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 services 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 Noatak 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. The terrain reflects the presence of permafrost, and the topography of the area is very flat. 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 of waste disposal sites.

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.

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 geographic location 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 Noatak. 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 span; 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; 98 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).

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 Noatak 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.

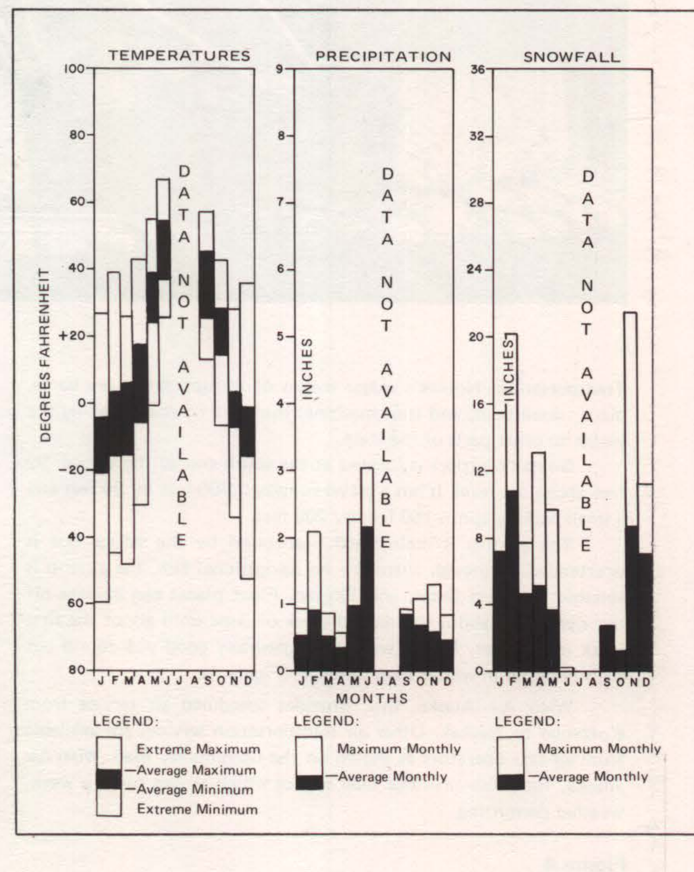


Figure 5
Climatic Data Recorded at Noatak

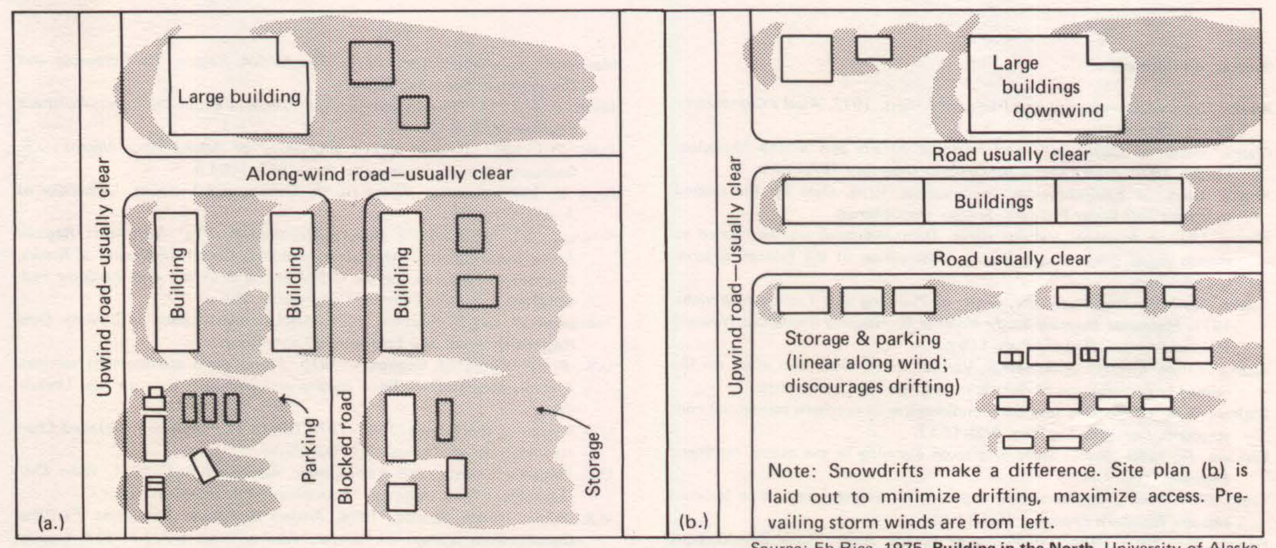
Note: Noatak is on the border between the transitional and continental climate zones and is characterized by long, cold winters and warm summers. It is influenced somewhat by its nearness to the coast—the area is slower to warm up in the spring, and the summer temperatures tend to be cooler than at inland locations. Precipitation averages from 10 to 13 inches annually, including 48 inches of snow. There are an estimated 900 growing degree days at Noatak, less than the 1,500 considered necessary for large-scale agriculture. Prevailing winds average 10 knots annually and are easterly in winter and westerly in summer. 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)	4	4	4	4	4	4	4	4	4	4	4	4	
J	-4.7	-21.4	-13.1	26	-60	0.41	0.40	0.78	6.9	8.0	15.5	26	2421
F	2.5	-16.4	-7.0	39	-45	0.84	0.70	2.05	10.5	5.0	20.0	38	2034
M	5.1	-15.7	-5.3	25	-49	0.43	0.40	0.80	4.4	3.0	7.5	45	2179
A	16.3	-6.1	5.1	41	-31	0.26	0.18	0.48	4.7	4.0	13.0	38	1797
M	39.3	24.6	32.0	55	-2	0.90	0.80	2.20	3.4	3.0	9.5	37	1023
J	54.3	35.2	44.8	67	26	2.10	1.80	2.96	T	T	T	0	606
J	M	M	M	M	M	M	M	M	M	M	M	M	341
A	M	M	M	M	M	M	M	M	M	M	M	M	465
S	45.0	26.1	35.6	57	14	0.72	0.47	0.72	2.5	2.0	2.5	3	882
O	28.1	14.9	21.5	43	-7	0.60	0.37	0.96	1.0	0.5	1.0	3	1349
N	3.0	-7.2	-2.1	28	-35	0.47	0.40	1.20	8.3	8.0	22.5	16	2013
D	-1.1	-15.8	-8.5	35	-54	0.36	0.25	0.69	6.7	3.0	11.0	24	2279
YR	M	M	M	67	-60	M	M	M	48.4	8.0	22.5	45	17389

Figure 6
Wind Chill Temperatures

WIND SPEED (MILES PER HOUR)	COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE" — TEMPERATURE (°F) / EQUIVALENT CHILL TEMPERATURE
CALM	[illegible]
5	[illegible]
10	[illegible]
15	[illegible]
20	[illegible]
25	[illegible]
30	[illegible]
35	[illegible]
40	[illegible]
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT	LITTLE DANGER / INCREASING DANGER / GREAT DANGER
	DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS

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.

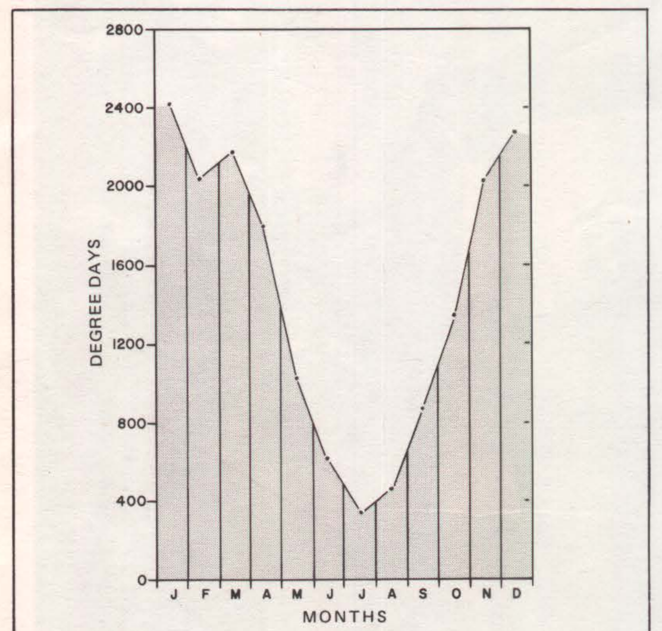
Source: Eb Rice, 1975. **Building in the North.** University of Alaska.

Topography and Soils

Noatak is situated on a low bluff overlooking the Noatak River. The bluff is the eroded edge of an old river terrace that now stands about 20 feet above the modern floodplain. Soils under the village consist of ice-rich frozen sandy silt. Clean, thawed gravels occur in the beaches along the Noatak River.

Permafrost—Permafrost (permanently frozen ground) is continuous under the village. Massive ice is common in vertical lenses that form the boundaries of polygonal ground. Where the vegetation has been stripped away by excavation, the ice lenses have melted, causing the soil to melt, become unstable, and collapse. At the unfinished sewage lagoon, water from melting ice has been drained through a ditch to the Noatak River. Excavation of the ditch allowed ice in the river bank to melt, causing erosion of the bank and siltation of the stream.

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.



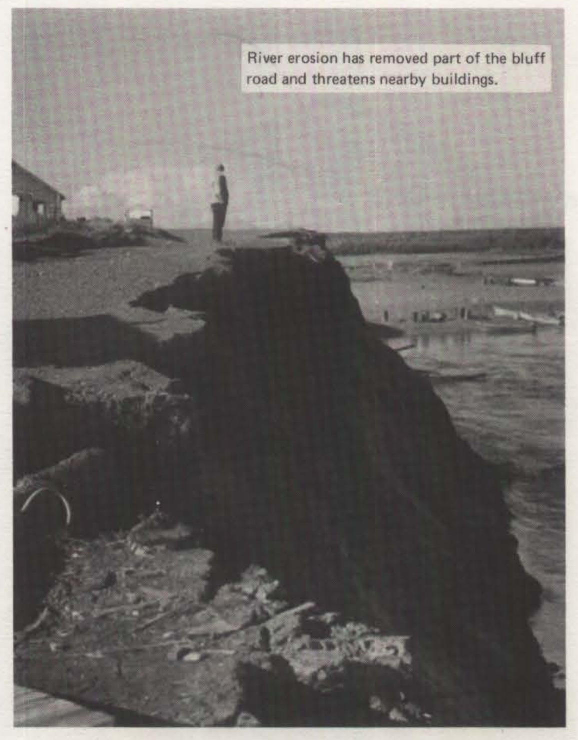
A rectangular 800-square-foot home insulated with fiberglass requires about 70 gallons of fuel oil for heating during January in Noatak. This estimate is based on four-inch-thick fiberglass in the walls and floor, six inches in the ceiling, and a desired temperature of 70°F inside the home. Fuel consumption 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.

Erosion and Flooding—Noatak is located on the concave outer bank of a bend in the Noatak River. The river has already damaged a road along the bluff and threatens several buildings. This natural erosion could be slowed by a structure along the river designed to reduce current velocity and deposit gravel at the base of the bluff. The only alternative to construction of an erosion control structure is to monitor the progress of erosion, eliminate future construction along the edge of the bluff, and move existing structures.

The most common cause of flooding at Noatak is the growth of ice jams downstream during spring breakup. High water can also occur in late August as a result of heavy rain storms. The Corps of Engineers estimates that floods to 15 feet above the normal channel height can occur every five to 20 years. At this flood level, 10 percent of the village is covered with water. Floods up to 25 feet high can be expected every 20 to 100 years. The Corps of Engineers estimates that the Noatak River floodplain has an average to low flood hazard.

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.

Figure 8
Heating Degree Days—Noatak



River erosion has removed part of the bluff road and threatens nearby buildings.