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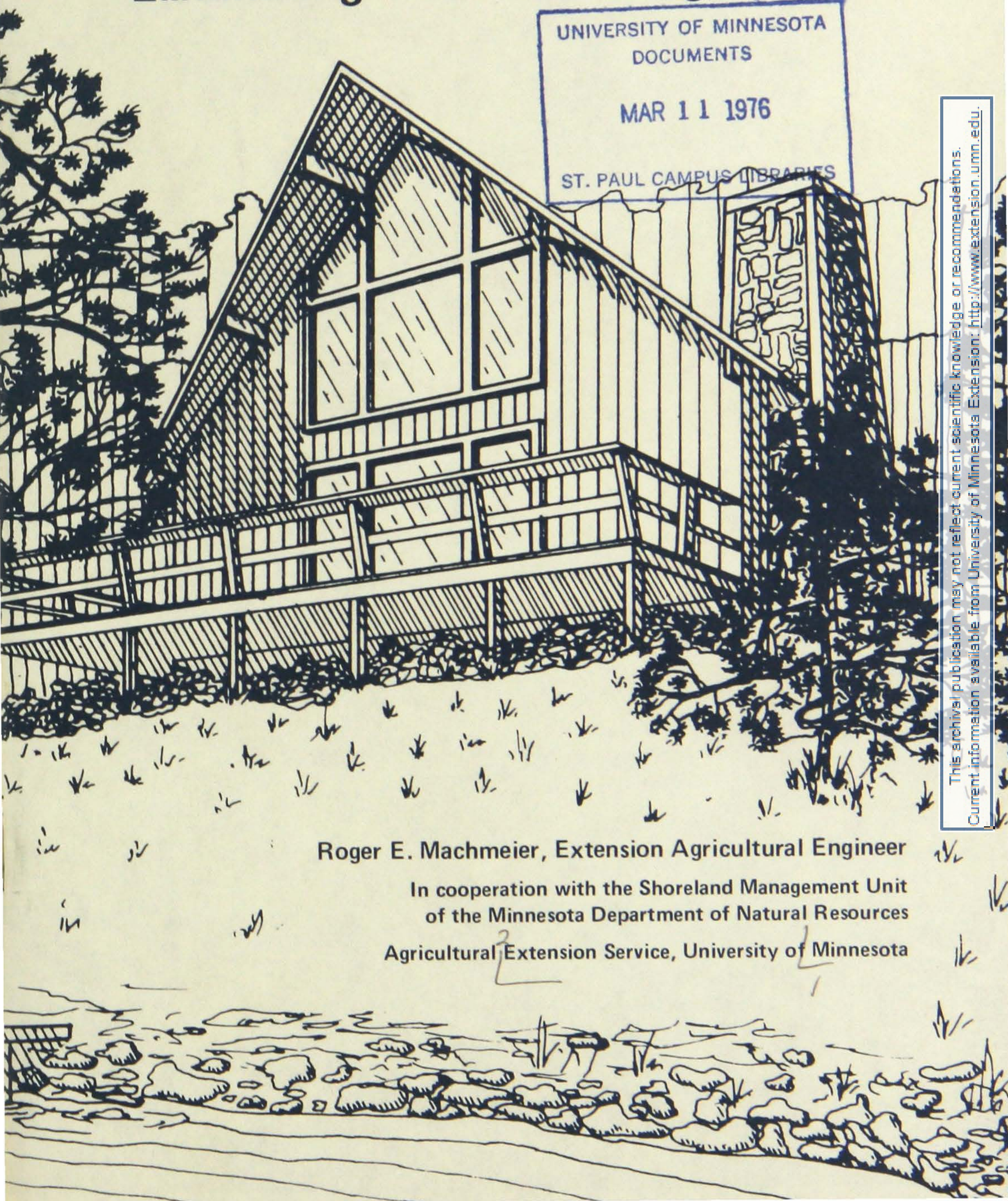
SHORELAND SEWAGE TREATMENT

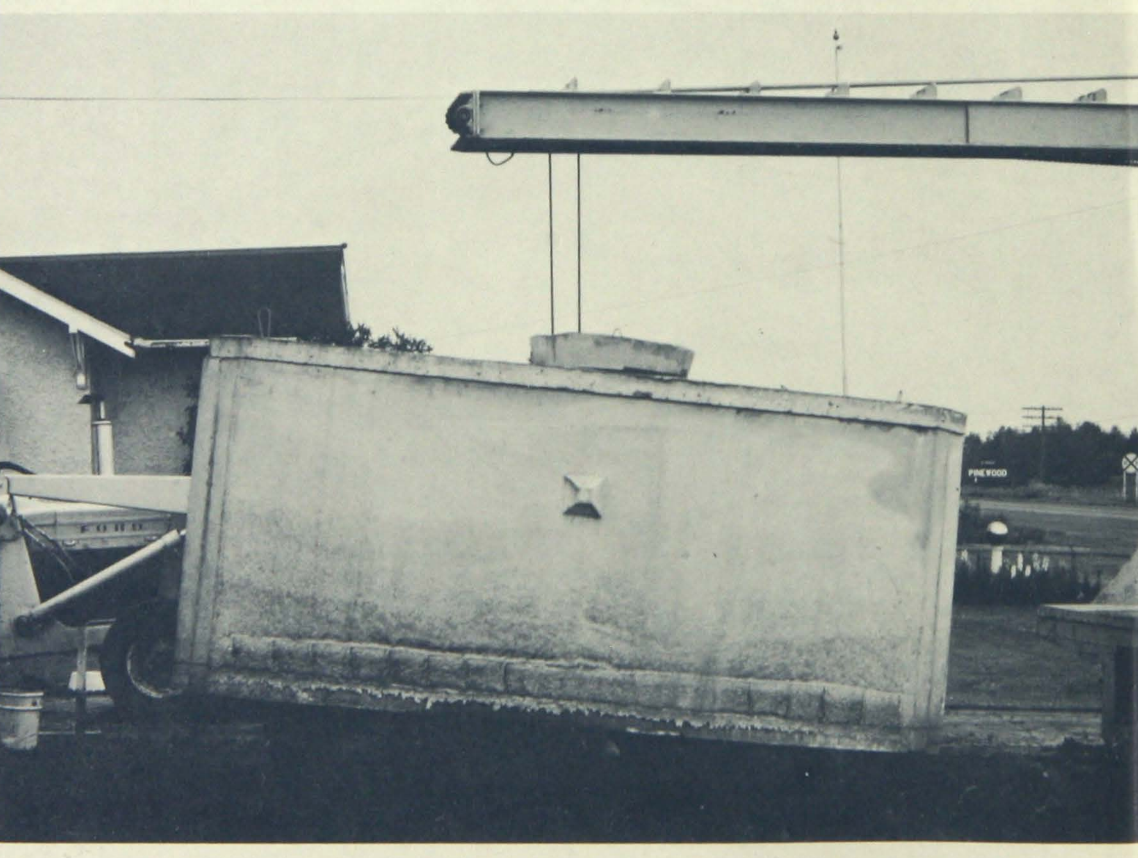
Recommendations for Identifying and Eliminating Nonconforming Systems



Roger E. Machmeier, Extension Agricultural Engineer

In cooperation with the Shoreland Management Unit of the Minnesota Department of Natural Resources

Agricultural Extension Service, University of Minnesota


PINEWOOD

Opposite page, top: A county extension agent and a zoning administrator read thermocouples to measure soil temperature for a research project on sewage treatment systems. This publication tells how to identify and correct nonconforming sewage systems in Minnesota. **Opposite page, bottom:** This precast concrete septic tank is being placed into position. Heavy equipment is required to lower the tank because of its weight.

Below: These specialists from the University of Minnesota Agricultural Extension Service are installing lysimeters to collect effluent from a soil treatment system and thermocouples to measure soil temperatures. Recent research results have been included in this publication to bring the latest information on shoreland sewage treatment systems to Minnesota citizens.

Table of contents

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Introduction

Minnesota's lake and river shorelands contain a variety of physical and cultural features—from pristine wilderness environments to high-density commercial and industrial areas. The state's lakes and streams vary, not only in their uses, but also in their physical characteristics of size, shape, depth, and water quality. Most northeastern Minnesota lakes have irregular rocky shorelines, with few beaches or swampy areas; lakes in other parts of the state generally have more regular shorelines, with many fine natural swimming beaches.

Minnesota has more than 11,500 lakes larger than 10 acres. Approximately 34,000 miles of lakeshore are in Minnesota, and there are an estimated 25,000 miles of rivers and streams. Of the 70,000 lakeshore homes in the state, more than 25 percent are permanent. However, two-thirds of the Minnesota lake homes occupy only 13 percent of the total shoreline, while only about one out of seven lakes has shoreland development.

Hundreds of miles of lakeshore remain undeveloped in Minnesota, while the density of lakeshore residences on developed lakes often compares to urban areas. In some areas of the state, the average countywide density is over 30 lake homes per 1 mile of shore. However, the density of lakeshore development in most counties is less than half this amount. The most densely settled lakes are located within a 3-hour drive north and west of the Twin Cities.

The attraction to Minnesota's lake and river shorelands often creates problems. Increasing demand for shoreland homesites increases land values. Lots with water frontage, and even back lot areas, are subdivided into smaller and smaller parcels. Scattered cabins and homes eventually merge to form a solid ribbon of buildings, docks, and boathouses.

Above and below: Trees are an asset to any lakeshore property, and they provide a natural setting and screening for a vacation home. Although sewage treatment systems sometimes require removal of trees, careful planning can usually prevent large-scale clearing.

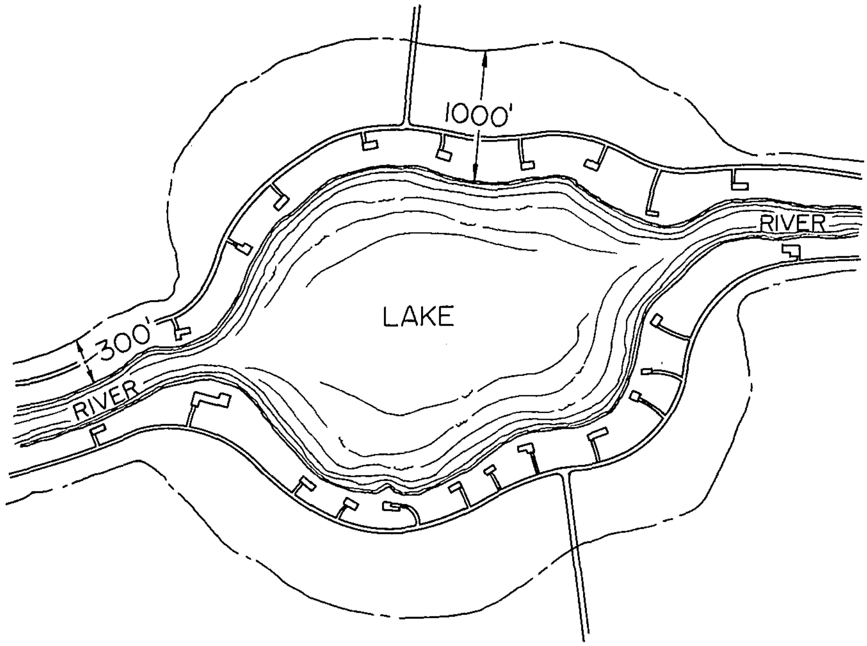


Figure 1. Area under jurisdiction of the Shoreland Management Act

Once a shoreline is crowded with buildings on small lots, second and third rows of homes quickly appear far beyond the shore.

After lakeshore development occurs, natural ecological processes often become irreparably damaged. Vegetation and scenic beauty are destroyed. Nutrients and other pollutants—from inadequate sewage systems on crowded lots—concentrate in the ground water. Eventually, they get into lakes and rivers, stimulating algal blooms and increasing weed growth. Such situations drastically impair recreation and domestic water use. Furthermore, in spite of their unsuitability, marginal lands are often developed that have steep slopes or that are subject to high ground water and intermittent flooding.

This publication helps identify these situations and suggests solutions to eliminate nonconforming sewage systems.

Shoreland Management Act

The 1969 State Legislature passed the Shoreland Management Act, recognizing the growing pressures of development on Minnesota lakes and rivers as well as the increasing problems of water pollution, overcrowding, unwise development, destruction of fish and wildlife habitat, and impairment of natural beauty in Minnesota. As stated in the act, its purpose is:

> . . . "to provide guidance for the wise development of shorelands of public waters, preserve the economic and natural environmental values of shorelands and provide for the wise utilization of water and related land resources of the State."

The act affects all land within 1,000 feet of a lake, pond, or flowage and within 300 feet of a river or stream (figure 1). Certain state and local responsibilities are established, and individual responsibilities are inferred.

State responsibilities

The Minnesota Department of Natural Resources (DNR) developed a body of standards and criteria for land use in shoreland areas in cooperation with other state agencies and local governments. These standards and criteria include zoning, subdivision, and sewage treatment. Secondary responsibilities include assistance and advice to local governments and ensuring that each city and county enacts a shoreland management ordinance complying with state standards.

Local responsibilities

Each county and city having shoreland must adopt a shoreland management ordinance consistent with minimum Statewide Standards. This ordinance must provide for administration and enforcement and be based on local resource characteristics and planning.

One of the most important provisions of the Statewide Standards relates to nonconforming sewage systems. Each county and city must establish procedures providing for elimination of nonconforming individual sewage systems in shoreland areas. This must be done within 5 years from the enactment date of the local shoreland management ordinance. Local governments and the state must inform the public about nonconforming sewage systems, including identification and proper abatement procedures.

Individual responsibilities

Citizens using water resources or owning shoreland property have basic obligations. They must be familiar with the "hows" and "why's" of the shoreland management program. Those contemplating buying or developing shoreland property should contact city or county planning and zoning offices to determine applicable laws and regulations.

Requirements for new systems

In shoreland areas, sewage treatment systems must be installed in accordance with the DNR Shoreland Management Rules and Regulations. These are a minimum requirement and a guide for local ordinances. Every county, except Hennepin and Ramsey, currently has sewage treatment regulations for shoreland areas.

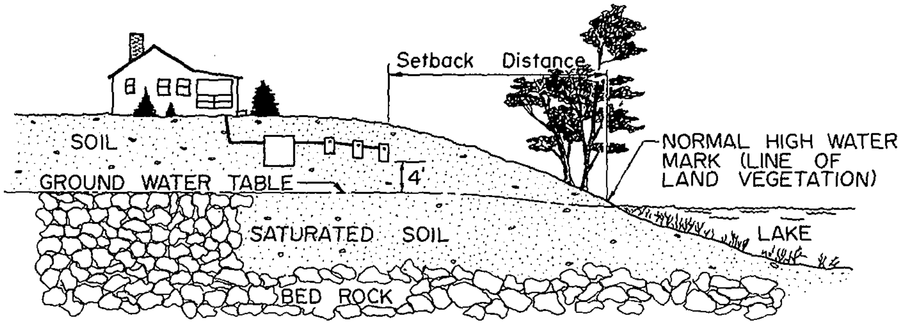
Each new sewage treatment system must be set back from the shoreline a minimum distance. For a general development lake or river, the minimum distance is 50 feet; for a recreational development lake or river, 75 feet; and for a natural environment lake or river, 150 feet (figure 2). Some county ordinances require greater setback distances.

Each system must have a watertight septic tank and a soil treatment unit large enough to handle expected use. When locating the soil treatment unit, consider the ground slope, soil type and texture, and height above the ground water table or bedrock. The bottom of the soil treatment unit must be at least 4 feet above bedrock or the highest known level of the ground water table. Detailed specifications may be obtained from the local zoning office or the DNR.

Nonconforming sewage systems

Why is it important to eliminate non-conforming sewage disposal systems?

Nonconforming systems are not properly designed, installed, or located, and they often create serious problems. Raw sewage or septic tank effluent contains disease-causing organisms, and surface discharge endangers the public health. Many diseases are waterborne; their discharge



LAKE CLASSIFICATION	SETBACK DISTANCE
GENERAL DEVELOPMENT	50'
RECREATIONAL DEVELOPMENT	75'
NATURAL ENVIRONMENT	150'

Figure 2. Minimum setback distances for onsite sewage treatment systems

into public waters creates a serious health hazard.

Improperly functioning sewage systems contribute nutrients to surface waters. These nutrients fertilize lakes, rapidly increasing lakes' natural aging process (eutrophication). The result can be obnoxious algal blooms, increased weed growth, and diminished game fish populations.

Elimination of nonconforming sewage systems helps ensure long term usefulness and value of our lake and river resources and will protect the public health, safety, and welfare.

What is a nonconforming individual sewage system?

The Statewide Shoreland Management Regulations define a nonconforming sewage system as one installed before the adoption date of the local shoreland ordinance and which has at least one of these characteristics:

* does not conform to the Shoreland Management Regulations or local shoreland management ordinance in size, construction, use, or maintenance.
* is creating a nuisance, endangering the domestic water supply, or is polluting a lake or river.
* is located in any of these areas:
  - a) low swampy area, area where standing water is prevalent, or area subject to flooding;
  - b) where the bottom of the soil absorption unit is closer than 4 feet to the ground water table or bedrock;
  - c) on a steep slope where soil conditions may cause effluent seepage to the ground surface.

What is a "substandard" individual sewage system?

Under the Statewide Standards, a properly sized and constructed sewage system which does not meet the minimum setback distance from the

This situation could have been prevented by paying attention to records showing high lake levels. All sewage treatment systems here are nonconforming. High-density development along much of Minnesota's shoreland means strict adherence to state regulations is necessary to prevent pollution of water resources.

shoreline, roads, or structures is considered "substandard." A substandard system may be used until there is evidence it has failed or when it needs major repair. Then, the system must be relocated to conform with required setbacks. A "substandard" system is *not* "nonconforming" since it has been properly constructed, is large enough to adequately treat the effluent, and is sufficiently elevated above the ground water table.

How can nonconforming sewage systems be identified?

The former owner may be able to provide this information. Your local building inspector may have a record of the system and who installed it.

Usually, you can determine for yourself whether a sewage system is nonconforming. A system can often be located by its 4-inch inspection pipe extending above the ground surface. If the system is located in an area less than 5 or 6 feet above the lake, it is probably nonconforming. Generally, ground water elevation is 1 foot higher than the lake level. An accurate determination of ground water level can be made by augering a hole 7 to 8 feet deep when the lake level is the highest (usually in early spring).

Surface discharge of raw sewage or effluent can be easily identified. Odor, discolored soil or water, foam, lush grass, or weed growth all indicate surface discharge.

You should test a well less than 30 feet deep located downslope from the sewage system or closer than 100 feet to a seepage pit. The Minnesota Department of Health, Minneapolis, 55440, tests well water for purity at no charge if the sample is collected properly with a kit they provide.

When nonconforming features are observed, immediately contact your building inspector, health official, or zoning administrator. These officials will help you solve the problem. As officers for the local health ordinances and sanitary codes, they can inspect sewage systems if proper notice is given and the inspection is done during working hours.

In addition to the obvious signs, other methods are used to check systems. Soil borings near the sewage system identify ground water or bedrock conditions. A soil probe can locate the parts of the system, determine their depth, and, in some cases, identify construction materials. A soil probe can be made from a 5-foot piece of ⅜-inch rod to which a T handle has been welded. A longer probe will be needed to investigate the tank bottom. A soil auger can locate sewage system components. The dimensions and shape (round or square) of the system can also be determined by probing. If the septic tank is round and older than 15 years, it probably is constructed of concrete blocks laid without mortar and without a solid bottom. Whether or not the tank has a concrete bottom can be determined by probing through the tank's inspection hole.

Dye testing is an excellent method to determine if sewage is being discharged into a lake or well. Presence of the tracer dye in lake water means your sewage system is discharging directly into the lake. If tracer dye appears in your drinking water, the water absolutely must not be used for cooking and drinking. The sewage system must be relocated, and a new well may have to be drilled if the water quality does not improve.

Even if dye is not observed in the lake or well water, the sewage system may still be nonconforming. Sewage effluent may be discharged into a shallow water table and move into the lake with very little, if any, adsorption of the phosphorus. If the dye test is negative, your system may still be nonconforming; therefore, use the other evaluation methods in conjunction with dye tests.

A dye testing program is most effective if conducted by a property owners association or under the direction of the zoning administrator. If a neighbor on either side is also planning to dye test a sewage system, schedule the tests 48 hours apart to accurately determine which system, if any, is discharging into the lake.

To test your sewage system, flush dye down the toilet. In some older systems, it may be best to place dye into each drain. Use plenty of dye: ½ to 1 ounce of powder or 4 to 6 tablets. Before adding the dye, start the water running. This helps dissolve the dye and minimizes staining the plumbing fixtures. After the dye has been added, run the water for 15 to 30 minutes and also flush the toilet several times to add water to the sewage system. After this, use the toilet and washing facilities as you would normally.

Tracer dye is commercially available in either powder or tablet form. A partial list of suppliers may be obtained from your zoning administrator or by writing to Extension Agricultural Engineering, University of Minnesota, St. Paul 55108.

Action programs

Local government:

The local zoning administrator must educate shoreland residents about shoreland sewage treatment requirements. The local unit of government must emphasize the educational aspects of an action program. The educational effort should increase public awareness and acceptance of the program. Residents with nonconforming sewage systems must be told the benefits of voluntary compliance.

Several methods can be used to disseminate information. Services of agencies such as the University of Minnesota Agricultural Extension Service and the DNR are available. Local officials can conduct workshops for installers in cooperation with appropriate university and/or DNR personnel. Informational meetings for shoreland property owner groups can be held by the zoning administrator or county extension agent.

All available news media should be used. News releases are good methods to keep the public informed. Local radio and television stations have successfully utilized telephone interview or talk shows. The zoning administrator should use every opportunity to distribute information.

A survey of existing sewage systems in shoreland areas should be started as soon as possible. First, all problem lakes should be identified and ranked on a priority list. Information is often available from local people knowledgeable about lakes, their histories, and their problems. Soil surveys, generally available from Soil Conservation Service (SCS) officials, can be used in heavily developed shoreland areas. Citizen complaints may also help establish priorities for surveys.

After survey priorities have been established, a procedure for conducting the surveys is necessary. One effective technique is to enclose a questionnaire with the annual property tax statement to all shoreland property owners. An explanation of nonconforming sewage systems and a description of procedures for identifying them should accompany the questionnaire.

A second method is onsite investigations. This is more accurate than questionnaires, but it is also more costly. Individuals with seasonal jobs, such as school teachers and college students, can be trained to conduct investigations during the summer. Training should include familiarization with the shoreland program as well as the use of equipment and techniques to evaluate sewage systems.

Accurate records must be maintained for sewage treatment systems installed under the shoreland management ordinance. The number of permits issued annually may indicate the total number of sewage treatment systems located on shoreland.

After the shoreland survey, the local governmental unit must establish a compliance schedule to correct or upgrade nonconforming systems. An education program will convince most shoreland owners to voluntarily eliminate nonconforming sewage systems. They will realize the obvious benefits of protecting their water resource from a major source of pollution.

The state law provides legal enforcement. Sewage systems identified as nonconforming must be brought into compliance within 5 years of the enactment date of the local shoreland management ordinance. Whenever the shoreland administrator finds a nonconforming sewage system, he should issue an abatement order. This usually means the system must be upgraded or rebuilt within a specified time (i.e. 10, 30, or 60 days), as set forth in the local ordinance. This gives the offender due process under the law to correct the nonconforming system. If the property owner fails to obey the abatement order, the shoreland administrator should turn the matter over to the county or city attorney, who then has responsibility for prosecuting the offender. Penalties for this offense may be a maximum fine of $300 per day and/or 90 days in jail.

Groups

Private and public citizen action groups can help to solve many nonconforming sewage system problems. These groups may range from public service interest groups, such as the League of Women Voters, to private interest groups, such as specific lakeshore property owners associations.

Group interest will determine the focus of activities, but all groups can be effective educators. Information can be distributed both to group members and to the general public via the same news media available to the local government. Informational bulletins and questionnaires can be distributed door-to-door. The local zoning administrator, university extension personnel, and DNR officials can be invited to participate in educational meetings. The process of education and disseminating information can often be more effective when handled by a group independent of local government.

A group may also help the local government unit by conducting site evaluations. The costs can be minimal since the group volunteers its time and labor; the local government unit would only contribute the time of the zoning administrator. Volunteers should be trained and have their activities guided by the zoning administrator. The expertise of other agencies—such as the Agricultural Extension Service, the SCS, and the DNR—can be utilized for the training program.

Private and public group action can encourage voluntary compliance with sewage treatment regulations. Peer group pressure will encourage individuals to comply voluntarily.

Finally, organized interest groups can exert substantial local political influence. Such pressure can force local government units to actively enforce the nonconforming sewage system provisions. Interest groups can endorse and campaign for political candidates whose views on environmental issues reflect the group's views. Such groups can also "watchdog" local officials by attending government meetings and voicing the group's opinions, especially when the local budget is being debated and allocated. Such political activism can be the most effective means to upgrade nonconforming sewage systems.

Individuals

Although the local government and the organized interest groups can focus on activities such as information dissemination and education, each citizen can contribute by inspecting his own sewage system and voluntarily correcting it if needed. He can also disseminate information and influence his neighbors by his actions.

Each citizen has the legal right to file complaints with the zoning administrator. As a minimum, such action will usually require the enforcing officer to inspect the suspected nonconforming sewage system. The citizen can, and should, demand to see the results of such an inspection.

If an individual feels local government officials are not executing their duties as called for in the shoreland management ordinance, he can obtain a writ of mandamus which compels performance of a specific duty by a specific official. Then, if the official refuses to perform his required duty, he can be removed from office by a district court.

The individual also has recourse to political action just as do groups. Interested citizens should attend public meetings of local officials, both elected (i.e., city council, county board of commissioners) and appointed (i.e., planning commissions and boards of adjustment). The individual can often obtain satisfactory results by simply participating in these meetings, voicing his opinion, and questioning both elected and appointed officials. The citizen can also support candidates who express his viewpoint or become a candidate himself. Personal interest

This is a properly developed lakeshore lot and shoreline. A home has been built at a proper elevation above the lake level. Trees in the front yard provide screening. Natural vegetation remains along the water line to minimize surface runoff and to prevent shore erosion.

and commitment will often solve the problem of nonconforming systems.

Solving the problem

To find the best solution to your sewage treatment problem, solicit all available resource people. Start with the zoning administrator, and find out if your county regulations are stricter than are the State Standards. Obtain all printed information that relates to the Shoreland Ordinance.

Learn what information is required to apply for a permit to repair your sewage system or to install a new one. If the county is properly administering its Shoreland Ordinance, you will need a topographic map of your lot, showing all improvements located on it, including the water well and the proposed sewage treatment system; soils information, including boring data and percolation tests; design information, including the number of rooms in your house definable as bedrooms and the size and layout of the proposed sewage treatment system; and, finally, the locations of sewage treatment systems and wells on adjacent developed property.

Sources of information

In many counties, considerable information is available at the courthouse. A plat map having the legal description of your property may be available at the register of deeds office. If there is a countywide soil survey, the county zoning administrator should have a copy. Use the legal description to locate your property on the soil survey and to determine the types of soils you are likely to encounter.

Suitable soil is necessary for a successful onsite sewage treatment system. Check with local SCS officials about the soils on your property. Even if the county does not have a complete soil survey, the SCS personnel will probably be familiar with your area. Soil interpretation sheets are available for the soils on your lot.

This spring snowmelt and frozen water show that water moves laterally above bedrock. Inadequate soil cover means a location is not suitable for a sewage treatment system.

Although the SCS is not responsible for making a thorough site evaluation of every piece of property, they evaluate the soil if you collect the samples. Soil boring holes should be at least 4 feet deeper than the bottom of the proposed soil treatment unit. This means at least 6½ feet deep and preferably 10 feet for a trench or bed system, unless you encounter the water table or bedrock at a less depth.

Collect soil samples at each foot and wherever the soil changes texture (sand to clay, etc.) or color (brown to grey, etc.). Place soil samples in plastic bags identified by depth and hole number.

Sandy-textured or loam soils are the best locations for your soil treatment unit. On a developed lot, you must consider the locations of all improvements, including the well. An inexpensive, but dependable, pumping station can be installed if the suitable soil area is located at a higher elevation than is your home. Therefore, investigate all areas of the lot either higher or lower than your house. Heavy clay soils with high seasonal water tables are not suitable. Also, very coarse-textured sand and gravel are not suitable, since such soils do not adequately filter the sewage effluent, enabling pollutants to travel rapidly to your water supply well or into the lake. A suitable soil texture has a percolation rate between ½ minute per inch and 60 minutes per inch.

Leave the boring hole open. After 24 hours, check for the presence of a water table. In clay soils, a water table that will prevent the soil treatment unit from working may be within 1 to 3 feet of the surface. In the spring, the water table can be observed directly. In late summer or fall, the water table may not be physically present, but its former location can be identified by mottled soil. Mottling is a distinctive multicoloration of grey with splotches of red and yellow. Sometime during the year, the soil is totally saturated at this depth. The bottom of the soil

A hole must be augered to perform a percolation test. The instrument in the foreground is a percometer, used to measure the percolation rate.

treatment unit must be at least 4 feet above the highest location of evidence of the water table.

Stake and number the soil boring holes, and locate them on a scale map of the lot. Record all soils data. After an apparently suitable area of soil has been located, perform percolation tests. Some counties will allow the property owner to do this under supervision. Complete instructions are available in Extension Folder 261, "How to Run a Percolation Test," available from the county extension office.

The county extension agent is a good source of information. He has other bulletins on sewage disposal and probably is familiar with the general area in which your property is located. The extension agent has extension state specialists available for specific problems. Often, a telephone call can answer a specific question. The state extension specialist may be able to visit the lot on the next trip to the county. However for an onsite consultation to be most effective, collect as much information as possible in advance. Do not expect others to make extensive soil borings and run percolation tests unless they have a contract to perform such testing.

Private consultants are available to evaluate soils and to design onsite sewage treatment and disposal systems. However, learn their qualifications. For onsite systems, evaluation of soil suitability and systems design requires more qualifications than ownership of a power auger or registration as an engineer or architect.

A local, reputable installer who regularly attends educational meetings and workshops about the latest sewage treatment developments is an excellent information source. A list of reputable installers may be available from the local zoning administrator.

Another valuable source of information is the DNR, the state agency responsible for maintaining and improving the quality of ground and surface waters. The state offices are located in the Minnesota Centennial Building, St. Paul 55155. In addition, the DNR maintains these regional offices (figure 3):

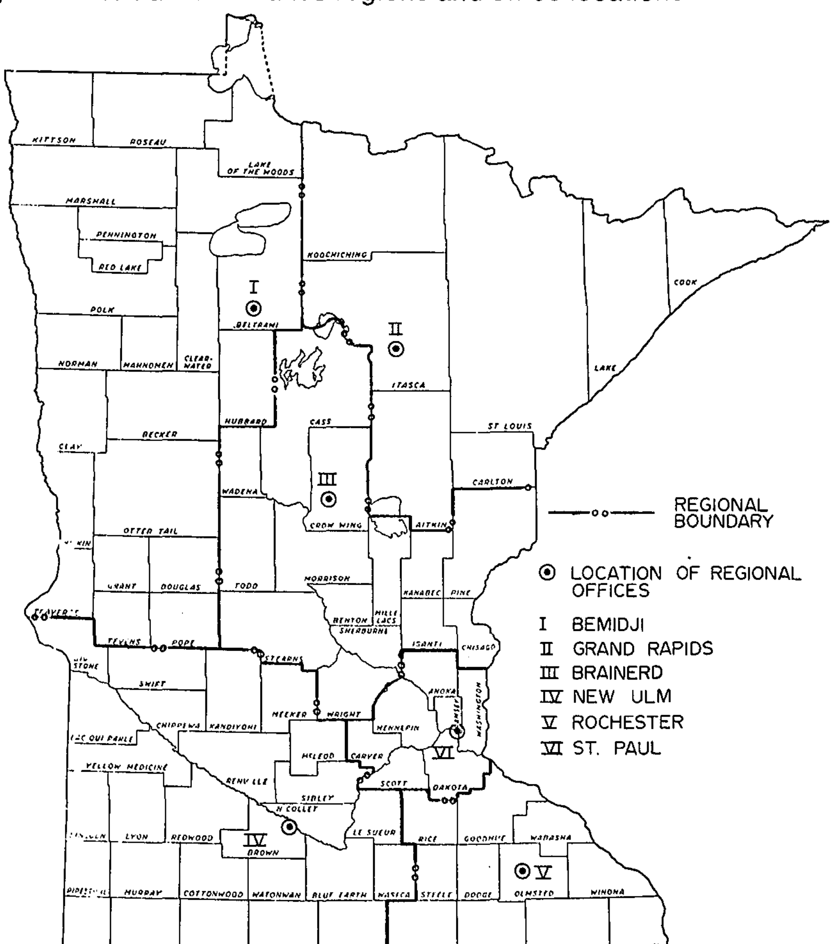
Region	Address and location
I	Rt. 5, Box 41A, Bemidji 55601
II	E. Highway 2, Box 388, Grand Rapids 55744
III	217 N.W. 4th St., Brainerd 56401
IV	116½ N. Minn. St., New Ulm 56073
V	2300 Silver Creek Rd., N.E., Rochester 55901
VI	1200 Warner Rd., St. Paul 55106

DNR state and regional staff are available to answer questions on all aspects of shoreland management. In addition, DNR publications are available on shoreland management and related topics.

Sewage treatment systems

Raw sewage from the home flows into a sewage tank, either a septic

Figure 3. DNR administrative regions and office locations



Careful construction of a sewage treatment system includes checking grades and elevations to assure proper installation.

tank or an aerobic treatment unit. Liquid discharged from these tanks is called effluent. Effluent from a properly maintained septic tank is slightly cloudy in color, while effluent from a properly maintained aerobic treatment unit appears clear.

However, both types of effluent contain some fine suspended solids, disease-causing bacteria, and nutrients. Sewage tank effluent cannot be discharged to the ground surface or into ground water or surface water.

The effluent must be discharged into a soil treatment unit. Suitable soils will filter the effluent, removing solids and bacteria. Many nutrients attach to soil particles (adsorption) and are removed from the percolating effluent.

Septic tanks

An existing sewage system should be carefully evaluated to determine if it is worth repairing or salvaging. Making a loose block tank watertight will usually cost more than would installing a prefabricated tank of adequate size. Only in rare instances is it economical to salvage parts of an existing system.

Abandon the old septic tank and/or cesspool if the location is not needed for the new tank. Remove the cover, pump out the sewage solids to prevent future settling of the soil surface, and fill the old tank with well-compacted clay or loam soil.

Sewage solids separate from the liquid as the sewage slowly flows through the tank. Some solids settle to the bottom of the tank, and some float in the scum layer at the top. Bacterial action partially decomposes the solids.

Liquid capacities for septic tanks are based on daily sewage flows. Check with the county ordinance for minimum septic tank size. Rarely should a tank be installed of less than 1,000 gallons liquid capacity. Unless the county requires larger tank sizes, a good rule to follow is 1,000 gallons for a 3-bedroom home or less and 250 gallons of additional liquid capacity for each bedroom over three.

Extra tank capacity can usually be purchased for modest additional cost. A larger tank will have a longer sewage detention time, and it will do a better job of removing solids. This increases the life of the soil treatment unit. The larger tank provides more volume for storage of accumulated solids, and removal is not required as often. Thus, there are long term economic benefits in installing a larger than minimum size tank, even though the initial cost may be slightly higher.

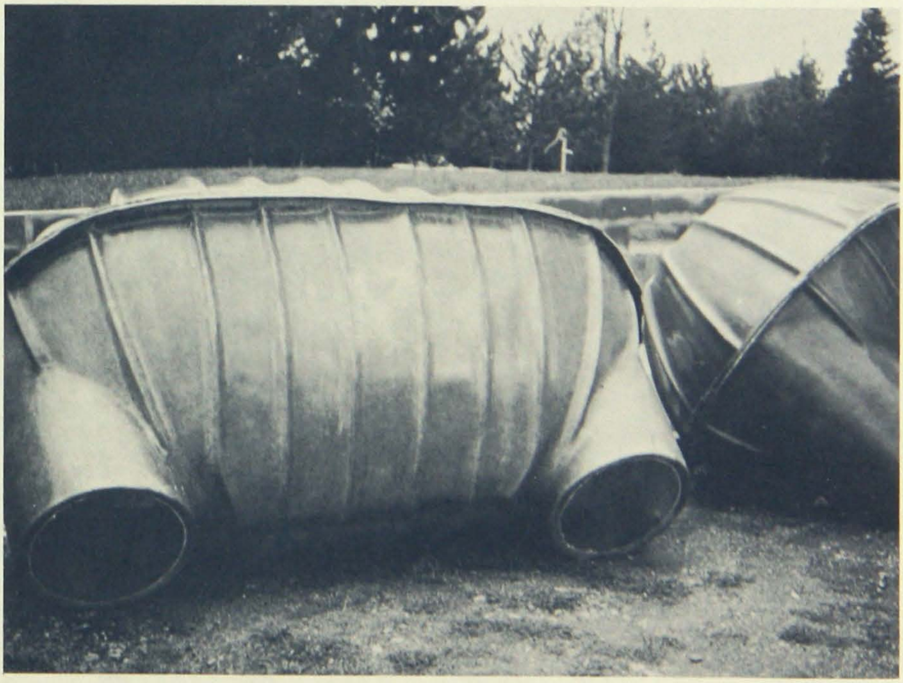
Frequency of sludge and scum removal depends on tank size and the amount of solids in the raw sewage. A minimum size septic tank for a yearround 3-bedroom home will require solids removal every 2 to 3 years. A septic tank for a seasonal residence should require far less frequent cleaning. A garbage disposal unit will about double the rate at which solids accumulate in the septic tank. Proper maintenance of the septic tank protects the soil treatment unit, which is the most expensive part of the sewage treatment system.

The septic tank must be watertight. The liquid level must not fluctuate. A watertight bottom prevents soil from decreasing the tank volume. Certain types of soil tend to enter the tank from the bottom when the liquid level fluctuates or when the tank is pumped to remove accumulated sludge.

Septic tank materials must be strong and resistant to corrosion and decay. Some authorities report that metal tanks rust through and begin to leak in 5 to 10 years. Fiberglass does not corrode or decay, but it is more expensive than concrete. However, the weight of fiberglass tanks permits easier handling and reduces freight costs. Careful installation is required of fiberglass tanks to prevent structural damage.

Precast concrete is both suitable and economical. Concrete block tanks should have mortar joints. A poured concrete bottom and two plaster coats of concrete on the in-

A major advantage of fiberglass septic tanks is their light weight.



side are necessary to make a block tank watertight.

For effective solids removal, a rectangular septic tank should be two to three times longer than it is wide. A circular tank should have at least a 5-foot inside diameter.

Tank capacity depends on liquid depth. The depth cannot be less than 3 feet or greater than 6½ feet. An inside height above the liquid equal to 20 percent of liquid depth must be allowed for floating scum storage.

The inlet pipe must be 3 inches higher than the outlet pipe to provide free flow into the tank. Access for inspection and sludge removal requires a manhole.

Septic tanks must have both inlet and outlet devices, either baffles or tees. Dimensions of the devices are related to the depth of liquid measured from tank bottom to the point where the effluent flows from the tank (figure 4). The bottom of the inlet device must extend at least 6 inches into the liquid, but no deeper than 20 percent of the liquid depth. The bottom of the outlet baffle must extend into the liquid a distance of 40 percent of the liquid depth to the nearest inch.

The upper part of the inlet and outlet baffles must extend above the liquid level a dimension equal to 20 percent of the liquid depth. However, the tops of the baffles must be open and extend no closer than 1 inch to the inside top of the tank. This allows gases to move through the tank.

For complete tank specifications, contact your local zoning administrator. Personally check that the septic tank has the proper baffles and dimensions (figure 4).

Manholes are extended to the level of the final grade so the septic tank can be inspected and so solids can be removed.

The cost of a 1,000-gallon precast concrete septic tank will range from $200 to $300. The cost of fiberglass tanks ranges from $250 to $350. The cost of removing solids is about $30 to $45 for a 1,000-gallon load. Figure about $15 annual cost for solids removal (pumping once every 2 or 3 years) from a septic tank for a year-round residence.

Do not introduce additives to septic tanks. According to the Public Health Service, U.S. Department of Health, Education, and Welfare, some 1,200 products—many containing enzymes—are on the market for use in septic tanks. Extravagant claims have been made for some of them. However, none proved advantageous in properly controlled tests. Some additives cause the sludge to "bulk," i.e., expand in volume, and be carried into the soil treatment system. This sludge will plug the soil treatment unit and require its replacement.

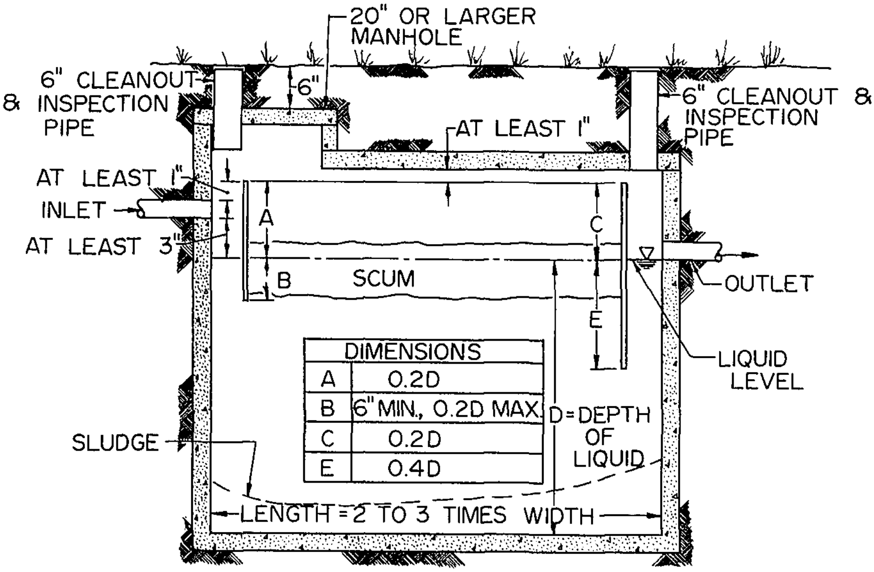
Aerobic tanks

With aerobic treatment, air mixed into the sewage allows oxygen-using (aerobic) bacteria to grow. Aerobic bacteria are more efficient decomposers than are anaerobic (septic) bacteria. The effluent from a properly operating aerobic treatment unit appears clear and has no septic odor. However, the aerobic effluent still contains disease-causing bacteria and nutrients. Thus, aerobic tank effluent cannot be discharged to the ground surface or into ground or surface waters.

Aerobic tanks require considerable maintenance, and a continuous service agreement must be carried with the dealer or installer. If the pump or air compressor fails, the aerobic treatment unit will change to anaerobic in 4 to 6 hours.

Any aerobic treatment unit installed must have had that model tested by the National Sanitation

Figure 4. Dimensional requirements and baffle submergence of a rectangular septic tank



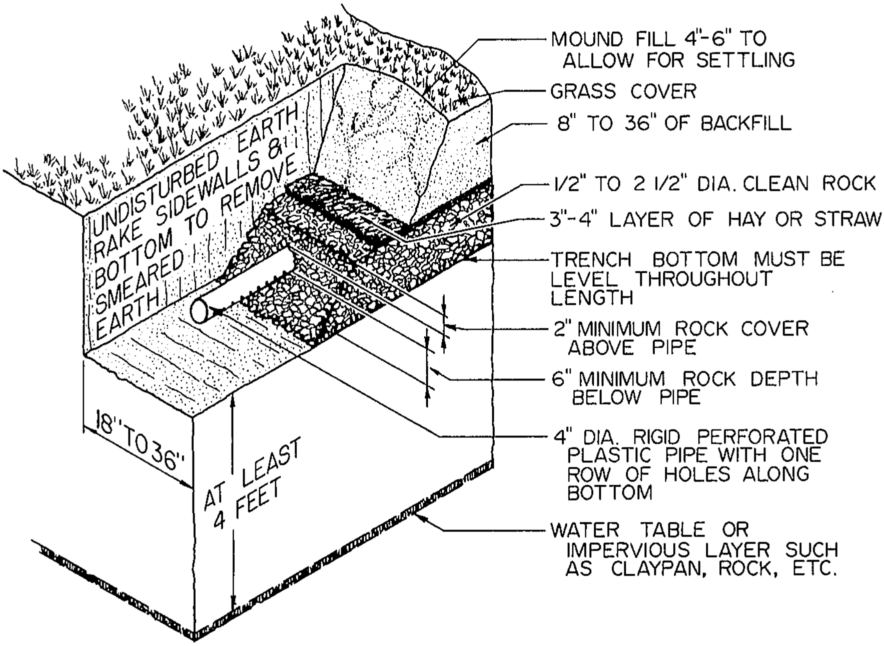


Figure 5. Construction requirements for a drainfield trench

Foundation (NSF). The unit must meet the specifications of NSF Standard No. 40.

The initial cost of an aerobic treatment unit may range from $1,000 to $2,000. Electricity to run the equipment will cost $50 to $150 per year. The service contract will cost $50 to $100 per year.

Soil treatment and disposal

Drainfield trenches installed into suitable soil are the most effective onsite soil treatment unit. The trench sidewalls and bottom filter the sewage tank effluent as it percolates into the soil.

Construction of the drainfield trench is shown in figure 5. The trench bottom must be at least 4 feet above the highest known level of the water table. The minimum distance from the water table to the final ground elevation is 6½ feet, which is determined from the following dimensions: 4 feet below the bottom of the trench; at least 6 inches of clean rock (½-to 2½-inch diameter) below the distribution pipe; the 4-inch pipe; 2 inches of rock cover; and 18 inches of soil cover.

Where soil depth is 5 feet from the ground surface to the highest elevation of the seasonal water table, trenches must be excavated only 12 inches deep. Soil backfill is needed over the drainfield area to protect the trenches from freezing. The final ground elevation should be 6½ feet above the water table.

Maintain a grass cover over the drainfield trenches. Allow snow to accumulate in the winter. Do not compact the snow with snowmobiles or foot traffic. With proper care of grass and snow cover, trenches with only 12 inches of soil cover have not frozen under Minnesota weather conditions.

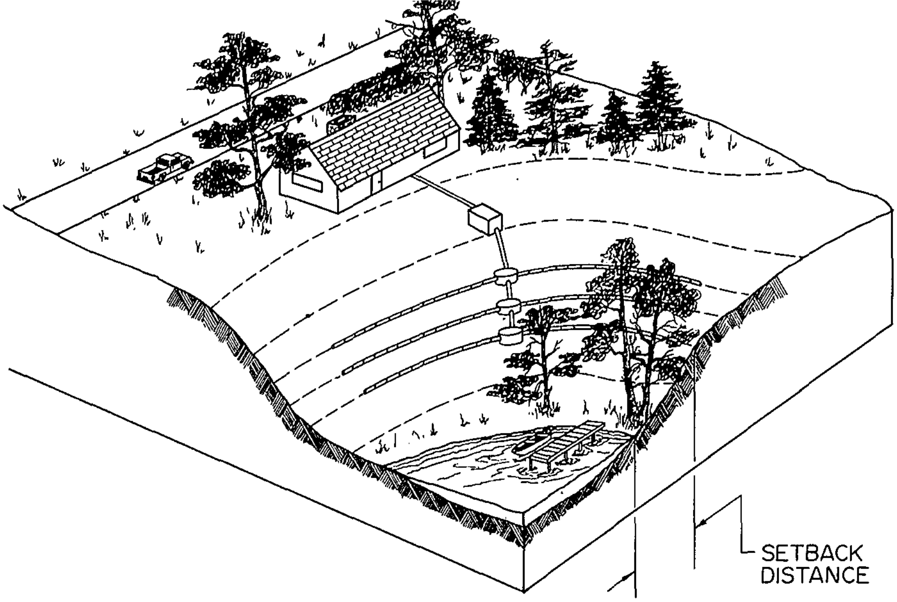


Figure 6. Drop box distribution of effluent

Table 1. Soil treatment areas for trenches and beds

Percolation rate in minutes per inch	Required treatment area in square feet					
	Per gallon of waste per day	Per bedroom[a]				
		Beds	Trenches: Depth of filter material below distribution pipe, inches			
			6	12	18	24
½ or faster[b]	—	—	—	—	—	—
½ to 5	0.83	125	125	100	85	75
6 to 15	1.27	190	190	150	125	115
16 to 30	1.67	250	250	200	165	150
31 to 45	2.00	300	300	240	200	180
46 to 60	2.20	330	330	265	220	200
60 or slower[b]	—	—	—	—	—	—

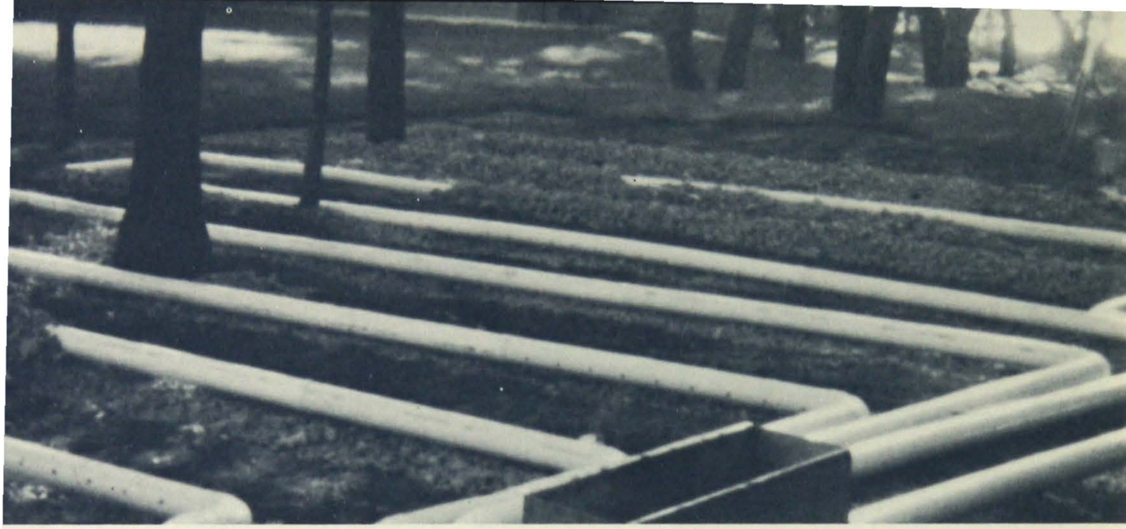
[a]In every case, sufficient area shall be provided for at least 2 bedrooms in residential units.

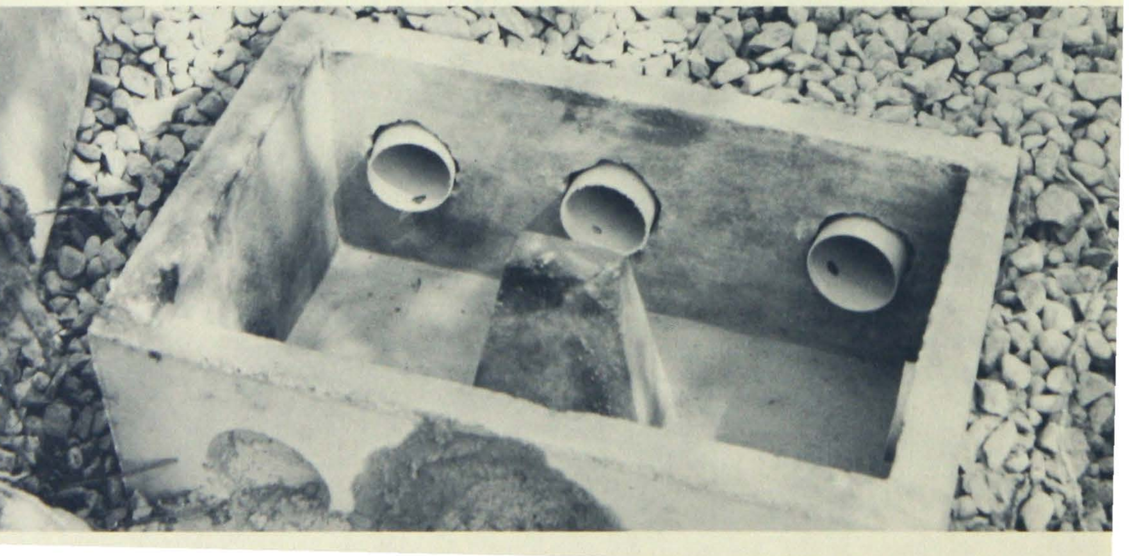
[b]Special design must be considered to provide adequate sewage treatment.

The trench bottom should be level throughout its length. To keep the bottom level, you will have to follow a contour line. No trench should be longer than 100 feet. Each system should have at least two trenches.

The total length of drainfield trench depends upon the size of the home, soil conditions, and trench width. The trench width may be 18 to 36 inches. Table 1 presents the amount of soil treatment area required for a private residence.

When the total length of drainfield trench has been determined, the trench layout will depend on the topography. On level ground, where the elevation does not vary more than 6 inches, a closed or continuous layout may be used to distribute effluent to individual trenches.





Opposite page, top: A distribution box distributes effluent to a shallow trench system on level ground. A least 12 inches of sandy loam backfill will be added to protect the system from freezing. **Middle:** Clean rock is being carefully placed into this seepage bed while the distribution pipe is being held on grade. The rock performs additional treatment on the sewage effluent and distributes the effluent over the soil bottom of the bed. **Bottom:** This baffle is needed when effluent is pumped into a distribution box. Extreme care must be used in installing the distribution box so all outlets are at the same elevation.

On sloping ground, drop boxes in a serial system provide the best method of distributing effluent to the trenches (figure 6). A drop box is installed at each individual trench. A supply pipe is connected to the drop box of the next trench downhill. When the liquid level reaches the top of the crushed rock in the first trench, effluent flows through the supply pipe into the second trench, and so on. This system allows each trench to be utilized to maximum capacity before the sewage flows to the next trench. No sidehill seepage occurs unless the total sewage treatment system is used at greater than design capacity.

Distribution boxes may be used to distribute effluent to trenches where the ground elevation at the lowest trench is at least 1 foot higher than the box outlets. All the distribution box outlets must be at *exactly* the same elevation. Extreme care is required! The box must be carefully placed on a firm foundation so that it will not settle after backfilling. The bottom of the box must be watertight. The elevation of each outlet must be set by measuring up from a liquid surface in the bottom of the box.

Distribution boxes should not be used for distributing effluent on sloping ground. If one outlet is lower than the others, it will draw the most effluent. This unequal distribution will result in uneven loading of the drainfield trenches. The sewage may surface on the lawn from the overloaded trench, while the other trenches are not being used to capacity. Sewage surfacing is most often due to improperly installed distribution box systems.

The construction of seepage beds is basically the same as for trenches. The amount of required bed area is presented in table 1. Less lawn area is needed for a seepage bed than for drainfield trenches. Beds have less sidewall area than do trenches with the same bottom area. Consequently, beds are more subject to failure than are trenches and need to be replaced more often. Trenches are preferable if sufficient yard area is available.

Vehicular traffic cannot be allowed on drainfield trenches or on seepage beds. Trees can remain in the drainfield trench area. When trees larger than 6 inches in diameter are located or are likely to be planted in the trench area, at least 12 inches of rock should be placed below the distribution pipe in the trench. Trenches and beds with no more than 18 inches of soil cover will contribute effluent to evaporation and plant use.

Pumping stations

Many sewage systems are nonconforming because they are too deep and, consequently, too close to the water table. The sewage will need to be lifted to a higher elevation, either before entering or after leaving the sewage tank.

If the sewage flows by gravity from the home into an adequately sized and properly designed septic tank, then a watertight tank for a pumping station can be installed to collect the septic tank effluent. Manhole access to this tank is also required.

Install a pump to deliver the effluent to the soil treatment unit. Pump in doses of at least 75 gallons and no more than the capacity of your soil treatment unit. (A 3-foot wide trench with 6 inches of rock holds 3.75 gallons per lineal foot).

Use a 1½ or 2-inch plastic pipe from the pump to the drop box or distribution box. This pipe needs not be below frost level if it is installed on grade to drain back to the pump. A 1½-inch plastic pipe holds 10 gallons per 100 feet, and a 2-inch pipe holds 18 gallons.

The pump should have enough head to overcome the elevation difference plus an additional 5 feet for friction loss. The pump should deliver at least 600 gallons per hour (gph), but no more than 2,700 gph. A good quality submersible sump pump—cast iron fitted with stainless steel screws—is adequate for sewage tank effluent. The pump does not need to pump large solids since these are retained in the sewage tank. A good quality pump costs $75 to $125.

To pump doses of at least 75 gallons, an adequately sized pumping tank is needed. Liquid level controls —such as pressure switches, electrodes, mercury bulbs, floats, etc.— are used to start and stop the pump. An electrode control plus relay costs from $50 to $75.

A pump may be used to lift house basement wastes to the elevation of the gravity sewer line flowing to the sewage tank. If there is no flush toilet in the basement, a standard sump pump will do the job. A submersible sump pump is usually of better quality than is the pedestal type. It is quieter, and the top of the sump can be flush with the basement floor.

With a flush toilet in the basement, a sewage ejector pump must be located in a sealed sump vented through the plumbing stack. Basement wastes are lifted to an elevation where they flow by gravity into the sewage tank. A sewage ejector pump with sealed sump costs about $400 to $600, plus installation.

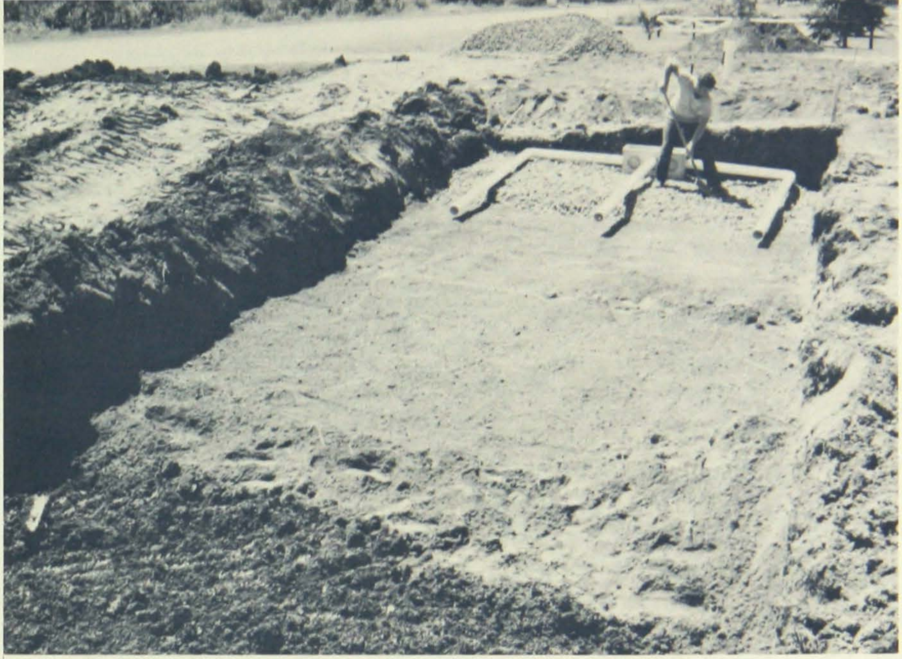
If the major portion of the household wastes flows by gravity into the septic tank, a pump breakdown is not as critical as when all household wastes are pumped. A septic tank near the ground surface is more accessible for maintenance. It is less of a problem to pump settled sewage. Also, dosing increases the life of the soil treatment unit. With a mound, dosing is required for proper operation.

Sometimes it is necessary to pump all raw sewage to a septic tank at a higher elevation. Sewage effluent can then flow by gravity from the septic tank into the soil treatment unit.

Pumps are mechanical devices, and we depend on them daily. Cars, refrigerators, furnaces, water systems, etc., all contain one or more pumps. A quality product will provide many years of trouble-free service. Select a quality pump from a reputable dealer who can provide any necessary maintenance or replacement.

Special designs

Consider special designs where soil conditions are unsuitable for the installation of drainfield trenches or a seepage bed, i.e., a percolation rate slower than 60 minutes per inch and/or a high water table. Contact the local zoning administrator and mutually decide whether the proposal



Layers of sandy loam, clean sand, and clean rock are used to construct a sewage treatment mound.

is technically sound, economically feasible, and enforceable.

Special designs include sewage disposal mounds, a reduced size soil treatment unit with restricted water use, a single soil treatment unit for more than one home, and holding tanks. Each of these designs has special considerations and will be discussed separately.

Whenever special designs are used, install a water meter to measure the amount of liquid that flows into the sewage treatment system (outside sillcocks not included). Water use data is necessary to evaluate the performance of the special design treatment system. In a holding tank, the water meter reading can assess pumping frequencies and hauling charges.

Mounds

Where the original soil surface is at least 3 feet above the highest known level of the water table, a mound soil treatment unit can be considered. Where lake elevation records are available, they should be analyzed to determine the highest elevation of the lake. Soil should be evaluated to determine that it is original and not fill. In some instances, fill has been recently placed on peat to increase the elevation of a lot. The additional weight of a mound will cause severe settlement of the peat and not allow the 4-foot separation to be maintained.

With inorganic soil of sandy loam or finer texture, a sewage treatment mound will adequately treat the sewage tank effluent if the water table or impervious surface is no closer than 3 feet to the original soil surface. Select an area for the mound that is as level as possible. Place a layer of sandy loam soil at least 6 inches deep on the original top soil. Rotary till the sandy loam into the existing soil. Level the top surface of the sandy loam layer.

Place a 6-inch layer of clean sand on the sandy loam. The elevation of the top of the clean sand layer is at least 1 foot above the original soil or 4 feet above the water table. Add a 6-inch layer of clean rock, ½ to 2½ inches in diameter, and distribution pipes, etc., as in the construction of a seepage bed.

Construct the mound in two halves, alternating their use annually. A pumping station is necessary to dose the sewage tank effluent into the mound. Dosing and resting contribute to effective sewage treatment and to long life of the mound.

Dikes are needed around the edges of the mound. If adequate space is available, a 4:1 slope (4 inches horizontal to 1 inch vertical) should be used on the dike. With a clay soil, a lawn area of about 50 by 70 feet is required for a mound serving a 3-bedroom home. With a dike slope of 1:1, the required lawn area is 35 by 55 feet. For a mound on sandy soil, the required area is 45 by 50 feet for a 4:1 dike slope and 30 by 35 for a 1:1 slope.

If your county allows the installation of a sewage treatment mound, the zoning administrator will provide complete plans and specifications. You may also be required to report on the liquid level in the mound as well as water meter readings, etc.

Where original soil is not 3 feet above the highest level of the water table, sandy loam fill may be used to develop adequate elevation before constructing the mound. Adequate yard area is necessary for such construction. Check with your local zoning administrator before adding fill or beginning construction.

Reduced water use

The size of the soil treatment unit depends on the soil texture and the amount of sewage wastes. If the amount of sewage wastes can be reduced, the size of the soil treatment unit can be reduced.

The amount of sewage wastes can be reduced by these methods: using a chemical, incinerator, outdoor, or composting toilet instead of a flush toilet; fine spray shower nozzle with shut-off valve; using a wringer-type or suds saver washer; eliminate the bathtub; do laundry at a laundromat; using container of drinking water in the refrigerator rather than allowing the water faucet to run; and having a general awareness of economy of water use.

Eliminating flush toilet wastes reduces sewage wastes about 40 percent in an average home. Outdoor toilets are allowable if the bottom of the pit is at least 4 feet above the ground water table. If the water table is closer than 4 feet, a watertight pit is required.

A shower can be taken with 3 gallons of water if a fine spray is used and the water is shut off at the showerhead while lathering. A wringer-type or suds saver washer with a washday once or twice a week will save 50 to 75 percent of the water required by daily use of an automatic sequence washer.

Some water-saving techniques can be easily put into effect. Others may cause minor or major changes in lifestyle. However if water can be conserved and the actual water use is metered, a reduced size soil treatment unit may be considered by the local zoning administrator.

However, this would only be considered for developed property, not for undeveloped lots. Have a complete understanding with your zoning administrator, and agree on the proposed solution. The agreement should preferably be in writing and also apply to all future owners of the property.

Holding tanks

For an existing residence located on a lakeshore lot where there is not enough area or suitable soil for an onsite treatment system, the sewage wastes will have to be discharged into a holding tank and transported to a treatment and disposal system. An average 3-bedroom home uses 200 to 300 gallons of water per day.

A holding tank is needed where the topography or the lot area does not allow installation of a soil treatment system.

The capacity of most pumper tanks is about 1,000 gallons. Therefore, the sewage would need to be hauled out every 3 to 4 days. Costs per load vary according to location, but they will range from $20 to $40. At $30 per 1,000 gallons, it would cost 3 cents to dispose of 1 gallon of waste. Thus, a 5-gallon toilet flush costs 15 cents, a 30-gallon shower costs 90 cents, a 50-gallon water use by an automatic washer costs $1.50, etc.

The high cost of hauling the sewage makes it imperative that water be conserved. However, water conservation may also be costly. Incinerator toilets cost $300-$600 to install plus 3 cents to 6 cents of fuel for each use. The cost of doing the laundry at the laundromat also includes the transportation cost.

Thus in some cases, the apparent saving in cost of hauled sewage will be transferred to another cost. The cost of sewage treatment can be very expensive when an adequate onsite treatment system cannot be installed.

The zoning administrator should require a water meter to be installed to record all liquid wastes entering the holding tank. The fee for hauling the sewage should be based on the water meter reading. This procedure removes much of the incentive for a homeowner to do "midnight" pumping into a lake or stream.

The zoning administrator may find it difficult to enforce the proper use of holding tanks. Holding tanks should be allowed only for developed lots and then only under adequate assurance that the sewage will be hauled away and treated.

Group systems

In some shoreland areas, early subdivisions platted small lots. Many lots are so low in elevation that installation of a conforming onsite soil treatment system is virtually impossible. However in most situations, soil suitable for an onsite treatment system is available within ½ mile or less.

If possible, plan to pump rather than haul the sewage to the treatment site. Try to purchase land across the road, and pump the septic tank effluent to that location. Join

A collector sewer line for effluent serves these lakeshore cabins. Each cabin has its own septic tank.

with other property owners to purchase a common soil treatment site.

In a group system, a collector sewer line transports the sewage effluent to a centrally located pumping station. The sewage is pumped under pressure to the soil treatment unit. Each homeowner has a properly sized septic tank. The effluent generally flows by gravity into the collector line. However in some cases, additional lift stations may be needed along the collector line.

Since the collector line is transporting settled sewage, sewage grinder pumps are not required. Good quality sump pumps, which are relatively inexpensive, are adequate for the lift stations and the main pumping station.

Each member of the group should own an undivided share of the soil treatment site. Since grass cover is to be maintained over the trenches, the treatment area can be utilized as a common playground or picnic area.

In some cases, the raw sewage is collected in a large septic tank at a central location. The effluent flows into another tank from where it is pumped to the soil treatment area. When raw sewage is carried in a sewer pipe, the slope is more critical than with sewage effluent. Systems are more trouble-free when each lot has its own septic tank and only the effluent flows into the collector line.

The size of the soil treatment unit is based on the soil characteristics and the total number of bedrooms in all residences. Use 3-bedrooms per lot as a minimum and include all undeveloped lots. Use drainfield trenches or seepage beds as the soil treatment unit. Divide the soil treatment unit into at least two parts, and plan to alternate between them annually.

For a group system, the pumping station should have dual pumps. The pumps may alternate in operation, or one may be installed for automatic standby. A liquid level warning device should be installed to warn of pump failure.

In the event of pump failure, additional tank capacity or an overflow tank should be provided. Provide 30 to 50 gallons of extra tank storage capacity per lot.

Pump capacity should be adequate to handle the maximum inflow rate. The maximum possible continuous flow rate will be realized if all the individual water systems are discharging full capacity into the sewage system. This is not a realistic condition, however, and certain components of the maximum discharge rates, such as automatic washers, will not operate at the same time in all homes.

Accurate data are not available on the maximum flow rate into a pumping station. As a guideline, the pump should be capable of delivering at least 1,200 gallons per hour or 200 gph per home, whichever is greater.

Several group systems have been installed in Minnesota, with more under consideration. Your local installer can help design parts of a collector system. Engineering advice may be available locally or through your county extension agent. When property owners join together to solve their sewage treatment problems, competent legal advice is necessary. An understanding and legal agreement should be developed on these items: easements for the collector and pressure sewer lines; ownership of system components; maintenance and operating costs; maintenance schedule for individual septic tanks; assessment of initial costs to each lot; a service contract with a reputable installer or pump dealer; use of the common soil treatment area; and others.

When the group has agreed on organizational and operational details, proceed with the design and installation of the system. The group system depends on mutual agreement and understanding of all participants as well as proper design, installation, and maintenance.

Among group systems installed in Minnesota, the cost per lot has been about the same as for individual systems. Costs of collector lines and the soil treatment unit have ranged from \$800 to \$1,200 per lot, depending upon disposal site accessibility, land cost, and the soil percolation rate (which determines soil treatment unit size).

Flood plain area

Special consideration must be given to the location and construction of sewage treatment systems on lots which abut streams. If a system is located at too low an elevation, it will be frequently underwater. If the sewage system is not floodproofed, sewage could flow into the stream. Installation and maintenance of a sewage treatment system in areas subject to flooding are also regulated by the DNR. Some recommendations for flood-plain areas are: have the elevation of the bottom of the drainfield trenches or the seepage bed at least as high as the elevation of the "10-year flood"; either vacate the premises or discharge sewage into a holding tank having an inlet invert at or above the regional flood elevation when portions of the sewage treatment system are at an elevation lower than the regional flood; cover the tops of septic tank covers, inspection pipes, and manholes by at least 6 inches, but with no more than 12 inches of soil; and carefully inspect and clean a sewage treatment system before returning it to service whenever it is inundated. For more information on flood plain regulations, contact your local zoning administrator.

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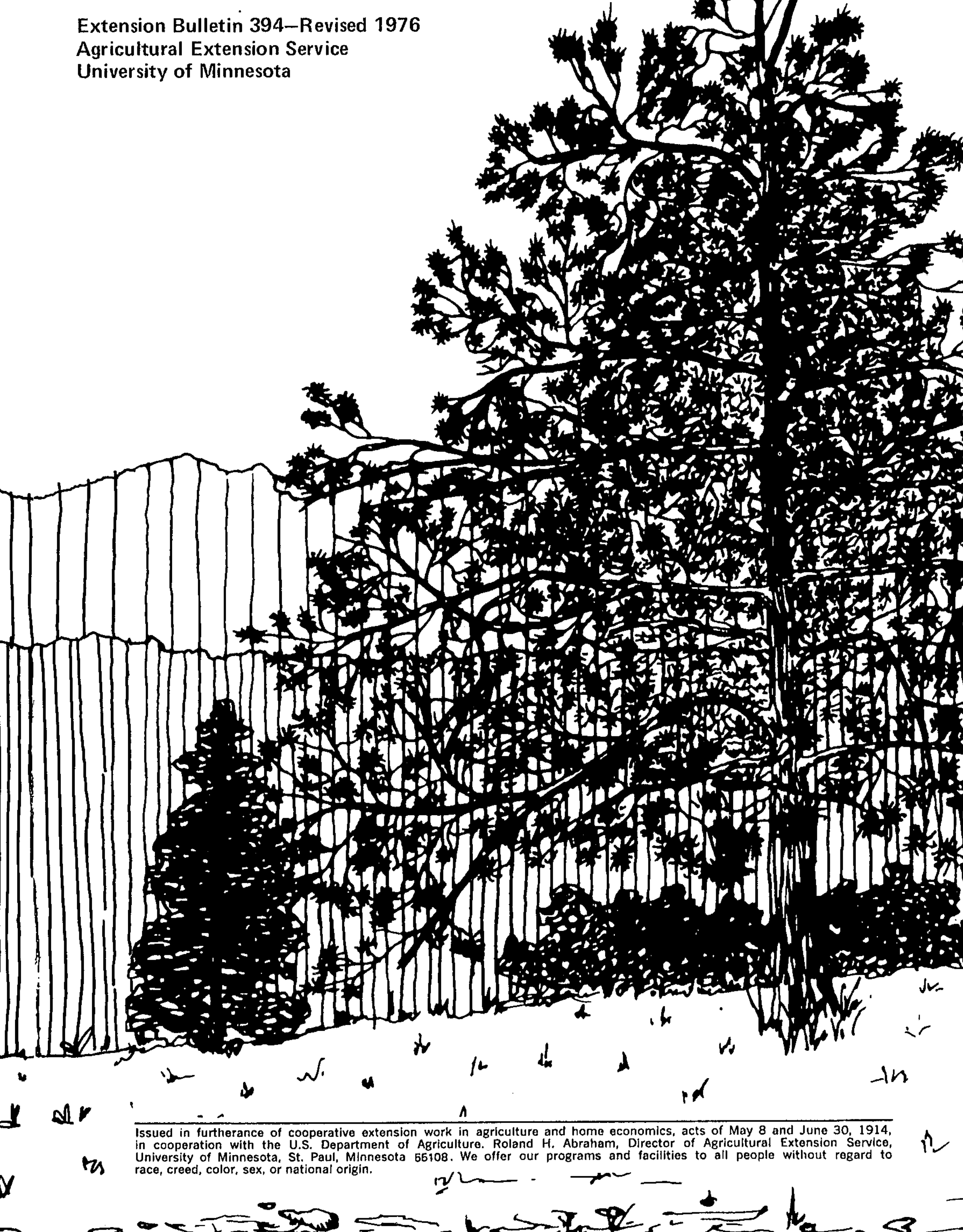

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