Environmental Considerations for Community Development

Community development must consider all environmental factors that affect the engineering design and location of structures, including climate and geological setting—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

WIND SPEED MILES PER HOUR	COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE" — TEMPERATURE (°F)																				
CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
	EQUIVALENT CHILL TEMPERATURE																				
5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-65	-70
10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT.	LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 min.)						GREAT DANGER (Flesh may freeze within 30 seconds)									
	DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS																				

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 87 pounds of snow per square foot is considered safe for five years in Shungnak. A building with a life expectancy of 25 years must be able to withstand a snow load of 132 psf; 152 psf for 50 years; 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 172 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 62 miles per hour should be chosen; 70 miles per hour for a structure with an expected life of 25 years; 75 miles per hour for a 50-year life; and 82 miles per hour for a structure with a life expectancy of 100 years or more.

In locating buildings, consideration must be given to the direction of wind to minimize snowdrifts (Figure 7).

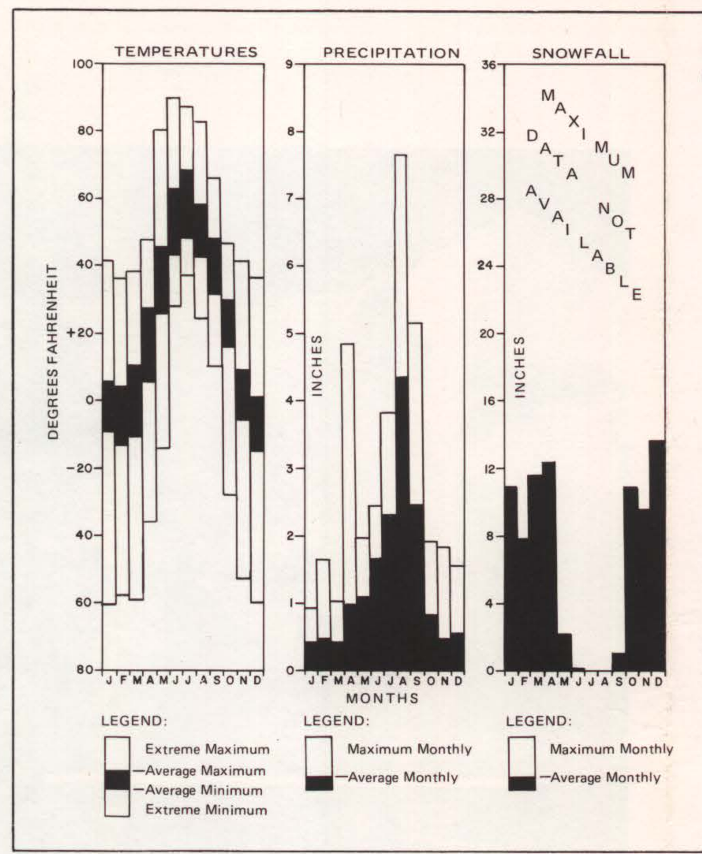
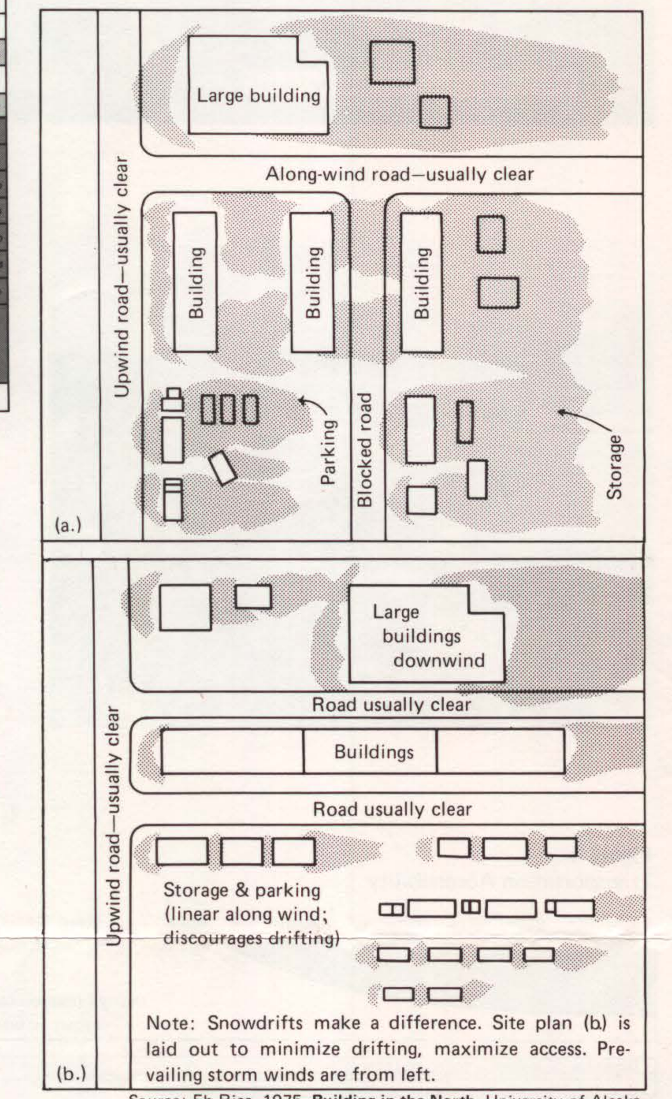


Figure 5
Climatic Data Recorded at Shungnak

Note: Shungnak is located in the continental climate zone which is characterized by long, cold winters and relatively warm summers. Temperature extremes of 90°F in summer and -60°F in winter have been recorded. Precipitation averages 16 inches annually, including 80 inches of snow. There are an estimated 1,289 growing degree days at Shungnak, less than the 1,500 considered necessary for large-scale agriculture. Prevailing winds average five knots annually and are east-northeast most of the year but westerly in June, July, and August. 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)	9	9	9	9	9	8		8	8				
J	5.7	-9.3	-1.8	41	-61	.43	NOT AVAILABLE	.90	10.9	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	2071
F	5.2	-12.8	-3.8	36	-58	.46		1.61	7.9				1944
M	11.0	-10.1	0.4	38	-59	.42		1.01	11.6				2003
A	26.6	5.8	16.2	48	-36	1.02		4.87	12.4				1464
M	45.7	26.3	36.0	80	-16	1.09		1.99	2.0				899
J	63.3	43.0	53.2	90	26	1.66		2.47	T				354
J	68.6	48.4	58.5	87	37	2.35		3.85	0				202
A	58.1	42.3	50.2	83	25	4.40		7.67	0				459
S	48.1	32.0	40.1	66	10	2.52		5.19	0.9				747
O	30.0	16.7	23.3	47	-28	.84		1.95	11.0				1293
N	9.6	-5.6	2.0	41	-53	.48		1.84	9.6				1890
D	1.2	-14.0	-6.4	37	-60	.55		1.58	13.6				2213
YR	31.1	13.6	22.3	90	-61	16.22		7.67	79.9				15539

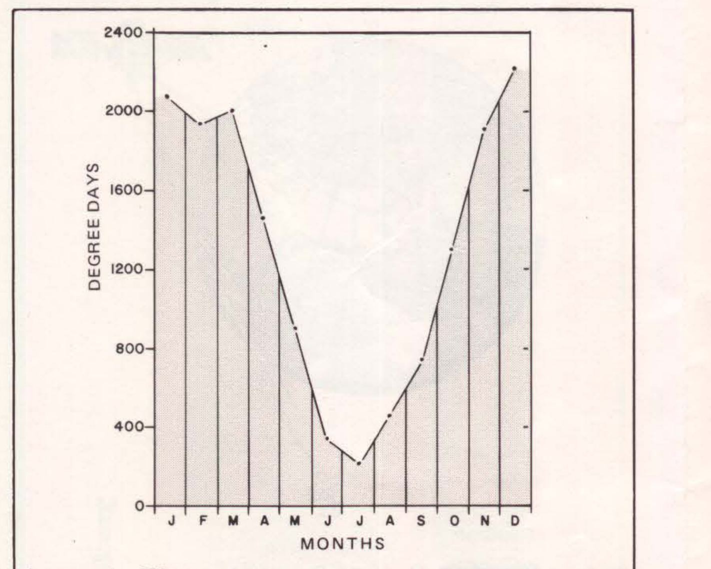


Note: Snowdrifts make a difference. Site plan (b) is laid out to minimize drifting, maximize access. Prevailing storm winds are from left.
Source: Eb Rice, 1975. **Building in the North.** University of Alaska.

Figure 7
Snowdrifts and Wind Direction

Insulation around pipes prevents freeze-up and protects the surrounding frozen ground from melting. These urethane foam insulated pipes will be used in the new housing scheduled for construction in 1977.

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 Shungnak 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 960-square-foot home insulated with fiberglass requires about 85 gallons of fuel oil for heating during January in Shungnak. 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—Shungnak

Topography and Soils

Part of Shungnak is located on the active floodplain of the Kobuk River. The newer part of the village, however, is located on the higher land adjacent to the present floodplain. The upland area is probably part of an abandoned floodplain of the river and is composed principally of sandy silt. Locally, the soil is coarser and has been excavated for fill as shown in the aerial photograph. Gravel occurs along bars and beaches of the river and may also be present in the active floodplain. The highland area seems to be locally well drained where trees and other vegetation are present.

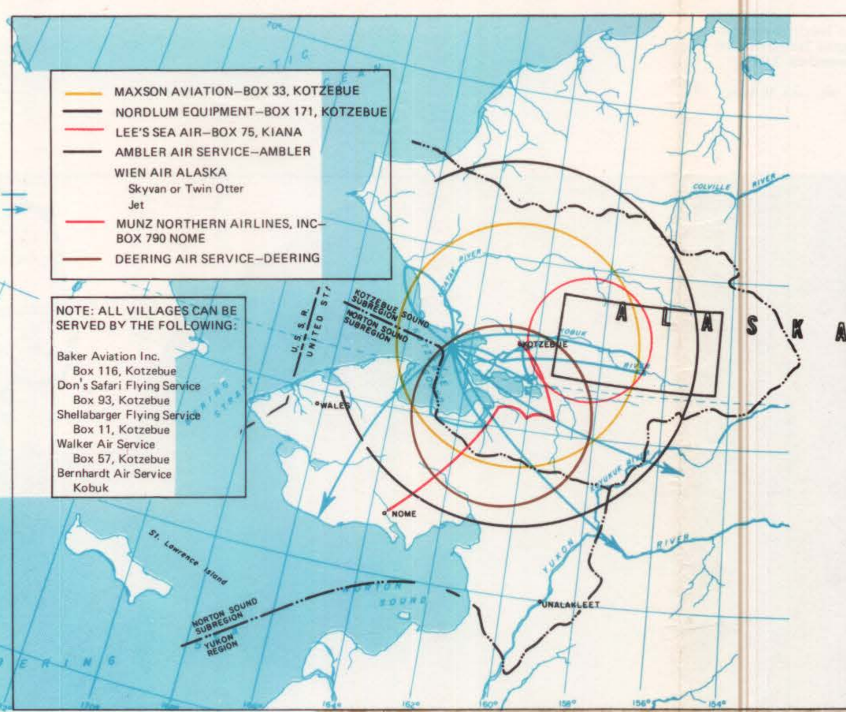
Permafrost—Permafrost (permanently frozen ground) is continuous under most of the area. Major engineering problems arise when permafrost occurs in fine-grained, poorly drained material. These sediments can contain large amounts of ice. If the ice melts, the soil will become unstable and may move.

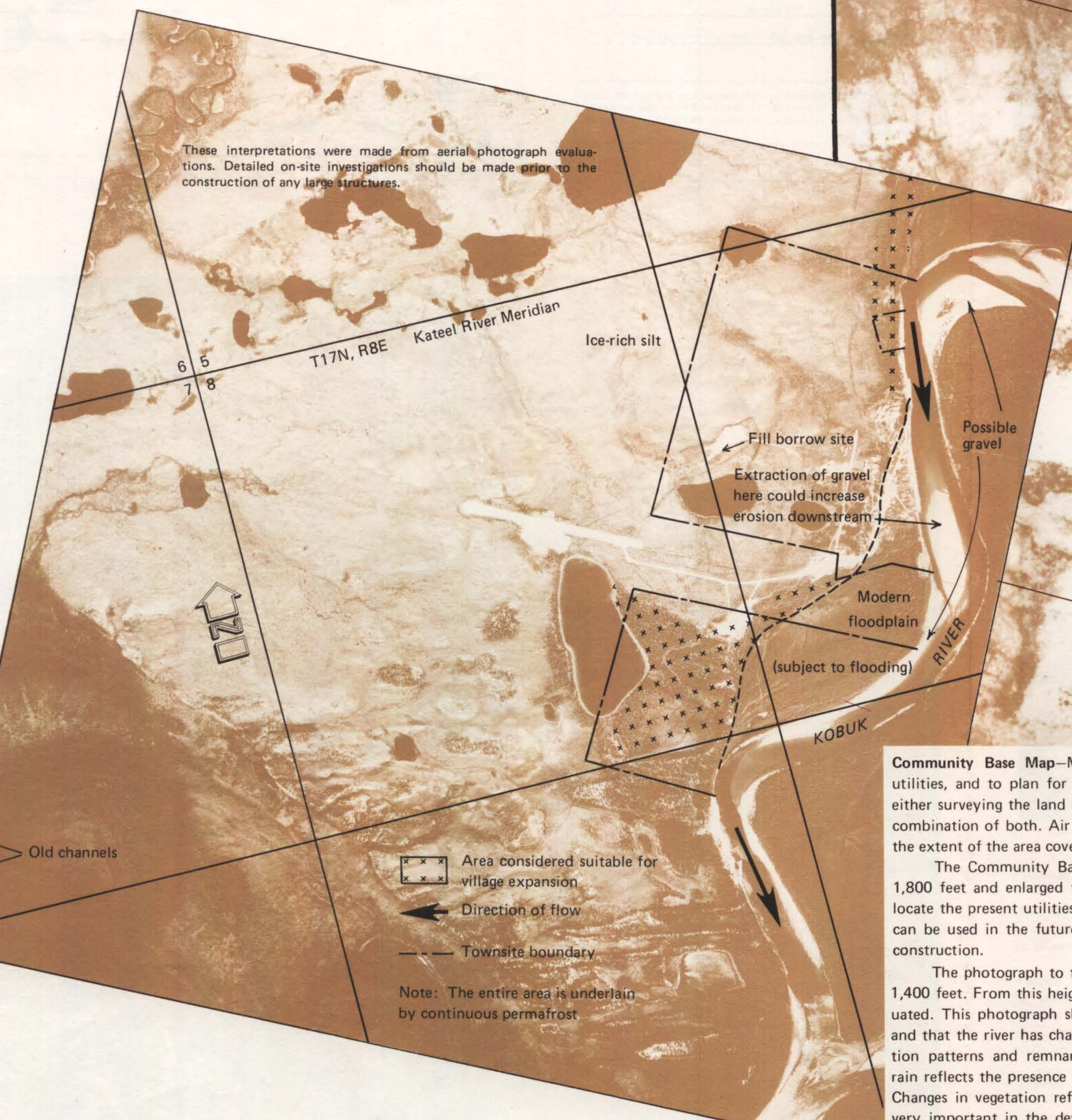
Permafrost should be protected from thawing whenever new structures and utilities are built in the village. The most common methods of protecting permafrost are to place a thick gravel pad between the structure and the frozen ground to limit heat transfer or to raise buildings on pilings to allow air 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.

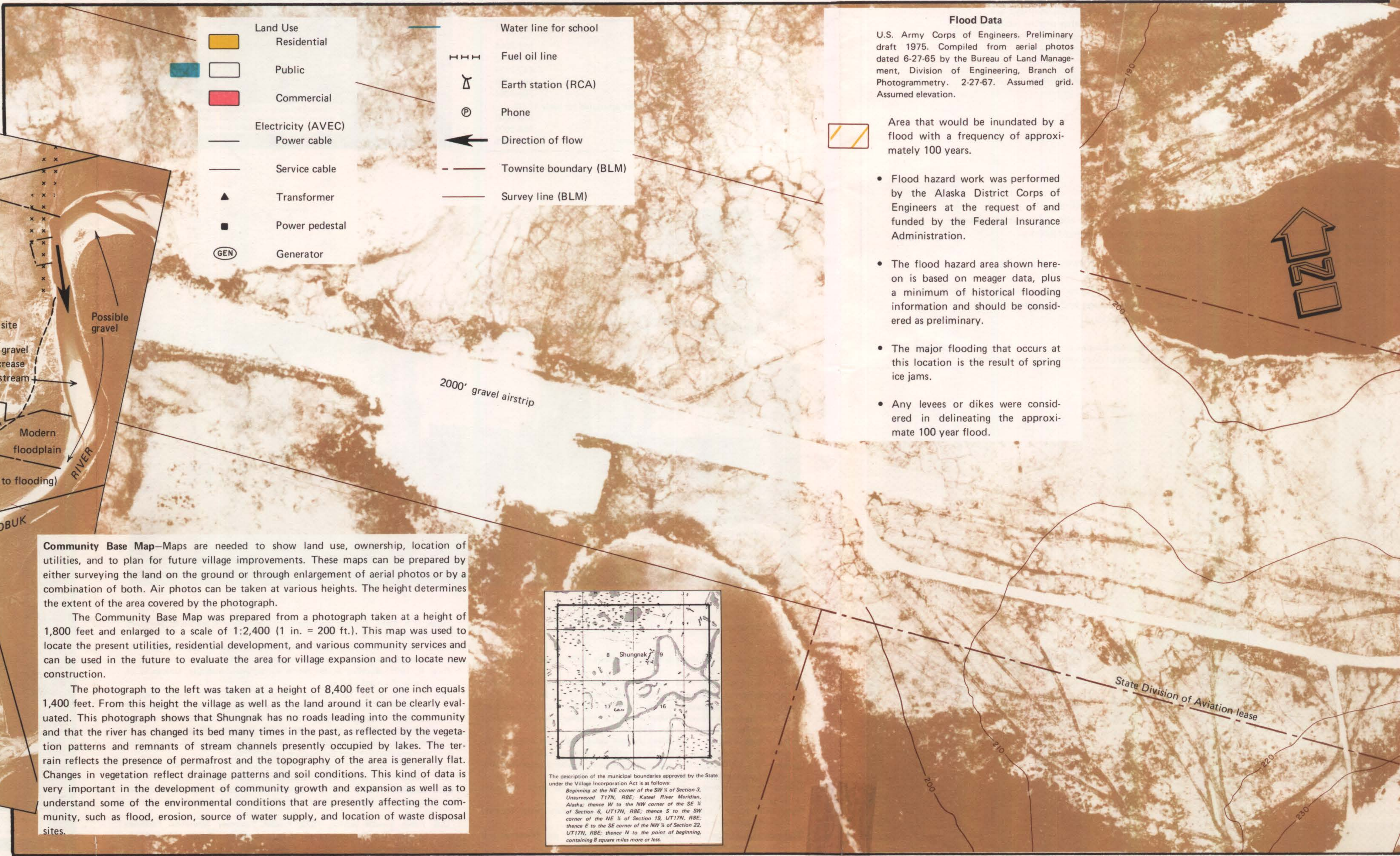
Erosion and Flooding—The newer portion of the village is built atop a bluff that is high enough and far enough back from the active floodplain to be generally safe from erosion or flooding. However homes and equipment stored at the base of the bluff are subject to flooding during periods of high water. This has necessitated the construction of new homes on higher ground to replace residences endangered by possible floods. The straight coarse of the Kobuk River at Shungnak minimizes bank erosion. Some slumping occurs 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.

River erosion is not a serious problem at Shungnak. Some slumping occurs in sandy soils along the bluff as a result of spring runoff and thawing.







Flood Data

U.S. Army Corps of Engineers. Preliminary draft 1975. Compiled from aerial photos dated 6-27-65 by the Bureau of Land Management, Division of Engineering, Branch of Photogrammetry. 2-27-67. Assumed grid. Assumed elevation.

Area that would be inundated by a flood with a frequency of approximately 100 years.

- Flood hazard work was performed by the Alaska District Corps of Engineers at the request of and funded by the Federal Insurance Administration.
- The flood hazard area shown hereon is based on meager data, plus a minimum of historical flooding information and should be considered as preliminary.
- The major flooding that occurs at this location is the result of spring ice jams.
- Any levees or dikes were considered in delineating the approximate 100 year flood.

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 to the left 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 Shungnak has no roads leading into the community and that the river has changed its bed many times in the past, as reflected by the vegetation patterns and remnants of stream channels presently occupied by lakes. The terrain reflects the presence of permafrost and the topography of the area is generally flat. Changes in vegetation reflect drainage patterns and soil conditions. 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.

COMMUNITY MAP
SHUNGNAK

66°52'N 157°09'W Elevation 200' (at airstrip)

Scale: 0–400 Feet; 0–150 Meters

Prepared by the Arctic Environmental Information and Data Center, University of Alaska, for the Alaska Department of Community and Regional Affairs

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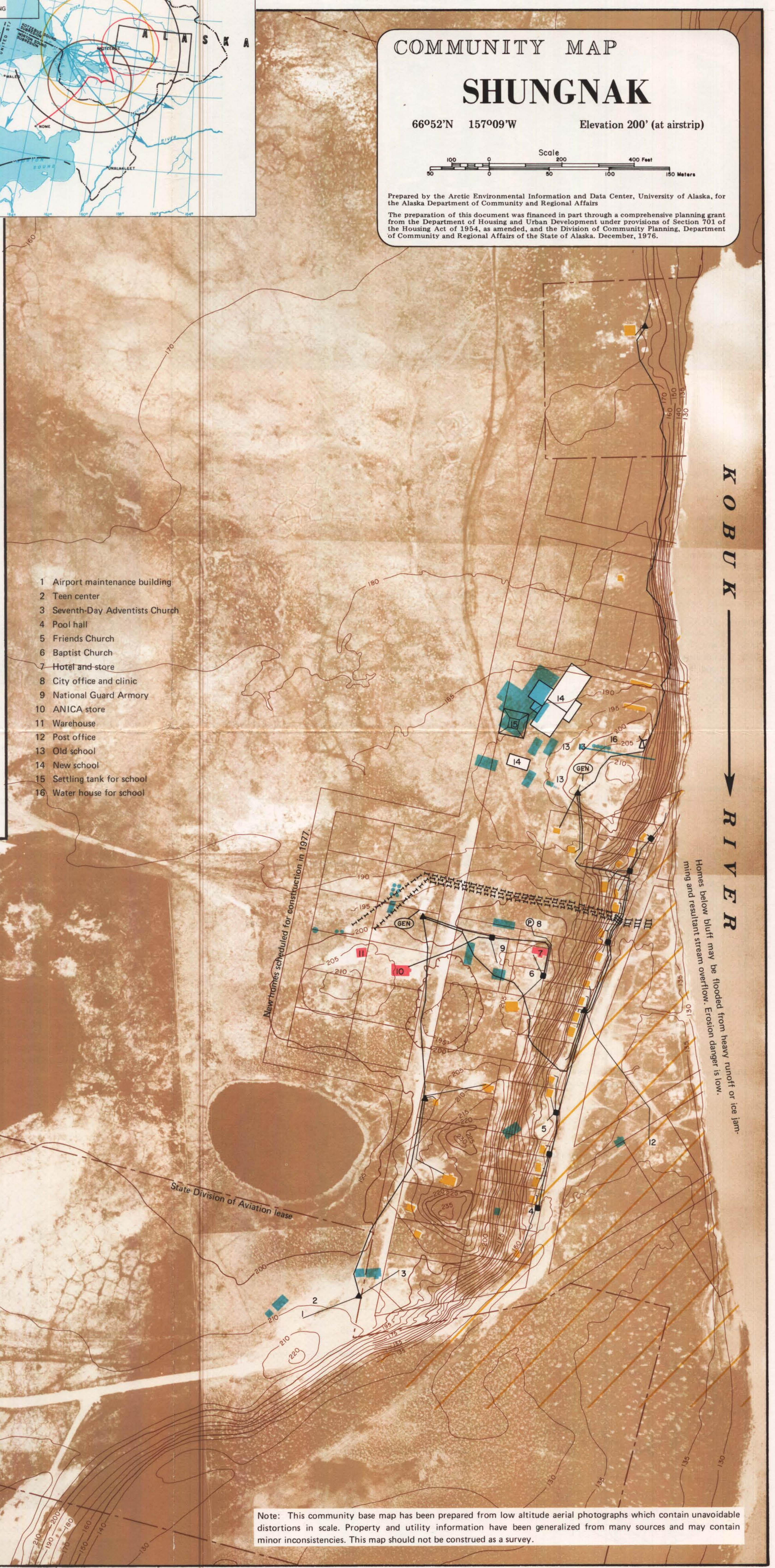

1 Airport maintenance building
2 Teen center
3 Seventh-Day Adventists Church
4 Pool hall
5 Friends Church
6 Baptist Church
7 Hotel and store
8 City office and clinic
9 National Guard Armory
10 ANICA store
11 Warehouse
12 Post office
13 Old school
14 New school
15 Settling tank for school
16 Water house for school

Note: This community base map has been prepared from low altitude aerial photographs which contain unavoidable distortions in scale. Property and utility information have been generalized from many sources and may contain minor inconsistencies. This map should not be construed as a survey.