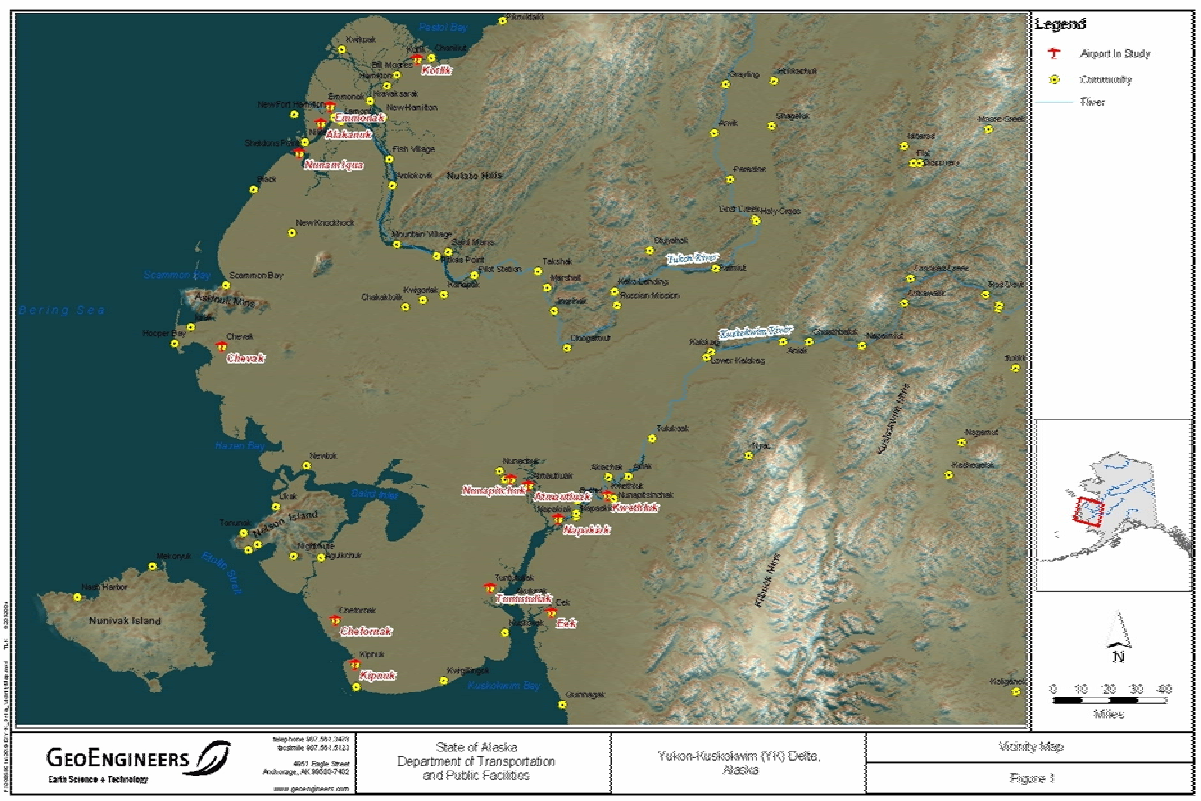
Performance of Yukon-Kuskokwim Airport Embankments

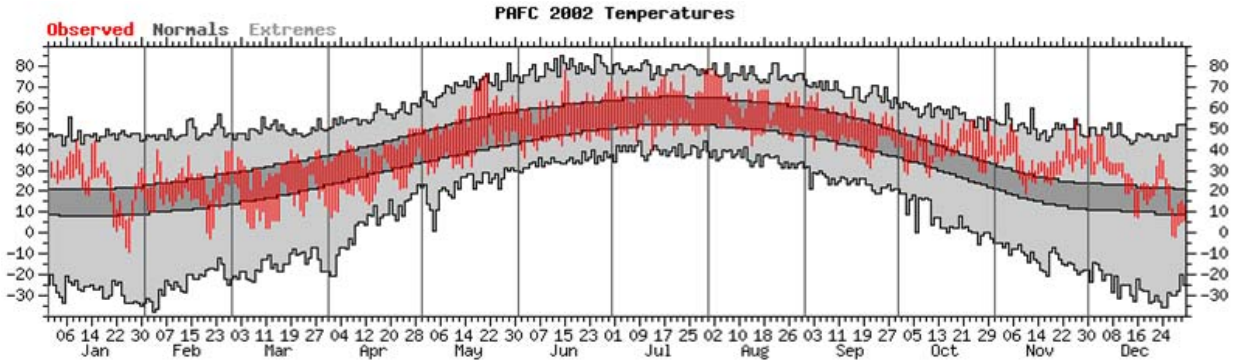
As presented by Tony Barter, P.E. at the Design and Engineering for a Warming World panel discussion January 12, 2007.

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. 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.

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. Bethel, by far the largest community in the region, has the longest climatic record history, dating back to1924. 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.



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

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 8.

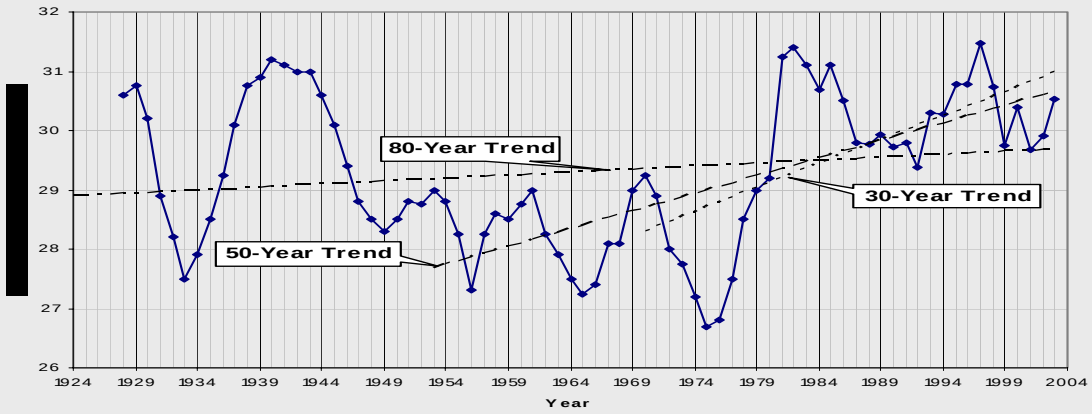


Figure 8
5-Year Running Average Temperatures and Temperature Trends - Bethel, Alaska

Warming trends for Alaska are consistent with forecasts of computer prediction models developed by various agencies. 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.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