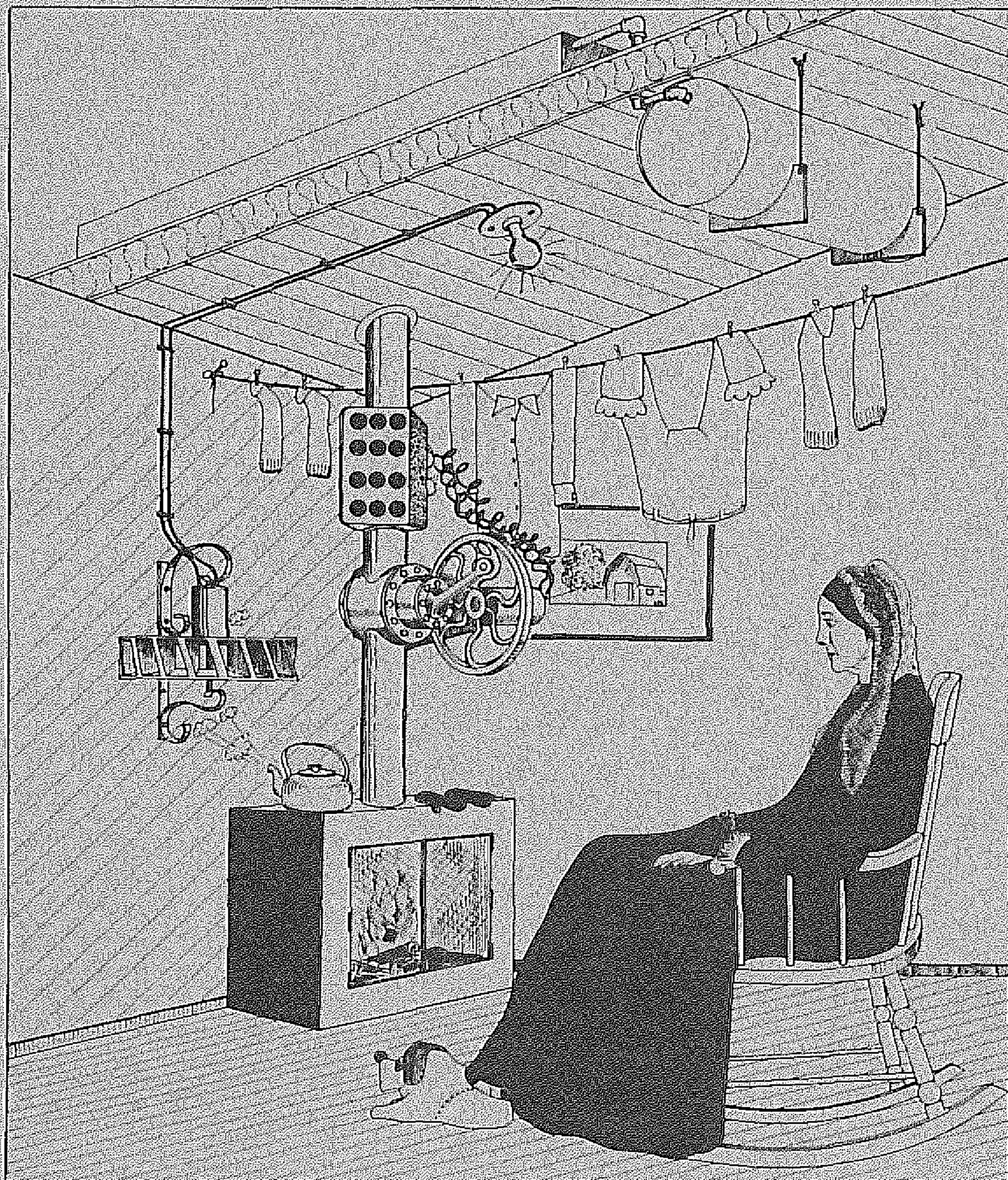
A Builder's Guide To Water and Energy



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The cover illustration by Bill Erkelens portrays a number of energy alternatives. Some, like the wood-powered clothes drier, are traditional. Avant-garde approaches include a solar hot water heater. Perhaps the steam generator and Stirling engine with flywheel are just a bit fanciful.

A BUILDER'S GUIDE TO WATER AND ENERGY

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ABSTRACT

Information on water and energy, while theoretically available to the Alaskan home builder and property developer, has been difficult to glean from widely diverse sources. A Builder's Guide to Water and Energy discusses this variety of planning considerations (from selecting a lot to the fine points of energy conservation) in the chronological order needed by a builder. Selecting the actual building site, water access, sewage disposal, energy access, energy conservation, tax credits, and government regulations are all discussed. The Guide provides step-by-step assistance for developing a site and building upon it, while taking maximum advantage of a site's best characteristics and minimizing its shortcomings.

Key Words: Energy, *Water law, *Water rights, *Available water, Consumer information, *Alaska, Reviews, Information retrieval, Energy conservation, Sewage disposal, Septic systems, *Alternative energy, Renewable energy, Builder's Guide to Water and Energy, Solar, Passive solar.

INTRODUCTION

This guide is designed to aid those who are developing or improving a piece of property in Alaska. It will also be useful to anyone who is considering investing in Alaskan property, especially those who are building in urban or suburban areas.

Site factors are often overlooked in purchasing or developing land. Furthermore, identifying and obtaining the appropriate permits (including borough or city zoning requirements, rights-of-way, and water rights certificates) is a necessary but time-consuming prerequisite to construction. This book is a guide to development and construction options, required permits, and regulations. It is generally directed at residents of urban Alaska and the organized boroughs, as there are many requirements for developing sites in these areas. Yet the basic information is useful for all residents, and should facilitate any development project.

This book was designed by considering the order in which resource information would be needed by the builder. The first section therefore deals with site characteristics of the land to be developed. Permafrost is treated as a major consideration because it is a unique problem for developers who have little or no previous experience with it. Water access, sewage systems and energy access are presented in the following sections. Energy conservation and special considerations for Alaska are discussed in the final section, as well as state and federal energy tax credits available to builders.

SITE DEVELOPMENT

Aspect, Slope, Soil Conditions

The development potential of a site can be determined by asessing a number of site factors.

What is the aspect of the land (does it face south, east, west, or north)? This can be determined by checking the site personally with a magnetic compass, or by examining a topographic map, which can be purchased from the U.S. Geological Survey in Anchorage, Fairbanks, and Juneau. By timing your visit near noon (on standard time), the sun should be close to due south. The aspect of the land determines other characteristics including soil type, vegetation, and drainage. North aspect gets markedly less sun, trees are often smaller, and permafrost (described in detail later) is often present at the more northerly latitudes.

What is the slope of the land? Steep slopes can be a problem during spring breakup when excavated areas become soft and eroded. Slope of the land is best determined by onsight inspection. Often steep slopes cannot be adequately described on topographic maps because of the scale.

What are the soil conditions? Soils have three important characteristics: texture, moisture content, and temperature (related to permafrost). Some soils also have properties that make them earthquake hazards. Certain clay soils in Anchorage liquified during the violent shaking of the 1964 earthquake and "failed" (yielded their normal support), causing destruction of buildings. The best source of soils information is the U.S. Department of Agriculture's Soil Conservation Service (SCS). The SCS has offices in Palmer and Fairbanks. The Palmer office has a catalog of the state soil surveys and is also the best source of information for the Anchorage area. An "Exploratory Survey" of the state is available, which may be of some help in assessing the soil conditions in rural areas.

The SCS publishes detailed reports on soil conditions in the urban areas of the state, called "Soil Surveys." The main geographic areas of the surveys have often been those areas of the state that have agricultural potential. Farmers and those who are interested in agricultural development can learn a great deal about soils from the soil surveys, including identification of the soils on their farm. They can then learn how to manage these soils and what yields can be expected. The soil survey can also aid newcomers. Additional information about the climate and other features of the survey area are given in the section "General Characteristics of the Area."

Further information on soil conditions and permafrost possibilities can be obtained from the following U.S. Soil Conservation Service offices in Alaska:

Anchorage: 824 S. Chugiak
Palmer, AK 99645
Phone: 745-4271

Fairbanks: 1760 Westwood Way
Fairbanks, AK 99701
Phone: 479-6767

Permafrost

Permafrost, or permanently frozen ground, is found in most of Alaska. It is continuous in the Arctic and becomes discontinuous and then sporadic or isolated as one proceeds south. Only the southern coasts and the Susitna Valley are free of permafrost. Permafrost is defined as that part of the lithosphere in which a naturally occurring temperature below 0°C (32°F) has existed for two or more years. This definition does not include moisture as a necessary ingredient, so an area of solid rock or well-drained gravel free of moisture is classified as permafrost if it meets the definition above. However, most permafrost contains ice in quantities ranging from partial filling of the soil pore space to massive formations of segregated ice.

Formation and maintenance of permafrost requires a mean annual temperature below freezing. Ground shading and insulation by ground cover (such as mosses) are favorable to the formation and maintenance of permafrost. Once permafrost is established, it stops the infiltration of groundwater and forces melt and rain water to escape by surface drainage. The mossy vegetation which then grows impedes surface drainage, so permafrost areas develop marsh and tundra characteristics.

The ground near the surface that goes through an annual freeze-thaw cycle is called the "active layer" and is from a few inches to several feet thick. Permafrost lies below the active layer, or depth of summer thaw, and extends from a few feet thick in the south to over 1,000 feet in the Arctic. Depths of permafrost are locally variable in the discontinuous and sporadic permafrost zones and depend upon exposure, ground cover, soil characteristics, and other factors.

Measured depths in Alaska (where two or more values are known, the maximum depth is given) include 100 feet near Tok, 175 feet near Dillingham, 265 feet near Fairbanks, 350 feet near Nome, 600 feet at Bethel, 1200 at Cape Thompson, and 1330 feet near Point Barrow.

Permafrost is very important in the engineering and design of structures such as pipelines, roads, and railroads. Particularly in fine-grained soils, the frozen ground forms an extremely strong and stable foundation material if it is kept in the frozen state. However, if the permafrost is allowed to thaw, the soil becomes extremely weak and foundation failures are very common. Engineering practice in permafrost areas uses three approaches:

1. Avoid it. Particularly in the subarctic zones of discontinuous and sporadic permafrost, areas free of permafrost can be found.
2. Destroy it. By stripping the surface vegetative cover, the depth of thaw can be greatly increased and the upper levels of permafrost destroyed over a period of years. In other cases, permafrost soils are excavated and the area refilled with coarse materials.
3. Preserve it. Buildings are built on piles so there is no thermal path for heat to travel from the building to the ground. Roads and airports can be built up with gravel fill so that the permafrost below is protected from summer thaw even though the surface vegetation has been destroyed. Refrigeration can be used to maintain low ground temperatures.

Permafrost is especially hazardous to the unsuspecting site developer. The indicators for permafrost are not fool-proof, but a combination of certain factors should make one suspicious enough to have a coring test done on the site. These indicators of possible permafrost conditions are:

1. Short stunted trees, usually black spruce or shrubby willow species, with a thick mat of vegetation such as sphagnum mosses, lichens, blueberries, and cloudberries. Trees are rarely more than 15- to 20-feet tall. On severe permafrost sites, trees are 10-feet tall or less.
2. Marshy conditions, low-lying, relatively flat land with poor drainage, often in bottomlands near small tributary streams.
3. North aspect slopes.

These are the common vegetative and geographic indicators. Neighboring homes that have had foundation or sewage disposal problems should also be considered as strong warning indicators. Known areas of permafrost are mapped in Figure 1.

The best basic book to read before beginning site development is "Building in the North" by Dr. Eb Rice. The book is available for $4 through the Northern Engineer Magazine, c/o the Geophysical Institute, University of Alaska, Fairbanks 99701.

Another excellent information source is the "Environmental Atlas of Alaska," which can be purchased for $16.00 plus $1.75 postage and handling from the Editor, Institute of Water Resources, University of Alaska, Fairbanks 99701.

Permit Requirements

One of the complications of urbanization is the increasing control over certain activities of private landowners. Alaska is no exception. The following permits are described in the "Directory of Permits" (Alaska Department of Commerce and Economic Development and Alaska Department of Environmental Conservation, 1979):

Source: Ferrians (1965)

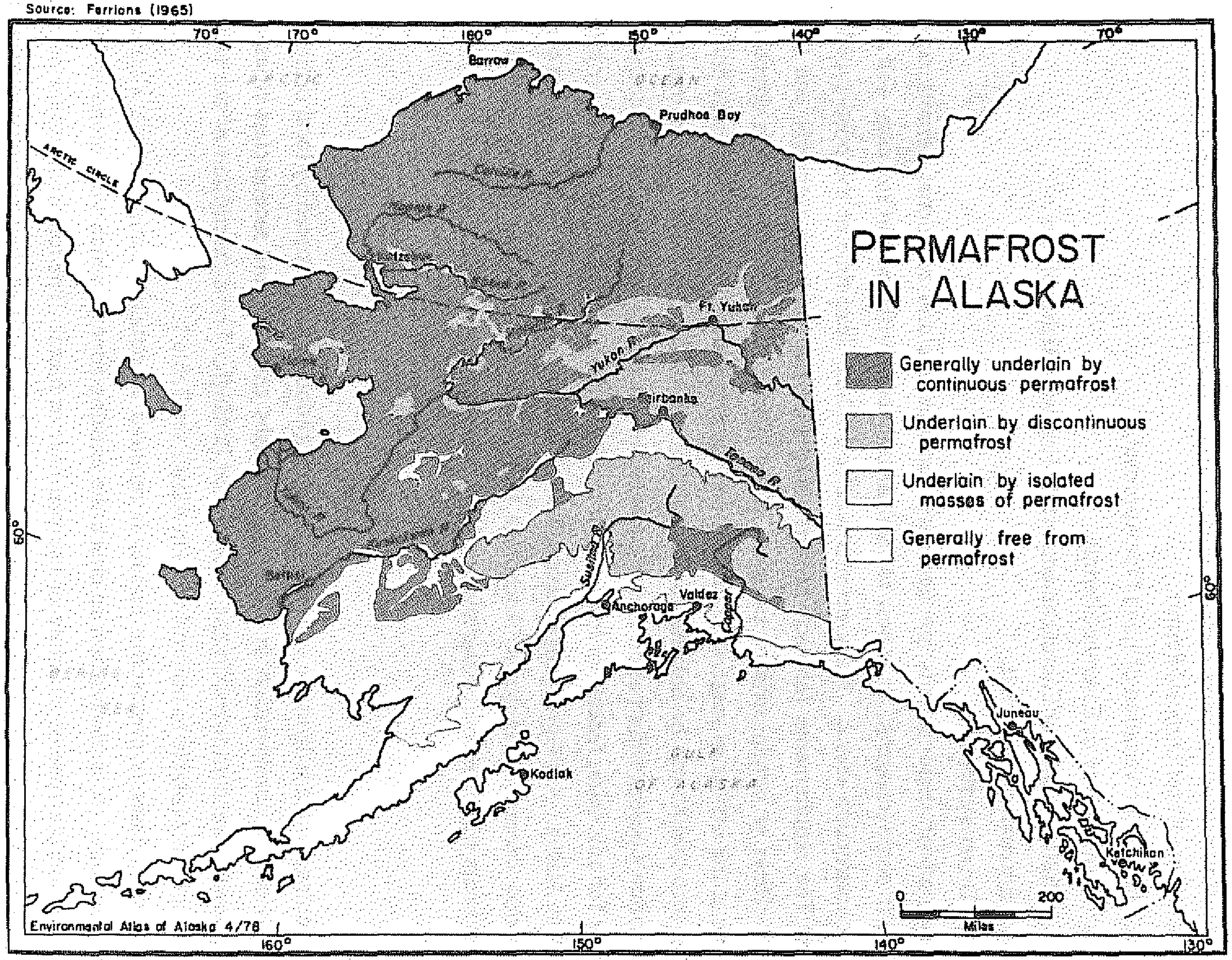


Figure 1. Known areas of permafrost in Alaska (from Hartman and Johnson, 1978).

1. Solid Waste Disposal Permit.
2. Subdivision Plan Review.
3. Waiver of Subdivision Plan Review.
4. Waste Water Disposal Permit.
5. Change or Vacation of Land Plot Approval.
6. Right-of-Way or Easement Permit.
7. Utility Permit for Encroachment within Highway Rights-of-Way.
8. Encroachment Permit.
9. Driveway Permit.

Not all of these permits are necessary for each site and additional permits may be required in some instances. It is best to familiarize oneself with them in any case, well ahead of the construction season. Many permits require a 60-day lead time or the posting of legal notices. The requirements for each permit, along with the legislative authority and list of contact offices to obtain permits, are given in the "Directory of Permits." This directory is available at the offices of most state, federal and local agencies and state depository libraries. Further information can be obtained by contacting the Alaska Department of Environmental Conservation's permit information centers, located in Anchorage and Juneau. Information is available for any state, federal, or local permit needed for an industrial, commercial, or private project in Alaska. A direct-dial or collect call to 465-2615 will connect callers with the permit information center in Juneau; in Anchorage the number is 279-0254. Calls received after business hours will be recorded and answered the following work day.

Zoning

Zoning, which is land use control in a neighborhood, is administered by local ordinance. Zoning is only a consideration in organized boroughs and first- and second-class cities. No zoning powers are authorized in the unorganized borough. For a description of the various political options available to political units in Alaska see Table 1.

In most cases, a prospective builder is required to obtain a zoning permit, a building permit, or both. It is always best to check the existing zone in which you intend to build. Does it permit the type of structure or use you have in mind? The requirements for permits are intended to make site developers aware of the zoning status of their property in order to avoid possible conflicts and inappropriate land uses in zoned areas. Zoning may also limit the parcel size of subdivisions and the size and type of building that may be constructed. For all these reasons, it is best to be fully aware of the zoning status of your property before attempting to develop it.

Usually a borough or city maintains a record of the status of land plats for tax purposes. These status plats are public information and are also dated as to the most recent property tax

TABLE 1:

Options of Municipal Governments (General Law*)

Name	Requirements	Local Action Needed	Available Powers (Services)	Municipal Officers
Unorganized Borough	Areas of the state which are not within the boundaries of an organized borough constitute a single unorganized borough.	None – established by the State Constitution.	The legislature may establish service areas for special services which include, but are not limited to, schools, utilities, land use regulations, fire protection. Service areas can be established by request of local citizens.	Legislators are the assemblymen of the unorganized borough.
Unified Municipality	An organized borough and all cities included within it may unite to form a single unit of home rule local government called a unified municipality.	A unified municipality may be initiated through a petition process. A charter commission, if approved by referendum, drafts a charter for the unified municipality. Following public hearings, an election is held.	A unified municipality has all powers granted to organized boroughs and cities of the first class not prohibited by law or charter.	Elected assembly. Elected school board. Commissions as established by charter. May adopt the manager plan of government.
First class Borough	Area may incorporate as an organized borough if it conforms to the following standards: 1. Population of the area is interrelated, integrated as to its social, cultural, and economic activities, and is large and stable enough to support organized government. 2. The boundaries of the proposed borough conform generally to natural geography and include all areas necessary for full development of local services. 3. The economy of the area includes the human and financial resources capable of providing local services. 4. Land, water, and air transportation facilities allow for communication and exchange necessary for the development of integrated local government.	A borough may be established by filing a petition to the Dept. of Community & Regional Affairs signed by 15 percent of the resident voters in each first class city and 15 percent of the voters outside first class cities contained within the proposed municipality (based on the total of the voters in the last general election). After review by the Dept. of Community & Regional Affairs and approval by the Local Boundary Commission, following a public hearing in the locality, election is held.	Three mandatory areawide powers: taxation, education, and planning, platting and zoning. Additional services, such as police, water, sewer, etc., are added by action of the assembly. No vote of the people is required.	Elected borough assembly and mayor. Elected school board. Appointed planning and zoning commission. May adopt the manager plan of government, or appoint a manager, as outlined in Article 8 of Municipal Code.
Second class Borough			Three mandatory areawide powers: taxation, education, and planning, platting and zoning. Additional services, such as police, water, sewer, etc., are added by approval of the voters through a referendum.	Elected borough assembly and mayor. Elected school board. Appointed planning and zoning commission. May adopt the manager plan of government, or appoint a manager, as outlined in Article 8 of Municipal Code.
Third class Borough			Two mandatory areawide powers: taxation and education. May establish service areas.	Elected borough assembly. The borough assembly is the school board. Borough chairman is also president of the school board.
First class City	A community having 400 or more permanent residents.	Petition to the Dept. of Community & Regional Affairs with signatures and addresses of 50 permanent resident voters of the proposed municipality. After review by the Dept. of Community & Regional Affairs and approval by the Local Boundary Commission following a public hearing election is held.	If the city is not in a borough, by law it must provide planning, platting, zoning, taxation, and education. Can add other powers for services (police, water, sewer, etc.) by council action.	Elected council and mayor. If the city is not part of a borough it will have an elected school board and appointed planning and zoning commission. May adopt the manager plan of government, or appoint a manager, as outlined in Article 8 of the Municipal Code.
Second class City	A community having 25 or more permanent residents.	Petition to the Dept. of Community & Regional Affairs with signatures and addresses of 10 permanent resident voters of the proposed municipality. After review by the Dept. of Community & Regional Affairs and approval by the Local Boundary Commission following a public hearing election is held.	If the city is not in a borough, it may provide planning, platting, and zoning. It is not required by law to do so. May add other powers for services (such as police, water, sewer, etc.) by council action. The city does not have the power of education; therefore, the city is not a school district.	Elected council. The mayor is appointed from council members. If the city is not part of a borough, it could have an appointed planning and zoning commission and an advisory school board.

* Formation of home rule municipalities is also provided for in the Municipal Code. A home rule municipality is a municipal corporation and political subdivision and is a borough of the first class or a city of the first class which has adopted a home rule charter. It has all legislative powers not prohibited by law or charter.

Alaska, University, Arctic Environmental Information and Data Center. 1976. p. 271.

assessment, which is another valuable piece of information for the property owner to know. Plats may be located by a grid reference system from topographic maps at most borough and city revenue department offices. Once a property is located by township and plat, it is usually a simple matter for the zoning department to inform the owner of its zoning status.

It is also very important to be aware of the comprehensive plan in your municipality or borough. If the comprehensive plan for the borough happens to call for the expansion of your access road to a four lane expressway you will surely want to know this. The comprehensive plan is the place to find out about it.

Most major political jurisdictions (boroughs, first- and second-class cities) have planning and zoning departments. Advice for the prospective site developer is available from the local planning department. In addition to providing answers to the above questions, the department can inform the developer/homeowner of local situations, conditions, and regulations which may often be overlooked and could cause problems. Some common oversights are:

1. Building within the established set-back (too close to property lines). Since a dwelling built in these circumstances is not in compliance with zoning laws, it cannot legally be expanded if expansion were desired.
2. Building for a use not permitted within certain specified zoning districts.
3. Illegal subdivisions, where lots are created without approval of the planning commission.
4. Zoning problems. These may require hearings and delay your construction.
5. Obtaining a building permit, required in organized boroughs.

For further information on zoning requirements, contact your planning and zoning department.

Anchorage: Municipality of Anchorage
Planning Department
Zoning and Plotting Division
630 W. 5th Avenue
Anchorage, AK 99501
Phone: 264-4215, 4216, 4217

Fairbanks: Fairbanks North Star Borough
Planning Department
520 5th Avenue
Fairbanks, AK 99701
Phone: 452-6741

Juneau: City and Borough of Juneau
155 S. Seward Street
Juneau, AK 99801
Phone: 586-3300

Soil Testing

Soil testing is a procedure used often in the construction of large civil engineering projects such as buildings, theaters, bridges, and highways. The purpose of testing is to determine the profile of a soil type so that its engineering properties can be determined or estimated. In Alaska, soil tests are used for much the same purpose. However, because of the possibility of poor soil conditions or permafrost at many locations throughout the state, it is very advisable to take a soil test at your building site. Even if the indicators of permafrost are not present, that is no guarantee that some remnant permafrost is not still present at depth. A soil test, drilled to a depth of 35 feet, is the best insurance against future foundation failures, subsidence, and sewage disposal problems. A special concern is the presence of "massive ground ice" in the soil. Large, lens-shaped pieces of ice, up to several feet thick and perhaps several feet in diameter, are a very serious hazard. Soil testing enables the home builder or developer to become aware of hazards and, in some cases, such a test may be required by a lending institution before a construction loan is granted.

Soil testing laboratories are available in both Anchorage and Fairbanks. They may be found in the yellow pages under "Laboratories — testing." In addition, some well drillers have the capability of performing soil tests. Check with your local driller if you do not live close to a city.

WATER ACCESS

City Hook-ups

When developing city property, access to a water supply is usually a matter of hooking into the main, getting metered, and registering with the utility. The following cities have water utilities:

Anchorage	College
Fairbanks	Kodiak
Seward	Juneau
Kenai	Wrangell
North Pole	Yakutat
Nome	Ketchikan
Valdez	Petersburg
Sitka	Kotzebue

In most cases, the water utilities are operated by the city. College Utilities in the Fairbanks area, and Central Alaska Utilities and Glacier Utilities in the Anchorage area are privately operated water utilities serving small areas not necessarily within city limits.

The best way to determine which water utility services a particular area is to call the city government. Rates for service levels (domestic or commercial) are public information and are available from the utilities. This is true for all utilities — water, sewer, electricity, and gas.

Well Drilling

If the property location does not allow access to a municipal water supply, drilling a well may be desirable. Yet well drilling is a complicated process and there are no guarantees. It is wise, in fact, to drill a well before beginning to build on the site. If the well produces a very small amount of water (less than one gallon per minute), you may want to limit the type of structure or sell the property. Few problems should occur if the well is productive (greater than five gallons per minute).

Drillers keep well logs, which are descriptions of the types and depths of materials encountered during drilling. These well logs can be used to detect possible permafrost zones.

Most well drillers pump a well for two or three hours and then make a yield estimate based on the pumping rate. Because the well is likely to tap a previously unused zone of an aquifer, some of the water yield is a once-only contribution to the well's yield. This is best illustrated by Figure 2.

The water above the pumping water level indicated in the diagram is the water that is pumped out in the initial testing. Under normal operation (pumping at irregular intervals), the only water available is that water located under the line marked "pumping water level." The water originally present at the nonpumping water level is pumped out at a high rate during the initial testing of a well, but is not replaced by underground flow at the rate of pumping. Pumping a well in an initial test for only two or three hours may result in yield estimates as much as two to three times higher than the well can actually produce under operating conditions. A well that is "pumped down" regularly simply has less water available (see diagram). The lesson here is to be very careful about stated yield estimates of wells.

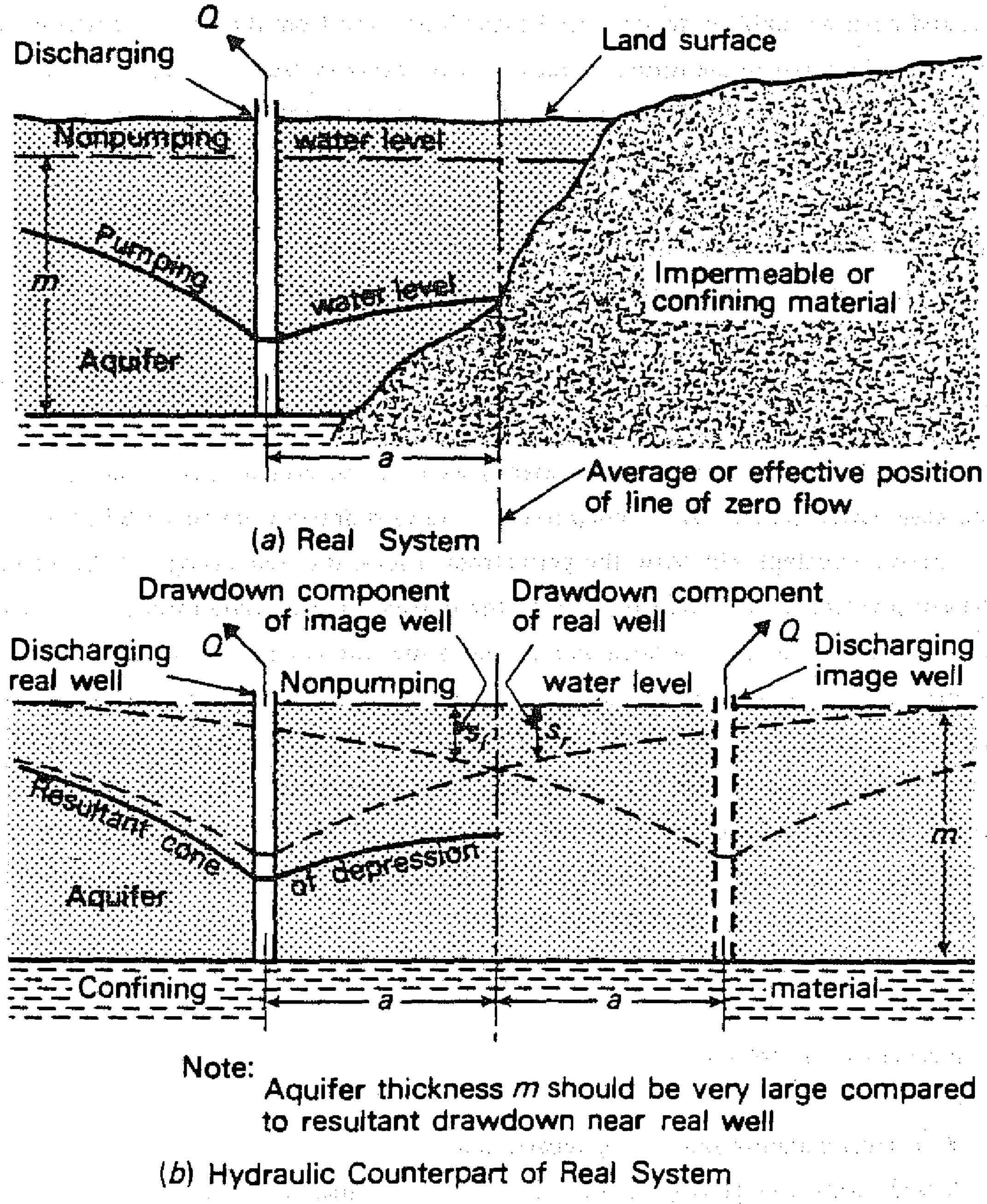


Figure 2. Influence of pumping a new well on the water table (from Concepts and Models in Groundwater Hydrology by Patrick A. Domenico; Copyright 1972 by McGraw-Hill. Used with the permission of the McGraw-Hill Book Company).

Well drilling is also quite expensive. Costs throughout Alaska are relatively equal, ranging from $20 - 23.50 per foot of drilling. This range of cost estimates is based on a survey of 16 Alaska well drillers made during November 1978. The range of costs are quite consistent statewide, and costs are unlikely to vary more than $3 per foot from this range. Inflation may cause unforeseen increases in the future. Depth to water can vary from as little as 12 feet to as much as 600 feet and more. There is a positive correlation between the elevation above the nearest tributary stream and the depth a well will need to be drilled. This means simply that the higher in elevation your property is, the deeper your well will probably need to be. Of course this is not a hard and fast rule, but certainly elevation is a factor to consider. An estimate of the probable depth range to water may be obtained from neighboring property owners.

It is best *not* to drill a well into permafrost, or through permafrost into a water-bearing stratum. In the first case, extensive deep permafrost is impermeable to water. Therefore no groundwater recharge can occur, and no water is likely to be present other than as ice. In the second case where permafrost is penetrated and water is drawn from beneath it, the water (since it is above freezing) will thaw the permafrost around the well casing. If the water is under artesian pressure, it will force its way up the outside of the casing through the thawed permafrost all the way to the well head and out onto the surrounding ground. Although not common, this has occurred in more than one well in the Fairbanks area. In one case, the well was drilled and capped, developed a leak, and flowed all winter long creating a huge glacier of ice that proceeded to engulf neighbors' houses and cars, sometimes to a depth of eight feet. The inevitable lawsuits followed, and the well was abandoned and plugged with concrete. The message is clear. Great caution and wariness should be used when drilling wells in permafrost. If you need advice, contact the following:

1. Institute of Water Resources
   University of Alaska
   Fairbanks, AK 99701
   Phone: 479-7775
2. Your local planning and zoning department.
3. A hydrological or geological consultant who is familiar with your area. Look in the yellow pages under geologists, hydrologists, or engineers-geotechnical, soils, or sanitary.

Well Drilling and Water Quality

In many areas of Alaska, surveys of water quality have been accomplished and maps of areas where poor quality water dominates have been made. Again, your local planning and zoning department should be able to tell you if water quality problems can be expected on your property. Common problems include nitrate and arsenic content, iron content, hardness, organic odor, cloudiness, and combinations of these factors.

Recently, a publication on this subject was put together for the Fairbanks area in a cooperative effort by the U.S. Geological Survey's Water Resources Division, the Fairbanks North Star Borough, the U.S. Environmental Protection Agency, and the Alaska Department of Environmental Conservation. The report "Arsenic, Nitrate, Iron, and Hardness in Groundwater, Fairbanks Area, Alaska" is available from the U.S. Geological Survey, Water Resources Division, Federal Building, 101 12th Avenue, Fairbanks 99701 (Phone: 452-1951). This organization has a number of publications available on Alaska's water resources and permafrost conditions. Water quality publications of the Institute of Water Resources are listed in Appendix I.

A variety of organizations perform tests on particular aspects of water quality. The Alaska Department of Environmental Conservation (DEC) tests only for the presence of arsenic and nitrate, which are toxic to humans. These tests are free. DEC has certified a number of private labs in Alaska to test for bacteria in the water. These labs charge about $16 for such a test. A list of certified labs is provided in Appendix II. General testing for dissolved minerals will often be done for free by local water softening companies. More detailed testing for dissolved minerals, as well as for organic and radioactive contaminants, can be arranged through several private labs listed in Appendix II.

Water Quality Regulations for Private Water Supplies

The Alaska Department of Environmental Conservation requires the following of private water supplies constructed after October 1973:

1. The well must be at least 100 feet from the septic tank or soil absorption system.
2. A community system (defined as a system serving more than a single residence) is governed by special regulations. Consult the nearest office of the Alaska Department of Environmental Conservation.

In addition, the following recommendations are provided to assist in the installation and protection of a private well:

1. Well casings should be protected with a sanitary seal at the top of the casing.
2. An impermeable ground seal (cement grout, bentonite, sealing clay, or equivalent) should be provided around the well, extending at least two feet in all directions and sloping away from the well. Well pits are not acceptable because water cannot drain away from the well.
3. In a water system with a pitless adapter, the ground seal should be placed below the level of any connecting line.
4. The well casing should extend at least one foot above the ground level.

5. New water systems should be chlorinated before use. See the following section for instructions.
6. Fuel tanks and other possible sources of contamination should be located at least 75 feet from the well.

Disinfection of Individual Wells and Water Distribution Systems

The following steps are recommended:

1. Pump the well until the well and water distribution system are flushed with clean, clear water.
2. Obtain one-half gallon of household bleach (i.e. Clorox, Purex, etc.) which contains five to six percent sodium hypochlorite. Pour one quart in a large bucket of water and pour this solution down the well casing. Repeat this procedure with the remaining quart of bleach. If you have a dug well of approximately three feet in diameter, add one-half gallon of bleach for each five feet of water depth in the well.
3. Turn the pump on and off several times to help mix the chlorine solution in the well. Then open all taps and flush the toilets until you can smell chlorine in all outlets. When you can smell chlorine at the last outlet on the system, shut off the pump and *hold the chlorine in the system overnight.*
4. The following morning, flush the chlorine from the distribution system by opening all taps until chlorine can no longer be smelled at any water outlet. Your well and distribution system should now be disinfected. Wait for at least one week and then have your water analyzed for bacterial contamination.

Alternative Water Supplies

In the event that the quality of groundwater at your site is very poor or unsafe for drinking, it may be advisable to pursue another option. A few communities have water delivery services that utilize tank storage in a basement, from which water is pumped to a normal water distribution system. Some rural villages rely entirely on water that is brought in by truck from a nearby water source or community well.

Again, contact the borough information officer at the planning and zoning department, or look in the yellow pages under water companies. The economics of delivered water may interest the person considering a well. Fairbanks has water supply delivery companies, as an example. The cost of delivered water is $45/1000 gallons. If you estimate your well to cost $23/foot and it is to be 250-feet deep (with $1000 for plumbing, pumps and insurance, then the well will cost $6750). For this much money, you could purchase for delivery at the present cost 150,000 gallons of water. For an economic analysis, it becomes very important to accurately estimate your water use per day. The table below compares the number of years needed to break even.

TABLE 2: ECONOMIC ANALYSIS OF WATER ALTERNATIVES

Daily Water Use (@ $45/1000 gal)	Days of Water	Years to Payback for Well
50 gal/day	3000 days	8.22 years
100 gal/day	1500 days	4.11 years
200 gal/day	750 days	2.06 years

It becomes very clear that if your water use is heavy and water quality problems are minimal, a well is probably worth the gamble. All factors of risk should be carefully considered in your final decision.

Water Rights: Legal Aspects of Water Supply

The State of Alaska passed a Water Use Act in 1966, and since then the demand for water by Alaska's growing population has increased rapidly. Water is obviously critical to quality of life, and therefore it behooves the site developer to be keenly aware of the legal aspects of water use and water rights in the state.

For further information, "Analysis of Alaska's Water Use Act" by H. J. Curran and L. P. Dwight reviews the legal status of water rights and appropriations in Alaska. This publication is available from the Institute of Water Resources, University of Alaska, Fairbanks 99701.

The important fact of which the site developer should be aware is that water rights must be applied for. Application is made to the Alaska Department of Natural Resources, Division of Forest, Land and Water Management. A sample water right application is included on pages 17-20.

Water Problems: Where to Go for Further Help

If your problems are unique or you require general information, the following organizations will be able to help you or direct you to the best source of information:

Institute of Water Resources
University of Alaska
Fairbanks, AK 99701
Phone: 479-7775

U.S. Geological Survey
Water Resources Division

Anchorage: 218 E Street
Anchorage, AK 99501
Phone: 271-4138 or 277-0577

Fairbanks: 101 12th Avenue
Fairbanks, AK 99701
Phone: 452-1951

Juneau: 709 W. 9th Street
Juneau, AK 99811
Phone: 586-7216

Alaska Department of Natural Resources
Division of Forest, Land, and Water Management

Anchorage: Southcentral District Office
941 E. Dowling Road
Anchorage, AK 99504
Phone: 349-4524

Fairbanks: Northcentral District Office
4420 Airport Way
Fairbanks, AK 99701
Phone: 479-2243

Juneau: Southeastern District Office
Pouch M
Juneau, AK 99811
Phone: 465-2415

Alaska Department of Environmental Conservation

Anchorage: 338 Denali Street
Anchorage, AK 99501
Phone: 274-5527

Fairbanks: 675 7th Avenue
Fairbanks, AK 99701
Phone: 452-1714

Juneau: 419 6th Street
Juneau, AK 99811
Phone: 586-6721

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FOREST, LAND AND WATER MANAGEMENT

OFFICE USE ONLY

ADL

APPLICATION FOR WATER RIGHT

Instructions: You will need (1) a map showing the location of your source of water and the area of use, (2) a copy of your property ownership document, i.e. deed, patent, lease agreement or an easement agreement if you do not own the property involved, (3) a copy of your driller's well log, if application is for an existing well, (4) Statement of Beneficial Use Of Water (Form 10-1003A) if this is an existing water use, and (5) Application for Permit to Construct or Modify Dam (Form 10-1015) if you will be constructing a dam over 10 feet high or over 50 acre feet of storage. Please type or print in ink.

1. Full legal name of Applicant(s) ______________________________

____

2. Mailing Address ______________________________

____

Home Phone ______________ Business Phone ______________

3. Source of Water Supply:

(a) ☐ Well

☐ Drilled ☐ Hand Driven ☐ Dug ☐ Other ______________

If existing well, attach copy of driller's well log.

If existing well, and no log, supply all known information

Total depth ________ Drawdown ________

Intake Depth ________ Screened Yes ____ No ____ Unknown ____

Static level ________

(b) ☐ Surface Water

☐ Stream ☐ River ☐ Lake ☐ Spring

Give geographic name (if unnamed, state so) ______________

Water will be taken from surface water source by:

☐ Pumping

☐ Gravity Flow System

☐ Diversion (Altering a watercourse) - Attach sketch and plans giving dimensions and specifications.

☐ Damming - Attach sketch and plans giving dimensions and specifications. If dam is over 10 feet high or over 50 acre feet storage, MUST file Application for Permit to Construct or Modify Dam (Form 10-1015).

☐ Other ______________________________

4. Location of point of WITHDRAWAL, DIVERSION, or IMPOUNDMENT:

MUST attach copy of map or subdivision plat and indicate location

(a) Fractional part ______________ Section ______
Township ______, Range ______, ______________ Meridian.

(b) If applicable, Lot, Block, Subdivision; U.S. Survey No. ______________________________

____

(c) Does applicant own or lease the property at point of water withdrawal and over which water is transported? Yes ☐ No ☐

If "Yes," MUST attach copy of ownership document (i.e. deed, patent)

If "No," MUST obtain an easement or right-of-way and supply copy. Give name, mailing address and phone number(s) of legal owner.

Name ______________________________

Mailing Address ______________________________

______________________________ Zip ______

Home phone ______________ Business Phone ______________

5. Location of point of USE: If same as question 4, check and go to question 6. ☐

MUST attach copy of map or subdivision plat and indicate location.

(a) Fractional part ______________ Section ______
Township ______, Range ______, ______________ Meridian.

(b) If applicable, Lot, Block, Subdivision; U.S. Survey No. ______________________________

____

(c) Does applicant own or lease the property at point of water use? Yes ☐ No ☐

If "Yes," MUST attach copy of ownership document (i.e. deed, patent)

If "No," MUST obtain an easement or right-of-way and supply copy. Give name, mailing address and phone number(s) of legal owner.

Name ______________________________

Mailing Address ______________________________

______________________________ Zip __________

Home phone ______________ Business Phone ______________

6. Type of water use and Quantity of water needed: Please fill in the attached Water Use Chart indicating the quantity of water and months of use for each type of water use. Standard quantities and definitions are provided for your convenience. If water use is for a Commercial/Industrial purpose or Other Use not on the Water Use Chart, refer to question 7.

7. Commercial/Industrial and Other Uses:

Explain in detail the basis for quantity of water requested. Use additional sheet of paper if needed. Indicate type of operation including structures and methods used. Include a sketch or engineering drawings. Enter quantity requested and months of use on attached Water Use Chart.

8. Date when water use began or is expected to begin ______________. If water use is existing, fill out Statement of Beneficial Use of Water (Form 10-1003A).

HAVE YOU ATTACHED?

- ☐ Deed, patent, lease, etc.
- ☐ USGS or Subdivision map
- ☐ $25 Filing fee (checks payable to State of Alaska)
- ☐ Water Use Chart
- ☐ Statement of Beneficial Use of Water (Form 10-1003A) (if existing water use)
- ☐ Driller's log (if existing well)
- ☐ Diversion sketch and plans
- ☐ Dam sketch and plans

Statements appearing herein are to the best of my knowledge true and correct.

SIGNED ______________________________
(Applicant) DATE

OFFICE USE ONLY	x,y	RMI	Location check	Other

WATER USE CHART

Office Use SIC	Type(s) Of Use	Standard Quantities	Quantity Requested	Months of Use From (Inclusive)	To
8800	(1) Single Family	Per Household			
	(a) Fully plumbed	500 GPD	GPD		
	(b) Partially plumbed	250 GPD	GPD		
	(c) Unplumbed	75 GPD	GPD		
6514	(2) Duplex	Per Duplex 1000 GPD	GPD		
	(3) Multi-Family	Per Unit 250 GPD	GPD		
7011	(4) Motel, Resort	Per Room 100 GPD	GPD		
	(5) Livestock	Per Head			
0241	Dairy Cows	30 GPD	GPD		
	Hosing dairy barn	35 GPD	GPD		
0212	Range Cattle	15 GPD	GPD		
0272	Horses	15 GPD	GPD		
0214	Sheep	2 GPD	GPD		
	Goats and Hogs	3 GPD	GPD		
	Poultry, Rabbits, etc.	1 GPD	GPD		
		Livestock Total	GPD		
	(6) Irrigation (Type of Crop: ____________)	Per Acre 0.5 AFY	AFY		
	(7) Commercial/ Industrial				
	(8) Other: ____________				

DEFINITIONS:

GPD - gallons per day AFY - acre feet per year CFS - cubic feet per second

(1) SINGLE FAMILY - Water use necessary for a single household and the irrigation of up to 10,000 sq. ft. of yard and garden.

(a) Fully plumbed - Water piped into the residence for domestic uses. Hot water heater and water flush toilet included.

(b) Partially plumbed - Water piped into residence for limited domestic uses. Generally no hot water heater and no water flush toilet included.

(c) Unplumbed - No water piped into the residence. Water is hand carried for limited domestic use.

(2) DUPLEX - Water use necessary for two single households and the irrigation of up to 20,000 sq. ft. of yard and garden.

(3) MULTI-FAMILY - Water use necessary for three or more households. Apartment units included.

SEWAGE SYSTEMS

Sewage disposal in the far North has always been a challenge since soil often freezes to depths of three to six feet or more in nonpermafrost areas. Adding large amounts of water to frozen soil, low biological activity rates during subarctic winters, and keeping plumbing free flowing are all standard sewage treatment problems. Nothing is worse than a malfunctioning sewage system. For all these reasons and one's own health, it is wise to carefully plan and design the sewage system. This section deals with the experiences, regulations, and alternative methods of sewage treatment in Alaska.

By far the largest Alaskan sewage facilities are in the three municipalities of Anchorage, Fairbanks, and Juneau. Hooking up with these systems is a standard operation, and normally can be easily accomplished during construction. The best source of information is your local municipality's water department. Normally municipal sewage systems are relatively reliable and require only routine maintenance. Sewage is treated at large central treatment plants, often being transported from individual homes through collector mains.

Where municipal systems are not available, it is often cost effective to treat waste from homes on an individual basis. A modern home with running water produces a large amount of waste including: urine; fecal matter; garbage; and laundry, shower, and dishwashing wastewater. About 40 percent of the average wastewater flow of 60 gallons per capita per day (gpcd) is used for flushing toilets and 40 percent for showers and washing.

While the most commonly used treatment systems for sewage are septic systems, aerobic treatment units are becoming more popular. In contrast, a vast majority of the people in the world practice indiscriminate ground- and water-surface disposal (Chanlett, 1973). Even though a large majority of the households in Alaska are treated via individual or community systems, dumping of excreta on the land or into the sea is still practiced in some communities (Johnson and Dreyer, 1977). For rural residents living at a subsistence level, economic realities sometimes dictate this as the only alternative. For these kinds of rural settings, the wastewater volumes are much less than those quoted for a modern home. For some native villages where the water is individually hauled, the usage may be as low as 2 gpcd.

There are additional accepted technical means for waste disposal using standard water systems. These are described further in Johnson's (1978) "Alaska Wastewater Treatment Technology," Report IWR-86, available from the Institute of Water Resources, University of Alaska, Fairbanks 99701.

Privies, Honey Buckets, and Cesspools

Diagrams of a privy, honey bucket, and cesspool appear in Figure 3. The latter (illegal in Alaska) is simply a sump approximately five feet in diameter sometimes filled with stones.

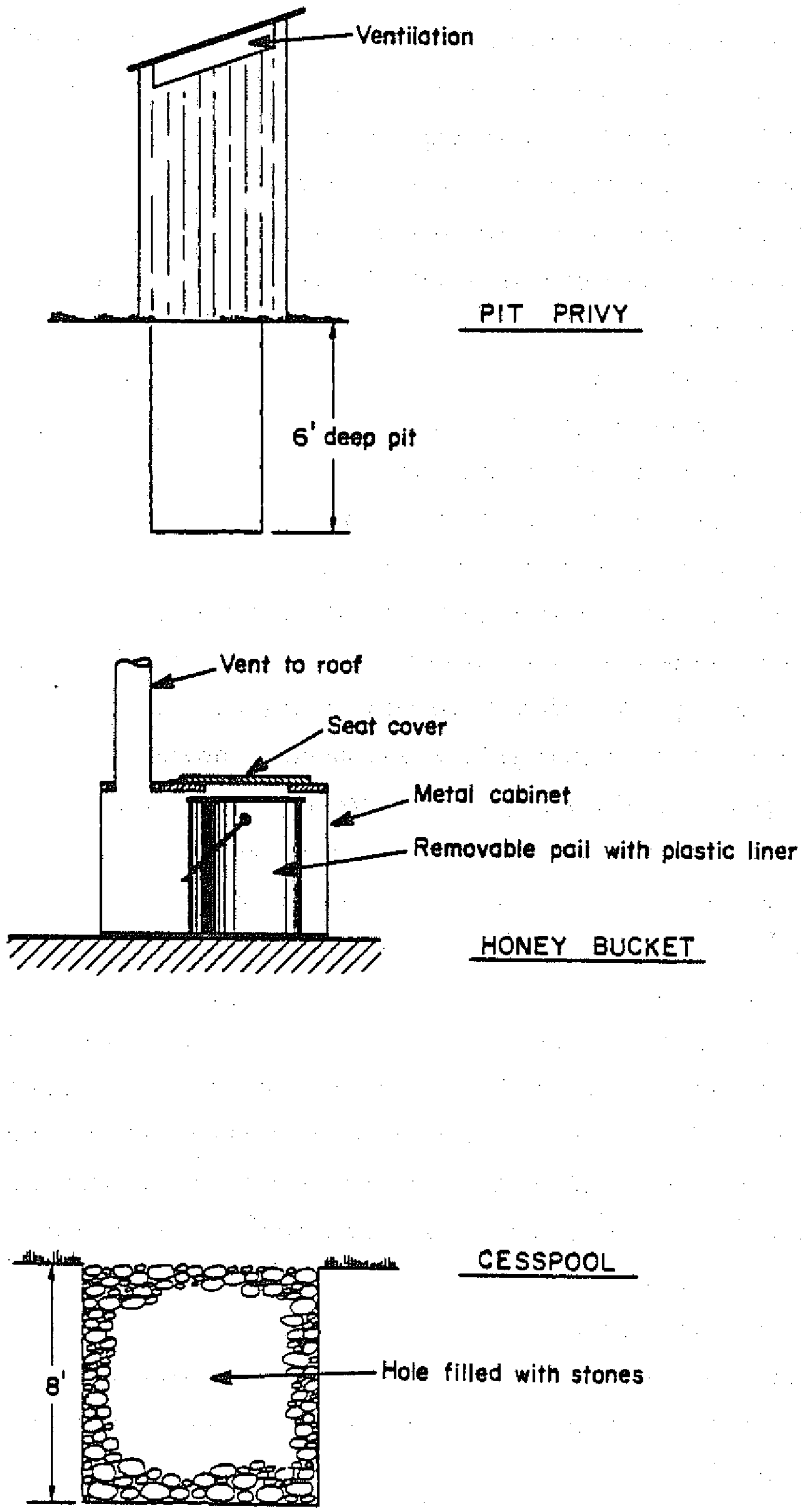


Figure 3. Primitive waste disposal facilities (from Johnson, 1978).

Although intended to serve both as a septic tank and percolation system, it fails as the latter because of the limited surface area for absorption and subsequent clogging of the pores. The use of privies is more widespread in the state, especially for recreational dwellings.

Honey buckets are still widely used in the villages. They can be thought of as privies with removable inserts so that the wastes may be removed periodically. This results in a transfer of the waste matter from various locations within a village to a central site, typically the dump.

In none of these cases is any appreciable treatment of the waste products occurring. With the below-freezing temperatures found in large portions of Alaska for much of the year, no biodegredation is occurring much of the time, although normal degradation will occur in the summer. Recent work by Johnson (1979) indicates that *summer* rates of biological decay in the North are similar to other areas for equivalent temperatures.

A two-year study (Heinke and Prasad, 1977) on the decay of human wastes in permafrost was recently carried out. They found that little biological activity occurs at -5°C (23°F), with small changes being observed at +5°C (41°F).

Septic Tank Systems

The most popular individual household treatment system used in the United States is the septic tank and absorption field combination. The former is typically constructed out of concrete, steel, or fiberglass. The minimum allowable volume for Alaska is 1000 gallons. It is highly desirable to have cleaning ports accessible for maintenance as shown in Figure 4. Note the partitions near the outlet to prevent scum accumulation from clogging it. Although some anaerobic degredation takes place in the septic tank, its primary function is to allow removal of suspended solids to avoid rapidly clogging the pores in the absorption field.

Septic Tank Failures — What You Should Know

Septic tank systems fail most often not because the tank fails but because the pores of the soil clog. Two reasons for this phenomenon are: 1) sludge and scum carryover, and 2) the constant application of liquid to the soil. The former can be prevented by annual inspections and by removing scum and sludge when the latter is thicker than 1.5 feet. Some sludge should be permitted to remain since it is needed to serve as a seed for the fresh sewage. The second cause of clogging can be prevented by periodically allowing the soil to drain and the pore spaces to fill with air. Alternatively, hydrogen peroxide can be periodically injected to oxidize the clogging material (Otis et al., 1977).

Clogging occurs because slimes and precipitates will form if anaerobic conditions persist in the soil. Even if the soil were continuously inundated with pure water, clogging would soon

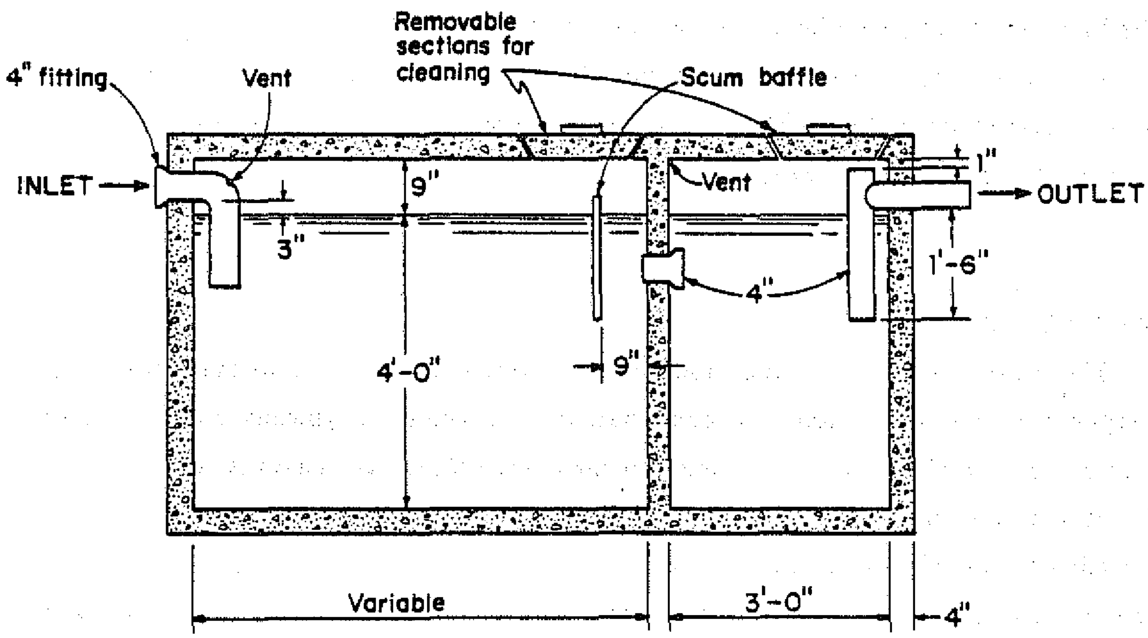


Figure 4. Typical septic tank (after Metcalf and Eddy, 1972).

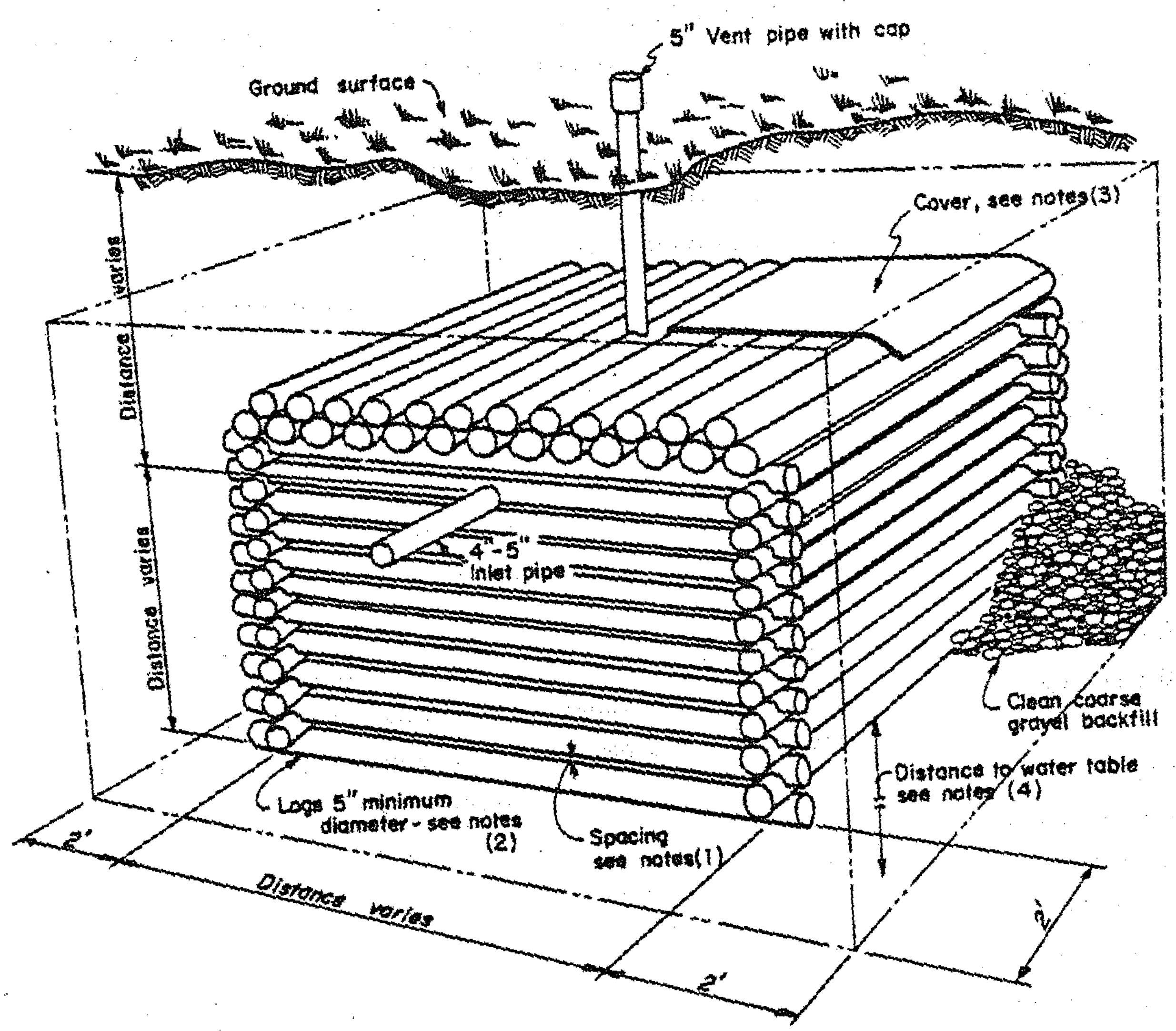
develop when the aerobic bacteria initially present in the soil became deprived of oxygen. Specific biological clogging mechanisms include growth of organic slimes because of anaerobic bacteria and precipitation of ferric sulfide (McGauhey, 1975). One study (Laak, 1970) found 90 percent of the clogging material was bacterial cells. Since one cannot dissolve enough oxygen in water to maintain aerobic conditions in inundated soils, aerated septic tanks are not the answer. One other recommended practice to prevent clogging is to avoid abrupt changes in particle size between the trench fill material and the surface of the soil.

The seepage pit is the most commonly used absorption system in Alaska (Figure 5). It is typically built out of logs or rough-cut lumber. Because the upper six feet or so of the ground is frozen or very cold for much of the year in Alaska, a surface percolation system is not practical. Hence, the deeper pits are constructed with absorption occurring beneath the biologically active zone. According to Bateman (1977), surfacing sewage is the primary complaint about septic tank systems in the Fairbanks area. The septic tanks themselves, built typically out of steel or fiberglass, appear to hold up satisfactorily.

Problems are encountered near the city of North Pole due to the high-water table and permafrost, and in the foothills around Fairbanks because of thin overburden. Similar problems are often associated with areas of clay soils, such as on the Kenai Peninsula. These soils cause problems because of their impermeability and low capacity for absorbing water. Where there is gravelly ground in the Fairbanks area, systems appear to be performing adequately with annual pumping. But there has not been a recent study on system survival in Fairbanks. The average survival time of septic tank seepage pit systems in the Anchorage area was ten years in 1961 (Hickey and Duncan, 1966). The same study indicated an average survival time in the Fairbanks area of about six years. In each case, the main source of trouble was in the absorption systems. It was also found that the homes experiencing no failures had greater septic tank and absorption field capacity per person than those where the system failed. But the differences were small.

It is interesting to note that 17 percent of the failures reported in the Fairbanks area before 1960 were caused by collapse of the seepage pits. This was prior to the 1960 Federal Housing Authority requirement that the pits be filled or lined with coarse stone. In observations of 136 seepage pits in California (Robert A. Taft Sanitary Engineering Center, 1963), it was found that 18 percent of the pits not backfilled with gravel collapsed while only 1 percent of the backfilled pits collapsed. An alternate pit design suggested by Hickey and Duncan (1966) is to dig a trench of the same depth and sidewall area thus eliminating a large amount of almost useless floor area. This trench could be around 1-foot wide, requiring much less stone.

A recent study (Neale et al., 1974) indicates an average lifetime of septic systems in the Anchorage area of less than five years. Here (as in the above 1966 study), tank failures, broken pipes and structural failures were omitted so only those failures due to nonabsorption in the



NOTES:

1. Log spacing: Maximum 3", Minimum 1"
2. Use green logs throughout. Nail log joints.
3. Cover with 2 layers of logs and cover with impervious material such as sheet plastic or sheet polyethylene.
4. Bottom of pit 4' from water table - 6' from bedrock.

Figure 5. Seepage pit (after Alaska Department of Environmental Conservation, 1975).

seepage pit were considered. The area chosen for this survey was known to have poorer soils than that used for the 1966 survey. Two other factors contributing to the high failure rates were poor quality backfill material and undersized systems. Since this report, the Borough of Anchorage has tightened its regulations to restrict backfill material to gravel between 1/2" and 2 1/2" in diameter and to require inspections of all onsite systems. The latter allows the inspector to verify that the excavation is large enough and that the soils are sufficiently permeable. A minimum lot size of 1 1/4 acres is also required.

The annual cost for a septic tank-seepage pit system in the Anchorage area was estimated to be about $1050 (Neale et al., 1974). This assumes pit replacement every five years, a tank life of 25 years, 7 percent interest, no yearly maintenance, and an initial cost of $6,000. Table 3 is a listing of the initial capital and annual operation and maintenance costs.

TABLE 3: INITIAL CAPITAL COSTS AND ANNUAL OPERATION AND MAINTENANCE COSTS

Unit	Cost, in Dollars
Septic tank (1000 gal.)	
Equipment and installation cost	350-450
Maintenance cost	10/yr
Aerobic treatment unit	
Equipment and installation cost	1000-1300
Maintenance cost	35/yr
Operation cost (4 kwhr/day at 4¢/kwhr)	60/yr
Wet well pumping chamber	
Equipment and installation cost	250-350
Operation cost[1] (.75 kwhr/day at 4¢/kwhr)	10 yr
Sand filter	
Equipment and installation cost	10-15
Maintenance cost	1/yr
Chlorination and settling chamber	
Equipment and installation cost	700-1000
Operation cost[1] (chemical)	40/yr
Ultraviolet radiation unit	
Equipment and installation cost	1100-1500
Operation cost[1] (1.5 kwhr/day at 4¢/kwhr)	22/yr
Maintenance cost, cleaning and lamp replacement	Undetermined

[1] Does not include pump replacement.
SOURCE: Adapted from Sauer (1977).

In Fairbanks, Ron Bless of ABC Service and Lamar Wood of Northern Precast (Wells, 1977) have pointed out that homeowners have sometimes constructed marginal absorption systems to minimize capital costs. Such items as wooden boxes and junked automobile bodies have been used as seepage pits. Bud Hilton of Bud Hilton Pumping Company (Wells, 1977) has recommended flushing warm water through the system during periods of low water use to maintain reasonable temperatures in the septic tank. To conserve both energy and groundwater, it would be preferable to insulate the septic tank initially. Joiner (1977) found that at least one Fairbanks resident had not pumped out his septic tank for about 10 years without noticing any ponding. Under these conditions, however, clogging would occur in all but the most porous soils.

Private Waste Disposal System Regulations

A copy of the regulations regarding private waste disposal for Alaska is included here for information along with instructions for conducting a percolation test, building a seepage pit system, and the specifications for a septic tank system. The following summary of the Alaska Department of Environmental Conservation's Waste Water Regulations is provided to assist you in installing an acceptable private waste disposal system:

1. For any septic tank installed after October 1973, the minimum size tank for a 1-3 bedroom home is 1,000 gallons. For each additional bedroom, 250 gallons should be added to the tank capacity.
2. If a community sewer system is available within 200 feet *at the time of construction of the waste disposal system*, a private system is not permitted.
3. Minimum distance between a septic tank or soil absorption system and a lake, creek, stream, river, or coastal waters is 100 feet.
4. Minimum distance between a septic tank or soil absorption system and a well is 100 feet. If the well serves two or more dwellings, the minimum distance is 150 feet.
5. Minimum distance between the bottom of a seepage pit or soil absorption system, and the highest groundwater level is four feet.
6. Minimum distance between the bottom of a seepage pit, or soil absorption system, and bedrock is six feet.
7. Septic tanks and soil absorption systems are not permitted in permanently frozen ground.
8. Cesspools are not permitted. A cesspool is an underground leach pit that receives raw sewage.
9. In areas of questionable soil conditions, percolation tests will be required. If the percolation rate is less than one inch in sixty minutes, soil absorption systems are

not permitted. However, variations of this type system may be permitted at the discretion of the Department. Detailed plans of alternate systems should be submitted to the Department for review. The procedure for performing a percolation test is given below.

In addition to the above, the Alaska Department of Environmental Conservation recommends that the septic tank have clean-out pipes with air-tight caps, extending at least two feet above the ground. No malfunctioning system will be approved.

Procedure for Percolation Tests

The procedure described herein is a brief summary of percolation test procedures as developed by the Robert A. Taft Sanitary Engineering Center. Further information on the percolation tests can be found in the "Manual of Septic Tank Practice," U.S. Department of Health, Education, and Welfare (1967).

1. **Location of Test Hole** - Test holes should be located on the proposed site of the soil absorption system.
2. **Type of Test Hole** - Dig or bore a hole with diameter of 4 to 12 inches and a depth equal to estimated depth of the absorption system.
3. **Preparation of Test Hole** - Provide a clean, natural soil interface into which water may percolate and remove all loose material from the hole. Add 2 inches of coarse sand or fine gravel to protect the bottom from scouring and sediment.
4. **Procedures** - Carefully fill the hole with water to a minimum of 12 inches above sand or gravel. It may be necessary to keep a surplus reservoir of water in order to keep the hole flooded to the above stated minimum depth for at least four hours and preferably for 24 hours.
5. **Percolation Measurement** -
   a. If water remains in the test hole after 24 hours, adjust the depth of water to 6 inches above gravel. Using a reference point, measure the drop in water level over a 30-minute period. The drop is used to measure the percolation rate.
   b. If no water remains in the hole after 24 hours, add water to 6 inches above the gravel. Using a reference point, measure the drop in water level at 30-minute intervals for four hours. Refill water to 6 inches as necessary. The level drop in the final 30 minutes is used to calculate the percolation rate.
   c. In sandy soils, and for soils in which water seeps away in less than 30-minutes after the 24-hour swelling period, the readings shall be taken every 10 minutes for an hour. The drop that occurs in the final ten minutes is used to calculate the percolation rate.

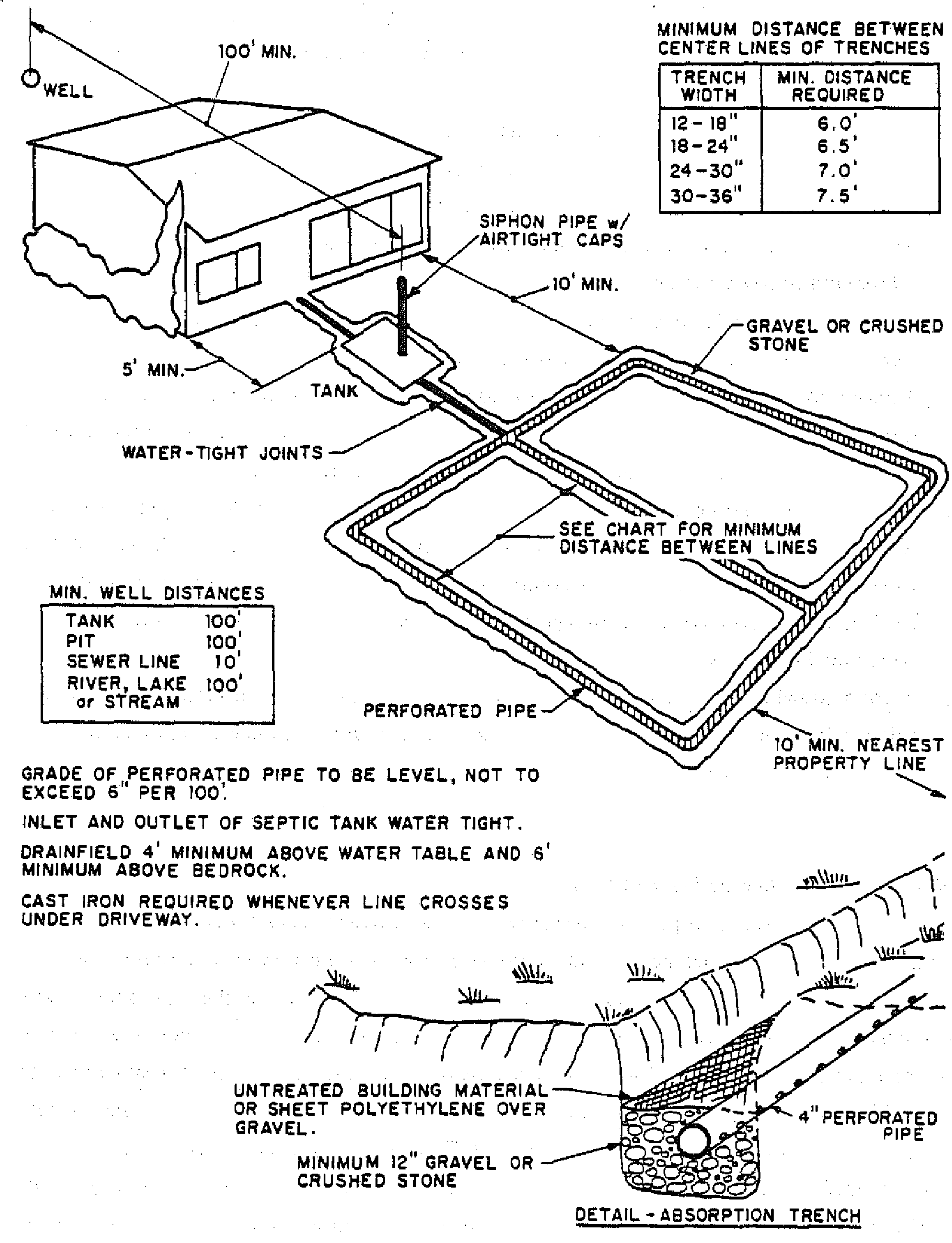
Septic Tank – Seepage Pit System

The septic tank conditions sewage so that it may be readily absorbed by the soil. Waste, consisting of a large amount of liquid and small amounts of solids, flows into the septic tank. The liquid then flows out of the septic tank into the disposal field (seepage pit, drain field, or absorption bed), from where it filters through the gravel surrounding the disposal field (Figure 6). The solid matter remains in the tank and is broken down by bacterial action. The heavy solids settle to the bottom of the tank (sludge), while the lighter parts rise to the surface (scum).

If adequately designed, constructed, maintained and operated, septic tanks are effective in accomplishing their purpose to provide a favorable environment for settling and decomposition of organic matter in wastewater. Likewise, disposal fields require attention to function properly. If functioning properly, the disposal field should provide an environment for further decomposition of any remaining organic matter in the wastewater. In addition, the disposal field distributes the treated liquid so that it can filter into the soil and percolate through the soil without clogging the soil pores.

Satisfactory service from a septic tank/seepage pit system requires periodic maintenance. The following recommendations will assist in proper septic tank operation:

1. Toilet paper substitutes, paper towels, newspaper, wrapping paper, rags, socks, etc. decompose very slowly and should not be flushed into the septic system.
2. Drainage from garage floors or other sources of oily waste should be excluded from the septic tank.
3. Roof drains, foundation drains, and drainage from other sources producing large volumes of clear water should not be piped into the septic system.
4. Waste drains from household water softener units have no adverse effect on the action of the septic tank, provided that the volume of water is not so great as to wash solids out of the septic tank. However, the life of a drainage field in clay-type soil may be shortened.
5. Since effective septic tank operation relies on the action of bacteria, disinfectants or other toxic materials (paint thinner, gasoline, etc.) which will kill bacteria should not be deposited in the system. Soaps, detergents, bleaches, and drain cleaners used with moderation should have no adverse effect on the system.
6. The natural bacterial action of the septic tank will provide all the decomposition needed. Commercial additives are not necessary for proper functioning of the system.
7. A septic tank of adequate size can handle all the wastes from the kitchen, laundry and bathroom. The life of the septic system may be extended by conserving water whenever possible. Home consumption of water is about 75 gallons per person per day, a figure that could be reduced considerably by using the water carefully. Water should not be run unnecessarily when brushing teeth, shaving, showering or cleaning. Automatic dishwashers and washing machines should be fully loaded before they are run. Water may be conserved



MINIMUM DISTANCE BETWEEN CENTER LINES OF TRENCHES

TRENCH WIDTH	MIN. DISTANCE REQUIRED
12 - 18"	6.0'
18 - 24"	6.5'
24 - 30"	7.0'
30 - 36"	7.5'

MIN. WELL DISTANCES

TANK	100'
PIT	100'
SEWER LINE	10'
RIVER, LAKE or STREAM	100'

Figure 6. Alaska Department of Environmental Conservation requirements for typical drainfield on level terrain.

by placing a plastic bottle full of water in the toilet tank. Bricks are not recommended as they may swell and crack the tank.

8. Septic tanks should be inspected at least once a year and cleaned when necessary. In Alaska, where cold soils prevail, bacterial action is slow and septic tank pumping is recommended at least once every two to three years. Septic tanks should not be washed or disinfected after pumping and a small residual of sludge should be left in the tank to start subsequent bacterial action.
9. To check your septic tank, a long stick wrapped in white toweling is inserted through the cleanout pipe. Push the stick to the bottom of the tank and let it stand for 20-30 minutes. Remove the stick and observe two dark bands. The band on the bottom represents the sludge and the band on the top represents the scum. If the combination of these is equal to one-third or more of the total depth of the tank, it is time to clean the tank.
10. Do not enter a septic tank until it has been thoroughly ventilated and gases have been removed to prevent explosion hazards, or asphyxiation. Anyone entering the tank should have one end of a stout rope tied around his waist, with the other end held above ground level by another person strong enough to pull him out if he should be overcome by any gas remaining in the tank.
11. A chart showing the location of the septic tank and disposal system should be placed at a suitable location in dwellings, along with such information as to size of septic tank, material it is made of, size of drain field, etc.

Waste Treatment Alternatives and Costs

There are several types of alternatives to the standard flush toilet available to most Alaskans, and they should be carefully considered for their advantages and disadvantages in your particular application. These alternatives include recirculating chemical toilets, and composting and incinerating units. For comparison purposes, cost data are presented for five of these systems in Table 4. The costs for the incinerating unit were obtained from Grainge et al. (1971) and, therefore, are not up to date. All systems still have a septic tank system for greywater disposal. Several people (Wells, 1977) have indicated that incinerating toilets are characterized by excessive odor problems and frequent mechanical failure. Grainge et al. (1971) report that the high salt-content liquid developed during incineration is very corrosive, so much maintenance is required.

Incinerating toilets are power consumptive and chemical and oil flush units make waste permanently unusable, whereas composting toilets turn waste into a usable form. About 60 pounds of humus is produced for each person over one year. Composting is the aerobic or anaerobic decomposition of solid organic matter by microorganisms. The preferred mode of operation is aerobic, in which the by-products are carbon dioxide and water. The humus

TABLE 4: APPROXIMATE COST OF DISPOSAL ALTERNATIVES

Item	Chemical Toilet[1]	Human Toilet	Eco-let	Incinolet	Clivus Multrum
Capital cost	$900	$944	$700	$595[4]	$1662
Maintenance (yr)	1300[2]	(minimal)[3]	(minimal)[3]	12[4]	(minimal)[3]
Shipping and installation	—	100	—	—	1000
Septic tank absorption field cost	3750	3750	3750	3750	3750
Electricity (yr)	—	25	25	3757	—
Heating (yr)	—	180	180	—	90
Annual cost over 25-year period	1486	398[3]	384[3]	410[5]	371

[1]Capacity of 10 users.

[2]Includes weekly pumping costs of $25.

[3]Includes $25 annually, to cover maintenance costs (assumed).

[4]Includes $150 for an air compressor in Canada in 1971.

[5]At 5¢/kwhr.

SOURCE: Adapted from Wells, 1977.

represents the nondecomposable organics plus cellular matter. For optimum operation, the organic matter should consist of both animal and plant (cellulose) wastes. The latter helps provide the porosity to keep the pile well aerated. Moreover, since pathogens are anaerobic, they don't compete successfully with the aerobic forms in the compost pile. Hence, compost *sometimes* can be safely applied to gardens.

Prices for the three composting systems reflect current Fairbanks costs as compiled by Wells (1977). The Humus and Eco-let units cost less than the Clivus Multrum because of their smaller volumes. To accomplish the desired waste decomposition processes in these smaller units requires electrical heating coils to maintain the piles at 90°F. Since decomposition is accelerated in the small units, the ash has to be emptied more often than in the large units. This is done through use of a door at the base of the toilet. There can be problems with excessive compaction if the unit is not used for a long period. On the other hand, the microorganisms will not die during long periods of cold and can be reactivated by simply turning the system back on. Mitchell (1977) reports that power outages or human neglect caused inactivation of decomposition processes in humus toilets used in Alaskan villages.

Even though the Clivus Multrum is expensive and difficult to install, it does have the advantage of not requiring any electric motors. Because of its large volume (Figure 7), a sufficiently large heap can be created so that the internal heat generation can be significant (Maine Times, 1977). This is basically a matter of maintaining an adequately large volume per unit surface area, since the metabolic heat output of the microorganisms is proportional to the former and heat losses are proportional to the latter. The Clivus Multrum is typical of the large-volume units in that the 30° incline allows the waste matter to slide slowly down the chamber at a rate sufficient to produce odorless, pathogen-free compost by the time the material reaches the access door at the lower end of the unit. It had been installed in 1300 homes in Scandanavia by 1975 (Lindstrom, 1975).

Even though some manufacturers claim composting toilets are almost maintenance free, the pile must be turned frequently to avoid compaction — weekly for some small units. Clivus Multrum admits it will take about two years for equilibrium to be reached (Maine Times, 1977). After that, it supposedly produces 3 to 10 gallons per capita per year of humus. Unlike the product of small-volume units, its compost is supposedly pathogen free because of the long, 3- to 4-year detention time.

One must beware of overstating the savings with respect to power comsumption needed by these composting units. It is true that the energy used by a large-volume unit such as the Clivus Multrum is nil in warm climates. But, in Alaska, if such a unit is to operate efficiently during the winter, heat must be provided. It is claimed that the Clivus needs 7 liters per second of air (Maine Times, 1977). Assuming that one's home heating system must warm this air from -23°C to 20°C, this corresponds to a heat loss of around 30,000 BTU/day. Adding these losses over the colder months of the year would result in an annual fuel cost of around

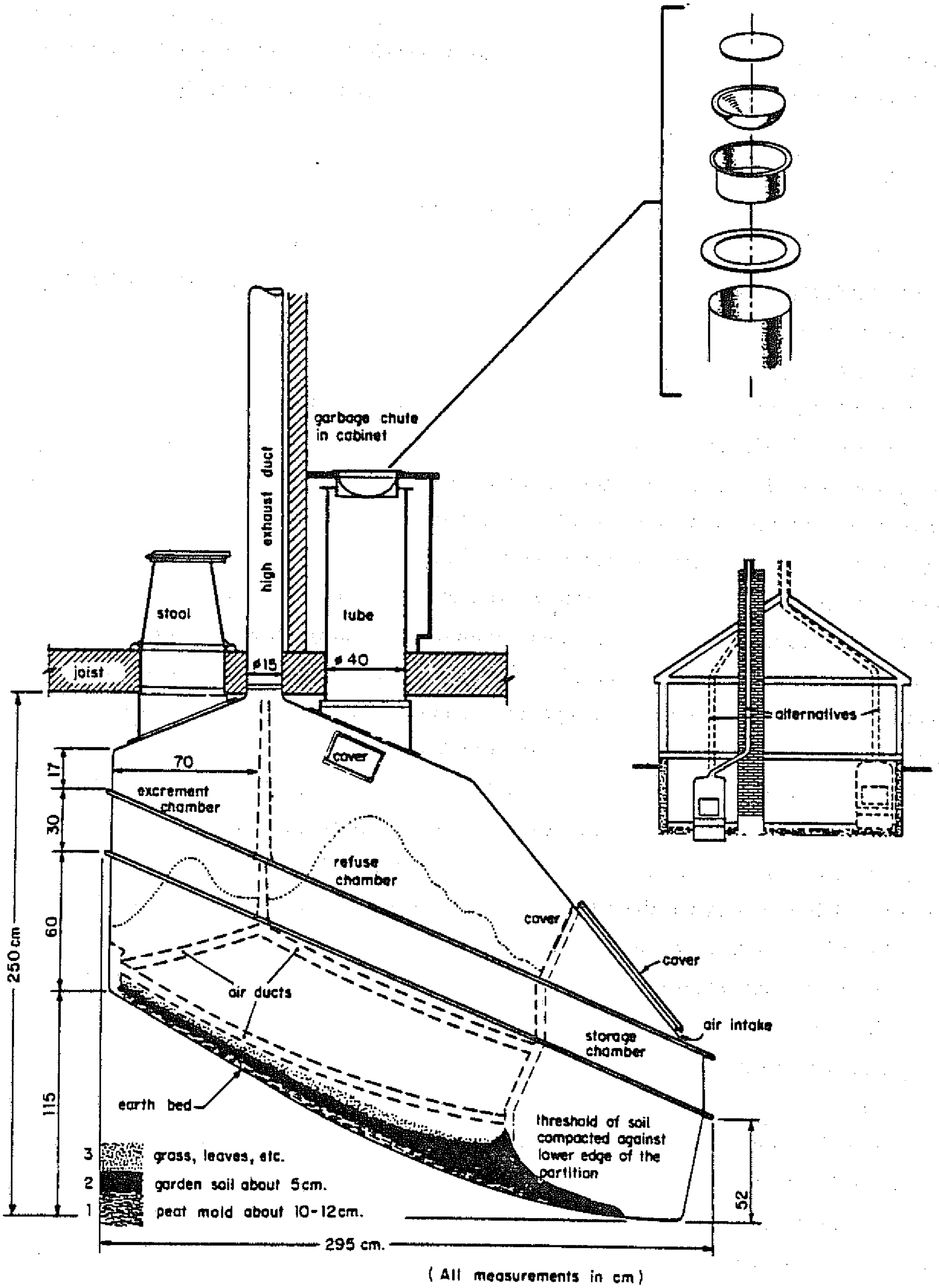


Figure 7. Clivus Multrum unit (after Lindström, 1975).

\$70 assuming a cost of 85¢/gal for heating oil. Such considerations have led some people to consider the use of solar panels or stack robbers to provide heat for the Clivus Multrum.

ENERGY ACCESS

The final important utility access to consider is energy (mainly electricity and heating) as well as conservation measures.

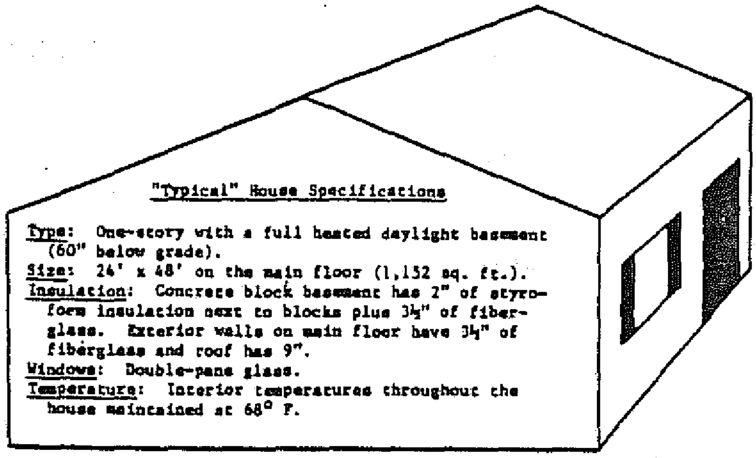
Heat is probably the most precious and necessary commodity that Alaskans require. A comparison of the best type of heating for the site developer is perhaps best made on an economic basis. There can be many factors that complicate the economic decision, such as prospects for available supply, the rate of price increases, and general uncertainties due to transportation, demand, and world market influences. For information purposes we will attempt to give up-to-the-month information as of June 1979. Some of the uncertainties of the world energy supply can cause overnight price increases and therefore one must consider the price comparisons we make here as subject to important changes as time passes.

If energy is confusing or technically difficult for you to understand, you are not alone. To help understand the important concepts and technical words used in energy discussions, a glossary of energy terms is included in this report as Appendix III.

Figure 8 includes a very instructive table of comparisons for the lowest cost fuels available (of the most commonly used heating fuels) in Fairbanks, Anchorage, Juneau, and Seattle. The chart was prepared by the Fairbanks North Star Borough Community Information Center. While it is dated, the relative comparisons are still valid. The comparison shows that in Anchorage, natural gas is the least expensive heating option. For Juneau, fuel oil is the most economical choice. And in Fairbanks, coal is by far the least expensive heating option. It is clear that these options, although the least expensive, are not equal in their maintenance, storage and other requirements. Be sure to consider all the factors when selecting a heating fuel.

It is very important to remember when comparing alternative heating fuels that burners have widely different efficiencies. This is especially true when comparing fuel types as in Figure 8. You should be interested in the net (useful) BTU output that actually heats your home, not the absolute heat content of the fuel. This useful heat is referred to as the net heating value of the fuel.

The net heating value depends upon a number of factors such as: method of firing the fuel, the firing rate, air supply, amount of heating surface, volume of the combustion chamber, and cleanliness of the combustion chamber and radiating surfaces. The gross heat output of various fuels is listed in Table 5. The efficiencies of selected types of heating systems are given in Table 6. The net heat output of various fuels is listed in Table 7.



	Unit	Cost/* Unit	x No. of Units	= Fuel Cost	+ Delivery or Other Charges	+ Tax Rate	= Total Heating Costs	Average Monthly Heating Costs
FAIRBANKS								
Average Annual Temp. 26.6°F								
Bituminous Coal - city	ton	$ 37.50	13	$ 488	$159	5%	$ 679	$ 56.57
Bituminous Coal - 10 miles outside city	ton	$ 37.50	13	488	174	2%	675	56.23
Electricity - MUS	kwh	5.5¢	52,392	3,023	-	5%	3,174	264.51
Electricity - GVEA	kwh	6.4¢	52,392	3,798	-	2%	3,894	322.83
Fuel Oil	gallon	57.5¢	1,910	1,098	-	-	1,098	91.52
Propane	gallon	98.0¢	2,783	2,727	-	-	2,727	227.28
Wood	cord	$ 55.00	22	1,210	-	-	1,210	100.83
ANCHORAGE								
Average Annual Temp. 35°F								
Electricity - city	kwh	2.0¢	40,917	$ 994	-	-	$ 994	$ 82.83
Fuel Oil	gallon	51.0¢	1,492	761	-	-	761	63.41
Natural Gas	ccf	.23767¢	1,995	474	$2.51	-	477	39.72
Propane	gallon	71.0¢	2,173	1,543	-	-	1,543	128.57
Wood	cord	$ 55.00	17	935	-	-	935	77.92
JUNEAU								
Average Annual Temp. 42.8°F								
Electricity	kwh	3.6¢	31,197	$1,171	-	4%	$1,218	$101.46
Fuel Oil	gallon	49.6¢	1,166	578	-	-	578	48.19
Wood	cord	65.00	13	845	-	-	845	70.42
SEATTLE								
Average Annual Temp. 53.2°F								
Electricity	kwh	.78¢	19,351	$ 212	-	-	$ 212	$ 17.66
Fuel Oil	gallon	47.9¢	706	338	-	-	338	28.18
Natural Gas	therm	33.0¢	944	312	-	7.5%	335	27.91

*Lowest Cost/Unit is shown except for average price for cord of wood.

Source: Determinations of fuel and heating requirements for a typical house in each city were made for the Community Information Center by Axel B. Carlson, Extension Engineer, Cooperative Extension Service, U of A, Fairbanks. Fuel costs/unit were determined by a Community Information Center survey of suppliers.

Figure 8. Estimated annual fuel requirements and heating costs for typical houses in Fairbanks, Anchorage, Juneau, and Seattle in October 1978 (from Fairbanks North Star Borough, 1979).

Although electricity at the house is rated 100 percent efficient, the energy efficiency at the power generation plant in converting fossil fuel to electricity is only 20-35 percent.

TABLE 5: GROSS HEATING VALUES OF FUELS

Type Fuel	BTU/lb	BTU/unit
Propane	21,550	91,000/Gal
Natural Gas	73,890	1,000/CF
Lignite Coal	8,700	17,400,000/Ton
Fuel Oil	19,800	138,000/BTU/Gal
Wood, Birch	4,300	14,000,000/Cord
Wood, Spruce	4,700	14,000,000/Cord
Electricity	---------	3,413/KWH

TABLE 6: EFFICIENCY OF HEATING SYSTEMS

Type Fuel	Method of Firing	Efficiency Percent
Coal, Anthracite	Hand fired with controls	60-70
Coal, Anthracite	Stoker fired	60-80
Coal, Bituminous	Hand fired with controls	50-65
Coal, Bituminous	Stoker fired	50-60
Electric	Resistance	100
Gas	All types	70-80
Oil	Designed unit	65-80
Oil	Conversion	60-80
Wood	Hand fired with controls	50-60

TABLE 7: NET HEATING VALUE OF FUEL

Type Fuel	Efficiency Percent	Net Heating Value BTU per Unit
Gas, natural	70	700/CF
Coal, bituminous	55	7,700,000/Ton
Electricity	100	3,413/KWH
Fuel Oil	65	89,700/Gal
Wood, birch	50	7,000,000/Cord
Wood, spruce	50	7,000,000/Cord
Propane	70	64,300/Gal

Home Heating — The Conventional Sources

1. Fuel Oil Systems:

Fuel oil is the dominant mode of heating for most Alaskan homes. Oil heating is reliable, clean, convenient and usually requires only annual maintenance checks. The decision to use oil is usually a practical and economic one, although oil is not always the least expensive alternative. While petroleum fuels are subject to world market pressures, some fuel oil is produced within the state, so prices are more stable than they would be otherwise.

Oil heating equipment and technology is somewhat complex, but its basic operation is quite simple. The heating system consists of four principal parts: burner, furnace or boiler, heat distribution system, and chimney. The burner generates heat by burning fuel oil. Part of the resultant heat is absorbed by the furnace or boiler and transferred to air or water, which is then distributed throughout the home by air ducts or hot water pipes and radiators. The heat that is not absorbed by the furnace or boiler is lost up the chimney as smoke and gases. The overall heating system efficiency depends on the performance of each of these parts.

Once you've decided to use an oil heating system, it is important to keep it in top running condition. Excellent information is found in "How to Improve the Efficiency of Your Oil Fired Furnace," which is available from the U.S. Department of Energy, Office of Public Affairs, Washington, DC 20585. The Cooperative Extension Service at the University of Alaska is a good place to seek advice.

2. Natural Gas Systems:

There are general similarities between gas and fuel oil systems, and the advice on maintaining them is equally valuable. Natural gas in Alaska is available at Barrow, the northern Kenai Peninsula area, and in the Anchorage area. It is very inexpensive at present, but is subject to future increases as new supply contracts replace older ones. Where gas is available, it is best to contact the local gas utility. These include:

A. Kenai Utility Service Corporation
Kenai, AK 99611
Phone: 283-7932

B. Alaska Gas and Service Company
3000 Spenard Road
P.O. Box 6288
Anchorage, AK 99501
Phone: 277-5551

C. Barrow Utilities and Electric Company

P.O. Box 449

Barrow, AK 99723

Phone: 852-6166

Gas is usually supplied via mains and is distributed through a metering system. It is a clean, convenient fuel for domestic heating.

3. Coal Heating:

Presently the only active mine in Alaska selling coal for home heating is the Usibelli Coal Company, whose operations are at the Nenana coal fields near Healy. Coal is bulky to handle and is somewhat less convenient to use than liquid fossil fuels. Its principal advantage is that coal has only about half the cost per BTU supplied. It is also easy to store.

Coal heating systems nearly disappeared from the market during the last 10 years because of competition from fuel oil systems. Coal furnaces have recently been in great demand, however, as fuel oil prices rise, and they are available at retail heating equipment suppliers in the state. To obtain coal, check the yellow pages of your phone book under "Coal." Coal is only generally available in the railbelt, and is most widely used in Fairbanks and Nenana due to its competitive position in these areas.

Renewable Energy Alternatives

1. Hydroelectric - Small Scale:

The possibility of generating electricity onsite from a small hydroelectric system is very appealing and appropriate to many areas of Alaska. Recently the state held a workshop in Anchorage on Small Scale Hydroelectric Power, March 28-29, 1980. Proceedings of this workshop are very comprehensive and are available for public review at the:

Division of Energy and Power Development

Alaska Department of Commerce and Economic Development

7th Floor MacKay Building

338 Denali Street

Anchorage, AK 99501

Phone: 275-0509

Dr. Douglas Kane

Institute of Water Resources

University of Alaska

Fairbanks, AK 99701

Phone: 479-7808 or 479-7775

Another excellent source of information, which includes a product guide and sizing and estimating requirements, is "Micro-Hydropower. Reviewing an Old Concept." It is available for $5.25 from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Small hydropower does require some licenses from the state and the following persons should have information on these requirements:

Dave Sturdevant
Alaska Department of Environmental Conservation
Juneau, AK 99811
Phone: 586-6721

Dan Betts
Region X, U.S. Department of Energy
1992 Federal Building
915 2nd Avenue
Seattle, WA 98174
Phone: (206) 399-2820

2. Wind Energy:

Many areas of Alaska have sufficient wind for generating power, pumping, or operating equipment. Wind energy equipment is sold in Anchorage and several systems are presently operating in rural Alaska. Wind is often site specific, and careful site evaluation is important to maximize useful wind energy.

An Alaskan wind energy users manual is currently in preparation through the Energy Research Program of the Alaska Department of Transportation and Public Facilities. It should be available by September 1980. Recently an excellent wind energy products guide was featured in the February 1980 issue of Solar Age Magazine. A reprint is available from Bob Shipley (see address below).

Wind energy for Alaskan domestic applications is well worth pursuing, especially for coastal sites, the Aleutians, and mountain passes. Specific wind energy advice is available from:

Dr. Tunis Wentink
Geophysical Institute
University of Alaska
Fairbanks, AK 99701
Phone: 479-7607

Bob Shipley
Division of Energy and Power Development
Alaska Department of Commerce and Economic Development
7th Floor McKay Building
338 Denali Street
Anchorage, AK 99501
Phone: 276-0508

James Wise
State Climatologist
Arctic Environmental Information and Data Center
University of Alaska
707 A Street
Anchorage, AK 99501
Phone: 279-4523

3. Solar Energy:

Contrary to popular belief, the arctic regions potentially can receive 230 more hours of daylight per year than at the equator. Some of the most basic considerations about solar energy can be easily accomplished by good, forward-looking site planning. First, make maximum use of the south slope of your property if it has that possibility. Second, put most of your windows on the south side of the house. This solar design alone can save from $40 to $140 per heating season and add the benefits of daylighting. Shutters on these windows for night insulation will add to the benefits of south-facing windows. Information on solar energy for domestic hot water heating is available from the Institute of Water Resources, University of Alaska, Fairbanks 99701. Another excellent source of information is the:

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850
Phone: (800) 523-4700 TOLL FREE

For Alaska-specific information call:

Richard Seifert
Institute of Water Resources
University of Alaska
Fairbanks, AK 99701
Phone: 479-7987

Bob Shipley
Division of Energy and Power Development
Alaska Department of Commerce and Economic Development
7th Floor McKay Building
338 Denali Street
Anchorage, AK 99501
Phone: 276-0508

4. Further reading — solar energy:

These publications are available from:
National Solar Heating & Cooling Information Center
P.O. Box 1607
Rockville, MD 20850
Phone: (800) 523-4700 TOLL FREE

Solar Energy and Your Home. 20 pp. Answers most common questions about solar energy and home applications. May 1978.

Solar Energy System Consumer Tips. 4 pp. Tells consumers what they should watch out for in buying a solar system. October 1977.

Practical and Do-It-Yourself Projects for Solar Utilization (a bibliography). October 1977.

Sketches and Blueprints of Homes You Can Build, Ideas You Can Use in Planning an Energy-Saving Home (a bibliography). December 1977.

Solar Greenhouse Bibliography and List of Plans. January 1978.

Solar Retrofit Bibliography. August 1978.

Bibliography of Passive Solar Energy Designs and Systems. January 1978.

Residential Energy from the Sun. A brief description of HUD's Residential Solar Demonstration Program. November 1978.

Put the Sun to Work Today. A 26-page description of all forms of solar. Order DOE/OPA-0033 (8-78) from Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

Wood For Home Heating

Wood is a very popular fuel in Alaska. The following discussion was modified from a U.S. Forest Service/Alaska State Forester pamphlet entitled "Wood as a Fuel."

With the increasing awareness of the energy shortage, many Alaskans are turning to alternate or supplemental sources of heating fuel. Wood is an abundant resource in most areas of Alaska and is an excellent fuel if properly used.

Popularity of wood as a heating fuel has greatly increased in the past few years. Several of the advantages of wood for heating are:

1. Wood is a renewable resource.
2. Wood can provide an independent source of heat in case of power failure or a fuel shortage.
3. Firewood is inexpensive, especially if the labor for producing the wood is supplied by the user (See Table 8).
4. Wood is a safe fuel if properly used.
5. The ashes from a wood fire are biodegradeable and provide an excellent source of potash for garden fertilizer.
6. Wood is much lower in irritating pollutants than most fuels.
7. A wood fire is aesthetically pleasing from both visual and aromatic standpoints.

Wood has some disadvantages. These are:

1. It is bulky to store and transport.
2. It is heavy and may be dirty to handle.
3. A wood fire is inconvenient, because it requires periodic attention, stoking, and ash removal.
4. To achieve the greatest monetary savings from burning wood, a person must process his or her own supply. This is often hard work. It involves cutting, hauling, splitting, and stacking the wood.
5. If the maximum heating value is to be obtained, firewood must be seasoned 6 months or more.
6. Chimney fires can occur if wood is incorrectly burned and chimneys are not properly maintained.

The heat value that a fireplace log produces depends on the concentration of woody material, resin, water, and ash. When wood is compared to fossil fuels, a full cord of heavy hardwood (such as birch) weighs about 2 tons and is approximately equal in heating value to a ton of hard coal or 130 gallons of fuel oil.

TABLE 8: APPROXIMATE COST OF HEAT FROM FUEL OIL AND WOOD[1]

Fuel	Heat Value	Delivered Cost	Cost of Heat per Million BTU	Assumed Burning Efficiency
	BTU	Dollars	Dollars	
Home fuel oil	140,000/gal	0.80/gal	$9.52	60%
Dry birch	18,200,000/cord	65.00/cord	7.14	50%
Dry spruce	15,000,000/cord	65.00/cord	8.66	50%

[1]Based on 1979 Fairbanks prices, which are similar to Anchorage. Cost in Juneau not available.

Species characteristics: several species of trees may be used for firewood. The most commonly used in Alaska are birch, spruce, cottonwood, hemlock, cedar, and aspen. The heat value produced by these woods varies according to their moisture content and dry weight (Table 9). Wood that weighs more burns slower, and it produces much more heat. Table 9 shows the average heat values and approximate weights for four Alaskan species. Paper birch is the best wood Âlaskan forests offer. It burns cleanly and hot with little sparking or popping.

The most critical factor to satisfactory burning is using dry wood. Heat is lost when water has to be warmed and evaporated, and the vapor must be further heated to flue temperature.

Green wood should not be burned in a slow, cool fire, because creosote will accumulate in the chimney flue and can cause a chimney fire. If green wood is burned, especially resinous spruce, make sure the fire is a hot one.

TABLE 9: AVAILABLE HEAT UNITS AND WEIGHTS OF WOOD PER CORD[1]

Species	Air-dry Wood		Green Wood
		Million BTU	
Paper birch	18.2		16.7
Spruce	15.0		14.2
Hemlock	15.0		12.8
Aspen	14.1		12.1
		Pounds	
Paper birch	3,420		4,500
Spruce	2,520		3,060
Hemlock	2,520		4,500
Aspen	2,340		3,870

[1]One cord equals about 90 cubic feet of solid wood.

Chimney fires are commonly caused by filling the stove or fireplace full of small, fine fuels, such as loose paper, dry spruce boughs, or fine kindling. Fire consumes them so rapidly that hot flames surge through the chimney. Burn only a small amount of fine fuels at a time to prevent chimney fires. Woods, such as spruce and hemlock, are easy to ignite but burn rapidly with a hot flame. This is often undesirable, since it requires frequent attention and replenishment. To make a fire that will last longer and burn more uniformly, a wood such as birch would be your best choice.

If you burn hemlock or spruce in an open fireplace, be especially cautious. They contain moisture pockets in the wood. Upon heating, trapped gases and water vapor build pressure in these pockets and "pop" with great vigor. A metal or glass screen is needed to avoid burning spots on your rugs or furniture or, more seriously, burning your house.

Seasoning wood: again, the most important factor in efficient burning is using dry wood. Wet wood burns poorly in an open fire and produces less heat than dry wood. Wood with a high moisture content will burn more efficiently in a modern, slow, combustion furnace. These furnaces have a long flame path and recover most of the potential heat energy.

Wood that is cut green should be air dried for 6 months or more before use. The most rapid drying is obtained when the wood is piled in a sunny, well aerated place and the top of the stack is covered. During the drying process, most of the moisture is lost from the ends of pieces of wood. So cutting wood to final log lengths before seasoning will speed the drying process. Splitting wood aids drying and improves combustibility, especially with birch.

Standing hardwoods generally have a lower moisture content during the summer when soil moisture is less and leaves are actively transpiring water. During other seasons, the moisture content is considerably higher because of high soil moisture and low transpiration.

A method often used to reduce drying time is called leaf-felling. This method is used in the summer when trees are actively transpiring water. The tree is felled and left in place for about 2 weeks or until most of the water evaporates and the leaves wither. This method can be a fire hazard and an eyesore if not properly done. Check with the local fire warden to determine the potential fire danger before using this method.

Buying firewood: the most common measure of firewood volume is the cord. A standard cord can be described as a well-stacked pile of logs that measures 4 by 4 by 8 feet, or about 90 cubic feet of *solid* wood.

To determine the volume of firewood in cords, the wood must first be stacked. Then, measure the dimensions of the stack of feet. Multiply the width by the height by the length to obtain the total cubic feet. Divide this figure by 128, which is the number of cubic feet in a standard cord. For example, a load of wood is stacked level in the bed of a pickup truck. You want to know how many cords are in the load. The truck bed is 1.5 feet high by 5.5 feet wide by 8.0 feet long.

$$5.5 \times 1.5 \times 8.0 = 66 \text{ cubic feet}$$

$$66 \div 128 = 0.52 \text{ cord}$$

A word of caution: since green birch weighs approximately 4,500 pounds per cord, this pickup load weighs about 2,340 pounds. If you are transporting your own wood, know the weight capacity of your vehicle. Don't overload your vehicle; you will be asking for costly repairs.

One of the largest expenses for the firewood seller is the handling cost of seasoning and splitting wood. Your wood will be much less expensive if you do your own splitting and seasoning.

Cutting firewood: if living trees are harvested, take only undesirable trees. An undesirable tree would be one that is suppressed, diseased, or dying. These trees are competing with live, healthy trees for nutrients, moisture, and sunlight. When these are removed, the vigor and growth of remaining trees are increased.

If you have a problem identifying undesirable trees on your woodlot, contact the State Forester's Office or the U.S Department of Agriculture's Forest Service for assistance. Make sure you have permission to cut or remove trees if the property is not your own.

Windthrown or dead trees make excellent firewood, because their moisture content is generally low. However, wood that has rotted makes poor firewood, because it is very low in heat value. Land-clearing sites, logging slash, and road rights-of-way many times offer other good sources of firewood.

Personal or free use applications and permits for obtaining firewood may be obtained from the following agencies:

Alaska Department of Natural Resources
Division of Forest, Land and Water Management

Anchorage: 323 E. 4th Avenue
Anchorage, AK 99501

Fairbanks: 4420 Airport Road
Fairbanks, AK 99701

U.S. Forest Service
2221 E. Northern Lights Blvd.
Anchorage, AK 99502

Very few easily accessible areas are open or available for firewood cutting, and they are not near population centers. Only dead or down timber may be cut in national forests.

Energy Tax Credits

Both the state of Alaska and the federal government give tax credits related to energy.

State of Alaska tax credits: the state of Alaska gives a general 5 percent tax credit on the cost of home heating fuels of all types to Alaska's homeowners. The credit is equal to 5 percent of the total cost of fuel consumed in the tax year.

A second state tax credit is available for the installation of alternative power sources which depend upon renewable energy sources. Fossil fuel (coal, oil, natural gas, propane) alternatives do not qualify. Energy sources such as solar, wind, and geothermal are specifically mentioned in the legislation.

Both these state tax credits are easily located on the Alaska state income tax forms, which describe how to benefit from the tax credits.

Federal tax credits: On April 2, 1980, President Carter signed into law the $227.7 billion crude oil windfall profits tax legislation which includes provisions to increase tax credits for solar and other renewable energy sources. Under the new law, P.L. 96-223, the residential tax credit for renewable energy resource expenditures goes from the previous maximum of $2200 to 40 percent of the first $10,000 spent, or a maximum of $4000. The increase applies to expenditures made between January 1, 1980, and January 1, 1986. The new law specifies that renewable resource property includes the costs to install solar panels as a roof or part of a roof. It also adds to the eligibility list equipment installed at a residence to produce electricity from renewable energy sources. The present residential energy conservation credit remains unchanged, however, despite attempts in the Senate to increase the credit and add several measures, such as heat pumps, to the eligibility list.

For businesses, the new law increases the credit for solar, wind and geothermal property from the present 10 percent to 15 percent and it extends the credit through December 31, 1985. The new law also provides an 11 percent business energy credit for investments in qualifying hydroelectric property and a 10 percent credit for qualifying cogeneration equipment.

The law retains the Secretary of the Treasury's discretionary authority to add items to the list of those eligible for residential energy credits. But it sets standards that the Secretary must use in evaluating whether a measure can be added. First, the Secretary cannot specify an item as eligible unless he determines that it will reduce consumption of oil and natural gas enough to justify the cost to the government. Furthermore, no item can be added if it poses an environmental hazard or threatens public health or safety. Finally, an item cannot be approved "unless the Secretary finds that the available federal subsidies do not make such approval unnecessary or inappropriate." The Secretary is required to make a final decision on adding any item within a year after a formal request is made, together with any information required to be filed with the request. In another area, the new law also provides rules under which purchasers of eligible equipment must choose between the tax credit, and subsidized energy loans and nontaxable grants.

Alternative Power Resource Revolving Loan Fund

Low-interest loans ($10,000 maximum) are available for financing up to 50 percent of the cost of the following: 1) purchase and installation of alternative power sources; and 2) the development and implementation of methods for energy production, waste disposal, recycling, food production, transportation, building design, and industrial enterprise which may be more efficient, and less energy intensive than those methods presently utilized. The rate of interest may not exceed 9.5 percent, the duration of repayment may not exceed 20 years, and the interest rate is 5 percent if the application is approved before 1984. For detailed information and applications for the Loan Fund, contact the Division of Business Loans, Alaska Department of Commerce and Economic Development:

Anchorage: 201 E. 9th Avenue, Suite 103
Anchorage, AK 99501
Phone: 274-6693

Fairbanks: 675 7th Avenue
Fairbanks, AK 99701
Phone: 452-8182

Juneau: Pouch D
Juneau, AK 99811
Phone: 465-2510

Energy Consumer Protection

Although the following information was specifically aimed at protecting prospective solar energy consumers, it is valuable advice for *all* energy consumers. If there is one desire consumers have in common, it is to get one's money's worth in a commercial transaction. This means doing some investigative and comparison shopping. In the end, the extra effort will be well worth it.

Some Buying and Building Tips, Solar and General

1. To begin with shop around: get *written estimates* from *at least* three contractors. Estimates should include not only the cost of the system and installation but also details of the

parts that will be provided. For example, you want to know the make, model and number of collectors the contractor will supply.

2. Check the contractor's or installer's previous experience. Find out how long he has been in business and how many other systems he has installed.
3. Get names of previous customers and *contact* them. (Do not rely on testimonial letters.) Talk to them.
4. Be sure to find out *who* will service your solar system if something goes wrong and *how quickly* you can get service. (Is the contractor or serviceman located near your home?)
5. Ask if the collector has been tested and certified. You should get a copy of the test report.
6. Obtain in writing an estimate of the system's performance, giving the total solar energy supplied for the year. A widely used method of calculating this yield is "The F-Chart Computer Program" of the University of Wisconsin. F-Chart is available through the University of Alaska's computer system.

   This figure should be considered with the price quoted by the contractor in selecting a system. Family and house size should be factored into the decision.

   The system's performance should be calculated and preferably tested by an independent, recognized laboratory in accordance with HUD minimum property standards. The calculations should allow for your location and family size.
7. Get a copy of the warranty and read it *before* you sign the contract. Be sure you understand the warranty. If you do not, do not be afraid to ask questions. Check to see:
   a. How long the warranty lasts.
   b. What parts, service and labor are covered. What is not covered?
   c. Is installation covered?
   d. Does the equipment have to be sent back to the manufacturer for repairs. If so, who pays for shipping?
   e. Find out how you get warranty service. Who do you call?
8. Beware of extravagant claims. Get *all* oral representations in writing.
9. Be sure everything is completed and operating before you pay for it.
10. *Be careful of sellers who use post office box numbers.* Though many legitimate businesses use these outlets as a convenient way to receive bills and orders, a common tactic of the fly-by-night artist is to use a post office box number, operate a territory until the law starts closing in, then move to a new territory. *Find out from the seller where his place of busines is, how long he has been there, and ask for his financial references.*
11. *Beware of simplistic claims.* They generally have a catch. "This solar system will handle up to 90 percent of your heating needs" may only apply to homes that have extravagant insulation. A more modest and more accurate claim would be: "On a good sunny day, this solar system will handle between 40 and 60 percent of your heating needs."

12. Select a system with adequate protection against freezing. If antifreeze is used, note that toxic materials must be separated from the domestic hot water by a double wall design. If freeze protection depends on the electric operation of a valve, require firm assurance of the reliability and service life of the valve. If the system drains to avoid freezing, check the pitch of all piping exposed to low temperatures to avoid low pockets of water which may freeze and burst.
13. Check your State Energy Office regarding federal, state and local tax relief and subsidies for your system *before* you buy.

Because no condensed statement can replace public education on solar energy's potential and problems, users are advised to consult the many reference books available before buying, particularly Buying Solar (National Technical Information Service PB-262-134); or call the National Heating and Cooling Information Center's toll free hot line at 1-800-523-4700.

If you have what appears to be a *legitimate complaint, keep adequate and accurate records.* Then notify your local consumer protection office.

Electricity

In compiling this Builder's Guide, a survey was sent to most of the utilities in Alaska. The utilities were asked if they were an electric, water, or sewer utility (in some cases they were all three). They were also asked to give the name and phone number of a contact for all pertinent electric hook-up, billing, and general utility information. In alphabetical order then, here are the names and phone numbers of the utility contacts in those Alaskan cities which responded. Not included are cities with water and sewer utilities only.

1. Anchorage, Municipality of:
   Anchorage Municipal Utilities
   600 E. 38th Avenue
   Anchorage, AK 99503

   Contacts: Jerry Nelsen (Telephone)
   Phone: 265-1527

   Jackie Mace (Water and Sewer)
   Phone: 277-7622, Ext. 231

   Customer Service (Electrical)
   Phone: 279-7671

2. Anchorage Area, Eagle River, Chugiak:
   Chugach Electric Association, Inc.
   731 Gambell
   Anchorage, AK 99501
   Phone: 276-3500

3. Alaskan Villages — call AVEC to find out what their jurisdiction is for your area:
   Alaska Village Electric Cooperative
   4831 Eagle Street
   Anchorage, AK 99503
   Contact: Gene Kane
   Member Services Specialist
   Phone: 277-6632

4. Auke Bay:
   Glacier Highway Electric Assn. Inc.
   P.O. Box 115
   Auke Bay, AK 99821
   Contact: Charles Y. Wallis
   General Manager
   Phone: 789-7344

5. Barrow:
   Barrow Utilities and Electric Co-op, Inc.
   P.O. Box 449
   Barrow, AK 99723
   Contact: Edith Vorderstrasse
   Office Manager
   Phone: 852-6166

6. Bethel:
   Bethel Utilities Corporation
   P.O. Box 729
   Eagle River, AK 99577
   Contact: Frances Davidson
   Phone: 694-9631

7. Fairbanks:

Fairbanks Municipal Utilities
645 5th Avenue
Fairbanks, AK 99701

Contact: Fred L. Brantingham
Customer Service Department
Phone: 452-1000

Golden Valley Electric Association
Box 1249
Fairbanks, AK 99707

Contact: Customer Service Department
Phone: 452-1151

8. Homer:

Homer Electric Association, Inc.
P.O. Box 429
Homer, AK 99603

Contacts: W.C. Rhodes (Homer)
Phone: 235-8551

E.R. Collins (Soldotna)
Phone: 262-5831

9. Juneau:

The City and Borough of Juneau
155 S. Seward Street
Juneau, AK 99801

Contacts: Marian Holmly (Charges)
Phone: 586-3300, Ext. 63

Earl Kubaskie (Connections)
Phone: 586-3300, Ext. 30

10. Ketchikan:

Ketchikan Public Utilities
P.O. Box 7300
Ketchikan, AK 99901
Contact: Margret E. Mall
Phone: 225-3111, Ext. 31

11. Kodiak:

Kodiak Electric Association, Inc.
P.O. Box 787
Kodiak, AK 99615
Phone: 486-3261

12. Petersburg:

City of Petersburg Power and Light
P.O. Box 329
Petersburg, AK 99833
Contact: City Clerk's Office
Phone: 772-4425

13. Seldovia:

City of Seldovia
P.O. Drawer B
Seldovia, AK 99663
Contact: Elain Giles
Phone: 234-7643

14. Seward:

Seward Public Utility
Box 337
Seward, AK 99664
Phone: 224-5214, 5215, or 5216

15. Sitka:

City and Borough of Sitka
Box 79
Sitka, AK 99835
Phone: 747-3294

16. Wrangell:

City of Wrangell
Box 531
Wrangell, AK 99929

Contact: Donna Klein
Phone: 874-2381

17. Yakutat:

Yakutat Power, Inc.
Box 257
Yakutat, AK 99689

Contact: Fred O. Miller
Phone: 784-3248

These numbers and contacts should enable an interested site developer to get electricity to the site and to understand the obligations and arrangements involved. Some key elements of which the developer should be aware are:

1. Determine the type of customer service your development will require: residential, commercial, or industrial, and specify this for all service requests.
2. Be aware that an electric utility often requires that electrical wiring and equipment meet certain standards and that inspections are required before service begins. Shortcuts in wiring or insufficiently safe installations can be rejected, costing time and money. Use good materials and do it properly the first time. Any such equipment and materials specifications are available from the utility. For commercial or industrial buildings, some utilities require detailed electrical load data and electrical prints prepared by a registered electrical engineer or licensed electrical contractor.
3. Be advised that poles may be necessary in order to get power to your property. Poles may be costly. Determine if they are needed and discuss the installation options with the utility.

ENERGY CONSERVATION

Proper insulation can increase the efficiency of your heating and cooling systems, increase comfort, reduce energy waste, and pay for itself in a relatively short time.

Increased energy costs have increased the demand for insulation. This demand is expected to increase even further with federal and state conservation tax credits. Unfortunately, proper controls and standards have not developed at the same rate. As a result, some opportunists seeking quick profits are operating in the insulation field. Although they are far outnumbered by legitimate and honest insulation contractors, consumers should be aware of potential problems.

What's an "R" Value

An "R" value is a number indicating how much resistance insulation presents to heat flowing through it. A higher "R" value means more effective insulation. Consumers should pay more only for a higher "R" value.

To help the consumer guard against dishonest contractors or salespeople who overstate the "R" value of an insulation product, the current generally accepted "R" values for the most commonly used insulating materials are outlined in Table 10. Any claim of an "R" value above this maximum design standard should be highly suspect. Be on guard against the "hard" sell.

TABLE 10

Product	Maximum "R" Value per Inch of Insulation
Fiberglass batts and blankets	3.1
Cellulose loose fill	3.1-3.7
Urea formaldehyde	4.1
Polystyrene (expanded)	5.5
Polyurethane	5-6
Perlite	2.7
Aluminum foil	2.0

Designing for an optimum amount of energy conservation is difficult to describe in simple terms. An expert in this field is Axel R. Carlson, an extension engineer for the Cooperative Extension Service, who has developed publications on energy conservation and building design. Especially useful publications for the prospective builder on insulation and special considerations of Alaskan construction are reprinted in Appendix IV.

Other publications are available that contain valuable information on energy conservation in Alaskan buildings. These include titles such as:

1. Tips on insulating an existing house.
2. Special considerations for building in Alaska.
3. Ventilation of fossil-fueled heating systems.
4. Effect of windows and ventilation on office heating requirements.
5. Thermal properties of walls.
6. Vapor barriers for log houses.
7. Temperature gradients of 2 x 4 stud walls.
8. Ceiling access openings.
9. Heat loss and condensation in northern residental construction.
10. Heating values of fuels.

Doing It Yourself

The Consumer Product Safety Commission advises people who want to do their own insulation work to take the following safety precautions:

1. Wear protective clothing, preferably long sleeves, long trousers, gloves, a hard hat to protect your head, and a disposable respirator marked for "dust" to avoid breathing small fibers.
2. Avoid direct contact with insulation dust since flame-retardant chemicals may be absorbed through the skin.
3. Do not place insulation near electrical light fixtures, a furnace or similar heat-producing device. Extreme heat, even without a flame, can ignite some insulation.
4. Do not place insulation over attic vents.
5. Be sure that there is good ventilation when installing insulation to help remove water vapor.
6. To avoid locking in moisture and causing wall or ceiling rot, install insulation with any vapor barrier placed toward the living space.
7. If adding new insulation over old, either purchase a product that has no vapor barrier, or slash the barrier at frequent intervals to allow moisture to escape.

An additional source of information on northern building design is a book entitled "How to Build a Superinsulated House" available from: P.O. Box 81961, Fairbanks, Alaska 99708, for $3.00. This book is Alaska-oriented and was written by Ed McGrath and some of his associates in Fairbanks. It is an excellent resource for familiarizing oneself with building techniques, types of insulation, what a vapor barrier is and where it belongs (on or close to the warm side of the wall), and problems of conventional structures.

Vapor Barriers

Vapor barriers are put in buildings for the reason their name implies: to keep water vapor from passing through them. This is important because moisture decreases considerably the insulating quality of insulation. Wet insulation is virtually worthless unless it is blue, closed-cell styrofoam. Consequently, it is important to keep insulation *dry*. Warm air inside a normal house has a high moisture content. If it is cold outside (colder than the dew point of the air inside the house) any air escaping from the house through a wall or ceiling will condense within the wall, and the insulation becomes wet and useless. The colder it is outside, the more likely this event will occur without a proper vapor barrier. Vapor barriers assure that insulation will retain its insulating qualities throughout the winter. They are *very* important. The problem is usually not with the vapor barrier itself but with *holes* in the barrier.

Some vapor barrier materials are: polyethylene plastic film (Visqueen), aluminum foil, butyl rubber sheeting, glass, Dow blue styrofoam insulation, and *some* (not all) paints. Paints that claim to have vapor barrier qualities should have a perm rating listed directly on the label. This rating should be at least *0.75* perms or lower. Four mil polyethylene is 0.08 perms.

Energy Conservation Tax Credits

There are both state and federal tax credits for energy conservation. For the state of Alaska the credit is equal to 10 percent of the material and labor costs of installing the insulation (the maximum credit is $200). It is similar to the energy tax credit and is also explained on the state income tax forms. Be sure to save your receipts for all energy conservation expenditures including labor, weather stripping, storm windows, and caulking, as well as insulation. All provide credits on your taxes.

The federal tax credits are claimed on IRS form 5695, which is available from your local IRS office and also is contained in the normal federal income tax forms. A nonrefundable credit, up to a maximum of $300, is provided for 15 percent of the first $2000 invested in qualifying property. The property claimed for the credit must be installed between April 20, 1977 and December 31, 1985, in a principal residence *already in existence* on April 20, 1977.

The insulation credit is not available for new homes. A credit is provided for investments in insulation, caulking, weather stripping, modified flue openings, storm and thermal doors and windows, automatic furnace ignition systems, clock thermostats, and other items.

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APPENDIX I

PUBLICATIONS LIST OF THE INSTITUTE OF WATER RESOURCES

Listed below are the publications produced by the Institute of Water Resources since its formation in 1965. These have been separated into two series. The IWR group is published by the Institute, and the "R" group are reprints from nationally distributed journals.

Those publications marked with an asterisk (*) are out of print, but can be copied photostatically for 15¢ per page. This fee will be invoiced when the report or reprint is mailed.

All IWR publications are available on microfiche at:

Arctic Environmental Information and Data Center
University of Alaska
707 A Street
Anchorage, Alaska 99501
(907) 279-4523

Those IWR publications with NTIS order numbers are also available from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

When ordering, be sure to include the NTIS Identification number.

IWR Series

*IWR-1 Peyton, H.R., P.R. Johnson, and C.E. Behike. 1967. Saline Conversion and Ice Structures from Artificially Grown Sea Ice. 30 pp. (NTIS No. PB190371).

*IWR-2 Miller, A.P. 1967. The Biochemical Bases of Psychrophily in Microorganisms. 35 pp.

*IWR-3 Behlke, C.E. 1968. Evaluation of Water Research Needs in Alaska. 9 pp.

*IWR-4 Burton, S. 1968. Inherent and Maximum Microbiological Activity in Smith Lake 8 pp.

*IWR-5 Murphy, R.S. 1968. Treatment of Low-Quality Water by Foam Fractionation. 12 pp.

*IWR-6 Swartz, L.G. 1968. Reconnaissance of the Distribution and Abundance of *Schistosomatium Douthitti*, A Possible Human Disease Agent in Surface Waters in Alaska. 18 pp.

IWR-7 Wagner, D.G., R.S. Murphy, and C.E. Behlke. 1969. A Program for the Collection, Storage, and Analysis of Baseline Environmental Data for Cook Inlet, Alaska. 284 pp.

*IWR-8 Murphy, R.S., and C.W. Hartman. 1969. A Water Distribution System for Cold Regions - the Single Main Recirculating Method - An Historical Review, Field Evaluation, and Suggested Design Procedures. 78 pp. (NTIS No. PB187685).

*IWR-9 Murphy, R.S. 1969. Practical Application of Foam Fractionation Treatment of Low Quality Water. 11 pp. (NTIS No. PB188827).

*IWR-10 Kim, S.W., P.R. Johnson, and R.S. Murphy. 1969. A Ground Water Quality Summary for Alaska. 32 pp. (NTIS No. PB187683).

*IWR-11 Hartman, C.W., and R.F. Carlson. 1970. Bibliography of Arctic Water Resources. 344 pp. (NTIS No. PB198668).

*IWR-12 Brickell, D.C., and J.J. Goering. 1971. The Influence of Decomposing Salmon on Water Chemistry. 27 pp. (NTIS No. PB198431).

IWR-13 Kim, S.W. 1971. The Effectiveness of a Contact Filter for the Removal of Iron from Ground Water. 46 pp. (NTIS No. PB202211).

*IWR-14 Morrow, J.E. 1971. The Effects of Extreme Floods and Placer Mining on the Basic Productivity of Sub-Arctic Streams. 7 pp. (NTIS No. PB201654).

*IWR-15 Morrow, J.E. 1971. The Effects of Water Quality and Quantity on the Fauna of a Non-Glacial Alaskan River. 8 pp. (NTIS No. PB201655).

*IWR-16 Erickson, G.K., and A.R. Tussing. 1971. Economic and Organizational Issues in Alaskan Water Quality Management. 20 pp. (NTIS No. PB206185).

*IWR-17 Carlson, R.F., and C.E. Behlke. 1971. A Computer Model of the Tidal Phenomena in Cook Inlet, Alaska. 69 pp. (NTIS No. PB210812).

*IWR-18 Long, W.E. 1972. Glacial Processes and Their Relationship to Streamflow - Flute Glacier, Alaska. 22 pp. (NTIS No. PB208694).

*IWR-19 Greenwood, J.K., and R.S. Murphy. 1972. Factors Affecting Water Management on the North Slope of Alaska. 42 pp. (NTIS No. Com-72-11470).

*IWR-20 Murray, A.P., and R.S. Murphy. 1972. The Biodegradation of Organic Substrates under Arctic and Sub-Arctic Conditions. 56 pp. (NTIS No. PB211999).

*IWR-21 Guymon, G.L. 1972. Application of the Finite-Element Method for Simulation of Surface Water Transport Problems. 105 pp. (NTIS No. PB211079).

*IWR-22 Haring, R.C. 1972. An Analysis of the Demands for Water from the Private Sector in a Sub-Arctic Urban Area. 64 pp. (NTIS No. PB211610).

*IWR-23 Murray, A.P. 1972. The Effects of Suspended Silts and Clays on Self-Purification in Natural Waters: Protein Adsorption. 52 pp.

*IWR-24 Guymon, G.L. 1972. Application of Artificial Recharge Technology for Managing the Water Resources - Anchorage, Alaska. 40 pp. (NTIS No. PB211331).

*IWR-25 Carlson, R.F., and G.E. Weller. 1972. A Catalog of Hydroclimatological Data for Alaska's Coastal Zone. 57 pp. (NTIS No. PB221375).

*IWR-26 Murphy, R.S., et al. 1972. Effect of Waste Discharges into a Silt-Laden Estuary - A Case Study of Cook Inlet, Alaska. 26 pp. (NTIS No. PB223009).

*IWR-27 Ranganathan, K.R., and R.S. Murphy. 1972. Bio-Processes of the Oxidation Ditch When Subjected to a Sub-Arctic Climate. 57 pp.

*IWR-28 Carlson, R.F. 1972. Development of a Conceptual Hydrologic Model for a Sub-Arctic Watershed. 58 pp.

IWR-29 Hoskin, C.M., and R.M. Slatt. 1972. Iron in Surface and Subsurface Waters, Grizzly Bar, Southeastern Alaska. 15 pp. (NTIS No. PB220248).

*IWR-30 Nyquist, D., L.A. Casper, and J.D. LaPerriere. 1972. A Survey of Lentic Waters with Respect to Dissolved and Particulate Lead. 33 pp. (NTIS No. PB219994).

IWR-31 This publication is not for distribution.

*IWR-32 Tilsworth, T. 1972. Sludge Production and Disposal for Small Cold Climate Bio-Treatment Plants. 43 pp. (NTIS No. PB219980).

*IWR-33 LaPerriere, J.D., and D. Nyquist. 1972. The Limnology of Two Dissimilar Subarctic Streams and Implications of Resource Development. 73 pp. (NTIS No. PB223353).

*IWR-34 Goering, J.J., and D.C. Brickell. 1972. Distribution of Organics from Salmon Decomposition. 9 pp. (NTIS No. PB222017).

*IWR-35 Ostrem, G., T. Ziegler, and S.R. Ekman (translated by Helga Carstens). 1972. A Study of Sediment Transport in Norwegian Glacial Rivers, 1969. 59 pp.

*IWR-36 Benson, C.S. 1973. A Study of the Freezing Cycle in an Alaskan Stream. 31 pp. (NTIS No. PB223905).

*IWR-37 Tilsworth, T. 1973. Water/Wastewater Evaluation for an Arctic Alaskan Industrial Camp. 175 pp.

*IWR-38 Murphy, R.S. 1973. Water Quality in Alaskan Campgrounds. 108 pp. (NTIS No. PB228851).

IWR-39 Carlson, R.F., and J.G. Butler, eds. 1973. Alaska Water Resources Research Needs for the 70's - A Seminar. 155 pp. (NTIS No. PB227244).

*IWR-40 LaPerriere, J.D. 1973. Laboratory Rearing Experiments on Artificially Propagated Inconnu (Sheefish). 25 pp. (NTIS No. PB232141).

IWR-41 Kane, D.L., and R.F. Carlson. 1973. Hydrology of the Central Arctic River Basins of Alaska. 51 pp. (NTIS No. PB228011).

*IWR-42 Hartman, C.W., and R.F. Carlson. 1973. Water Balance of a Small Lake in a Permafrost Region. 23 pp. (NTIS No. PB227241).

IWR-43 Carlson, R.F., W.R. Norton, and J.C. McDougall. 1974. Modeling Snowmelt Runoff in an Arctic Coastal Plain. 72 pp (NTIS No. PB232431).

IWR-44 This publication is not for distribution.

IWR-45 This publication is not for distribution.

IWR-46 LaPerriere, J.D., and R.F. Carlson. 1973. Thermal Tolerances of Interior Alaskan Arctic Grayling *Thymallus Arcticus*. 36 pp. (NTIS No. PB227239).

IWR-47 Behlke, C.E., and J.C. McDougall. 1973. Polyethylene Sheeting as a Water Surface Cover in Sub-Zero Temperatures. 42 pp.

IWR-48 Smith, D.W., and L.A. Casper. 1974. Ground Water Quality Effects on Domestic Water Utilization. 139 pp. (NTIS No. PB232535).

IWR-49 Carlson, R.F., T. Tilsworth, and C. Hok. 1978. Effects of Thermal Discharge Upon a Subarctic Stream. 66 pp. (NTIS No. PB289369).

*IWR-50 Tilsworth, T. 1974. Organic and Color Removal from Water Supplies by Synthetic Resinous Adsorbents. 53 pp. (NTIS No. PB233068).

*IWR-51 Guymon, G.L. 1974. Sediment Relations of Selected Alaskan Glacier-Fed Streams. 17 pp. (NTIS No. PB245104).

IWR-52 Carlson, R.F., P.M. Fox, and S.D. Shrader. 1974. Methods of Flood Flow Determination in Sparse Data Regions. 37 pp (NTIS No. PB235261).

IWR-53 Guymon, G.L. 1974. Suprapermafrost Water. 11 pp.

IWR-54 This publication is not for distribution.

IWR-55 Carlson, R.F., and P.M. Fox. 1974. Flood Frequency Estimation in Northern Sparse Data Regions. 15 pp. (NTIS No. PB235262).

IWR-56 Tilsworth, T. 1974. The Characteristics and Ultimate Disposal of Waste Septic Tank Sludge. 30 pp. (NTIS No. PB241488).

IWR-57 Smith, D.W., and M.J. Hayes. 1975. Study of Trace Elements in Waters of Two Alaskan Reservoir Sites. 81 pp. (NTIS No. PB241470).

IWR-58 Smith, D.W., and S.R. Justice. 1975. Effects of Reservoir Clearing on Water Quality in the Arctic and Sub-Arctic. 15 pp. (NTIS No. PB241853).

IWR-59 This publication is not for distribution.

*IWR-60 Carlson, R.F., D.L. Kane, and G. Wendler. 1974. A Study of the Breakup Characteristics of the Chena River Basin Using ERTS Imagery. 32 pp.

IWR-61 Joy, R.W., T. Tilsworth, and D.D. Williams. 1975. Carbon Monoxide Exposure and Human Health. 100 pp.

IWR-62 Smith, D.W., and T. Tilsworth. 1975. Environmental Standards for Northern Regions. 389 pp.

IWR-63 LaPerriere, J.D. 1975. Evaluation of the Trophic Types of Several Alaskan Lakes by Assessment of the Benthic Fauna. 49 pp. (NTIS No. PB251158).

IWR-64 This publication is not for distribution.

IWR-65 Kane, D.L., J.N. Luthin, and G.S. Taylor. 1975. Heat and Mass Transfer in Cold Regions Soils. 50 pp.

IWR-66 Smith, D.W., and R.W. Pearson. 1975. Community Response Strategies for Environmental Problems of Water Supply and Wastewater Disposal in Fairbanks, Alaska. 28 pp.

IWR-67 Smith, D.W., and S.R. Justice. 1976. Clearing Alaskan Water Supply Impoundments; Management, Laboratory Study, and Literature Review. 106 pp.

*IWR-67a Justice, S.R., and D.W. Smith. 1976. Clearing Alaska Water Supply Impoundments: Literature Review. 96 pp.

*IWR-67b Smith, D.W., and S.R. Justice. 1976. Clearing Alaska Water Supply Impoundments: Data. 26 pp.

*IWR-68 LaPerriere, J.D., and L.A. Casper. 1976. Biogeochemistry of Deep Lakes in the Central Alaskan Range. 35 pp.

IWR-69 Smith, D.W., and J.M. Hargesheimer. 1975. Investigations of an Ozone-Filter System for Color and Iron Removal at Low Temperatures. 71 pp.

*IWR-70 Kane, D.L. 1975. Winter Soil Water Dynamics. 10 pp.

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APPENDIX II
WATER LABS APPROVED BY THE ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Microbiology

1. Chemical and Geological Laboratories of Alaska, Inc.
   P.O. Box 4-1276
   Anchorage, AK 99509
   Phone: 279-4014, 274-3364

2. Northern Testing Laboratories
   600 University Avenue
   Fairbanks, AK 99701
   Phone: 479-3115

3. Phillips Petroleum
   Kenai LND-Plant Laboratory
   P.O. Drawer 66
   Kenai, AK 99611

4. City and Borough of Juneau
   Wastewater Treatment Plant
   155 South Seward Street
   Juneau, AK 99801
   Phone: 586-6888

5. Petersburg General Hospital
   Microbiology Laboratory
   P.O. Box 589
   Petersburg, AK 99833
   Phone: 772-4291

6. Southeast Alaska Water Quality Services
   Rt. 6 Box 4144-11
   Juneau, AK 99803
   Phone: 789-7414

7. U.S. Air Force Hospital (AAC-SGPM)
   Environmental Health Lab
   Elmendorf, AK 99506

Inorganic Chemical Contaminants

1. Chemical and Geological Laboratories of Alaska, Inc.
   P.O. Box 4-1276
   Anchorage, AK 99509
   Phone: 279-4014, 274-3364

2. Northern Testing Laboratories
600 University Avenue
Fairbanks, AK 99701
Phone: 479-3115

Organic Chemical Contaminants

1. CH2M/Hill (Redding Lab)
P.O. Box 428
Corvallis, OR 97330
Phone: (503) 752-4271

2. Chinook Research Laboratories
P.O. Box 1392
Corvallis, OR 97330
Phone: (503) 757-7990

3. Columbia Laboratories
P.O. Box 40
Corbett, OR 97019
Phone: (503) 375-3387

4. Umpqua Research Company
P.O. Box 791
Myrtle Creek, OR 97457
Phone: (503) 863-5201

5. Century Testing Laboratories, Inc.
P.O. Box 1174
Bend, OR 97701
Phone: (503) 382-6432

6. Neptune-Microfloc
P.O. Box 612
Corvallis, OR 97330
Phone: (503) 754-7654

7. Water Analysis and Consulting, Inc.
304 Blair Blvd.
Eugene, OR 97402
Phone: (503) 485-8404

8. Chemical and Geological Laboratories of Alaska, Inc.
P.O. Box 4-1276
Anchorage, AK 99509
Phone: 279-4014, 274-3364

Radioactive Contaminants

1. LFE Corporation
   Environmental Analysis Laboratories
   2030 Wright Avenue
   Richmond, CA 94804
   Phone: (415) 235-2633

APPENDIX III

A GLOSSARY OF ENERGY TERMS

Several definitions and explanations would help the wise energy consumer to better understand the technical terms which can often be confusing to the layman.

British Thermal Unit (BTU) - An engineering unit of heat energy, the quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit, about one-quarter of a Calorie.

Calorie - A metric unit of heat energy, the amount of heat that will raise the temperature of one kilogram of water 1° Celsius. It is approximately equal to 4 BTUs. (In scientific terminology it is equivalent to the kilocalorie, 1,000 small calories.)

Capacity factor - A measure of the ratio of the electrical energy actually produced at a generating plant to the maximum design capacity of the plant.

Celsius - The metric temperature scale in which the temperature of melting ice is set at 0°, the temperature of boiling water at 100°. One degree Celsius is 9/5 of a degree Fahrenheit. The Celsius scale is also known as the Centigrade scale.

Centigrade - See Celsius.

Crude oil - A mixture of hydrocarbons in liquid form found in natural underground petroleum reservoirs. It has a heat content of 1.46 million Calories/barrel and is the raw material from which most refined petroleum products are made.

Declining block rate - A method of charging for electricity wherein a certain number of kilowatt hours (the first block) is sold at a relatively high rate and succeeding blocks are sold at lower and lower rates. Thus the average charge per kwh decreases as the amount consumed increases. (See "inverted block rate.") This does *not* mean that total charge for electricity is less, the more you use. It just means that the first block costs more, with each successive block costing a bit less for each kwh.

Efficiency - The efficiency of an energy conversion is the ratio of the useful work or energy *output* to the total work or energy *input*. (This is sometimes called "First Law Efficiency.")

Energy - A quantity having the dimensions of a force times a distance. It is conserved in all interactions within a closed system. It exists in many forms and can be converted from one form to another. Common units are Calories, joules, BTUs, and kilowatt-hours.

Gasoline - A petroleum product consisting primarily of light hydrocarbons. Some natural gasoline is present in crude oil but most gasoline is formed by "cracking" and refining crude oil. It has a heat value of 1.32 million Calories/barrel.

Generating capacity - The capacity of a power plant to generate electricity. Usually measured in megawatts (Mw).

Heat - A form of kinetic energy that flows from one body to another because of a temerature difference between them. The effects of heat result from the motion of molecules. Heat is usually measured in Calories or British Thermal Units (BTUs).

Heat engine - Any device that converts thermal heat energy into mechanical energy.

Heat pump - A device that transfers heat from a cooler region to a warmer one (or vice versa) by the expenditure of mechanical or electric energy. Heat pumps work on the same general principle as refrigerators and air conditioners.

Heat value - The energy released by burning a given amount of the substance; also energy equivalent.

Inverted block rate - A method of selling electricity wherein a first "block" of kilowatt hours is offered at low cost and prices increase with increased consumption.

Kilowatt (kw) - A unit of power, usually used for electric power, equal to 1,000 watts, or to energy consumption at a rate of 1,000 joules per second.

Kilowatt-hour (kw-hr) - A unit of work or energy. Equivalent to the expenditure of one kilowatt in one hour, about 853 Calories.

Kinetic energy - The energy of motion. The ability of an object to do work because of its motion.

Life cycle costs - The total cost of an item including initial purchase price as well as cost of operation, maintenance, etc. over the life of the item.

Megawatt (mw) - A unit of power. A megawatt equals 1,000 kilowatts, or 1 million watts.

Mill - A tenth of a cent. The cost of electricity is often given in mills per kilowatt hour.

"Off-peak" power - Power generated during a period of low demand.

Peak demand period - That time of day when the demand for electricity from a powerplant is at its greatest.

Peak load - The maximum amount of power delivered during a stated period of time.

Peak load pricing - Charging more for the delivery of power during the daily period during which the utility's power delivered is maximum. This system is designed to discourage the use of electric power during peak use periods.

Photovoltaic process - The process by which radiant energy is converted directly into electrical energy. Solar radiation striking certain materials is absorbed, causing separation of electrons from atoms. The migration of these electrons in one direction and of the positively charged electron vacancies ("holes") in the other can produce a small potential difference (or voltage), typically about 0.5 volts.

Potential energy - "Stored" energy. Energy in any form not associated with motion, such as that stored in chemical or nuclear bonds, or energy associated with the relative position of one body to another.

Power - The rate at which work is done or energy expended. It is measured in units of energy per unit of time such as Calories per second, and in units such as watts and horsepower.

Second Law of Thermodynamics - One of the two "limit laws" which govern the conversion of energy. Referred to sometimes as the "heat tax," it can be stated in several equivalent forms, all of which describe the inevitable passage of some energy from a useful to a less useful form in any cyclic energy conversion.

Second Law Efficiency - The ratio of the minimum amount of work or energy necessary to accomplish a task to the actual amount used.

Solar cell - A device that converts radiant energy directly into electrical energy by the photovoltaic process. Each cell produces about 0.5 volts and about 0.6 watts of power.

Solar energy - The electromagnetic radiation emitted by the sun. The Earth receives about 4,200 trillion kilowatt-hours per day.

Thermal storage - A system that uses ceramic brick or other materials to store heat energy.

Thermodynamics - The science and study of the relationship between heat and other forms of energy.

Thermostat - A temperature-sensitive device which turns heating and cooling equipment on and off at set temperatures.

Watt (w) - A metric unit of power usually used in electric measurements which gives the rate at which work is done or energy expended. One watt equals one joule of work per second.

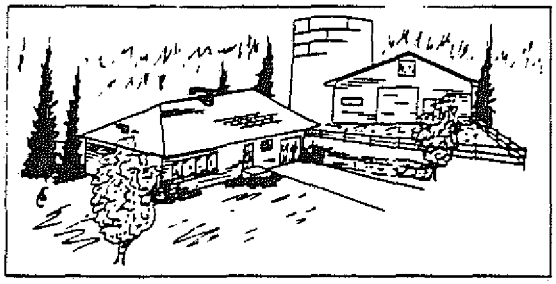
Work - Energy that is transferred from one body to another in such a way that a difference in temperature is not directly involved. The product of an external force times the distance an object moves in the direction of the force.

APPENDIX IV
COOPERATIVE EXTENSION SERVICE REPRINTS

COOPERATIVE EXTENSION SERVICE
University of Alaska – Fairbanks
and U.S. Department of Agriculture Cooperating

Building in Alaska

Publication No. P-952



SPECIAL CONSIDERATIONS FOR BUILDING IN ALASKA

Axel R. Carlson
Extension Engineer

The following special considerations for building in Alaska are recommended which are normally not included in structures designed for the milder climates of the lower-49 states. Plans and publications will be developed as new construction techniques are developed in Arctic construction.

A. FOUNDATIONS

1. Consult with an architect, engineer or contractor before building on soils subject to permafrost which includes most of Interior Alaska.
2. Enclosed crawl spaces or basements should not be constructed in soils subject to permafrost. Wood piles, mud sills or freeze tubes with open crawl spaces are suggested in permafrost soil.
3. In areas where masonry or concrete foundations are used, they must be reinforced against seismic action in accordance with local or state codes. Masonry chimneys should also be reinforced against earthquake.
4. Consult with local insurance agent and borough engineer before building in areas subject to flooding.
5. Install adjustable louvres in the foundation wall of unheated crawl spaces that may be opened for summer ventilation to minimize formation of excess condensation and rotting of wood framing members.
6. Foundations should be closed in and the building heated to avoid excessive heaving and settlement of footers during winter.
7. All masonry and concrete foundations should be properly reinforced to minimize cracking due to heaving and settling of frozen ground.

B. FLOORS

1. In permafrost areas floors should be constructed over open crawl spaces and insulated to minimize melting of the permafrost and to avoid uneven settlement of the building.
2. The surface temperature of the floor is of particular concern in Arctic climates as this is where we work, play and relax during our waking hours. The closer the floor surface temperature approaches room ambient temperature, the greater the comfort level.
3. A cold floor results in discomfort of direct radiation, stratification of cold air near the floor and warm air near the ceiling.
4. Floors should be insulated as described in section on "INSULATION."
5. A polyethylene vapor barrier should be installed directly under the rough flooring of a floor placed over an unheated or open crawl space. Floors with deep trussed joists or lumber plywood "I-Beam" joists should be vapor proofed and insulated with a foamed-in-place urethane insulation applied to the bottom covering of the cavity.
6. An uninsulated concrete slab on-grade floor is not recommended for the main living area as ground temperatures in Alaska are near 33°F. If used as the living area, the entire floor should be insulated with at least one inch of rigid foam plastic insulation. Perimeter type insulation is not adequate for Alaska.
7. A polyethylene vapor barrier should be placed under all concrete floor poured on grade or laid on the ground of closed crawl spaces to minimize the migration and evaporation of excessive moisture from the soil.

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C. WALLS

1. Walls should be insulated as described in section on "INSULATION."

2. A polyethylene vapor barrier should be placed on the interior faces of the studs directly over the insulation (warm side). Be careful to seal all openings that must be made to accomodate plumbing vent stacks, chimneys, electrical wiring, etc.

3. The vapor barrier should be installed on the ceiling first before any interior partitions are installed. Place the wall vapor barrier on the inside (warm) side of ceiling lap.

4. Wherever possible, it is recommended that no electrical wiring be installed in the ceiling except as outlined in section on "ELECTRICAL WIRING."

5. Radiation and cold drafts caused by cold wall surfaces can be corrected by baseboard radiation or hot air registers placed along the perimeter of exposed walls.

D. CEILING

1. The ceiling should be insulated as described in section on "INSULATION."

2. To minimize condensation stains on the ceiling and glaciering at the eaves and valleys, the roof cavity must be kept cool and free of moisture by a combination of adequate vapor barrier, insulation and ventilation.

3. A polyethylene vapor barrier should be placed on interior surfaces of the ceiling directly under the insulation, prior to the erection of partitions. Leave 8 to 12 inches overhang on the walls.

4. Be careful to seal all openings through the vapor barrier that may be caused by the installation of plumbing, electrical outlets, chimneys, etc.

5. The roof cavity must be ventilated by a combination of 1/2 inch continuous slots at both eaves and louvres at the gable.

6. If the supporting beam of a flat roof must be reset into the ceiling, then a cricket must be constructed in the roof deck over the beam to assure adequate eave-to-eave ventilation.

7. Framing of scuttle openings or stairways into uninsulated attics should be avoided as it will eventually lead to condensation and frosting problems.

8. Openings into a cold attic, if absolutely essential, should be provided through the gable wall.

9. If an attic must be accessible from the interior of the house for storage purposes, then it should be adequately insulated, vapor proofed, ventilated and heated to avoid condensation and frosting problems.

10. The use of thicker insulation (6 to 10 inches or more) for the ceiling necessitates special precautions to assure adequate insulation at the eaves of gable roofs.

11. The trusses may be cantilevered so that they extend over the wall 18 to 24 inches on both sides allowing 12 to 18 inches between the roof deck and the plate which should provide 9 to 12 inches clear space over the top of the plate.

12. Lumber sizes of conventional rafters may be increased to provide sufficient ventilation space over the insulation at the eaves. Also the rafters may be raised up on a special header notched into the ceiling joists instead of setting the rafter onto the wall plate.

13. Do not taper the insulation at the eaves or pull the insulation back from the wall plate as this increases the heat conduction through the plate, joists, and rafters. Condensation and staining of interior finished surfaces may occur adjacent to the header and under the ceiling framing members.

14. Wherever possible it is recommended that the installation of concealed wiring be avoided in ceilings of cold roof cavities. Refer to section on "ELECTRICAL WIRING" for alternative suggestions.

E. INSULATION

The following minimum insulation values are recommended for Alaskan homes:

	FLOOR Closed Crawl Space unheated	FLOOR Open Crawl Space	WALL	CEILING
R-Value[1/] (1/U)	11.0	33.0	11.0	19.0
U-Value[2/] (BTU/Hr/SF/°F)	0.0737	0.0298	0.091	0.052
Interior Surface[3/] Temperature, °F	67.0	67.0	64.3	66.8
Fiberglass[4/] k=.27, inches	3.5	9.5	3.5	6.0
Polystyrene[5/] k=.24, inches	2.6	7.9	2.6	4.6
Urethane[5/] surface coat k=.17, inches	1.9	5.6	1.9	3.2
impervious skin k=.15, inches	1.6	5.0	1.6	2.9

1/ Minimum recommended R-value of the insulation alone.

2/ U-values include normal exterior and interior finished to determine interior surface temperature.

3/ Based on temperature of 70°F inside and -40°F outside and 35°F for the closed unheated crawl space. If higher floor surface temperature is desired then floor cavity must be heated.

4/ Normal rated thicknesses for fiberglass insulation.

5/ The k-values of foam plastic insulation varies with the density of material as applied.

F. VAPOR BARRIER

1. A 4-6 mil polyethylene vapor barrier shall be installed over all interior surfaces directly over the insulation prior to installation of partitions and interior finishes.
2. Refer to sections on "FLOORS, WALLS, AND CEILING" for further details. Also refer to section on "INSPECTION."

G. INSPECTION

1. It is recommended that no interior finished floor, wall and roof covering be installed until the insulation, vapor barrier, concealed plumbing, and electrical wiring has been approved by the prospective homeowner or his authorized representative consisting of either the building inspector, the finance agency and/or the architect.
2. If the building must be enclosed prior to inspection of the vapor barrier, then the contractor should be asked to extend the warranty or to provide sufficient funds in escrow with a bank to correct any damage due to negligent workmanship or faulty material for a period of two years after final inspection. Such an agreement should be drawn up by your personal lawyer before any contract is signed with the contractor, real estate agent, and/or the finance agent.

H. VENTILATION

1. Ventilation fans should be provided in the kitchen, bathroom and laundry room. Do not vent fans directly into the roof or crawl space cavities.

2. If electricity is not available, a simple exhaust duct installed over the cook stove and vented through the roof to the outdoors. The air flow may be controlled by an adjustable damper.

3. Automatic clothes driers, whether electric or gas heated, should be vented outdoors by an approved vent pipe.

4. An air intake should be installed from the outside into all furnace rooms. The air intake should be fitted with dampers that will close by gravity while the oil burner or stoker blower is not operating.

I. WINDOWS

1. Windows for Alaskan homes should be constructed with wood frames and sash and fitted with double sealed glass. Single glass may be glazed into the sash and fitted on the outside of the sash with a second removable glass pane.

2. Storm type windows fitted onto the window frames are not suitable for prolonged periods of subzero temperatures as migration of moisture around weather-stripping condenses out onto the storm window and will obscure the glass with heavy frost. Once the frost has formed, it cannot be removed except by warming the storm windows by special insulated storm shutters.

3. To eliminate condensation problems along the edge (rim) of double insulating glass panes, a third pane of glass may be installed over the outside of the wood sash.

4. Discomfort of drafts and radiation to windows can be nullified by properly designed baseboard radiation and hot air registers placed along the perimeter of exposed walls.

J. DOORS

1. Storm doors and closed entries are desirable for arctic climates.

2. Metal doors with an insulated core and special thermal separators between the inside and the outside shells are excellent for arctic conditions, except adjustable door frames are necessary to compensate for the continual heaving and settling of the active frost layer of the soils of the interior of Alaska.

K. STORAGES

1. The placement of closets, kitchen cabinets, and other built-in storages on exterior walls should be avoided wherever possible to minimize condensation and frosting problems. This includes storages placed under the eaves of 1-1/2 story houses.

2. If storage space must be placed along exterior walls, provide adequate ventilation by means of louvred doors, drapes or other openings. A section of baseboard radiation placed on exterior walls would be a positive aid in maintaining the closet above the dew-point temperature.

3. Avoid storing boxes, books, magazines and clothing tightly against exterior walls. Install 1" X 1" on 2" centers, wood slats on the wall and floor to facilitate natural ventilation.

L. ELECTRICAL WIRING

1. In order to avoid condensation problems caused by the inadvertant puncturing of the polyethylene vapor barrier by present concealed wiring techniques, it is suggested that either the wiring be run in exposed raceways or concealed in special chases as outlined below.

2. Exposed Wiring. Electrical circuits and outlets may be run with exposed "Wiremold" raceways with surface outlets or "Electrostrip" narrow feed-in cable with adjustable conveniences outlets. These circuits may be fed from wiring and outlets concealed in adjacent interior partitions.

3. Concealed Wiring. a) The wiring may be laid in chases constructed from 2" X 3" nailers that are installed perpendicular to the studs or rafters after the insulation and vapor barrier has been properly placed and sealed.

L. ELECTRICAL WIRING (cont'd)

b) Where circuits must pass through obstructions such as at the sole or plate, the nailers should be cut out and the cable protected from possible shorting of nails with 1" X 1" X 1/8" angle iron caps.

c) The added cost of the nailer may be partially offset by elimination of the need to bore holes and thread the cables through the framing members.

d) The short construction season of Arctic climates necessitates enclosing the building as soon as possible and installing temporary heat without having all of the concealed plumbing and wiring built into the wall before the insulation and vapor barrier can be properly installed and inspected. Refer to sections on "VAPOR BARRIER," "INSPECTION," and "UNVENTED SPACE HEATERS."

e) A 6-mil vapor should be used when nailers are provided as electrical chases.

M. UNVENTED SPACE HEATERS

1. Do not operate unvented fuel oil or bottled gas space heaters as temporary heat until the insulation and vapor barrier has been fully installed and adequately sealed.

2. If the vapor barrier is not sealed, the invisible water vapor produced by the space heater will condense out in the insulation and other cold surfaces.

3. The moisture may freeze and damage the siding.

4. During the spring thaw, melting of the ice will stain exterior and interior finishes.

N. CHIMNEY

1. The chimney must be tightly sealed at the ceiling to minimize migration of moisture and infiltration of excess heat into the roof cavity.

2. Gas furnaces should be provided with an approved masonry chimney or all-fuel pre-fabricated metal chimney.

3. Light weight uninsulated metal gas vents can result in excess heat formation in a poorly vented roof cavitiy, particularly a gable roof, which can result in excessive glaciering at the eaves.

O. HEATING

1. The packaged precut or panel home should include a complete set of plans and a tabulation of the heat losses of each room, the recommended size heating plant, the size of baseboard radiation, size of hot water heating pipes, electric heating conductors, sizes of hot air and return registers, size of ducts, and an estimate of annual fuel or energy requirements for Alaskan climates.

2. All hot water heating plans should provide for approved zone control valves and balancing cocks for each heating zone.

3. All hot air heating plans should provide for adjustable dampers on each branch duct and adjustable blower pulleys for proper balancing of the air flow to each register.

4. If the prime contractor or subcontractor do not maintain service personnel in Alaska during the winter season, then the local heating contractor should be designated to correct any normal deficiencies in the heating system, such as excess noise, improper balancing, excessive fuel consumption, etc.

P. SEPTIC TANK

1. The septic tank and seepage pit or drain field should be placed near the driveway for convenience in cleaning. The location should be accurately dimensioned on the plot plan and permanently marked on the ground with concrete monuments.

2. A 4-inch wood stove clean-out should be extended to the grade to facilitate cleaning without having to search and dig for the septic tank and seepage pit during subzero temperatures. The opening should be adequately sealed against infiltration of cold air.

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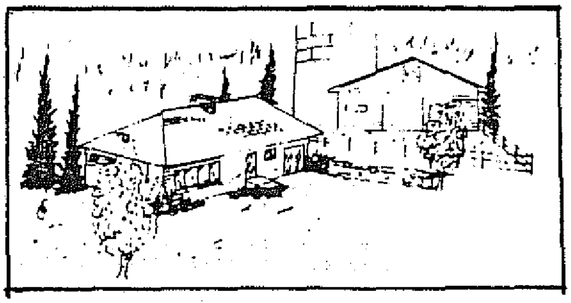

P-450

BLOWN-IN LOOSE FILL INSULATION

Axel R. Carlson
Extension Engineer

One should be extremely cautious about blowing loose fill fiberglass or cellulose insulation in the roof cavity of an existing or new home. Although adding insulation in the ceiling will conserve on energy and reduce heating costs, it can also result in perpetual maintenance and redecorating costs.

Blowing loose fill insulation tight against the bottom of the roof deck along the eaves may seriously reduce critical eave to eave ventilation. Gable ventilation usually is not adequate by itself, particularly in homes where the occupants persist in using a humidifier during the winter. Even a polyethylene vapor barrier may not be adequate, as it is often inadvertently punctured by electrical wiring, recessed lighting fixtures, plumbing vent stacks, chimneys, fireplaces, etc. The most serious violation consists of that innocent access opening cut through the ceiling into the cold roof cavity from a closet or a garage.

Perhaps, if all openings in the vapor barrier were sealed with caulking and/or water resistant gaskets, the eave ventilation might not be so critical. Even so, there still may be openings in the vapor barrier along the plate of interior partitions which is usually erected before any polyethylene vapor barrier is installed. In Canada, a 16 inch strip is laid over the top plate of interior partitions.

In spite of what the insulation applicator may indicate, field observations this past year indicate that blown-in loose fill fiberglass banked tight against the eaves did, in fact, seriously restrict ventilation at the eaves. In one residence in particular, excess moisture produced within the home simply migrated into the roof cavity through a scuttle opening in the hallway and froze on the bottom of the roof deck and in the insulation along the eaves. Although ventilation louvres were provided at both gables, it was not adequate. Apparently the ice in the insulation became so heavy that it weighted down the insulation and reduced the height and thermal properties of the material. In this case, luckily, last December during a sudden warm spell, a small portion of the ice melted and seeped down through the ceiling staining it in a few places. This was warning to the resident of a more serious deluge of water to come. Had it occured in April, the damage would have been far more serious.

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When the house was first inspected in the middle of March, the insulation along the eaves was still weighted down with ice. Although some of the ice had disappeared by sublimation (solid to vapor), a serious condensation problem would have resulted had spring occured earlier. The owner was advised to remove the frozen insulation immediately before it had a chance to melt! All of the loose insulation blown in over the fiberglass batts came out with the ice and had to be replaced.

If you plan to install more than six inches of any type of insulation in the ceiling of a new or existing home, insist that your insulation installer furnish specific details (drawings) of how the ventilation will be kept open at the eaves. If the contractor is not willing to furnish this type of information, then you can be assured that he does not understand the proper techniques for insulating, vapor proofing and ventilation of roof cavities in arctic climates.

The added cost of providing proper ventilation at the eaves will pay for itself through the elimination of costly redecoration and maintenance repairs that may follow.

For further information on vapor barriers, refer to the following publications:

P-557 CEILING ACCESS OPENINGS

P-4-452 TIPS ON INSULATING AN EXISTING HOME

P-558 HEAT LOSS AND CONDENSATION IN NORTHERN RESIDENTIAL CONSTRUCTION

P-559 DESIGN OF ROOFS FOR NORTHERN RESIDENTIAL CONSTRUCTION

P-952 SPECIAL CONSIDERATIONS FOR BUILDING IN ALASKA