Environmental Considerations for Community Development

Community development must consider all environmental factors that affect the engineering design and location of structures, including climate, topography, soils, permafrost, erosion, and flooding.

Climate

Climatic data on winds, precipitation, temperature, and snowfall (Figure 5) allow engineers to design buildings strong enough to withstand heavy winds and deep snow, select type and thickness of insulation to reduce heat loss, and estimate fuel requirements. Climatic data are also needed to determine the type of clothing needed to protect the human body against extreme temperatures.

Chill Factor—If the air temperature is below body temperature, a person loses heat to the atmosphere. When the wind blows, the rate of heat loss increases; therefore, air temperature and wind velocity are the two environmental factors which affect body heat loss. Wind chill data (Figure 6) were developed by combining wind and temperature measurements into numbers which express equivalent chill temperatures.

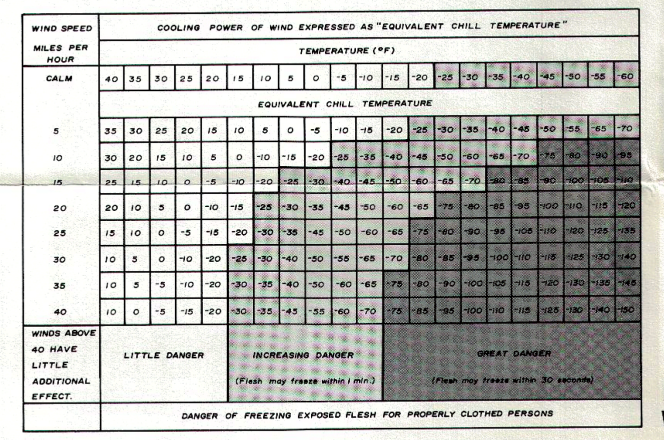


Figure 6
Wind Chill Temperatures

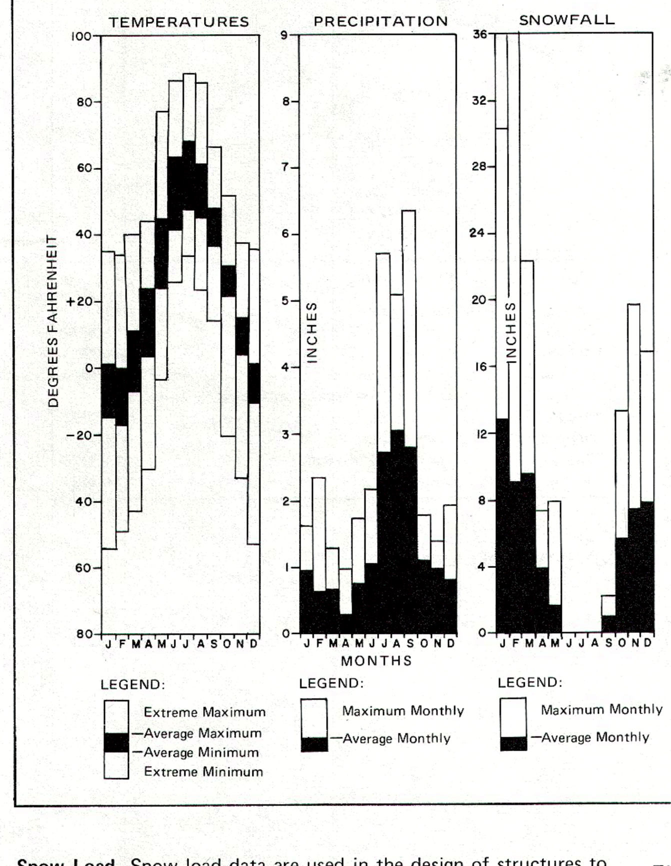


Figure 5
Climatic Data Recorded at Kiana

Note: Kiana is located in the transitional climate zone which is characterized by long, cold winters and cool summers. Temperature extremes of 87°F in summer and -54°F in winter have been recorded, with summer temperatures averaging 60°F. Precipitation averages over 16 inches annually, including 60 inches of snow. There are an estimated 1,354 growing degree days at Kiana, slightly less than the 1,500 considered necessary for large-scale agriculture. However, some vegetables such as potatoes, onions, carrots, lettuce, and cabbage could be grown with fair success. Prevailing winds are easterly in winter and westerly in summer, averaging 10 knots. Additional information on climate is available at the Arctic Environmental Information and Data Center, University of Alaska.

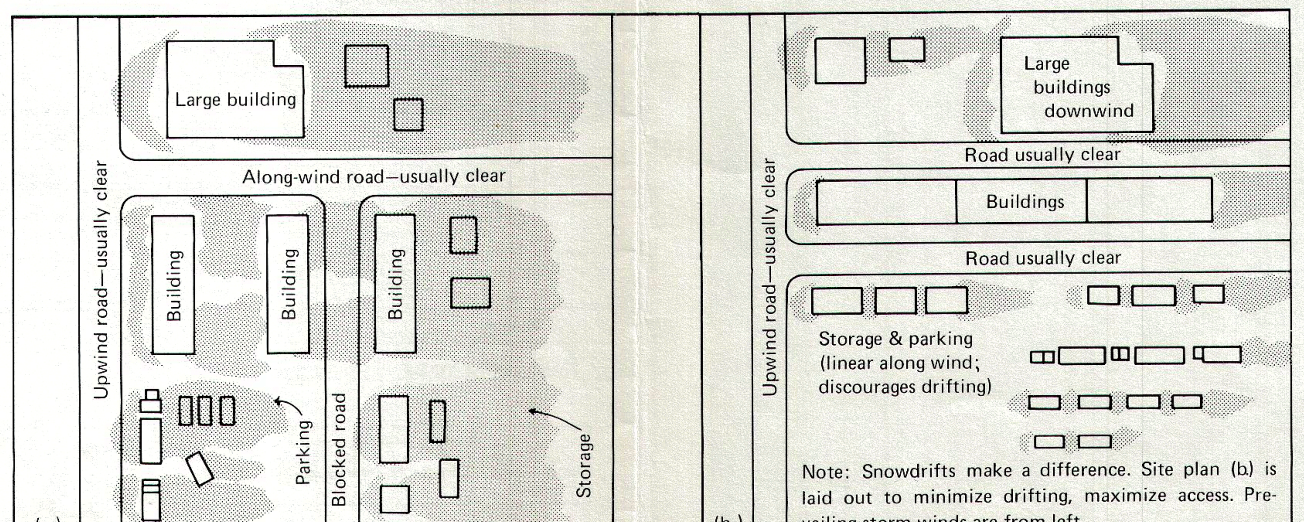
MONTH	Temperature (°F) Means: Daily Maximum	Daily Minimum	Monthly	Extr.: Record Highest	Record Lowest	Precipitation (in inches): Mean	Greatest Daily	Greatest Monthly	Snow, Ice Pellets: Mean	Greatest Daily	Greatest Monthly	Greatest Depth on Ground	Heating Degree Days
(a)	5	5	5	5	5	8	8	8	8	8	8	5	
J	0.9	-14.7	-6.9	34	-54	0.96	0.68	1.66	12.9	8.5	30.3	31	2229
F	-0.1	-16.3	-8.2	34	-49	0.63	0.47	2.39	9.2	12.0	37.8	38	2068
M	10.7	-6.3	2.2	40	-43	0.65	0.42	1.31	9.7	6.0	22.5	44	1947
A	22.7	3.1	12.9	44	-30	0.32	0.33	1.03	4.0	3.0	7.6	54	1563
M	44.8	24.4	34.6	76	-3	0.71	1.38	1.77	1.8	2.5	7.8	23	942
J	62.2	41.9	52.1	85	26	1.05	0.72	2.22	T	T	T	0	387
J	67.7	47.2	57.5	87	33	2.78	1.93	5.75	T	T	T	0	232
A	60.4	45.1	52.7	85	22	3.09	1.45	5.13	T	T	T	0	381
S	47.2	36.4	41.8	66	14	2.84	1.09	6.43	1.1	2.0	2.5	2	696
O	30.5	21.3	25.9	52	-20	1.24	1.01	1.84	5.8	5.0	13.5	8	1212
N	15.4	4.1	9.7	37	-33	1.05	0.91	1.46	7.7	7.5	19.8	13	1659
D	1.4	-10.4	-4.5	36	-52	0.88	0.49	1.99	8.1	6.0	17.1	14	2155
YR	30.3	15.4	22.5	87	-54	16.20	1.93	6.43	60.3	12.0	37.8	54	15471

Snow Load—Snow load data are used in the design of structures to determine the strength needed to withstand the weight of packed snow. The U.S. Army Cold Regions Research and Engineering Laboratory has estimated local ground snow loads in pounds per square foot (psf) for many areas of Alaska. The design load selected depends on the expected use, life span, and occupancy requirements of the building. For example, a five-year life could be selected for a temporary facility. A structure that can withstand 56 pounds of snow per square foot is considered safe for five years in Kiana. A building with a life expectancy of 25 years must be able to withstand a snow load of 77 psf; 86 psf for a 50-year structure; and buildings with an anticipated life of 100 years or more, such as hospitals and other long-lasting, permanent facilities, should be able to withstand 95 psf.

Wind Speed—Information on wind speed and direction is necessary to design and orient airports and other structures. It has been estimated that for a structure with an expected life of 10 years a structural design that could withstand extreme wind speeds of at least 80 miles per hour should be chosen; 90 miles per hour for a structure with an expected life of 25 years; 100 miles per hour for a 50-year life; and 105 miles per hour for a structure with a life expectancy of 100 years or more.

Location of buildings must also consider the direction of wind to minimize snowdrifts (Figure 7).

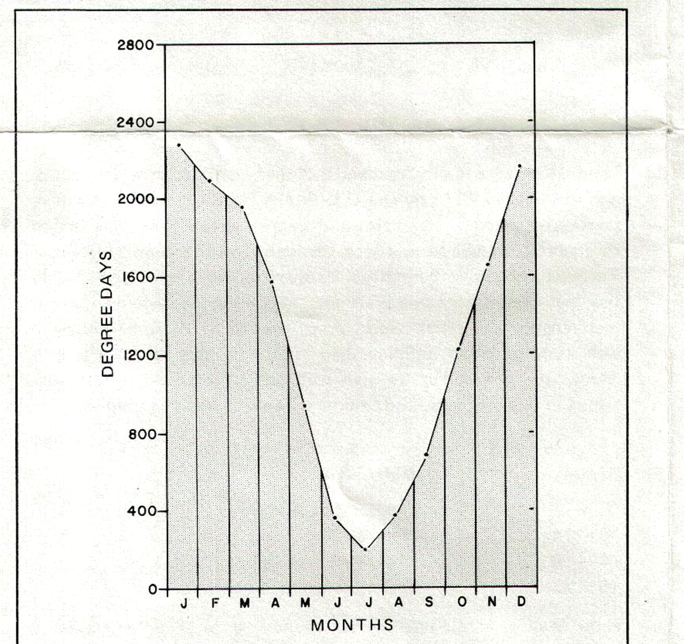
Figure 7
Snowdrifts and Wind Direction



Note: Snowdrifts make a difference. Site plan (b) is laid out to minimize drifting, maximize access. Prevailing storm winds are from left.

Source: Eb Rice, 1975. Building in the North. University of Alaska.

Heating Degree Days—Annual fuel requirements for a heated building can be calculated from heating degree days information. Structural heating usually begins when the air temperature is near 65 degrees F, the index temperature. If a particular day has a mean temperature of 50 degrees F, 15 heating degree days accumulate (65 minus 50). For the entire year the heating load is the sum of the daily degree days. The degree days for each month of the year for Kiana are shown in Figure 8. This information, combined with an inventory of types, sizes, and insulative qualities of buildings, can determine the amount of fuel required for a specific time period in the village.



A rectangular 440-square-foot home insulated with fiberglass requires about 45 gallons of fuel oil for heating during January in Kiana. This estimate is based on four-inch-thick fiberglass in the walls and floor, six inches in the ceiling, and a desired temperature of 70°F inside the home. Fuel consumption could be reduced by adding more insulation, minimizing window sizes, and by installing a subfloor to trap air between the floor and crawl space. Heaters should also be adjusted for efficient burning. Assistance in construction can be obtained from data developed by Dr. Eb Rice, University of Alaska, Fairbanks.

Figure 8
Heating Degree Days—Kiana

Village roads are improved and culverts have been placed to carry surface runoff.

Topography and Soils

Kiana lies on a gently sloping terrace about 100 feet above sea level. The terrace ends abruptly at an 80-foot-high bluff which forms the northwest bank of the Kobuk River. Most of the older homes and community buildings are located in a shallow valley that indents the bluff, providing good drainage and easy access to the river.

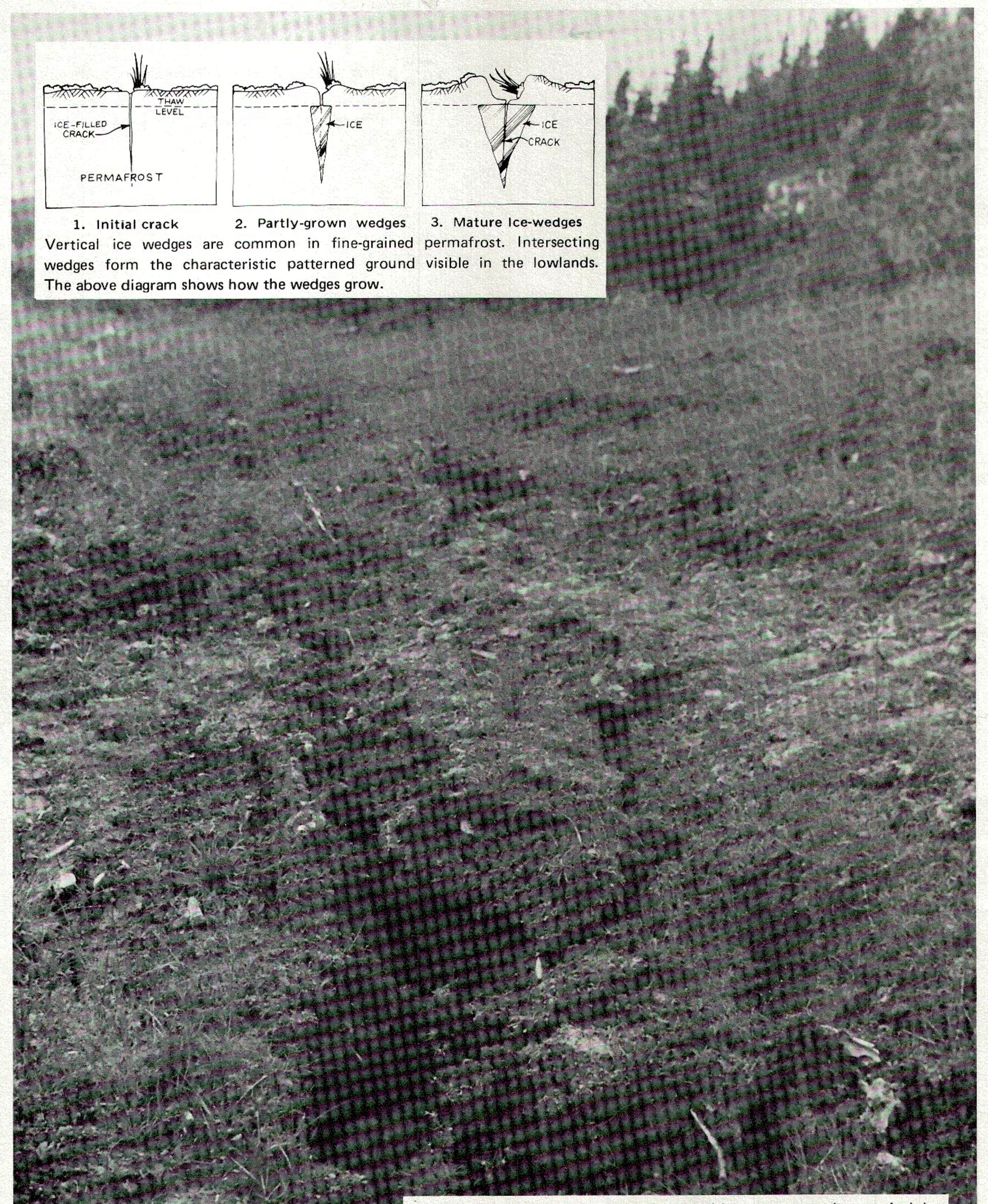
The village is built on frozen sandy silt. Soils under the older homes partially thaw each summer to depths of four to seven feet. The thickness of seasonally thawed ground is much less where tundra vegetation has not been disturbed. Thawed sandy gravel occurs at the base of the bluff along the Kobuk River.

Permafrost—Permafrost (permanently frozen ground) is continuous under the village. The soil is relatively dry and contains few masses of ice. Annual freezing and thawing of the silty soil under the older part of town can cause shifting of buildings on foundations because of the relatively thick thawed layer.

Permafrost should be protected from thawing whenever new structures and utilities are built in the village. The most common methods of protecting permafrost are to place a thick gravel pad between the structure and the frozen ground to limit heat transfer or to raise buildings on pilings to allow air circulation under the structure. Utility pipes should be properly insulated or placed in utilidors so that a minimum of heat transfers from the pipes to the adjacent ground.

Erosion and Flooding—Topography minimizes flooding and erosion problems at Kiana. The village is built atop a bluff that is high enough and far enough back from the active floodplain to be generally safe from erosion or flooding. Culverts have been placed under the roads to carry runoff during breakup and minimize the erosional effects of running water through the village during summer storms. Some slumping and gullies occur in steep spots along the bluff.

The most important thing to remember when building in the Arctic is that successful design requires site investigation and the advice of competent engineers because of the special conditions in the North. Neglecting these considerations can lead to complete failure of structures.



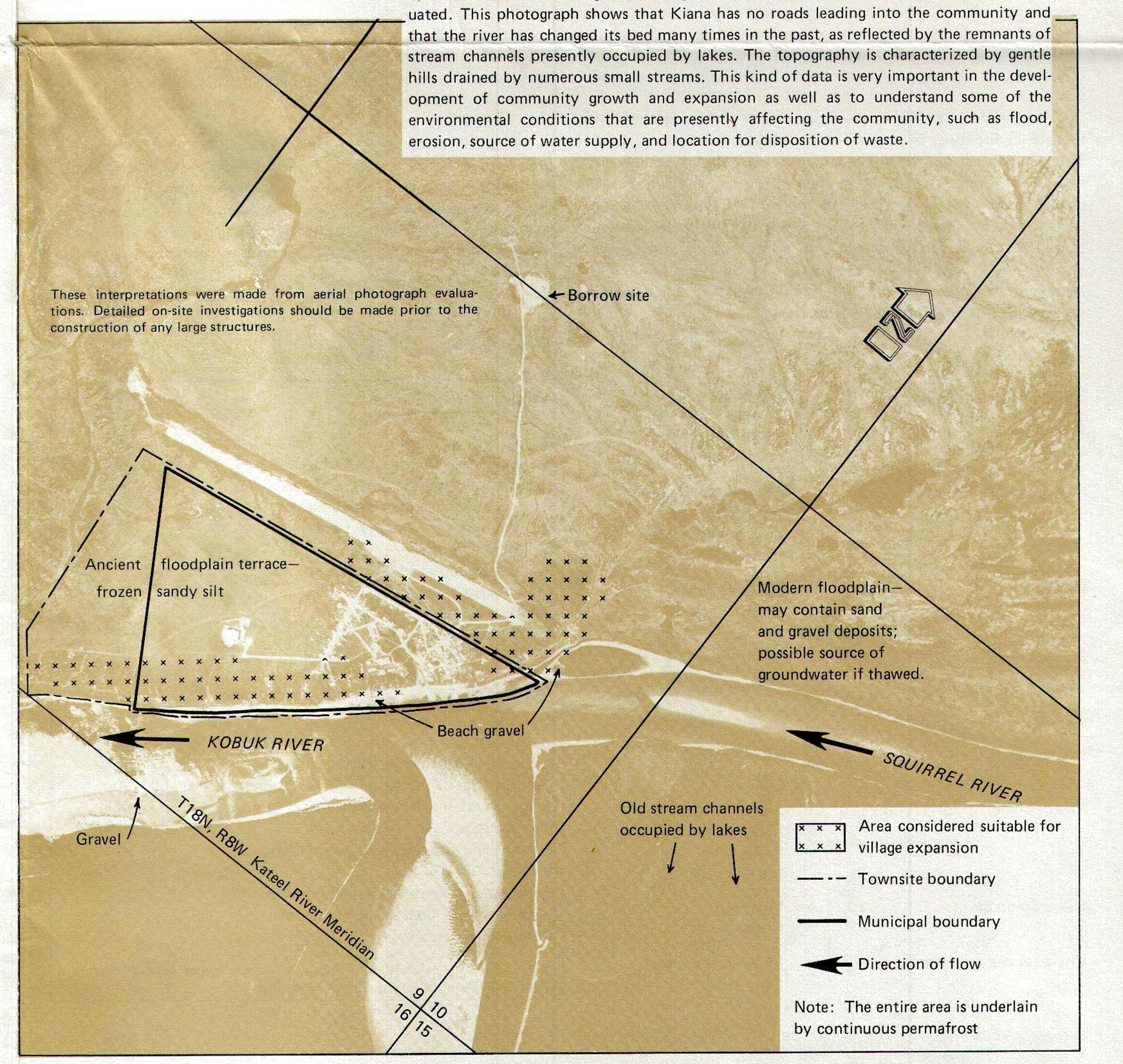
Vertical ice wedges are common in fine-grained permafrost. Intersecting wedges form the characteristic patterned ground visible in the lowlands. The above diagram shows how the wedges grow.

Removal of the surface vegetation at this spot exposed a vertical ice wedge. Thawing and ground subsidence have been the result. The inset diagram shows how ice wedges grow.

Community Base Map—Maps are needed to show land use, ownership, location of utilities, and to plan for future village improvements. These maps can be prepared by either surveying the land on the ground or through enlargement of aerial photos or by a combination of both. Air photos can be taken at various heights. The height determines the extent of the area covered by the photograph.

The Community Base Map was prepared from a photograph taken at a height of 1,800 feet and enlarged to a scale of 1:2,400 (1 in. = 200 ft.). This map was used to locate the present utilities, residential development, and various community structures and can be used in the future to evaluate the area for village expansion and to locate new construction.

The photograph below was taken at a height of 8,400 feet or one inch equals 1,400 feet. From this height the village as well as the land around it can be clearly evaluated. This photograph shows that Kiana has no roads leading into the community and that the river has changed its bed many times in the past, as reflected by the remnants of stream channels presently occupied by lakes. The topography is characterized by gentle hills drained by numerous small streams. This kind of data is very important in the development of community growth and expansion as well as to understand some of the environmental conditions that are presently affecting the community, such as flood, erosion, source of water supply, and location for disposition of waste.



Sources of Information

Alaska. Dept. of Community and Regional Affairs. 1972. *Alaska Community Survey: Kiana*

Alaska. Dept. of Community and Regional Affairs and Alaska Municipal League. 1976. *Alaska Municipal Officials Directory 1976.* 53 p.

Alaska. Dept. of Environmental Conservation. 1976. Data on file related to Village Safe Water Program. Juneau. Unpublished.

Alaska. Div. of Aviation. Various dates. Data and maps on file related to studies made prior to and during construction of the Kiana airstrip. Unpublished.

Alaska. State Housing Authority. Dept. of Planning and Technical Services. 1971. *Statewide Housing Study Volume II: Housing Resources, Housing Related Services, Housing Plan.* 115 p.

Alaska Village Electric Cooperative. Various dates. Data and maps on file related to construction of electric utility, Kiana. Unpublished.

Carlson, A.R. 1970. Heat loss and condensation in northern residential construction. *Northern Engineer.* 2(2):14-17.

Erskiwe, R. 1969. Architecture and town planning in the north. *Northern Engineer.* 1(4):7-11.

Fryer, M.W. 1969. An engineering approach to architectural design for cold regions. *Northern Engineer.* 1(4):11-13.

Mauneluk Association, Inc. 1974. *The NANA Region; Its Resources and Development Potential.* 289 p.

Mirth, R.A. 1974. The sun can heat our homes—even in the north. *Northern Engineer.* 6(3):3-10.

Orth, D.J. 1967. (revised 1971). *Dictionary of Alaska Place Names.* U.S. Geological Survey. Professional Paper 567. 1084 p.

Rice, E. 1975. *Building in the North.* Geophysical Institute, University of Alaska. 66 p.

Selkregg, L.L. et al. 1976. *Alaska Regional Profiles: Northwest Region.* Arctic Environmental Information and Data Center, University of Alaska, Anchorage. Prepared for the Office of the Governor and the Joint Federal/State Land Use Planning Commission. 265 p.

Tobiasson, W. and R. Redfield. 1973. *Alaskan Snow Loads.* U.S. Army. Cold Regions Research and Engineering Laboratory.

U.S. Army. Corps of Engineers. 1976. Flood plain management services, Alaskan communities flood hazard and pertinent data on file. Unpublished.

U.S. Bureau of the Census. 1972. *1970 Census of Population; Detailed Characteristics.* Final Report PC(1)-D3 Alaska.

U.S. National Oceanic and Atmospheric Administration. 1971. *Wind Chill (Equivalent Temperatures).* Environmental Information Series.

U.S. Public Health Service. 1970. *Project Summary: Sanitation Facilities Construction; The Village of Kiana, Alaska.* Project AN-73-621E. Unpublished.