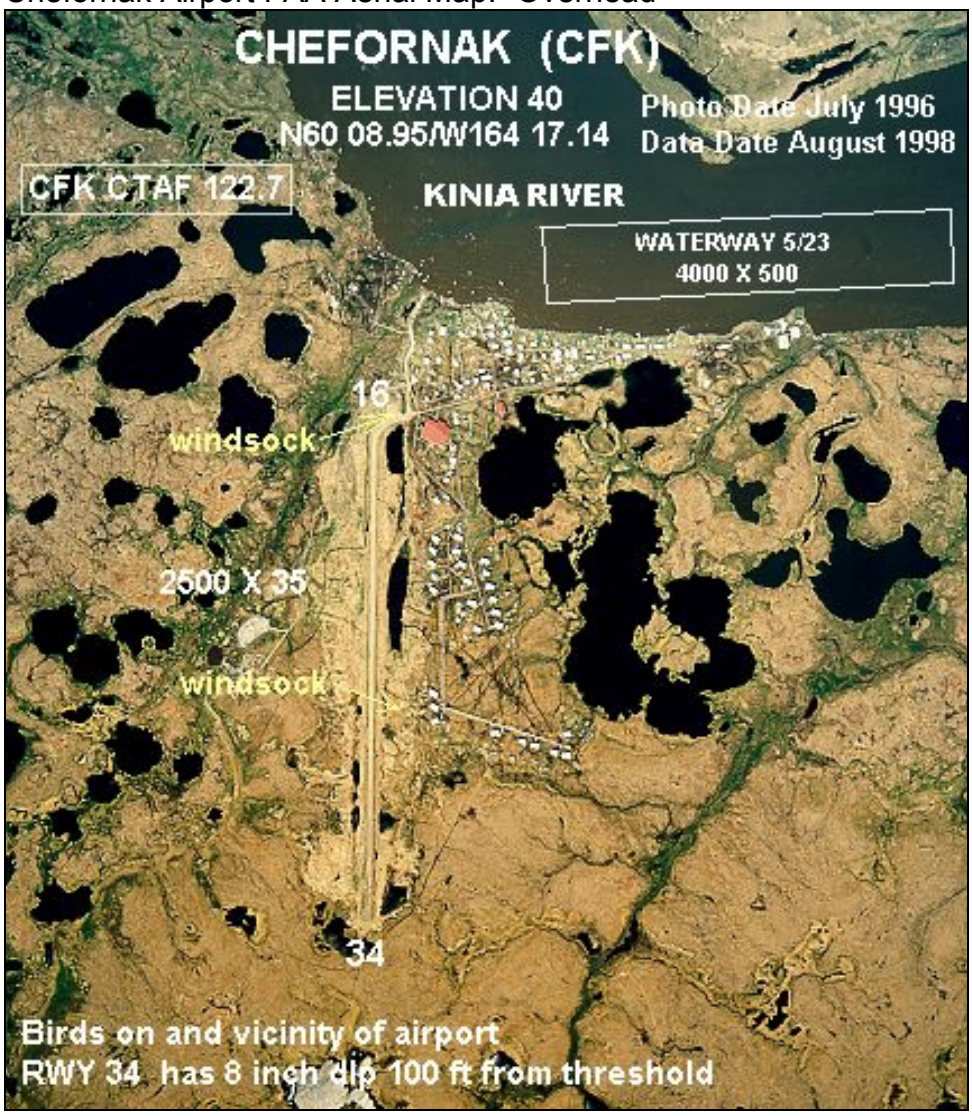
Atmautluak Airport FAA Aerial Map: “Oblique Northwest”



Atmautluak Airport FAA Aerial Map: “Oblique Northeast”

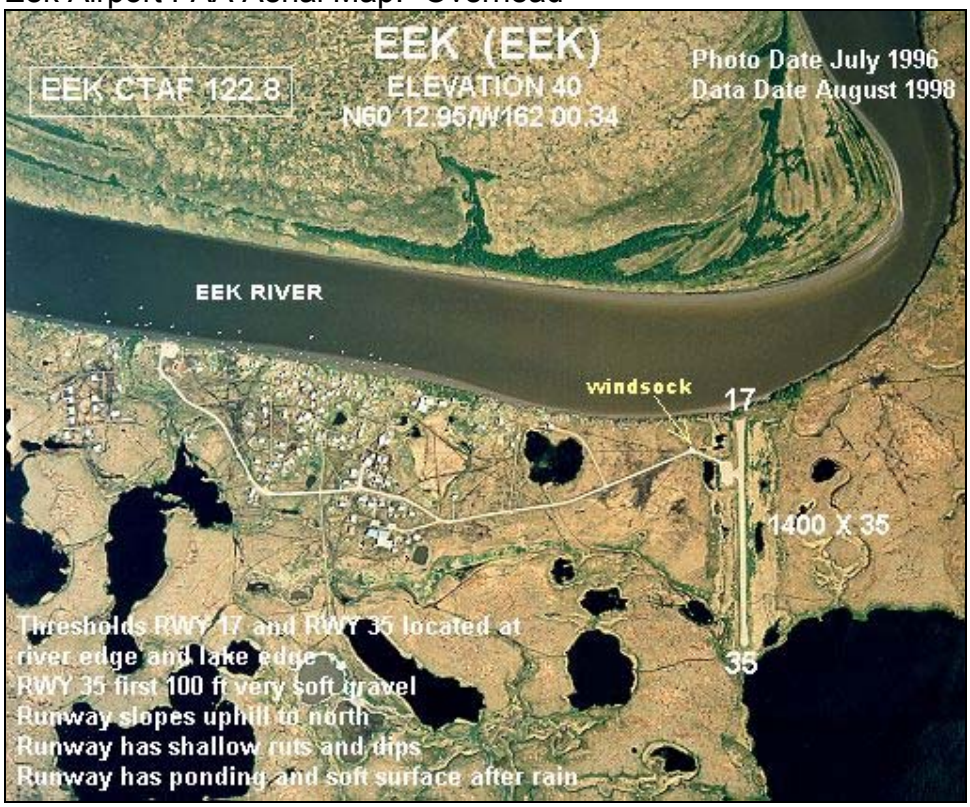


Chefornak Airport FAA Aerial Map: “Overhead”

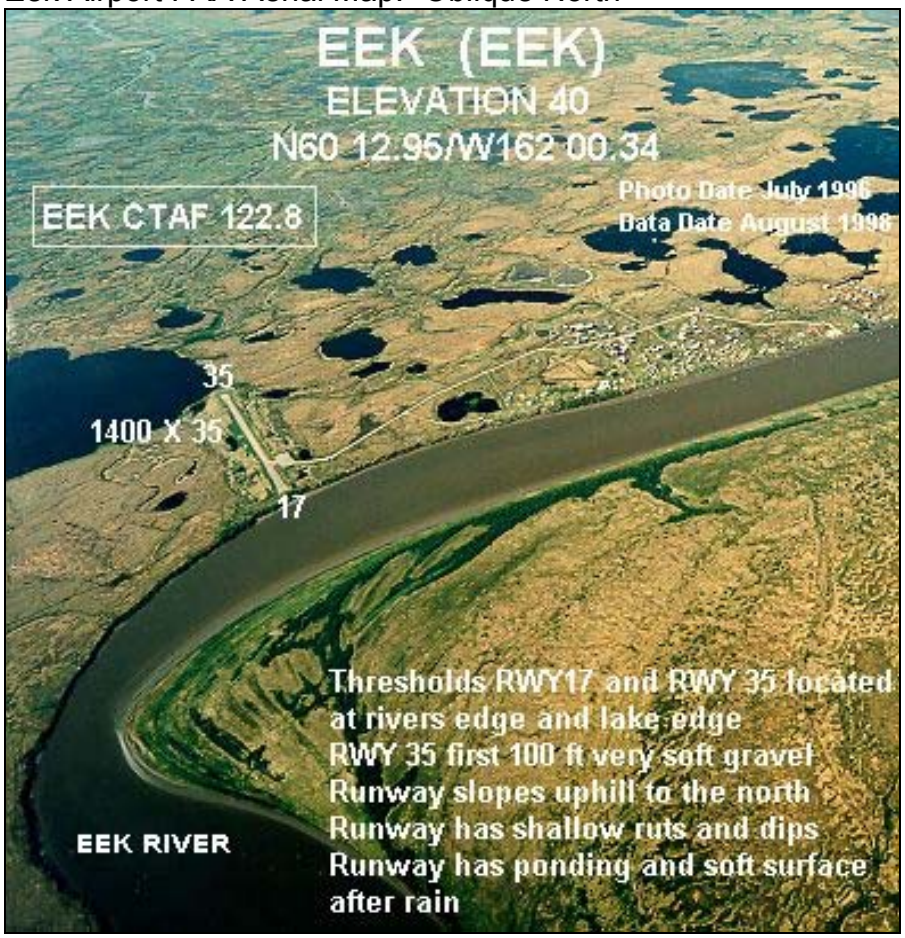


Chevak Airport FAA Aerial Map: No FAA aerials available as of Dec. 15, 2003

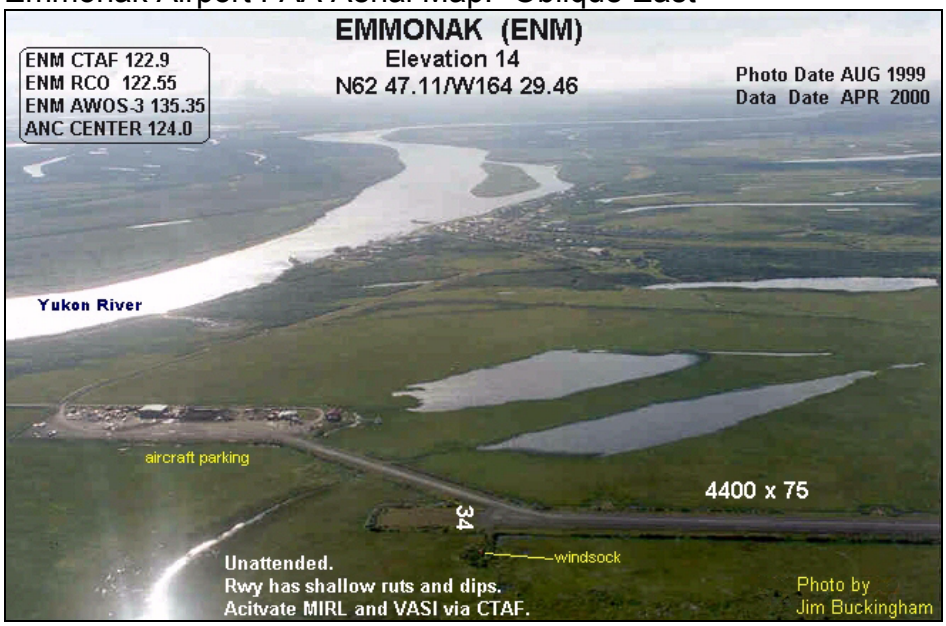
Eek Airport FAA Aerial Map: “Overhead”



Eek Airport FAA Aerial Map: “Oblique North”

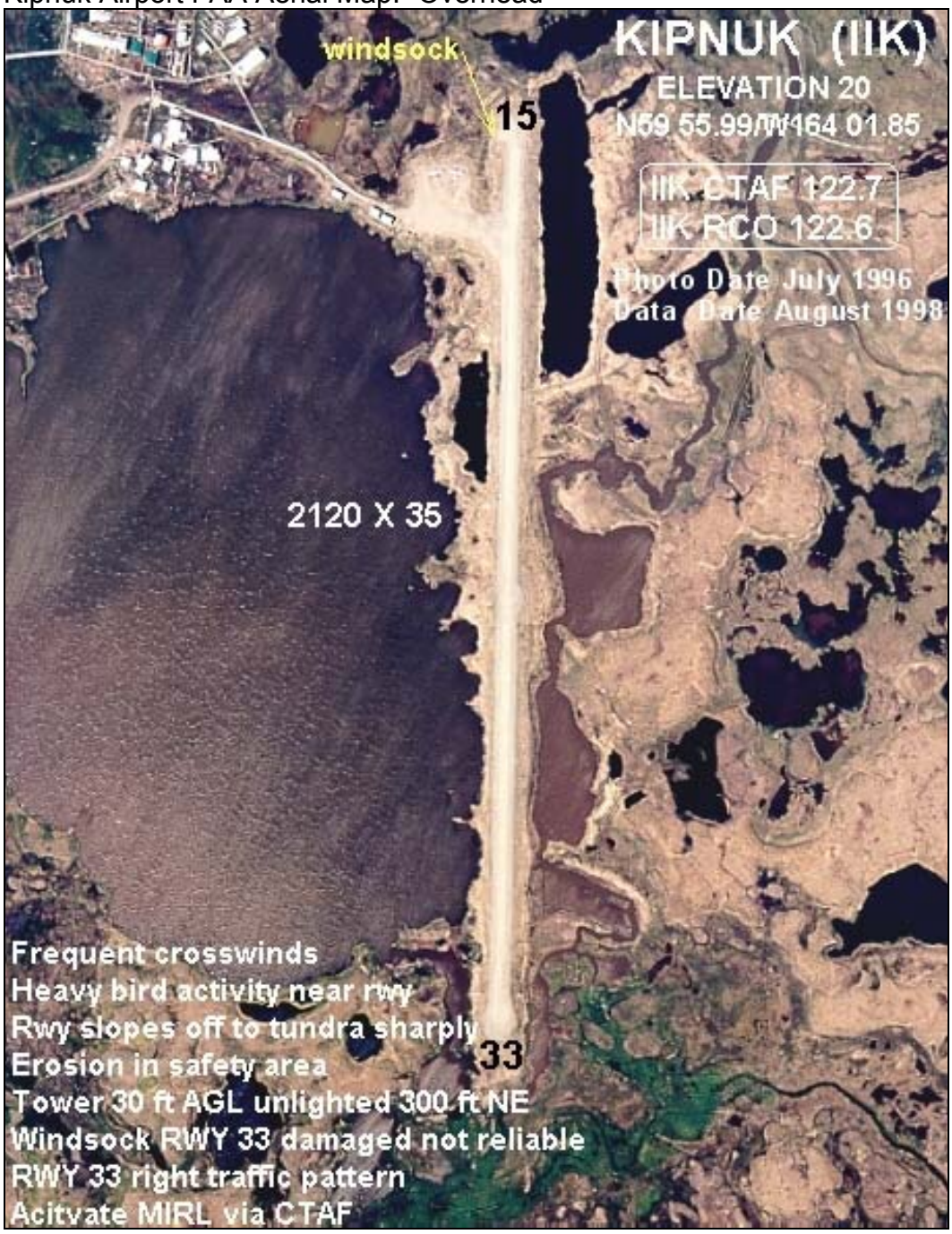


Emmonak Airport FAA Aerial Map: “Oblique East”

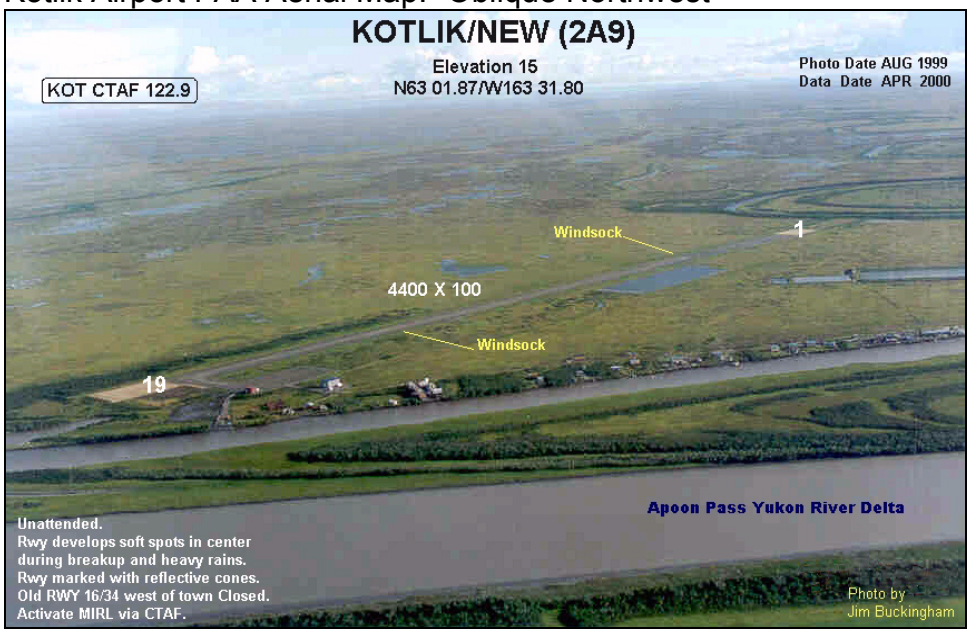


Emmonak Airport FAA Aerial Map: “Airport Commercial Lease/Parking”

Kipnuk Airport FAA Aerial Map: “Overhead

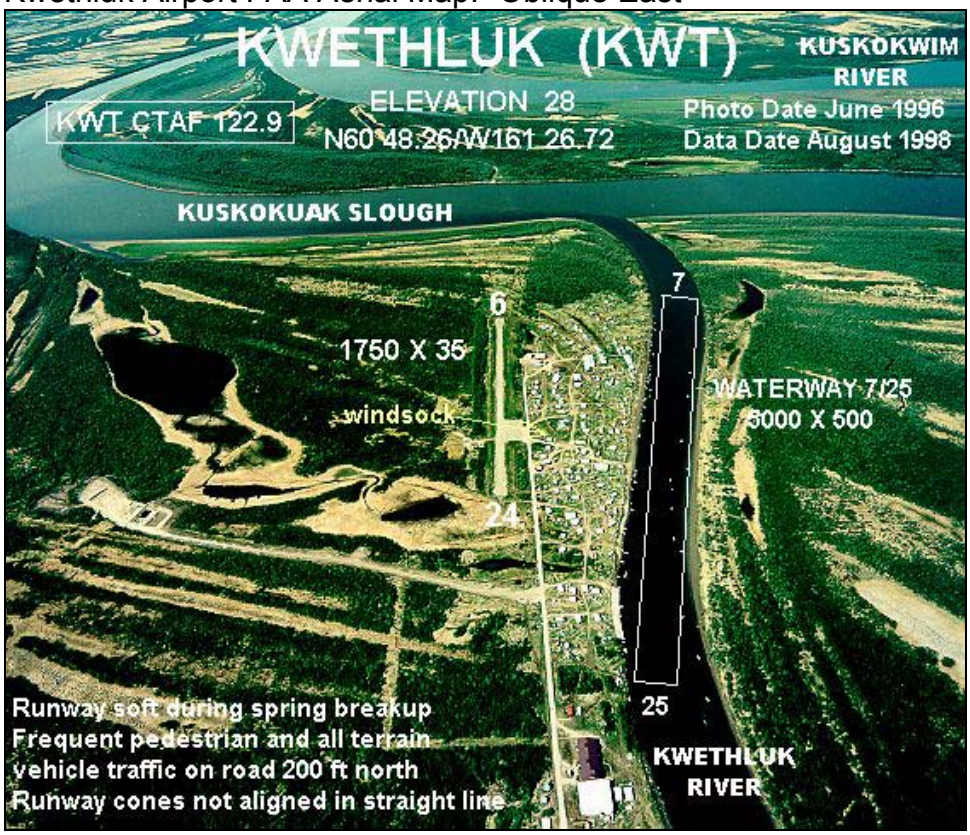


Kotlik Airport FAA Aerial Map: “Oblique Northwest”

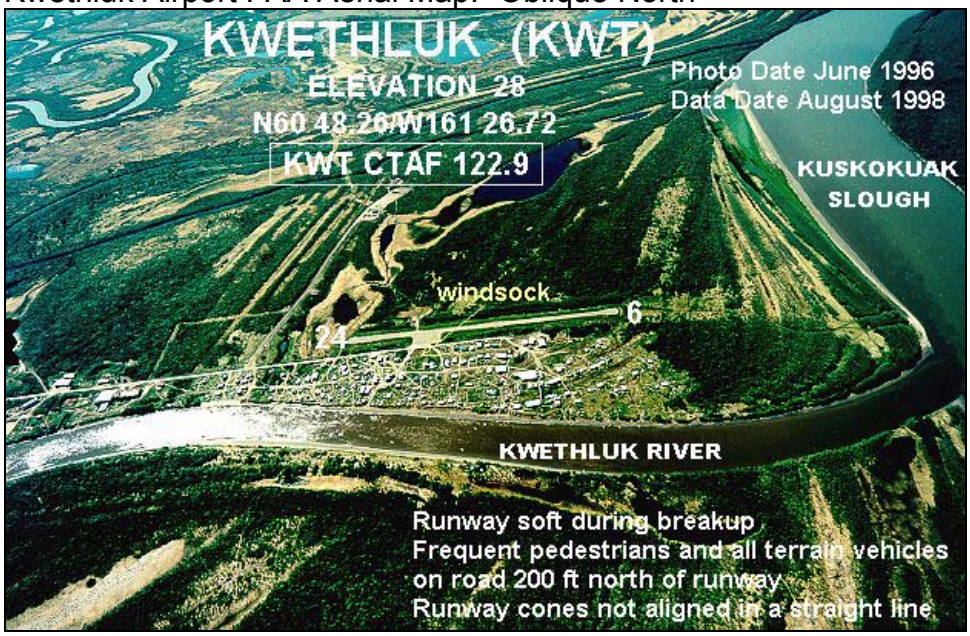


Kotlik Airport FAA Aerial Map: “Oblique North”

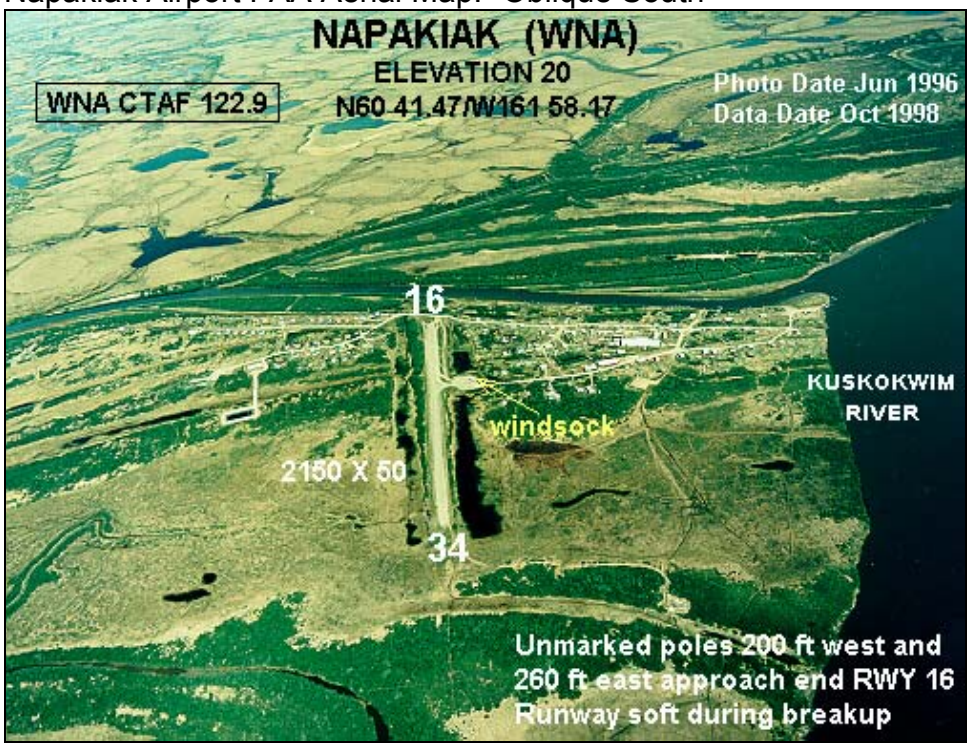
Kwethluk Airport FAA Aerial Map: “Oblique East”



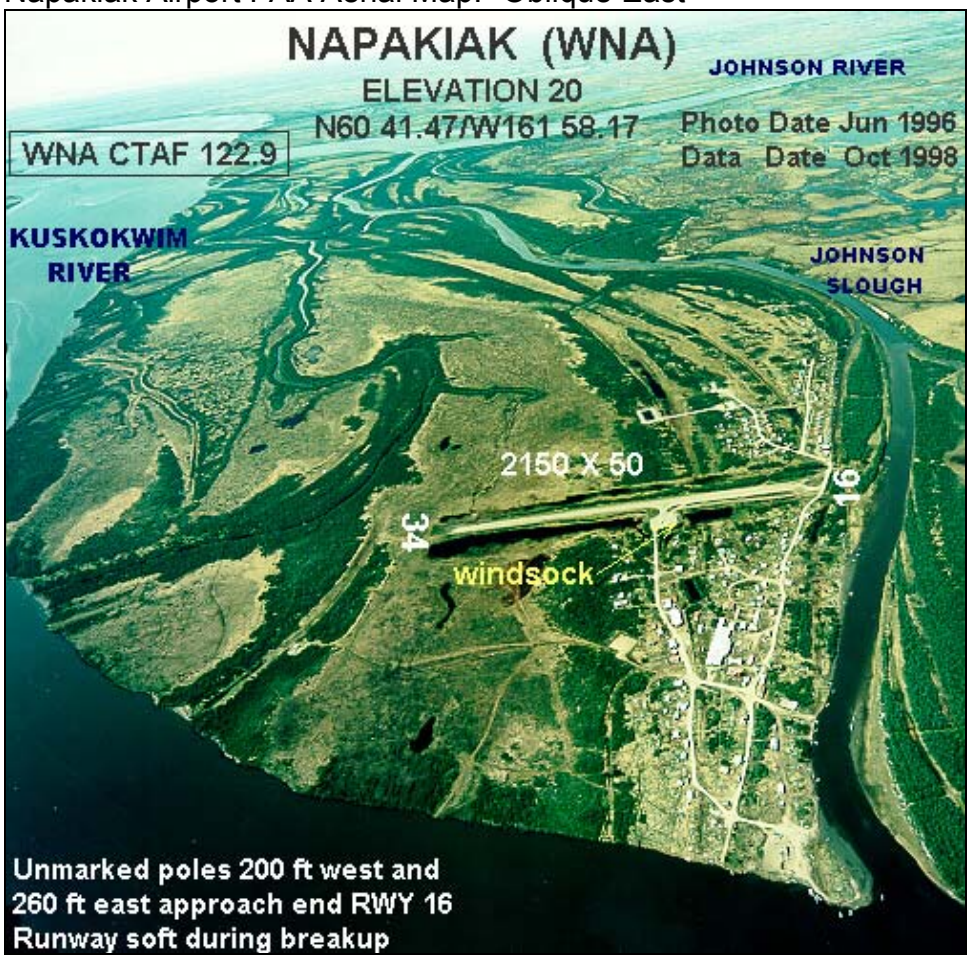
Kwethluk Airport FAA Aerial Map: “Oblique North”



Napakiak Airport FAA Aerial Map: “Oblique South”

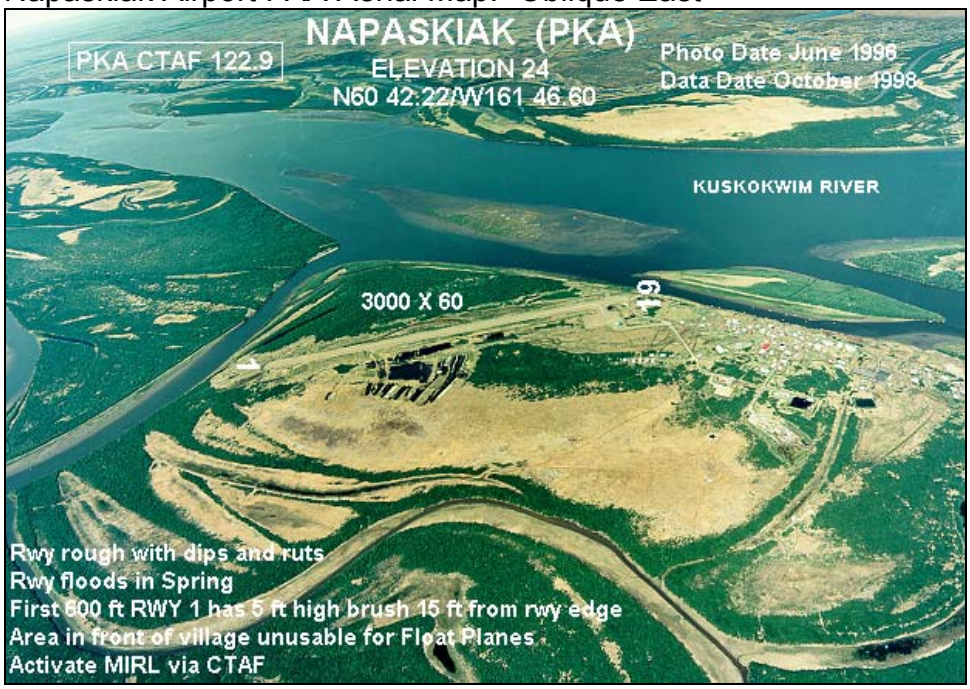


Napakiak Airport FAA Aerial Map: “Oblique East”



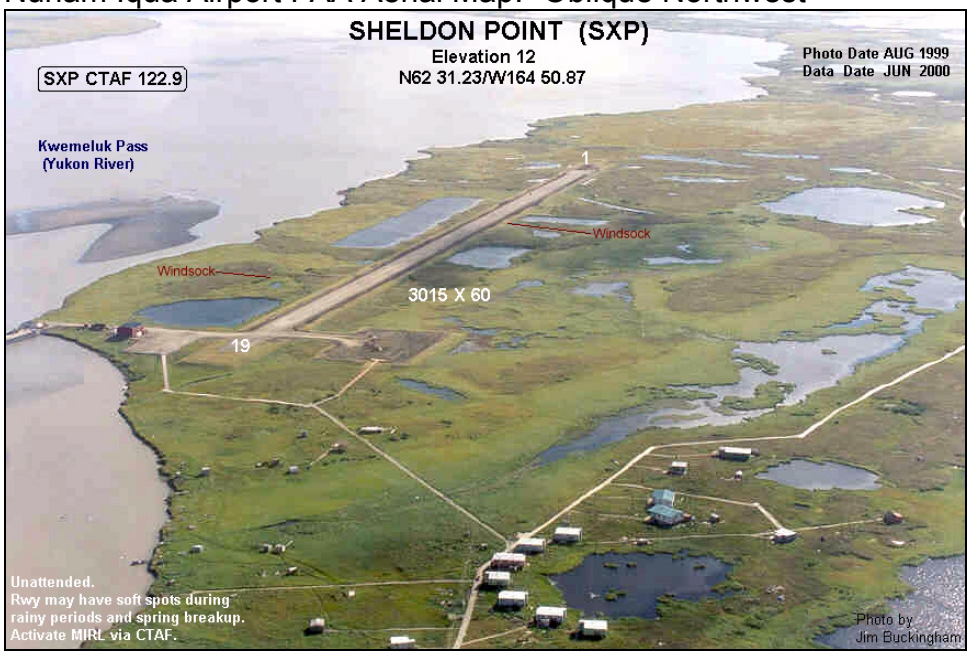
Napaskiak Airport FAA Aerial Map: “Oblique South”

Napaskiak Airport FAA Aerial Map: “Oblique East”

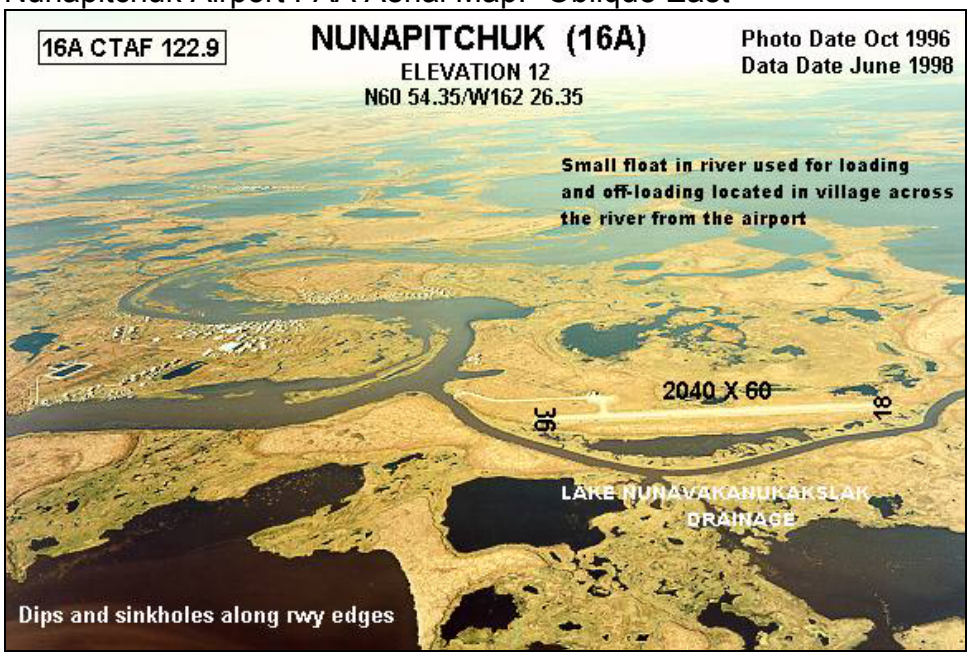


Nunam Iqua (formerly known as Sheldon Point) Airport FAA Aerial Map: “Oblique South”

Nunam Iqua Airport FAA Aerial Map: “Oblique Northwest”



Nunapitchuk Airport FAA Aerial Map: “Oblique East”



Nunapitchuk Airport FAA Aerial Map: “Overhead”

Tuntutuliak Airport FAA Old Aerial Map: “Oblique South”

Tuntutuliak’s new airstrip during development stage. At lower center left (red tank barely visible) is the former location of the Qinarmiut Corp. bulk fuel tank farm, which was located south of the community.
Photo by GeoEngineers, Inc.

APPENDIX E

FIELD RECONNAISSANCE NOTES
YUKON-KUSKOKWIM DELTA
JUNE 10 AND 11, 2003

Chefornak

Located about 100 miles WSW of Bethel; Field borings made in 1998 & 1999 for proposed runways; permafrost present in all but one boring, with soils being silts with fractured basalt rock: – Circled the recently constructed airstrip and village (Photo 1) in *fly-over only*.

- Access road (Photo 2) and airstrip constructed of weathered basalt and silt borrow; two hills in the area have been mined for basalt gravels. Frost shattered rock (Felsenmeer) visible from the air
- New airstrip has some ponded water on surface and is closed to use (Photo 3)
- Airstrip and nearby borrow site shown in Photo 4

Photo 1. Chefornak from air

Photo 2. Chefornak access road

Photo 3. Chefornak airstrip - new basaltic fill

Photo 4. Chefornak airstrip and borrow site

Kipnuk

Located 18 miles SSE of Chefornak; This site is one of very discontinuous permafrost with frequent taliks; probably due to saltwater intrusion and periodic tidal flooding.

- New airstrip is in its second summer of consolidation since the start of construction and intersects the old airstrip at a slight angle (Photo 5).
- The silt fill was placed during winter of 2001-02
- Significant irregular surface settlements were apparent, presumed due to permafrost thaw (Photo 6)
- Some gullying and slumping occurred from erosion of slopes from runoff and wave action along tidal channel (Photo 7)
- A buried 24" plastic culvert has recently failed in several places apparently due to failures of bands (Photo 8) and inflow of silt backfill creating large sinkholes (Photo 9). This installation was apparently installed to carry a meandering tidal channel beneath one side of the runway,
- Runway surface is damp and cracked from settlements and shrinkage of the silt fill, which was placed in the frozen state.
- Vegetation (mostly grass) is growing out of cracks, but the revegetation did not take well
- Soft surface conditions were noted at shoulders

Photo 5. Kipnuk and airstrips

Photo 6. Kipnuk settlement pit

Photo 7. Kipnuk new and old airstrips

Photo 8. Kipnuk slope failures

Photo 9. Kipnuk culvert pipe failures at joints

Tuntutuliak

Located 42 miles downriver (SW) of Bethel; Soils investigations reported in 1997 for new airstrip. Permafrost was prevalent and led to predictions of large settlements over time.- *Fly-over only*: The village is shown in Photo 10

- Well vegetated sideslopes and runway surface were visible (Photo 11)
- Fill placed wet from adjacent borrow site (Photo 12)
- Not in use yet

Photo 10. Tuntutuliak village

Photo 11. Tuntutuliak airstrip

Photo 12. Tuntutuliak borrow pit

Eek

Located 42 miles SSW of Bethel on Eek River; Soils and materials investigations done in 1997 and initial contract given to Osbourne Construction; embankment work done in winter of 1998-99; (Photo 13) shows airstrip on approach; Construction in progress to place surface gravels.

- Borrow silts stockpiled in 1998 were still primarily frozen on June 10 of this year; with 1 foot of thaw from seasonal re-freezing over past winter causing some delays in use of stockpiled silt for placement in embankment repair areas.
- Contractor personnel Larry Maxwell and Ron Larson assisted in visit
- Repair of side slope erosion gullies was in progress. Numerous small gullies had formed and required filling. Photo 14 shows the erosion gullies from air. (Photos 15 and 16 show unrepaired and repaired gullies)
- Placement of surface gravels is to be done under the current contract. Barge unloading is by conveyor, with importing of Bethel sand leveling course in progress (Photo 17)
- One area of fairly dry silt was sampled
- Some water filled ruts from vehicles were hindering drainage of runway. Equipment could only operate on parts of the runway due to the soft conditions.
- An excellent vegetation mat has developed on the runway since 1997 placement and seeding, with willow, horsetail and grass
- Plan to top with sand leveling course, geotextile and grid; followed by crushed gravel surfacing to 1-inch in max. diameter.
- Project used Enkagrid (Max 30), by Colbond Geosynthetics.

Photo 13. Eek and new airstrip

Photo 14. Eek erosion from air

Photo 15. Eek - old gully

Photo 16. Eek side erosion

Photo 17. Eek barge unloading system

Napaskiak

Located 10 miles downriver of Bethel on the south bank; Investigated in 1991 Runway extension fill placed in 1992 and surfacing in 1993. – The airstrip was viewed by Fly-over (no photos)

Kwethluk

Located 8 miles due East of Bethel. Old airstrip parallels the town roads (See Photo 18 of village and Photo 19 of new airstrip). Construction started in 2002 and is due for completion in 2003. The project required sub-excavation of peat prior to fill placement. (Photo 20)

- Silt and sand fill on access road was too soft and pumping for vehicle travel to the airstrip
- Gullying occurs along the fine sand fill side-slopes (Photo 21)
- Geofabrics were installed at the embankment base and in the slope areas at 2 feet and 4 feet below grade. Additional "Enkagrid Max 30" grid rolls were stockpiled at the barge landing (Photo 22)
- Airstrip has some wet spots too soft for wheeled vehicles
- The Vibro/roller (Photo 23) was getting stuck at times, but was able to function in most areas.
- The surface organics were stripped and the fill placed in winter.

Photo 18. Kwethluk village

Photo 19. Kwethluk new airstrip

Photo 20. Kwethluk excavated peat

Photo 21. Kwethluk erosion

Photo 22. Kwethluk grid closeup

Photo 23. Kwethluk roller on silt fill

Chevak

Photos of the village (Photo 24), located about 15 miles inland of Hooper Bay; and of the Chevak airstrip (Photo 25) were taken prior to landing. City manager Wayne Hill gave us the guided tour of the airstrip and the area. Initial placement of the sand embankment fill was done in 1989-90. The airport site is on an elevated ridge some 70' above mean sea level, described as a low ancient beach ridge. Due to the elevation, winds are a problem. Permafrost was found in all prior test borings, and fill settlements have occurred over time.

- The fine silty sand fill has been very susceptible to wind erosion. The loss of several feet of vertical fill height has occurred at the east end of airstrip due to erosion and settlement. (Photos 26 and 27) Erosion moves the sand to the downwind side and out onto the adjacent tundra. Some unknown quantity of material has totally "gone with the wind".
- Three seedings were performed over the past 12 years, but little vegetation has taken root due to the loose condition of the sands (Photo 26). Seeding has been even partially successful only on the upwind side at the South end. Burlap with seed was used on some slopes; a partial success.
- Aggregate for the surface placement was stockpiled along the riverbank in preparation for the final surfacing of the runway.
- The area roads were surfaced with a thin layer of gravel over a geotextile. Much of this fabric is now exposed and lying in tatters, indicating the problem of too-shallow placement of separation fabric layers (Photo 28).
- Materials are brought in by barge to the town landing (Photo 29) with adequate water depths available.

Photo 24. Chevak from air

Photo 25. Chevak airstrip from air

Photo 26. Chevak wind erosion

Photo 27. Chevak end markings and sand

Photo 28. Chevak road geotextile

Photo 29. Chevak barge landing

Sheldon Point (Nunam Iqua)

Located on south channel bank near Yukon River mouth.

- The 3,200-foot airstrip was finished 3-4 years ago and appeared to be in very good condition. Connection to the village is by boardwalk.
- The airstrip has a good 18" thick crushed gravel surface (Photo 30).
- Minor depressions were noted, and well vegetated slopes.
- Minor cracking was noted along the tops of the shoulders along with some shoulder area subsidence.
- This airstrip was insulated with several inches of polystyrene foam insulation due to the presence of permafrost and excessive ice contents in borehole samples, with typical visual ice estimates of 20-40%.

Photo 30. Sheldon Point shoulder view

Alakanuk

Located on the North bank of the Yukon; - Fly-over only; Photos of the new airstrip (Photo 31) and the village (Photo 32) were taken

- A slope failure was observed along the west side of the runway (Photo 33)
- Borrow pits adjacent to the end of the runway were observed (Photo 34)

Photo 31. Alakanuk airstrip overview

Photo 32. Alakanuk by air

Photo 33. Alakanuk drainage channel

Photo 34. Alakanuk new airstrip and pit

Emmonak

Located 8 miles upriver of Alakanuk; (Photos 35-Emmonak Village; 36-Barge landing; and 37-airstrip were taken on approach.). Emmonak soils reports indicated permafrost absent in low-lying slough areas but present elsewhere, with visual ice contents up to 50%. Permafrost was encountered in 14 of 29 borings, and generally present from Station 46 to 85

- Minor areas of stepped shoulders due to cracking and settlements; revegetation took well
- No permafrost, well crowned, hard and tightly packed
- Crushed surface approximately 1-foot thick
- Some holes at shoulder; willow revegetation
- Longitudinal cracks at shoulders and taxiway

Photo 35. Emmonak by air

Photo 36. Emmonak barge landing

Photo 37. Emmonak airstrip by air

Nunapitchuk

Constructed 1984-1986, Village located 25 miles WNW of Bethel and across river from airstrip; - (Photo 39) shows the airfield and distant village, and the access road to the river bank.

- Airport embankment constructed with 4" (or 6"??) insulation board, and with local sand fill
- Access road settlements apparent in spots (Photo 39)
- Rounded gravel surfacing imported from "Birch tree crossing" located upriver near Aniak
- Sideslopes have some open longitudinal stress cracks but are well vegetated and appear stable (Photo 40)
- Shoulders have minor cracking and settlement dips, but the landing surface appears level and stable and generally in very good condition (Photo 41)

Photo 38. Nunapitchuk airstrip and road

Photo 39. Nunapitchuk road settlement

Photo 40. Nunapitchuk slope cracks

Photo 41. Nunapitchuk halfway view

Kasigluk

Located five miles NW of Nunapitchuk - Fly-over and photos only (Photo 42 & 43 show airstrip and adjacent borrow pits from both ends) Photo 44 shows the village and airstrip.

- Airstrip and road appears to be made of sand with gravel surfacing
- Minor slope erosion gullying noted, with generally good condition of airstrip
- Poorly vegetated slopes visible, but good vegetation on top of embankment

Photo 42. Kasigluk airstrip and pits

Photo 43. Kasigluk airstrip

Photo 44. Kasigluk from air

Atmautluak

Located 6 miles ENE of Nunapitchuk (Photo 45); investigated in 1997 for runway extension and apron; Permafrost present except in sloughs and ponds- Fly-over only.

- Extension and realignment of existing airstrip is underway
- Large stockpiles and new fill in runway extension area are visible (Photo 46)

Photo 45. Atmautluak town and airstrip

Photo 46. Atmautluak airstrip and stockpiles

APPENDIX F

Mean (1996 - 2002) wind speed (mph)

Courtesy of the Western Regional Climate Center

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
AMBLER AIRPORT	6.9	8.5	8.2	8.0	6.6	5.4	5.1	5.5	6.3	6.7	6.9	5.9	6.6
ANAKTUVUK PASS	9.7	9.1	8.4	8.6	8.6	8.3	7.8	8.7	7.6	8.0	8.7	9.0	8.5
ANCHORAGE	7.3	5.7	7.4	8.1	9.1	8.3	7.8	7.0	7.4	7.0	5.6	6.3	7.2
ANIAK	5.5	6.4	6.5	6.6	5.8	4.5	4.1	4.4	4.7	5.6	5.3	4.1	5.2
ANNETTE	9.0	8.9	8.8	7.5	7.7	6.9	6.4	7.2	7.3	8.4	8.8	9.5	8.1
ANVIK	7.5	6.9	6.9	5.9	5.0	3.8	3.9	4.7	4.6	5.1	5.6	5.7	5.3
ARCTIC VILLAGE	2.4	2.5	4.2	5.0	6.1	6.7	6.7	6.9	4.9	4.0	2.9	3.1	4.5
BARROW	12.5	13.1	12.7	12.9	12.0	11.4	12.7	13.3	12.2	13.4	14.1	13.0	12.8
BARTER ISLAND	10.6	10.0	9.3	9.5	10.6	8.8	10.1	11.1	11.7	12.0	11.9	11.9	10.7
BETHEL	14.0	12.1	12.5	12.6	11.1	9.5	9.5	11.0	10.4	11.1	11.5	11.4	11.4
BETTLES	4.5	5.2	6.3	6.9	6.7	5.7	5.7	5.8	5.5	5.5	5.1	4.6	5.6
BIRCHWOOD	3.3	2.4	3.4	3.5	4.2	3.3	2.5	2.3	2.5	3.2	2.3	3.1	3.0
BUCKLAND	8.2	10.2	7.1	9.4	8.4	8.6	7.5	7.8	7.0	4.8	5.2	6.4	7.5
CANTWELL	7.9	6.9	8.3	8.2	8.7	8.6	7.8	7.4	7.2	8.4	6.3	8.2	7.8
CAPE LISBURNE	13.5	12.8	11.4	10.9	11.3	11.2	13.3	14.0	13.2	15.9	12.6	12.5	12.8
CAPE NEWENHAM	15.9	14.5	17.7	14.7	12.3	8.0	9.1	13.6	13.9	14.9	17.4	16.0	13.9
CAPE ROMANZOF	18.5	17.7	17.5	15.5	12.9	11.7	10.0	13.4	13.7	15.0	17.6	17.2	15.0
CHIGNIK	11.3	9.4	11.4	10.7	9.3	7.5	7.0	8.7	10.3	10.8	10.6	13.1	10.0
COLD BAY	16.9	17.3	17.7	17.5	17.0	14.7	14.8	14.8	16.1	16.0	17.6	16.9	16.4
CORDOVA	5.3	4.9	5.0	5.4	4.7	3.6	2.9	3.3	4.4	4.7	4.1	4.9	4.4
DEADHORSE	12.0	11.4	12.2	12.5	12.8	11.9	12.1	11.7	10.6	11.3	11.1	11.5	11.7
DEERING	12.7	14.2	10.3	11.0	9.6	9.5	10.2	11.2	10.8	9.8	9.8	11.1	10.8
DELTA JUNCTION	13.0	11.8	10.6	9.9	8.7	7.8	6.6	6.8	8.5	8.8	12.8	11.0	9.7
DEVILS MTN LODGE	4.7	4.1	5.0	5.8	7.3	6.5	5.8	5.0	4.4	3.8	3.0	3.6	4.8
DILLINGHAM	10.0	9.3	10.2	9.1	7.9	7.3	7.2	7.5	7.9	8.6	9.5	8.9	8.6
EAGLE	4.6	3.8	2.7	4.2	4.5	3.7	2.9	2.9	3.7	2.8	3.5	3.2	3.5
EGEGIK	12.9	13.8	13.1	13.4	11.5	11.1	11.5	11.2	11.6	11.7	11.4	12.6	12.1
EIELSON AFB	5.0	4.5	5.9	7.3	7.9	7.0	6.3	5.9	6.0	5.4	4.7	4.5	5.8
ELMENDORF AFB	8.1	7.2	8.4	7.9	8.1	7.3	6.9	6.6	7.0	7.6	6.8	7.8	7.5
EMMONAK	12.3	12.9	12.0	12.0	10.4	9.1	9.2	10.3	10.0	9.6	11.5	10.1	10.7
EUREKA-SKELTON	3.5	3.4	4.5	4.9	5.9	7.0	6.4	5.4	4.5	2.9	2.1	2.1	4.4
FAIRBANKS	1.8	2.1	4.2	5.7	7.0	5.7	5.2	5.3	4.5	3.9	2.3	1.3	4.0
FT WAINWRIGHT	5.3	5.7	7.5	9.0	9.6	8.6	8.2	8.0	7.6	6.6	5.1	5.3	7.5
GALENA	4.7	4.5	5.0	6.5	6.2	4.9	5.5	6.4	5.4	5.0	4.2	3.5	5.1
GAMBELL	25.2	24.7	21.6	17.7	14.7	13.4	13.8	16.3	16.8	19.9	25.2	21.9	19.1
GOLOVIN	13.2	15.6	13.3	11.9	8.2	8.1	10.0	11.7	10.9	10.3	11.0	13.0	11.4
GULKANA	3.6	3.4	5.6	7.7	8.1	7.2	7.2	7.2	6.7	4.4	2.1	2.4	5.3
GUSTAVUS	5.2	4.7	6.1	5.6	5.5	4.2	3.8	4.0	4.9	6.2	4.6	4.9	5.0

Mean (1996 - 2002) wind speed (mph)

Courtesy of the Western Regional Climate Center

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
HAINES	12.5	11.8	11.1	10.1	9.3	7.7	7.6	7.8	9.0	10.5	10.8	12.1	10.0
HEALY RIVER	5.8	6.6	6.5	8.3	6.7	5.5	5.7	5.4	6.0	4.5	4.6	4.2	5.7
HOMER	6.9	6.2	6.9	7.5	7.6	7.1	6.4	6.2	6.7	6.6	6.3	7.3	6.8
HOONAH	7.2	6.5	6.8	5.4	5.8	4.9	4.3	4.5	4.8	5.3	5.9	6.0	5.6
HOOPER BAY	17.3	18.3	16.3	14.3	13.1	12.4	12.1	14.7	14.2	13.4	17.1	15.9	14.9
HUSLIA	4.7	5.7	5.9	5.9	5.4	4.3	4.1	4.4	4.5	4.6	5.3	4.4	4.9
HYDABURG	8.6	8.2	7.7	7.1	7.5	6.1	6.0	6.9	7.3	8.6	8.4	9.0	7.6
ILIAMNA	12.0	11.4	11.0	10.4	9.6	9.0	9.0	9.2	10.2	11.1	11.8	11.8	10.6
JUNEAU	8.7	7.2	8.5	8.1	8.2	6.7	7.0	7.2	8.2	8.6	7.5	8.4	7.9
KAKE AIRPORT	7.6	6.7	7.4	6.3	6.1	4.9	4.8	5.2	6.3	7.8	7.3	7.9	6.5
KALTAG	5.0	5.3	7.0	6.3	6.0	5.3	5.0	5.2	4.0	5.0	5.3	5.1	5.3
KENAI	7.9	8.1	9.0	8.4	8.9	8.5	8.3	7.0	7.7	7.8	7.3	7.4	8.0
KETCHIKAN AP	8.0	8.2	7.5	7.7	8.2	7.7	7.5	7.9	7.9	8.1	8.1	8.5	7.9
KING SALMON	10.0	9.3	10.1	10.7	9.7	8.6	8.6	8.9	8.9	8.9	8.9	8.4	9.2
KIVALINA	12.9	14.4	13.4	12.5	10.6	9.9	10.6	14.5	12.6	13.0	12.9	13.6	12.6
KLAWOCK	3.8	3.1	3.7	3.5	4.1	3.8	3.4	3.4	3.2	3.6	3.5	3.6	3.6
KODIAK	12.4	11.6	11.9	11.2	10.0	9.1	7.5	7.9	9.7	11.0	11.1	12.7	10.5
KOTZEBUE	11.0	12.7	10.5	12.4	9.5	10.3	11.7	12.8	12.0	12.0	13.3	10.4	11.6
KOYUK	9.8	9.2	10.0	9.6	7.8	7.7	7.9	8.9	7.5	7.1	8.5	8.8	8.5
LAKE HOOD	5.0	3.9	5.3	5.8	6.8	6.4	5.8	5.0	5.5	5.3	4.0	4.4	5.2
MCGRATH	2.8	2.3	4.1	5.7	6.1	4.9	4.3	4.9	4.8	4.3	2.2	1.7	3.9
MCKINLEY PARK	4.7	4.0	5.3	6.0	5.7	4.5	4.3	4.3	4.4	4.7	3.6	3.4	4.5
MEKORYUK	16.3	16.7	15.2	15.7	12.5	10.4	10.1	14.0	13.9	14.8	17.2	15.3	14.4
MERRILL FIELD	3.6	2.8	4.2	4.7	5.7	5.2	4.7	4.0	4.0	4.1	2.6	2.8	4.0
METLAKATLA	9.4	8.5	8.8	7.4	7.5	6.2	6.0	6.4	6.4	7.9	9.4	9.7	7.8
MIDDLETON ISLAND	18.1	17.0	15.1	14.1	11.8	10.3	9.1	9.4	12.9	15.5	15.7	17.6	13.9
MINCHUMINA	1.8	1.3	2.5	3.2	3.7	2.8	3.0	2.9	2.3	2.2	1.2	1.3	2.3
NENANA	5.0	4.5	6.1	6.1	6.2	4.7	4.1	4.4	4.9	5.0	4.7	4.8	5.0
NOATAK	7.0	8.4	8.2	8.7	7.6	7.3	7.1	8.4	7.6	7.6	7.4	6.5	7.6
NOME	9.8	11.9	9.7	9.9	9.0	8.9	9.7	10.9	9.9	9.0	10.9	9.1	9.9
NORTHWAY	0.9	0.9	3.1	5.1	6.6	5.9	5.4	4.9	4.6	3.1	0.8	1.1	3.4
NUIQSUT	9.4	9.1	9.5	11.3	10.6	10.4	10.8	10.5	8.7	10.1	8.2	7.6	9.6
PALMER	6.8	7.2	8.2	9.3	8.4	7.1	6.2	6.0	6.9	5.8	5.9	6.6	7.0
PETERSBURG	3.4	3.6	4.0	4.2	4.5	3.8	3.0	3.0	3.2	3.9	3.4	4.0	3.7
POINT HOPE	16.4	15.4	14.2	12.5	11.9	12.4	13.3	15.4	16.1	16.4	17.5	16.2	14.9
PORTAGE	12.8	11.3	10.2	9.6	8.0	8.3	8.6	8.1	9.5	10.4	9.5	10.6	9.8
RED DOG	10.4	13.1	10.7	10.8	9.2	8.6	8.6	10.5	9.4	9.8	9.0	9.8	9.9
SAND POINT	13.2	11.4	11.9	11.3	9.7	7.7	7.9	9.2	11.8	13.5	13.1	13.7	11.2

Mean (1996 - 2002) wind speed (mph)

Courtesy of the Western Regional Climate Center

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
SAVOONGA	12.6	12.2	12.0	11.5	10.7	9.4	9.7	12.7	12.4	15.5	19.4	13.9	12.7
SELAWIK	9.0	11.2	9.7	10.6	9.1	9.7	8.6	9.3	8.9	7.8	9.4	8.5	9.3
SELDOVIA	3.7	3.2	3.8	3.6	4.4	4.2	4.6	4.0	3.6	3.6	2.1	4.1	3.7
SEWARD	12.0	10.9	9.4	8.8	8.3	6.7	6.0	7.0	7.5	10.3	9.1	12.6	9.0
SHISHMAREF	13.5	13.5	12.2	12.0	10.1	9.3	12.0	14.3	14.1	14.4	15.8	12.9	12.9
SITKA AP	9.8	8.8	8.5	7.8	7.5	6.3	6.0	6.3	7.1	9.3	9.4	10.2	8.1
SKAGWAY	14.7	11.9	11.8	9.5	10.4	9.6	9.0	8.3	8.4	9.6	10.4	11.7	10.4
SLANA	5.7	4.7	7.2	7.5	8.5	7.5	6.7	6.2	6.0	6.5	4.8	5.9	6.5
SLEETMUTE	2.3	1.8	2.9	3.4	3.8	2.7	2.4	2.5	2.1	2.2	1.5	1.8	2.4
SOLDOTNA	3.1	2.9	3.5	4.2	4.9	4.5	3.7	3.3	3.4	3.3	2.8	2.7	3.5
ST. GEORGE ISLAND	20.8	19.8	18.7	17.6	14.6	13.1	11.7	12.5	15.3	17.4	19.3	18.8	16.7
ST. MARY'S	14.1	15.5	14.1	12.6	10.8	9.2	9.1	10.7	10.3	9.9	13.2	11.5	11.7
ST. PAUL ISLAND	19.0	17.8	16.8	16.2	13.1	12.3	11.5	12.9	14.8	16.0	18.0	17.3	15.4
TALKEETNA	5.6	5.2	5.4	4.4	4.9	4.6	4.1	3.2	3.4	3.8	4.4	4.8	4.4
TANANA	5.3	6.3	7.1	6.9	7.0	5.9	5.8	6.0	5.8	5.8	5.5	4.7	6.0
TIN CITY	25.2	27.0	23.5	19.6	15.0	17.1	14.3	16.1	15.0	15.3	18.0	20.6	18.5
TOGIAK	12.0	12.3	12.5	12.2	11.1	9.4	10.0	10.9	11.1	10.5	12.3	12.2	11.3
UNALAKLEET	13.8	16.3	13.7	11.8	8.9	7.6	8.8	10.4	9.5	10.5	14.8	12.2	11.5
UNALASKA	12.7	12.1	13.0	12.0	10.6	8.7	7.8	8.6	11.3	12.4	13.1	12.8	11.2
UTOPIA CREEK	5.9	6.5	7.9	6.3	6.4	5.6	5.0	5.1	4.9	5.5	6.0	5.5	5.8
VALDEZ	3.0	2.7	4.2	3.3	4.3	4.3	3.4	2.7	2.4	3.4	2.3	3.3	3.3
VALDEZ	7.3	5.3	6.4	5.2	5.9	5.9	4.7	4.2	4.0	6.5	6.0	7.5	5.7
WAINWRIGHT	10.2	11.4	12.2	12.6	11.3	11.0	11.8	12.6	11.0	12.2	11.4	10.0	11.5
WASILLA	6.2	5.7	7.7	6.1	5.2	4.3	3.9	4.0	4.8	5.9	5.6	5.9	5.4
WHITTIER	11.4	9.6	9.3	8.4	7.8	6.9	6.0	7.3	8.2	10.3	8.9	11.1	8.8
WRANGELL	8.7	8.0	8.5	7.1	6.7	5.1	3.8	4.5	5.9	7.9	8.6	9.3	7.0
YAKUTAT	5.9	4.9	5.4	5.3	5.6	4.8	4.8	4.8	5.4	5.9	4.3	5.5	5.2

BETHEL, ALASKA

NORMALS, MEANS, AND EXTREMES

LATITUDE: 60 Deg. 47 Min. N LONGITUDE: 161 Deg. 48 Min. W ELEVATION: FT. GRND 125 BARO 131 TIME ZONE: ALASKA WBAN: 26615

	(a)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE (Deg. F)														
Normals														
-Daily Maximum		12.9	12.8	21.1	31.3	48.2	58.8	62.3	59.5	52.0	35.0	22.6	14.7	35.9
-Daily Minimum		0.4	-0.8	5.4	15.7	31.7	42.3	47.7	46.3	38.3	23.8	10.9	2.2	22.0
-Monthly		6.7	6.0	13.3	23.6	39.9	50.5	55.0	52.9	45.2	29.4	16.8	8.5	29.0
Extremes														
-Record Highest	37	48	4	46	55	80	86	83	84	72	56	48	45	86
-Year		1963	1970	1986	1993	1993	1959	1993	1977	1979	1979	1991	1963	JUN 1959
-Record Lowest	37	-48	-38	-39	-22	4	28	31	28	18	-5	-24	-37	-48
-Year		1989	1990	1964	1964	1965	1962	1959	1984	1970	1963	1990	1975	JAN 1989
NORMAL DEGREE DAYS														
Heating (base 65 Deg. F)		1807	1652	1603	1242	778	435	310	375	594	1104	144	1752	13098
Cooling (base 65 Deg. F)		0	0	0	0	0	0	0	0	0	0	0	0	0
% OF POSSIBLE SUNSHINE														
MEAN SKY COVER(tenths)														
Sunrise - Sunset	34	6.6	5.9	6.3	6.9	7.6	8.2	8.5	8.7	8.3	8.0	7.3	6.8	7.4
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	34	8.0	9.9	9.3	6.4	3.6	1.7	1.8	1.5	2.3	3.6	5.7	7.8	61.7
-Partly Cloudy	34	4.7	4.1	5.3	6.3	7.7	6.9	5.4	4.0	4.9	5.3	5.0	4.9	64.6
-Cloudy	34	18.3	14.2	16.5	17.3	19.6	21.4	23.7	25.5	22.7	22.1	19.3	18.3	238.9
Precipitation														
.01 inches or more	37	8.6	6.7	9.2	8.8	10.5	12.6	15.1	17.7	16.1	12.6	11.5	10.9	140.3
Snow, Ice Pellets, Hail														
1.0 inches or more	37	1.9	1.9	2.9	1.7	0.6	0.1	0.0	0.0	0.1	1.4	3.0	3.2	16.8
Thunderstorms	26	0.0	0.0	0.0	0.0	0.2	0.5	0.6	0.4	0.1	0.0	0.0	0.0	1.7
Heavy Fog Visibility														
1/4 mile or less	26	3.5	3.0	4.3	4.1	4.9	3.0	3.9	6.0	4.5	4.1	4.3	4.6	50.3
Temperature Deg. F														
-Maximum														
70 Deg. F and above	37	0.0	0.0	0.0	0.0	0.5	3.1	6.1	2.3	0.1	0.0	0.0	0.0	12.1
32 Deg. F and below	37	24.8	22.3	22.5	13.2	1.5	0.0	0.0	0.0	0.1	11.3	21.2	24.3	141.1
-Minimum														
32 Deg. F and below	37	30.2	27.8	30.6	27.6	15.9	0.7	0.1	0.1	5.7	25.6	28.6	30.4	223.3

	(a)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
0 Deg. F and below	37	15.5	14.4	12.8	5.1	0.0	0.0	0.0	0.0	0.0	0.5	6.9	15.1	70.4
AV. STATION PRES. (mb)	22	998.9	1002.7	1000.8	1004.0	1003.8	1006.4	1008.5	1006.3	1001.9	999.5	998.1	997.1	1002.3
RELATIVE HUMIDITY (%)														
Hour 04	45	77	75	80	85	88	89	92	94	92	88	83	78	85
Hour 10 (Local Time)	45	77	75	79	83	80	80	86	91	91	88	83	77	83
Hour 16	46	76	73	74	72	62	61	67	73	70	76	80	77	72
Hour 22	45	77	75	80	81	71	68	74	82	84	85	83	77	78
PRECIPITATION (in.)														
Water Equivalent														
-Normal		0.58	0.43	0.59	0.70	0.78	1.44	1.98	2.91	2.04	1.45	1.07	1.02	14.99
-Maximum Monthly	37	2.53	2.12	3.44	3.89	1.73	3.33	4.00	5.81	4.79	2.51	4.19	3.49	5.81
-Year		1993	1959	1991	1979	1985	1980	1980	1963	1993	1972	1994	1992	AUG 1963
-Minimum Monthly	37	0.06	T	T	0.02	0.10	0.25	0.56	0.99	0.42	0.11	0.04	0.11	T
-Year		1966	1984	1986	1985	1967	1974	1988	1976	1968	1965	1969	1973	MAR 1986
-Maximum in 24 hrs	37	0.85	0.77	0.64	0.94	0.53	1.37	1.22	1.90	2.02	1.55	1.63	1.34	2.02
-Year		1982	1959	1991	1979	1992	1981	1966	1994	1971	1974	1990	1970	SEP 1971
Snow, Ice Pellets, Hail														
-Maximum Monthly	37	15.3	18.1	30.6	14.3	6.2	2.2	T	0.0	4.0	12.8	34.7	36.0	36.0
-Year		1993	1959	1991	1975	1992	1963	1974		1992	1978	1994	1992	DEC 1992
-Maximum in 24 hrs	37	7.8	6.5	8.2	4.7	5.7	1.2	T	0.0	3.6	5.5	10.0	8.0	10.0
-Year		1987	1959	1974	1975	1992	1963	1974		1992	1982	1990	1992	NOV 1990
WIND														
Mean Speed (mph)	37	14.6	15.2	14.0	12.9	11.6	11.2	10.9	11.1	11.7	12.6	13.5	14.2	12.8
Prevailing Direction through 1964		NE	NNE	NNE	NW	S	NW	SSW	SSW	SSW	NNE	NE	NNE	NNE
Fastest Mile														
-Direction(!!)	41	15	16	19	15	18	19	19	22	18	19	16	17 1	6
-Speed(mph)		54	62	49	44	41	43	40	46	55	52	60	58	62
-Year		1979	1951	1977	1979	1960	1978	1974	1978	1960	1992	1958	1977	FEB 1951
Peak Gust														
-Direction(!!)	16	S	NE	S	S	S	S	S	NW	SE	S	W	S	S
-Speed(mph)	16	61	59	56	51	53	59	46	56	69	77	66	67	77
-Date		1993	1988	1991	1995	1985	1980	1982	1994	1982	1992	1990	1982	OCT 1992

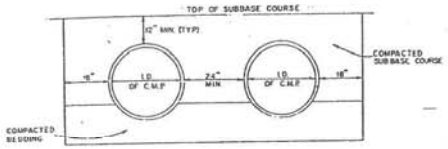
(a) - Length of Record in Years, although individual months may be missing.
0.* or * - The value is between 0.0 and 0.05.
Normals - Based on the 1961 - 1990 record period.
Extremes - Dates are the most recent occurrence.

Wind Dir.- Numerals show tens of degrees clockwise from true north.
"00" indicates calm.
Resultant Directions are given to whole degrees.

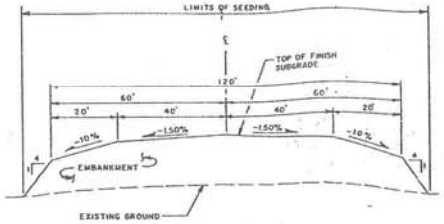
APPENDIX G

NOTES:

1. COMPACTION WITHIN THE WORK LIMITS OUTLINED SHALL BE PROVIDED BY HAND TAMPERS.

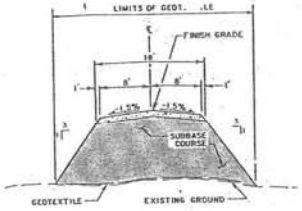


SECTION Z-Z



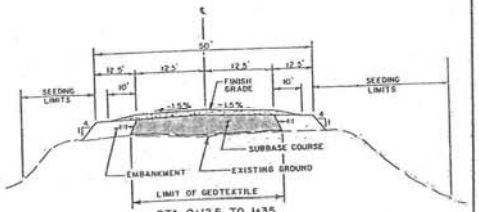
STA. 21+65 TO 24+05

STA. 48+12.5 TO 48+45



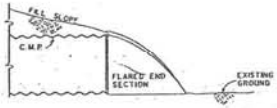
STA. 0+00 TO 4+00

ACCESS ROAD TYPICAL SECTION



STA. 0+12.5 TO 1+35

TAXIWAY TYPICAL SECTION



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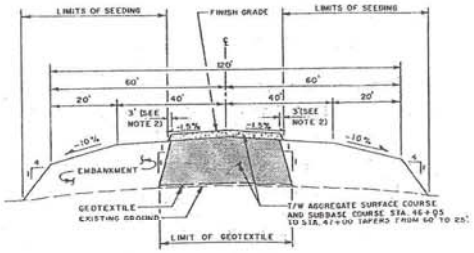
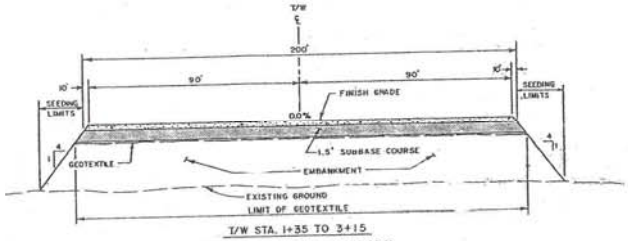
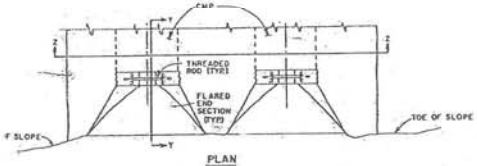


STA. 46+05 TO 48+45

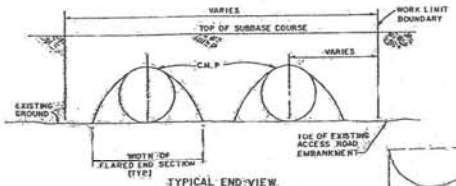


T/W STA. 1+35 TO 3+15

APRON TYPICAL SECTION

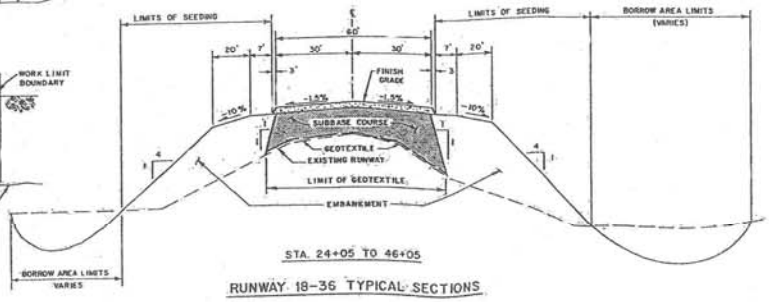


PLAN



TYPICAL END VIEW

TYPICAL CULVERT INSTALLATION



STA. 24+05 TO 46+05

RUNWAY 18-36 TYPICAL SECTIONS

NOTES

1. ALL REFERENCES TO "GEOTEXTILE" REFERS TO "ITEM 550) GEOTEXTILE, REINFORCEMENT."
2. FROM STA. 46+05 TO STA. 47+00 INCREASE SHOULDER FROM 3' TO 10'.
3. GEOTEXTILE TO BE PLACED FULL WIDTH OF SUBBASE COURSE AT TURNAROUNDS.

LEGEND

6" AGGREGATE SURFACE COURSE

SUBBASE COURSE

BY	DATE	CHANGE
	8/30/95	AS-BUILT

REVISIONS

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

ALAKANUK AIRPORT

56384

A.I.P. 3-02-0332-01

TYPICAL SECTIONS

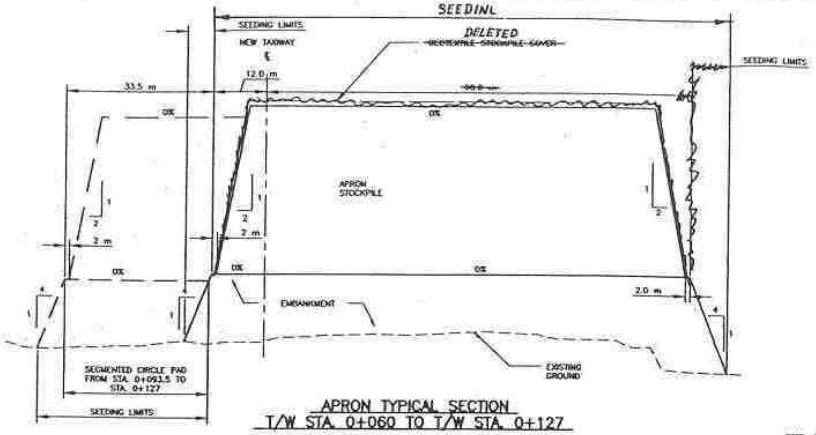
DESIGN GROUP CHIEF

PROJECT MANAGER

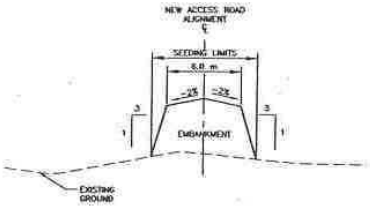
HORIZ. SCALE: NONE | VERT. SCALE: NONE | DATE: 9-19-88 | SHEET 6 OF 17

AS-BUILT 9/91

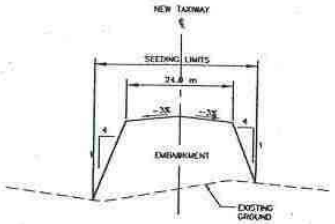
SHEET 6 OF 17



APRON TYPICAL SECTION
T/W STA. 0+060 TO T/W STA. 0+127

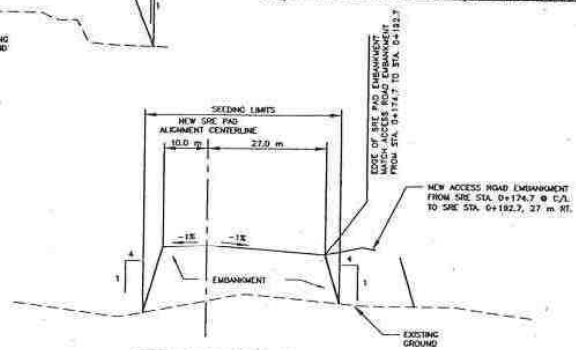


ACCESS ROAD TYPICAL SECTION
A/R STA. 0+016.0 TO A/R STA. 0+044.7
A/R STA. 0+095.0 TO A/R STA. 0+191.0



TAXIWAY TYPICAL SECTION
T/W STA. 0+018 TO T/W STA. 0+060

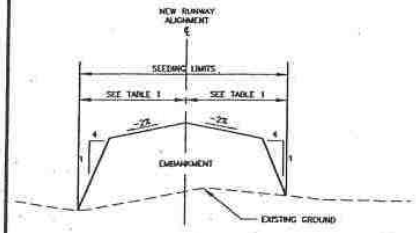
TABLE 1– R/W C/L TO TOE OFFSET					
STATIONS	OFFSET		STATIONS	OFFSET	
	LEFT	RIGHT		LEFT	RIGHT
			1+300	23.4	23.1
0+940	19.8	27.3	1+320	23.6	25.4
0+960	18.9	24.8	1+340	23.9	28.0
0+980	23.5	23.3	1+360	24.2	27.5
1+000	24.5	23.4	1+380	23.8	25.9
1+020	23.7	23.8	1+400	24.1	26.5
1+040	24.0	24.0	1+420	24.6	25.7
1+060	24.2	24.2	1+440	25.0	25.9
1+080	24.0	24.6	1+460	25.6	25.6
1+100	22.7	24.2	1+480	25.8	25.6
1+120	22.5	26.3	1+500	25.3	25.2
1+140	22.4	26.3	1+520	25.5	23.4
1+160	22.6	26.2	1+540	25.7	25.1
1+180	22.2	26.6	1+560	27.7	26.0
1+200	22.2	26.4	1+580	28.6	24.8
1+220	22.2	24.7	1+600	28.4	23.5
1+240	22.6	23.2	1+620	28.6	25.3
1+260	23.0	23.9			
1+280	23.0	25.8			



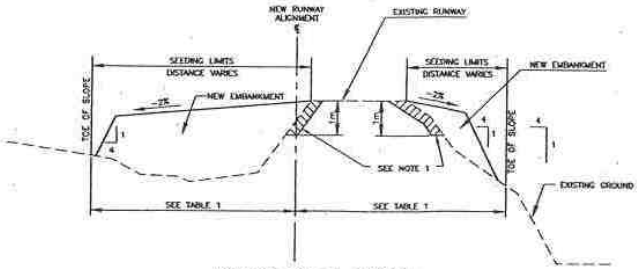
SRE PAD TYPICAL SECTION
SRE STA. 0+174.7 TO SRE STA. 0+230

NOTES

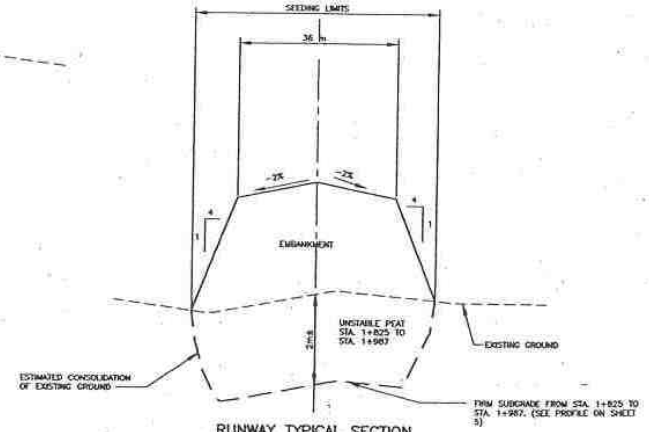
1. REMOVE ALL ORGANICS WITHIN 1.0m OF EXISTING RUNWAY SHOULDER ELEVATION. DO NOT REMOVE ORGANICS FROM RUNWAY SURFACE.
2. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE LABELLED.
3. STATIONS ARE IN METERS.
4. ALL EMBANKMENT WILL BE PAID UNDER ITEM 332a, BORROW EXCAVATION. SEE APPENDIX "A" FOR DETAIL OF BORROW SITE.



RUNWAY TYPICAL SECTION
STA. 0+928 TO STA. 0+941±



RUNWAY TYPICAL SECTION
STA. 0+941± TO STA. 1+625



RUNWAY TYPICAL SECTION
STA. 1+625 TO STA. 1+987

BY	DATE	REVISIONS
JB	1/22/01	AS-BUILT

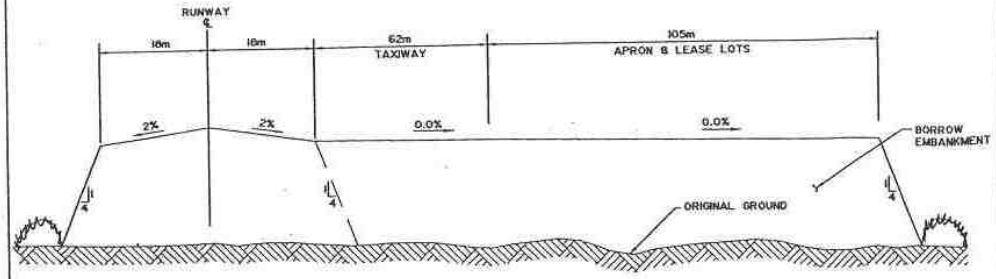
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

APPROVED: VICTOR B. WINTERS, P.E. — ACTING DESIGN SECTION CHIEF
APPROVED: JOHN C. BAKER P.E. — PROJECT MANAGER

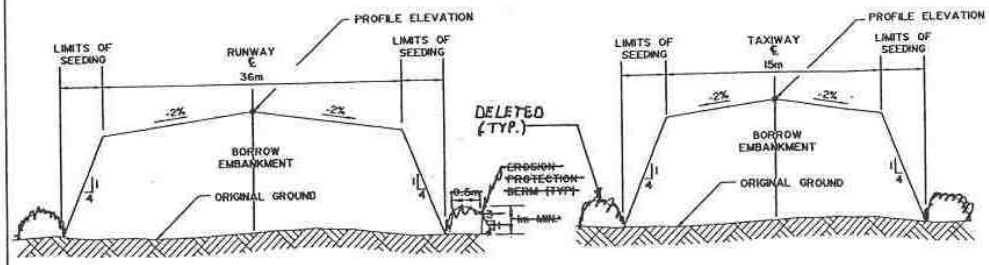
DATE 8-5-98
DESIGN BKS
DRAWN
CHECKED

ATMAUTLUAK AIRPORT
AIRPORT RECONSTRUCTION – PHASE 1
51355
A.I.P. No. 3-02-0379-01
TYPICAL SECTIONS

SHEET 8 OF 9



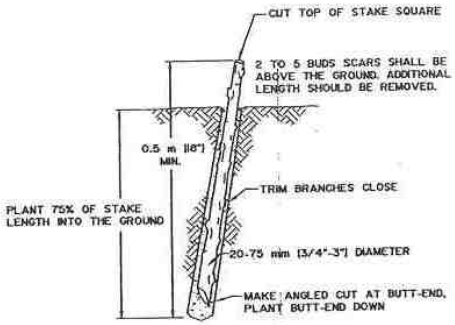
APRON AND TAXIWAY
N.T.S.



RUNWAY EMBANKMENT
STA. 0+960 - 2+028
N.T.S.

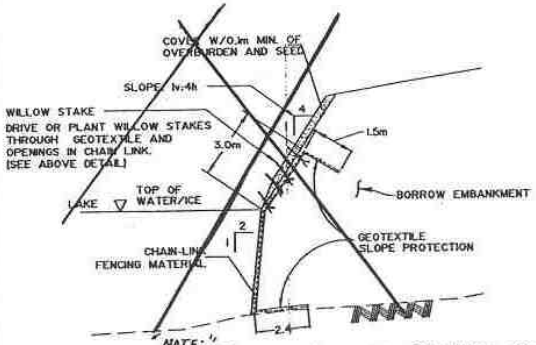
TAXIWAY EMBANKMENT
STA. 0+86 - 1+180
N.T.S.

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLSESS OTHERWISE NOTED

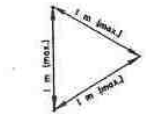


WILLOW STAKE

NOTES:
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION, USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS [MIN.] PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.



NOTE: THIS DETAIL DELETED BY CHANGE ORDER # 4
~~SLOPE PROTECTION~~
N.T.S.



PLAN VIEW OF PLANTING

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS SURVEYORS TESTLAB
PLANNERS COMPUTER SERVICES
8101 VANGUARD DRIVE, ANCHORAGE, ALASKA 99507
PH: (907) 522-1707, FAX: (907) 522-3403

BY	DATE	REVISIONS
DB	6-13-02	AS-BUILT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

APPROVED John C. Shea, P.E. — ACTING DESIGN SECTION CHIEF
APPROVED Frank G. Rue, P.E. — Project Manager

DATE 6/5/98
DESIGN DCS
DRAWN DCP
CHECKED FDR

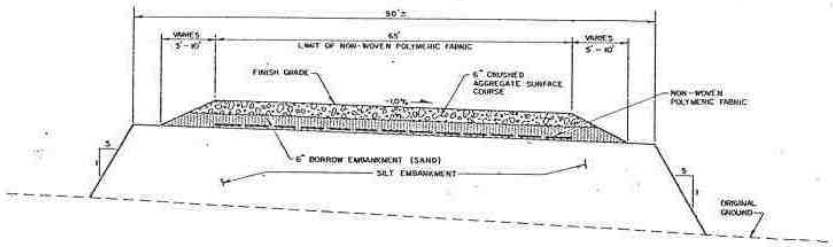
TUNTUTULIAK AIRPORT
PHASE I EMBANKMENT CONSTRUCTION
5793

EMBANKMENT TYPICAL SECTIONS, SLOPE PROTECTION

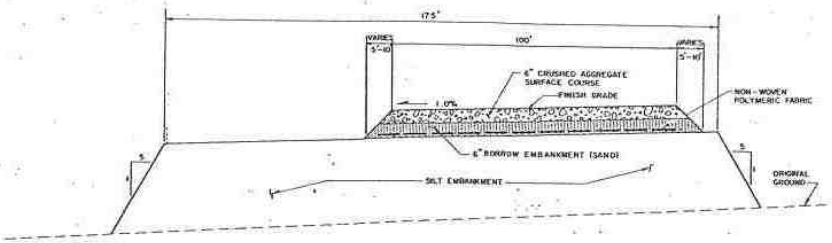
SHEET 8 OF 10

VIEW: DOB, DLOB
XREF: 6063B003

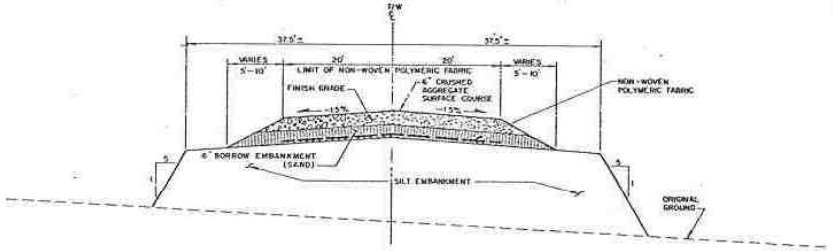
AS-F LT 6/2002 SHEET 8 OF 10



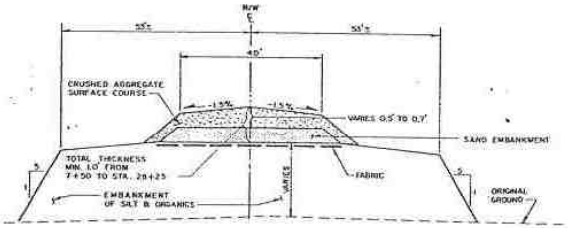
APRON SECTION "A-A"
NO SCALE



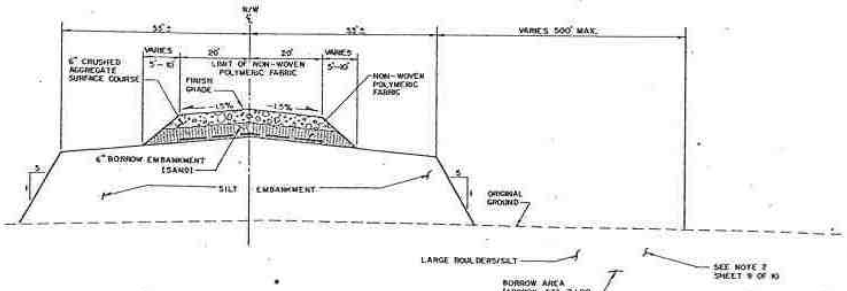
APRON SECTION "B-B"
NO SCALE



TAXIWAY TYPICAL SECTION
NO SCALE



RUNWAY TYPICAL SECTION
STA. 7+00 TO STA. 28+25
NO SCALE



RUNWAY TYPICAL SECTION
STA. 0+00 TO STA. 7+50
STA. 28+25 TO STA. 30+00

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
AVIATION DESIGN AND CONSTRUCTION CENTRAL REGION

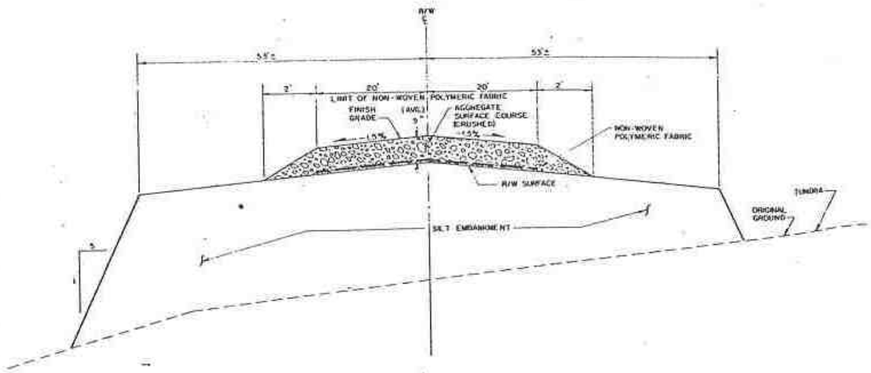
CHEFORNAK AIRPORT
DS7611
TYPICAL SECTIONS
(ADDITIVE ALTERNATE NO. 1)

BY	DATE	CHANGE
RBM	11/17/95	AS-BUILT

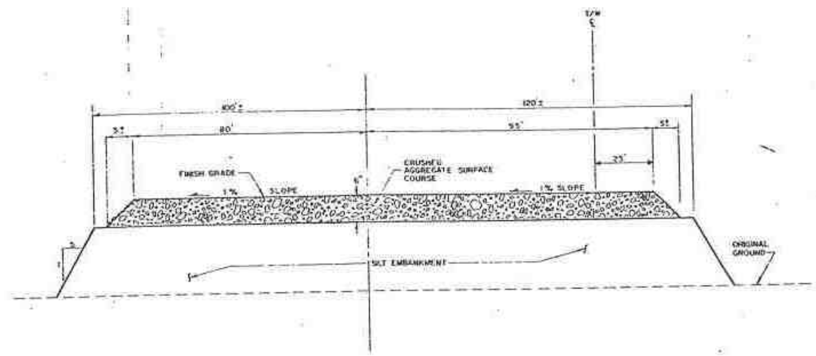
REVISIONS

SCALE: NO SCALE
DESIGNED: JDS
DRAWN: GT
CHECKED: RBM
DATE: 6-1-92
SHEET 10 OF 10

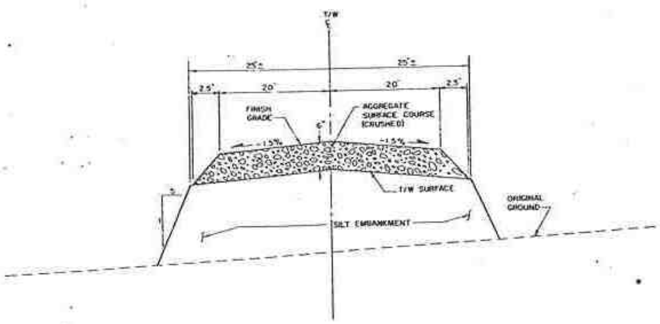
AS-BUILT



RUNWAY TYPICAL SECTION
STA. 9+00 TO STA. 11+00 AND
STA. 34+36 TO STA. 39+00
NO SCALE



APRON SECTION "A-A"
NO SCALE



TAXIWAY TYPICAL SECTION
NO SCALE

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
AVIATION DESIGN AND CONSTRUCTION CENTRAL

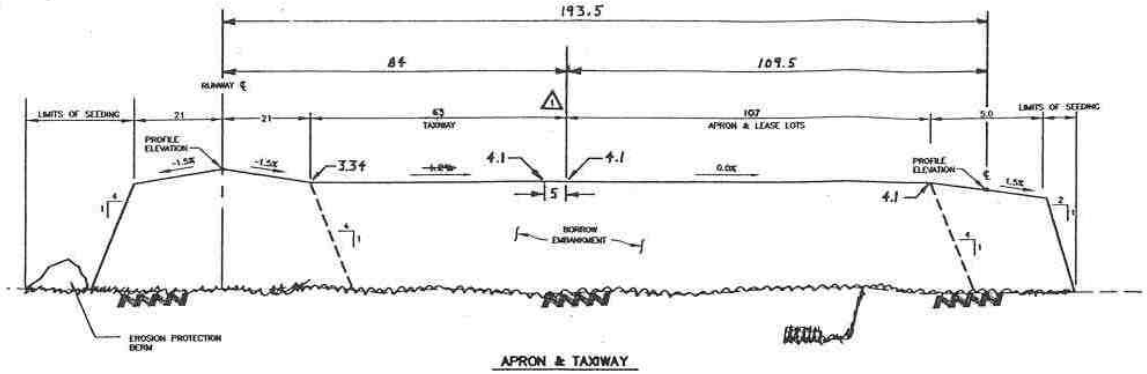
CHEVAK AIRPORT
D09321
TYPICAL SECTIONS

BY	DATE	CHANGE
		AS-BUILT

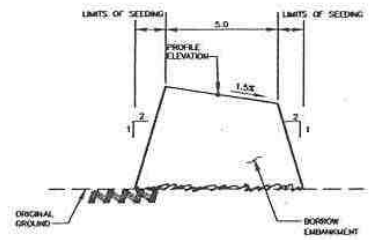
REVISIONS

NO SCALE
DATE 6-1-82

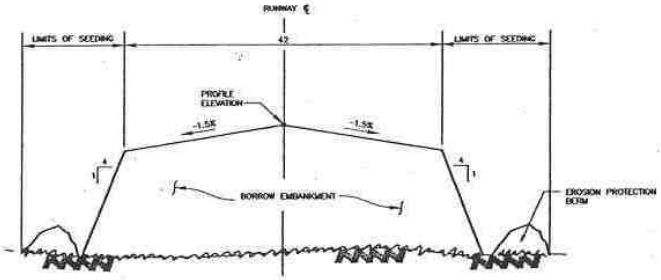
AS-BUILT 11-84 SHEET



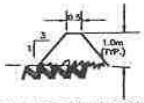
APRON & TAXIWAY



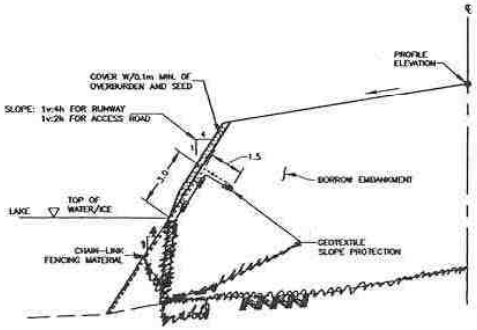
ACCESS ROAD STA. 1+000 TO STA. 1+731



RUNWAY STA. 0+928 TO STA. 2+066



EROSION PROTECTION BERM
DETAIL - minimum dimensions

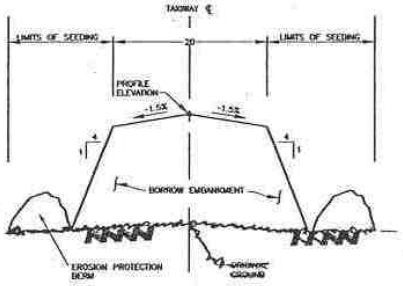


SLOPE PROTECTION AREAS

RUNWAY STA. 1+325 to 1+40~~0~~7 Lt., 1+800 to 1+8~~70~~48 Rt.
& 1+960 to ~~2+015~~ Rt. 1+990
ACCESS ROAD STA. 1+220 to ~~1+205~~ Lt. 1+289

NOTE: REMOVE ICE UNDER PROPOSED EMBANKMENT PRIOR TO CONSTRUCTION.

FOR RUNWAY EMBANKMENT CONSTRUCT 1v:2h SLOPE FROM ORIGINAL GROUND TO TOP OF ICE/WATER LEVEL.



TAXIWAY STA. 0+000 TO STA. 0+084

NOTES:

1. BORROW EMBANKMENT IS SHOWN AS PLACED IN INITIAL WINTER PLACED POSITION. SUBSTANTIAL FUTURE SETTLEMENT IS EXPECTED.
2. ALL AREAS TO BE SEEDED SHALL BE FERTILIZED.

DIMENSIONS ON THIS SHEET ARE IN METERS UNLESS OTHERWISE NOTED

BY	DATE	REVISIONS
RO	12-21-00	AS-BUILT
		ADJUST APRON & TAXIWAY SECTION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

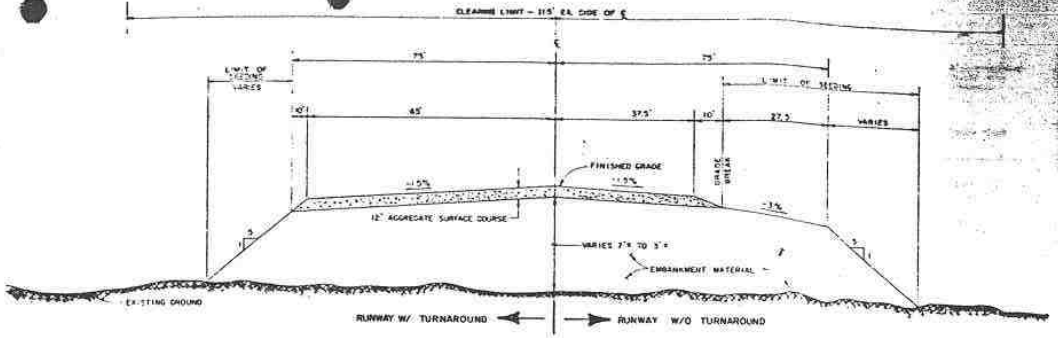
APPROVED: JOHN C. WAYE, P.E. — ACTING DESIGN SECTION CHIEF
APPROVED: VICTOR M. WINTERS, P.E. — PROJECT MANAGER

DATE 3/04/98
DESIGN DLR
DRAWN MKG
CHECKED

EEK AIRPORT
AIRPORT RELOCATION
52450
3-02-0085-0298
EMBANKMENT TYPICAL SECTIONS

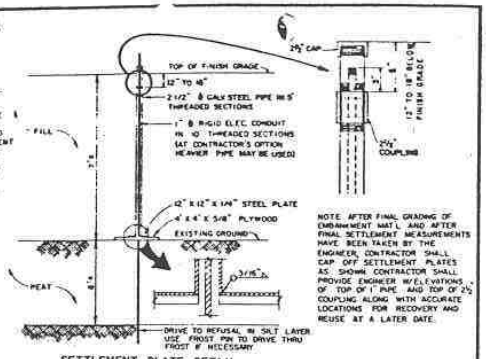
SHEET 8R OF 9

AS-BUILT 12/2000 SHEET 8 OF 9



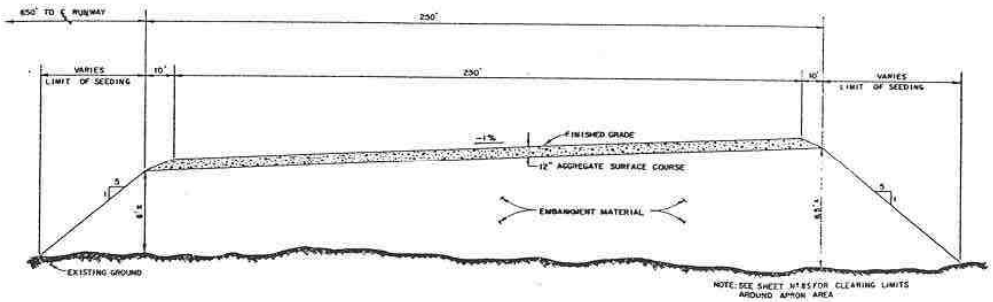
TYPICAL RUNWAY SECTION
NO SCALE

THE CONTRACTOR REQUIRED TO INSTALL SETTLEMENT PLATES AS PART OF PROJECT AND PROTECT THEM THRU THE LIFE OF THE CONTRACT. AT THE ENGINEER'S DISCRETION, THE CONTRACTOR SHALL BE REQUIRED TO REPLACE DAMAGED SETTLEMENT PLATES. CONTRACTOR TO OBTAIN INITIAL ELEVS OF TOP OF 2½" AND 1" PIPE AND ELEVS OF ANY PIPE LENGTH ADDITIONS. THE ENGINEER WILL TAKE ADDITIONAL MEASUREMENTS OF THE SETTLEMENT PLATES.

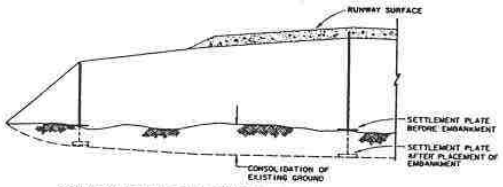


NOTE: AFTER FINAL GRADING OF EMBANKMENT MAT'L AND AFTER FINAL SETTLEMENT MEASUREMENTS HAVE BEEN TAKEN BY THE ENGINEER, CONTRACTOR SHALL CAP OFF SETTLEMENT PLATES AS SHOWN. CONTRACTOR SHALL PROVIDE ENGINEER W/ ELEVATIONS OF TOP OF 1" PIPE AND TOP OF 2½" COUPLING ALONG WITH ACCURATE LOCATIONS FOR RECOVERY AND REUSE AT A LATER DATE.

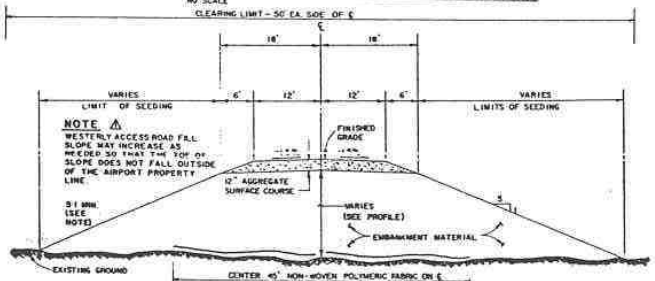
SETTLEMENT PLATE DETAIL
NO SCALE



TYPICAL APRON SECTION
NO SCALE

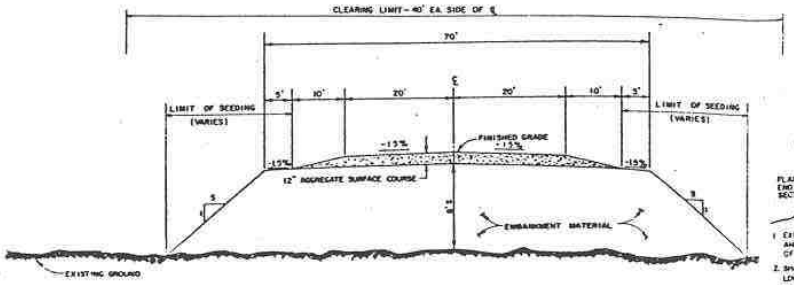


SETTLEMENT PLATE / EARTHWORK ADJUSTMENT SECTION
NO SCALE

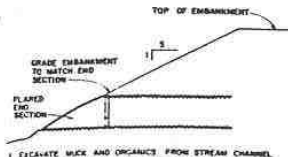


NOTE ⚠
WESTERLY ACCESS ROAD FILL SLOPE MAY INCREASE AS NEEDED SO THAT THE TOE OF SLOPE DOES NOT FALL OUTSIDE OF THE AIRPORT PROPERTY LINE.

TYPICAL ACCESS ROAD SECTION
NO SCALE



TYPICAL TAXIWAY SECTION
NO SCALE



1. EXCAVATE MUCK AND ORGANICS FROM STREAM CHANNEL AND BACKFILL TO AT LEAST 12" ABOVE THE TOP OF PIPE PRIOR TO RUNNING HEAVY EQUIP OVER PIPE
2. SHAPE BACKFILL TO PROVIDE EVEN BEARING FOR LOWER PORTION (APPROX 1/4 THE CIRCUMFERENCE) PRIOR TO PLACING PIPE.
3. COMPLETE INSTALLATION IN ACCORDANCE WITH SPECIFICATIONS.

CULVERT DETAIL
NO SCALE

⚠	AJK	7/19/85	ADDED ACCESS ROAD NOTE
	BY	DATE	CHANGE

REVISIONS

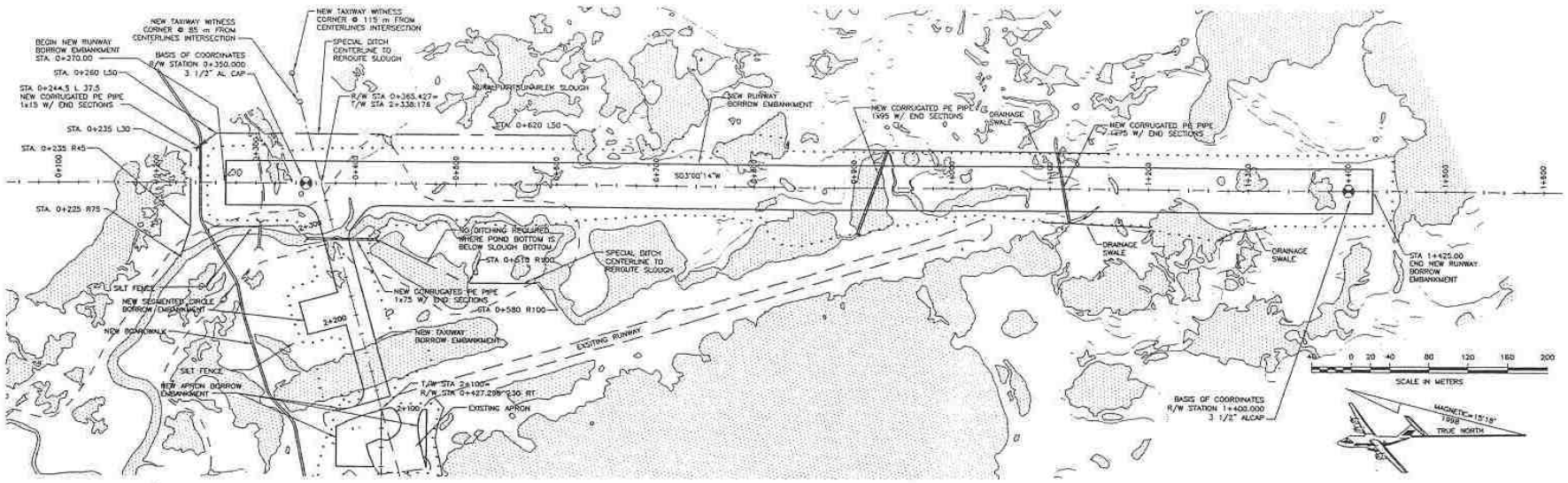
DOWL ENGINEERS

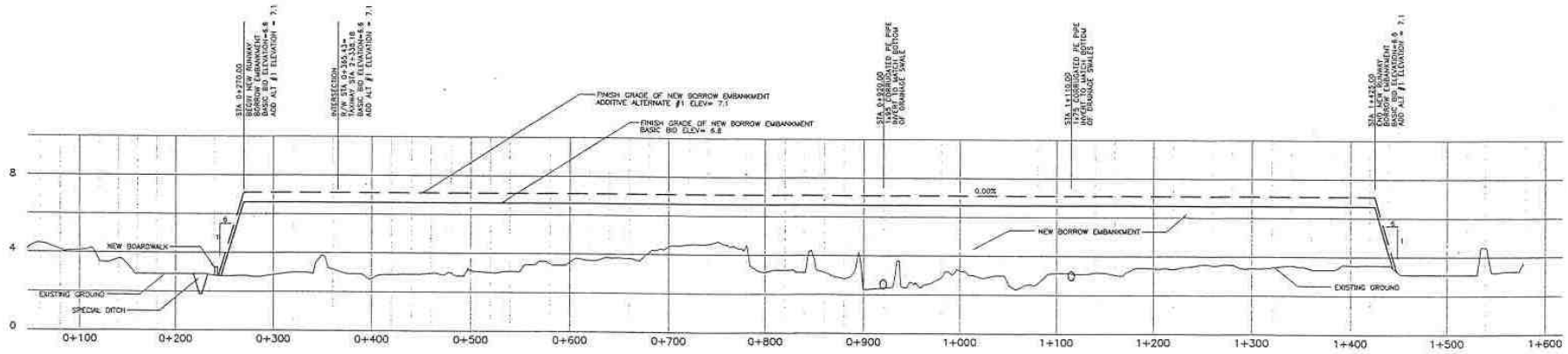
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
AVIATION DESIGN AND CONSTRUCTION CENTRAL REGION

EMMONAK AIRPORT
A.I.P. NO. 83-1-3-02-0093-01-83/055332
TYPICAL SECTIONS & DETAILS

CHIEF DESIGN ENG'R
WESTERN DISTRICT ENG'R
NO SCALE
DATE 7/19/85
SHEET 9S OF 17

STATE OF ALASKA 49TH REGISTERED PROFESSIONAL ENGINEER





BY	DATE	REVISIONS

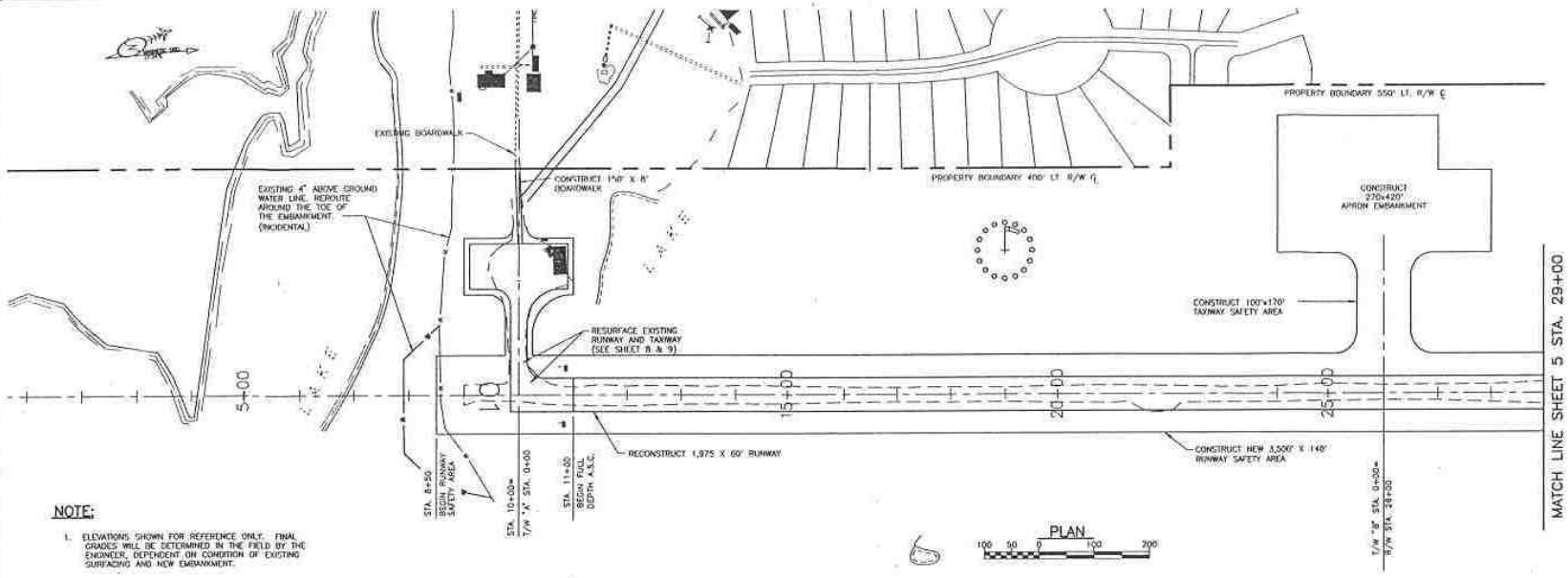
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

APPROVED: STEPHEN H. STRAUTZ — DESIGN SECTION CHIEF
APPROVED: JOHN C. RAHE, PE — PROJECT MANAGER

DATE 11/28/05
DESIGN TCC
DRAWN
CHECKED

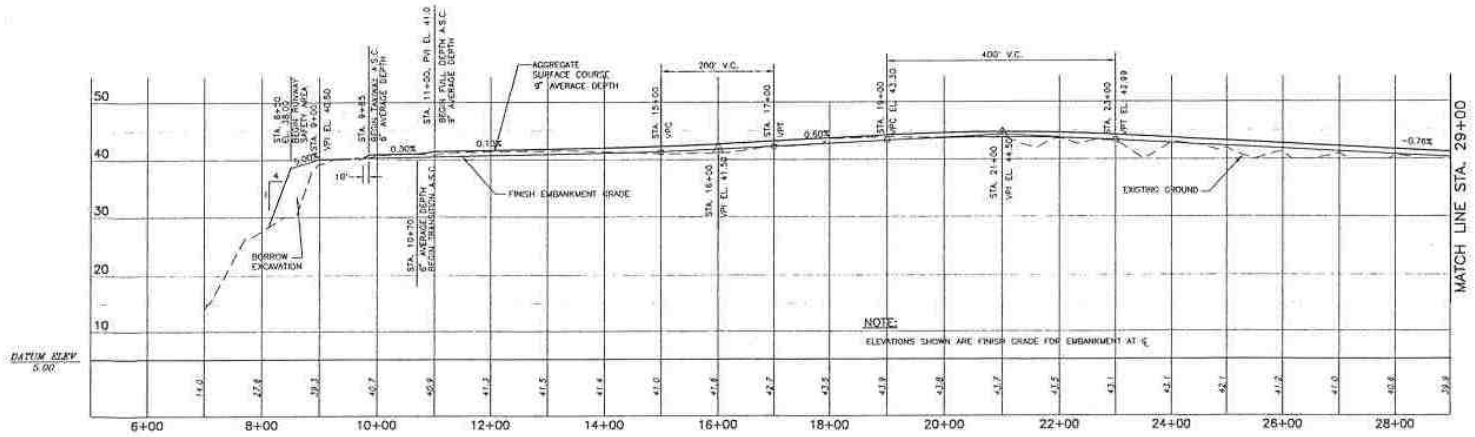
KIPNUK AIRPORT
RELOCATION–PHASE I
53658
A.I.P. No. 3-02-0150-02
RUNWAY PLAN & PROFILE

SHEET 5 OF 9



NOTE:

1. ELEVATIONS SHOWN FOR REFERENCE ONLY. FINAL GRADES WILL BE DETERMINED IN THE FIELD BY THE ENGINEER, DEPENDENT ON CONDITION OF EXISTING SURFACING AND NEW EMBANKMENT.



NOTE:
ELEVATIONS SHOWN ARE FINISH GRADE FOR EMBANKMENT AT ℄

PROFILE
HORZ. 1"=100'
VERT. 1"=10'

FILE:			
DATE: 5/13/94 1=1 CC VT	BY	DATE	REVISIONS

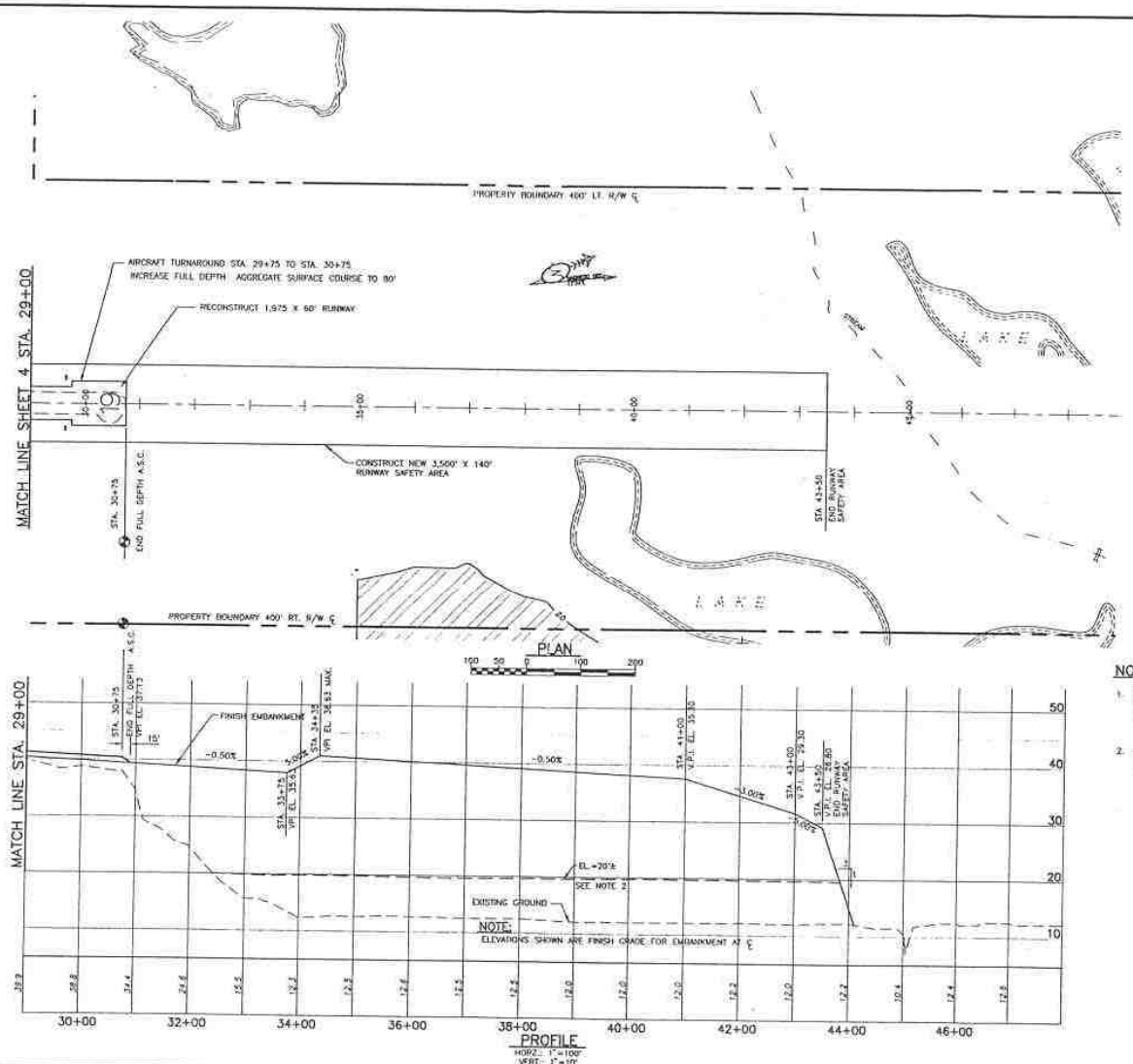
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION–DESIGN AND CONSTRUCTION–AVIATION

APPROVED: STEVE VAN HORN, P.E. — DESIGN SECTION CHIEF
APPROVED: JOHN G. WAHL, P.E. — PROJECT MANAGER

DATE
DESIGN
CHECKED
DRAWN

KONGIGANAK AIRPORT
AIRPORT RECONSTRUCTION
59794
A.I.P. No. 3-02-0380-01
RUNWAY PLAN AND PROFILE
STA. 6+00 TO STA. 29+00

SHEET 4 OF 21



NOTE:

1. ELEVATIONS SHOWN FOR REFERENCE ONLY. FINAL GRADES WILL BE DETERMINED IN THE FIELD BY THE ENGINEER, DEPENDENT ON CONDITION OF EXISTING SURFACING AND NEW EMBANKMENT.
2. PLACE TOP 5'± OF BORROW EXCAVATION MATERIAL WITHIN THE RUNWAY SAFETY AREA PRISM BELOW ELEVATION 20'±, APPROXIMATELY STA. 32+25 TO STA. 44+00.

FILE: g:\data\sang\dwg\rwpplp
DATE: 5/15/94 1=1 V2

BY	DATE	REVISIONS

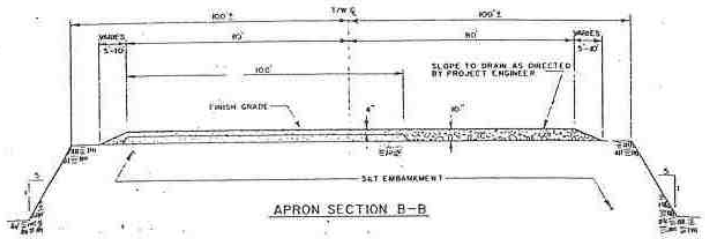
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION-DESIGN AND CONSTRUCTION-AVIATION

APPROVED: STEVE VAN HORN, P.E. — DESIGN SECTION CHIEF
APPROVED: JOHN C. MARK, P.E. — PROJECT MANAGER

DATE
DESIGN
CHECKED
DRAWN

KONGIGANAK AIRPORT
AIRPORT RECONSTRUCTION
59794
A.I.P. No. 3-02-0380-01
RUNWAY PLAN AND PROFILE
STA. 29+00 TO STA. 47+00

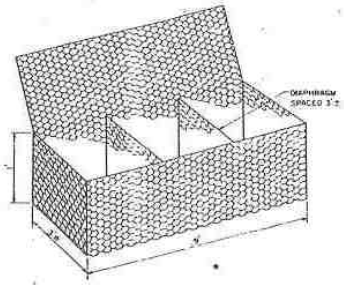
SHEET 5 OF 21



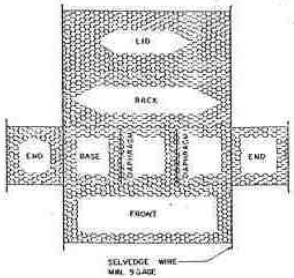
APRON SECTION B-B

LEGEND

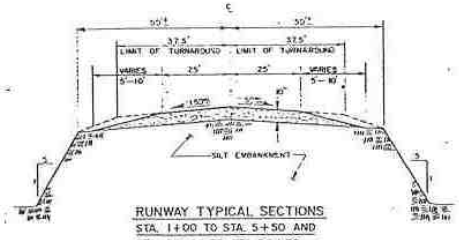
- CRUSHED AGGREGATE SURFACE COURSE
- 4"± OVERLAY
- PIT RUN AGGREGATE SURFACE COURSE



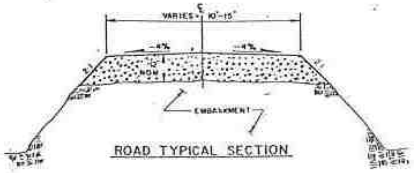
TYPICAL GABION
NO SCALE



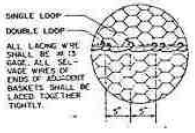
UNFOLDED GABION PLAN
NO SCALE



RUNWAY TYPICAL SECTIONS
STA. 1+00 TO STA. 5+50 AND
STA. 29+50 TO STA. 30+50



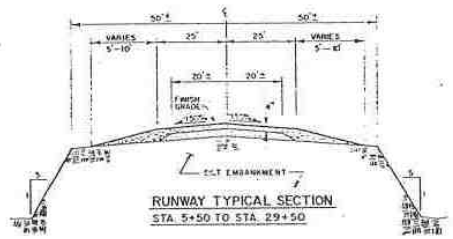
ROAD TYPICAL SECTION



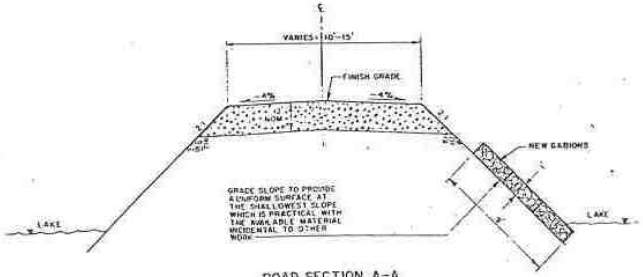
LACING DETAIL

NOTES FOR GABION

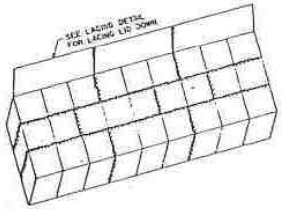
1. ALL GABIONS SHALL HAVE AN INSIDE FILTER FABRIC LINING SUCH AS CARTHAGE MILLS POLY-FILTER X OR APPROVED EQUAL.
2. USE GABION LENGTH IN MULTIPLES OF 3'0".
3. ALL GABION WIRES SHALL HAVE A GALVANIZED COAT OF MINIMUM 0.6 OZ. PER SQ. FT.
4. ALL WIRING SHALL BE DONE IN ACCORDANCE WITH THE SPECIFICATIONS.
5. ADJOINING GABIONS SHALL BE WIRED TOGETHER BY THEIR VERTICAL EDGES.
6. AFTER THE GABION IS FILLED THE LID SHALL BE FOLDED SHUT & WIRED TO THE ENDS & SIDES.



RUNWAY TYPICAL SECTION
STA. 5+50 TO STA. 29+50

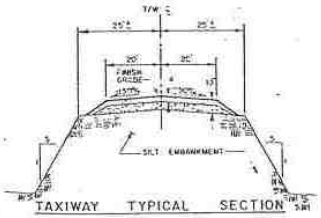


ROAD SECTION A-A
GABION SLOPE PROTECTION

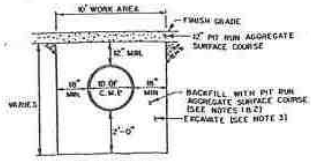


LACING GABIONS TOGETHER

GABION DETAILS
NO SCALE



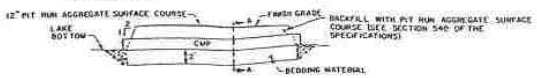
TAXIWAY TYPICAL SECTION



SECTION A-A

NOTES FOR CULVERT

1. PIT RUN AGGREGATE SURFACE COURSE SHALL BE PLACED A MINIMUM OF 2' BELOW, 1' ABOVE, & 10' EITHER SIDE OF C.M.P.
2. COMPACTION WITHIN THE 10' WORK LIMIT SHOWN SHALL BE ACCOMPLISHED WITH MECHANICAL HAND TAMPERS UNTIL A MINIMUM OF 1' OF COVER OVER PIPE IS OBTAINED.
3. EXCAVATED MATERIAL THAT IS UNSUITABLE SHALL BE DISPOSED OF IN A DISPOSAL AREA APPROVED BY THE ENGINEER



TYPICAL CULVERT INSTALLATION

REV	DATE	CHANGE
1998	4/15/85	AS-BUILT

REVISIONS

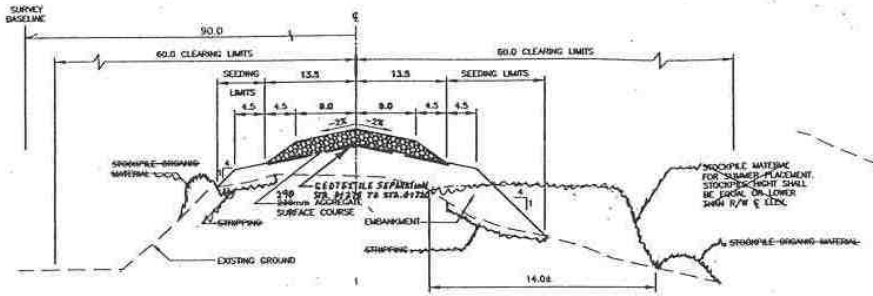
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
AVIATION DESIGN AND CONSTRUCTION CENTRAL REGION

KWIGILLINGOK AIRPORT
D23731
KWIGILLINGOK AIRPORT ROAD
ABI011
TYPICAL SECTIONS

CHIEF DESIGN ENGINEER
DESIGN ENGINEER

NO SCALE | DRAWN CMS | CHECKED BGH | 6-1-82 | SHEET 8 OF 10

AS-BUILT 11-8-84 SHEET 8 OF 10



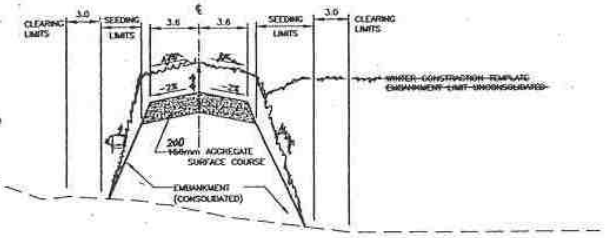
R/W TYPICAL SECTION
R/W STA 0+126.4 TO STA 0+720±

NO SCALE

~~ESTIMATED QUANTITY OF WINTER TEMPLATE IS 12,850 CU.~~

NOTES:

1. STRIP ORGANIC MATERIAL FROM EXISTING EMBANKMENT WHERE FILL IS TO BE PLACED. STOCKPILE MATERIAL AT TOE OF NEW SLOPE. REPLACE ORGANIC MATERIAL ON AREAS TO BE SEEDED, TO THE EXTENT OF MATERIAL AVAILABLE.
2. CENTERLINE LOCATION IS SET TO MAXIMIZE WIDENING ON THE RIGHT SIDE OF EXISTING EMBANKMENT.
3. ~~EXISTING BASE COURSE ON R/W, T/W AND APRON MAY BE SALVAGED FOR USE ON HAUL ROAD AT THE DESIGNATION OF THE ENGINEER. WORK WILL BE PAID BY ITEM 150 EQUIPMENT RENTAL.~~



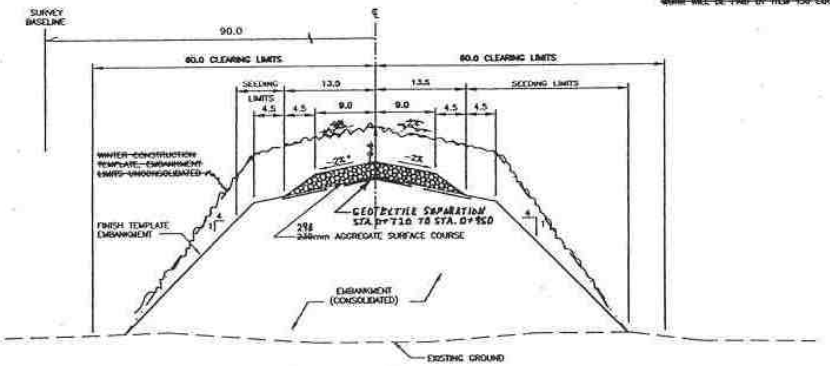
~~NOTES:~~

~~CONSTRUCT BORROW EMBANKMENT ON UNDISTURBED GROUND 0.3m HIGHER THAN FINISH GRADE TO ALLOW FOR COMPACTION AND CONSOLIDATION OF FROZEN MATERIAL.~~

ACCESS ROAD TYPICAL SECTION
ACCESS ROAD STA 3+000 TO STA 3+242.48

NO SCALE

~~ESTIMATED QUANTITY OF WINTER TEMPLATE IS 2,200 CU.~~



~~NOTES:~~

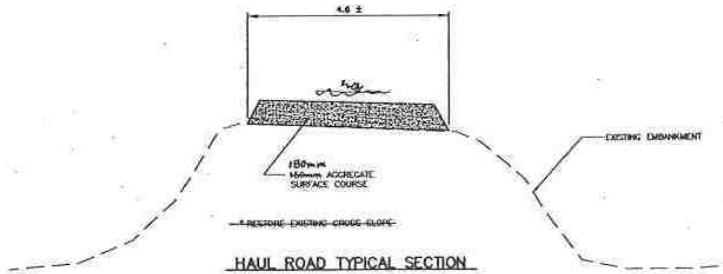
~~CONSTRUCT EMBANKMENT ON UNDISTURBED GROUND 0.6m HIGHER THAN FINISH GRADE TO ALLOW FOR COMPACTION AND CONSOLIDATION OF FROZEN MATERIAL.~~

~~* CONSTRUCT TAPER FROM 0 TO 0.6m BETWEEN STA 0+720 TO STA 0+735~~

R/W TYPICAL SECTION
R/W STA 0+720± TO STA 1+118.4

NO SCALE

~~ESTIMATED QUANTITY OF WINTER TEMPLATE IS 27,800 CU.~~



~~* RESTORE EXISTING CROSS SLOPE~~

HAUL ROAD TYPICAL SECTION

NO SCALE

HAUL ROUTE NOTES:

1. HAUL ROAD BETWEEN BARGE LANDING SITE AND EXISTING APRON IS ± 820m.
2. REGRADING OF HAUL ROAD SHALL OCCUR UPON THE CONTRACTORS COMPLETION OF AGGREGATE SURFACE GROUND HAUL FROM BARGE LANDING TO AIRPORT.
3. CONTRACTOR SHALL REGRADE EXISTING HAUL ROAD TO AS GOOD OR BETTER CONDITION PRIOR TO CONSTRUCTING AGGREGATE SURFACE COURSE.
4. REGRADING EXISTING EMBANKMENT SHALL BE INCIDENTAL TO CONTRACT AND SHALL NOT BE MEASURED FOR PAYMENT.

DIMENSIONS ON THIS SHEET ARE IN METERS UNLESS OTHERWISE NOTED

PLOT- V1	S.E.	2-9-2001	AS-BUILT
F:\data\napakiak\dwg\typsec2 2/12/98 7:06:52 am AST	BY	DATE	REVISIONS

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

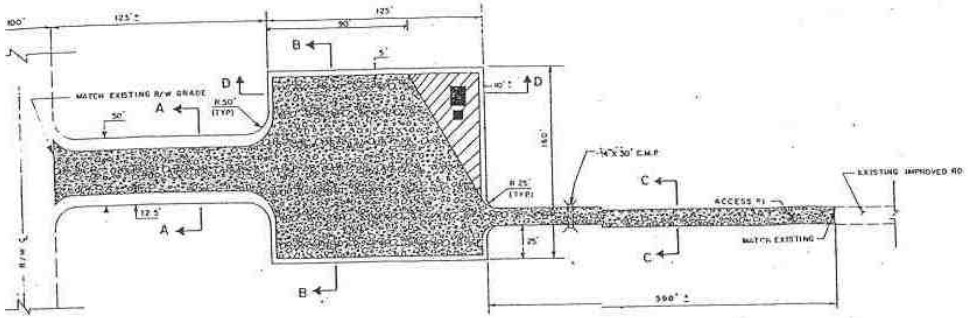
APPROVED: RICHARD A. BRIGGS, P.E. — ACTING DESIGN SECTION CHIEF
APPROVED: JOHN C. WALL, P.E. — PROJECT MANAGER

DATE 2/12/98
DESIGN
DRAWN
CHECKED

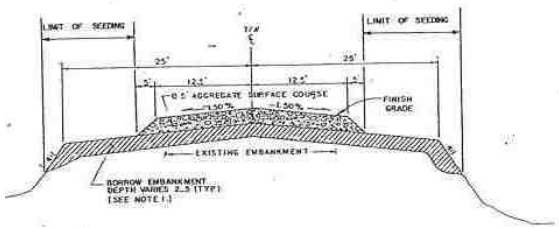
NAPAKIAK AIRPORT
AIRPORT RECONSTRUCTION
51358
A.I.P. No. 3-02-0188-01
TYPICAL SECTIONS

SHEET 9 OF 20

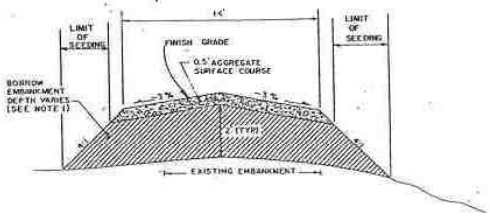
AS-BUILT 4/2002 SHEET 9 OF 20



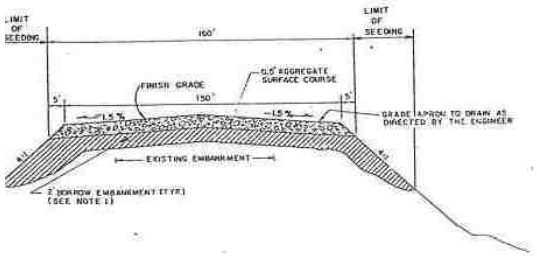
PLAN VIEW
NO SCALE



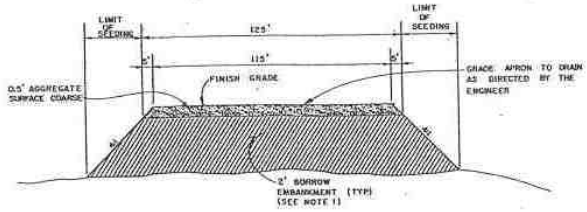
TAXIWAY TYPICAL SECTION A-A
NO SCALE



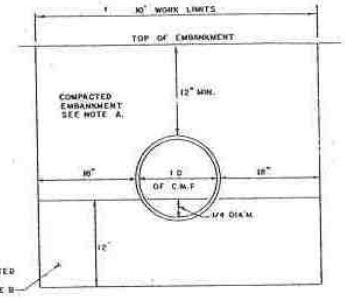
ACCESS ROAD TYPICAL SECTION C-C
NO SCALE



APRON TYPICAL SECTION B-B
NO SCALE



APRON TYPICAL SECTION D-D
NO SCALE



TYPICAL CULVERT INSTALLATION
NO SCALE

CULVERT NOTES

A. COMPACTION WITHIN THE WORK LIMITS OUTLINED SHALL BE PROVIDED BY HAND TAMPERS

B. COMPACTION AND SUITABILITY OF EMBANKMENT AS BEDDING MATERIAL SHALL BE AS APPROVED BY THE ENGINEER. MATERIAL SHALL BE INCIDENTAL TO THE CULVERT

LEGEND

AGGREGATE SURFACE COURSE

BORROW EMBANKMENT

ADDENDUM No. 3, 4/12/85
ATTACHMENT No. 2

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

NAPAKIAK AIRPORT
052712

TYPICAL SECTIONS AND PLAN VIEW

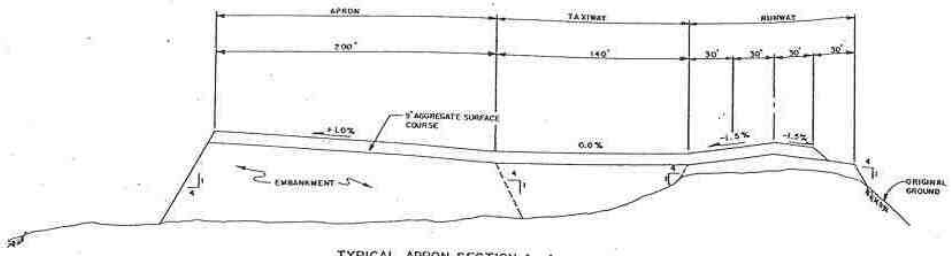
BY	DATE	CHANGE
BB	5/13/87	AS-BUILT
BB	4/1/85	REVISED NOTE 1 & 2

REVISIONS

APPROVED: Brooks H. Wade, P.E. — ASSIST. DESIGN CHIEF
APPROVED: William Doetter, P.E. — PROJECT ENGINEER

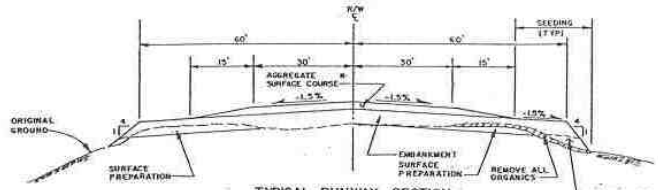
SCALE AS SHOWN	DESIGNED DJY	DRAWN RE	SHEET 7R OF 7
	CHECKED CAG	DATE 7-31-85	

AS - BUILT 5/87 SHEET 7 OF 7



TYPICAL APRON SECTION A-A

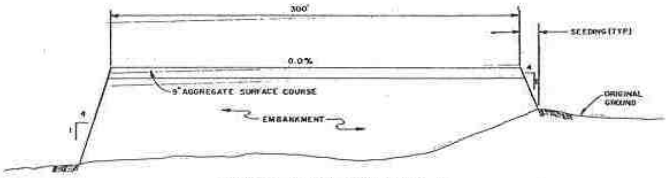
NO SCALE



TYPICAL RUNWAY SECTION

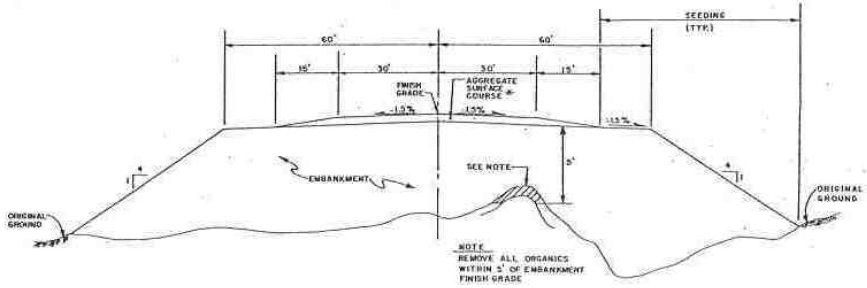
STA. 10+50 TO STA. 35+50

NO SCALE



TYPICAL APRON SECTION B-B

NO SCALE

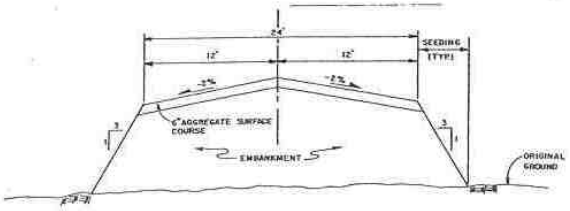


TYPICAL RUNWAY SECTION

STA. 35+50 TO STA. 43+80

NO SCALE

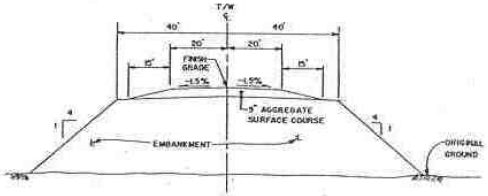
* REFER TO PLAN SHEETS 4 & 5 FOR DEPTH



TYPICAL ACCESS ROAD SECTION

STA. 0+00 TO STA. 4+75

NO SCALE



TYPICAL TAXIWAY SECTION

NO SCALE

STATE OF ALASKA
49TH
JOHN C. WEBB
CE-4361
REGISTERED PROFESSIONAL ENGINEER

BY	DATE	CHANGE
WDH	1/3/95	AS-BUILT

REVISIONS

STATE OF ALASKA
DEPARTMENT OF TRANSPORT. AND PUBLIC FACILITIES

NAPASKIAK AIRPORT

58285

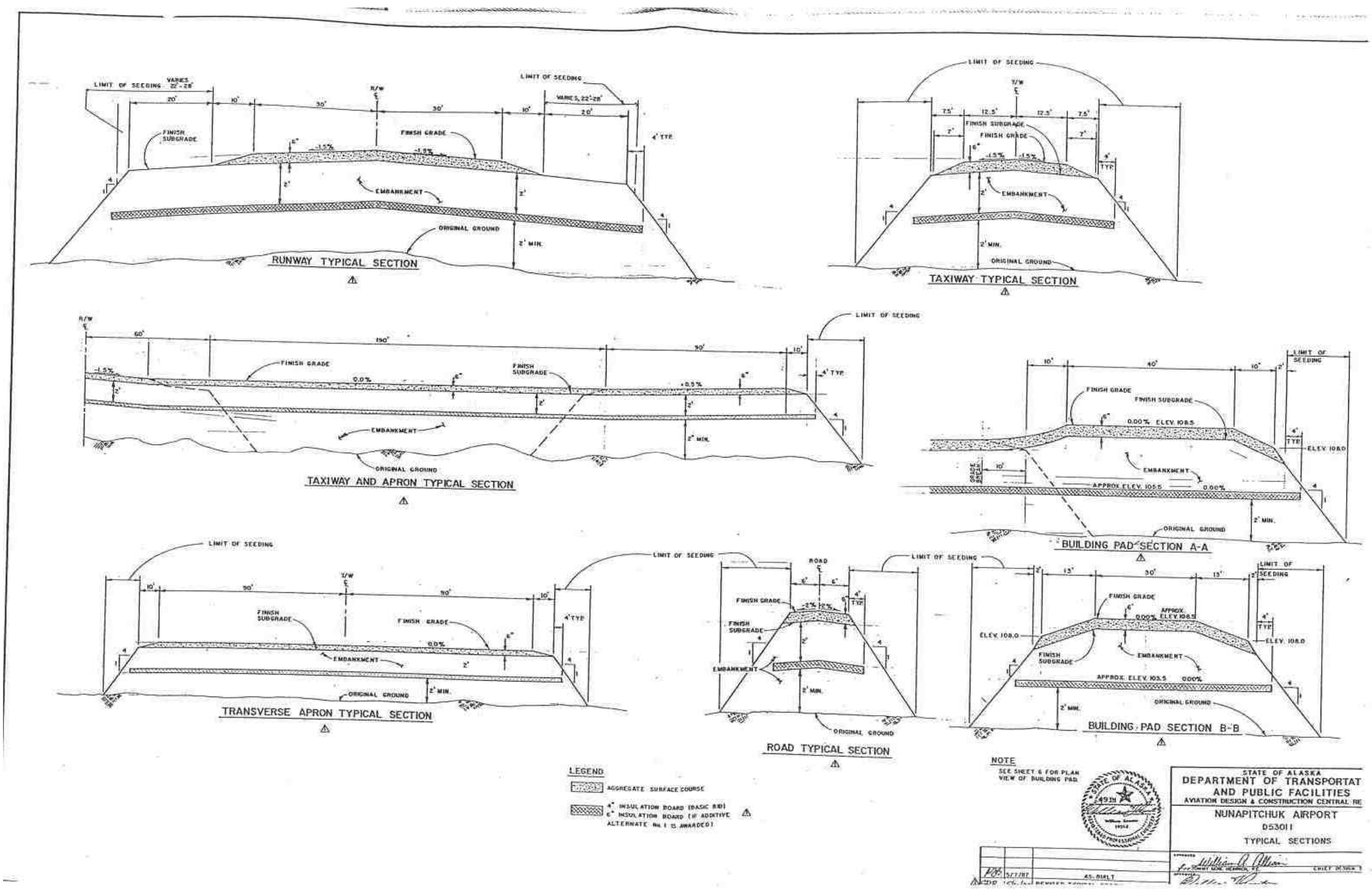
A.I.P. No. 3-02-0189-01

TYPICAL SECTIONS

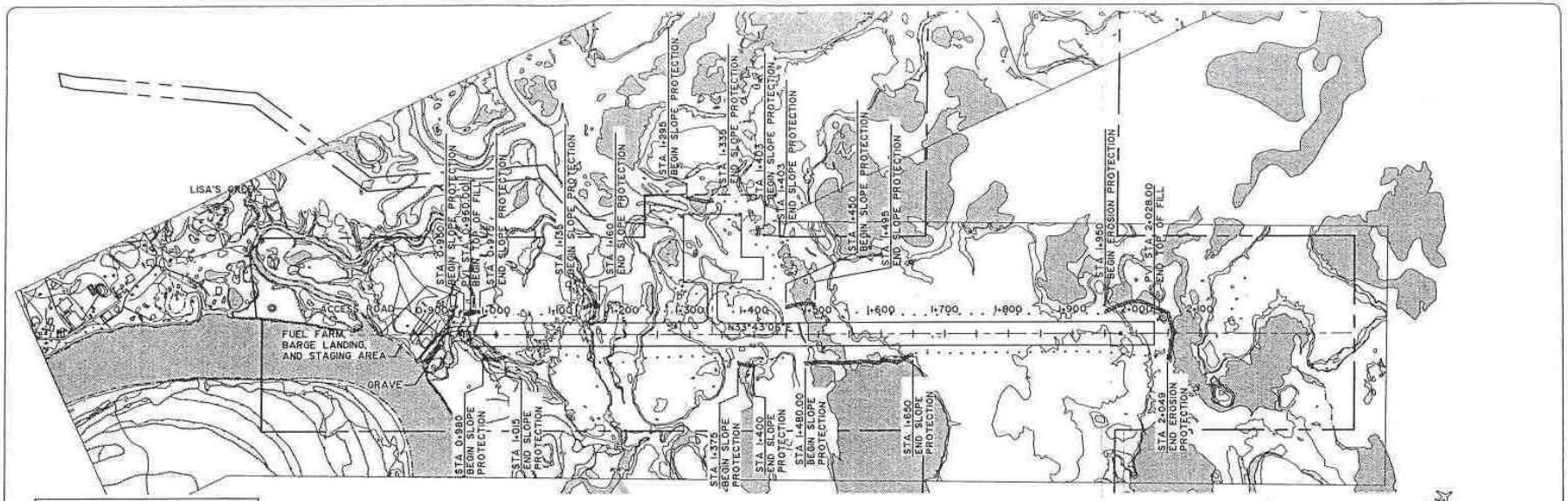
APPROVED: STEVE VAN HORN, P.E. — DESIGN E

APPROVED: JOHN C. WEBB, P.E. — PROJECT

SCALE: NO SCALE | DESIGNED: WDH | DRAWN: RE | DATE: 7-1-91 | SHEET



RUNWAY TYPICAL SECTION
LIMIT OF SEEDING
VARIES 22'-28'
FINISH SUBGRADE
FINISH GRADE
EMBANKMENT
ORIGINAL GROUND
2' MIN.
4' TYP.
TAXIWAY TYPICAL SECTION
TAXIWAY AND APRON TYPICAL SECTION
BUILDING PAD SECTION A-A
APPROX. ELEV. 105.5
ELEV. 108.0
TRANSVERSE APRON TYPICAL SECTION
ROAD TYPICAL SECTION
BUILDING PAD SECTION B-B
LEGEND
AGGREGATE SURFACE COURSE
4" INSULATION BOARD (BASIC BID)
6" INSULATION BOARD (IF ADDITIVE ALTERNATE No. 1 IS AWARDED)
NOTE
SEE SHEET 6 FOR PLAN VIEW OF BUILDING PAD.
STATE OF ALASKA
DEPARTMENT OF TRANSPORTAT
AND PUBLIC FACILITIES
AVIATION DESIGN & CONSTRUCTION CENTRAL RE
NUNAPITCHUK AIRPORT
D53011
TYPICAL SECTIONS
AS-BUILT
CHIEF DESIGN



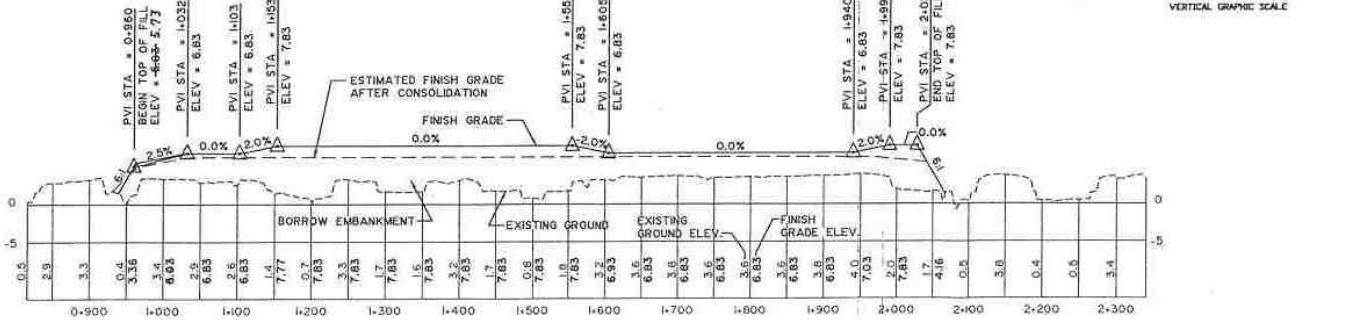
NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED

MAGNETIC DECLINATION 19°41'E DECEMBER, 1997

HORIZONTAL GRAPHIC SCALE 0 100 200 300

VERTICAL GRAPHIC SCALE 0 10 20 30



R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS SURVEYORS TESTLAB
PLANNERS COMPUTER SERVICES
9101 VANGUARD DRIVE, ANCHORAGE, ALASKA 99507
PH: (907) 522-1707, FAX: (907) 522-3403

BY	DATE	REVISIONS
GO	6-13-02	AS-BUILT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
CENTRAL REGION

APPROVED: JOHN G. RIVAL, P.E. — ACTING DESIGN SECTION CHIEF
APPROVED: Frank D. Rowe, P.E. — Project Manager

DATE 8/18/98
DESIGN DES
DRAWN DES
CHECKED FDR

TUNTUTULIAK AIRPORT
PHASE I EMBANKMENT CONSTRUCTION
51793
3-02-0303-0198
RUNWAY PLAN & PROFILE

SHEET 5 OF 10