Virginia Cooperative Extension

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VIRGINIA FARM*A*SYST

Virginia Farmstead Assessment System

Fact Sheet/Worksheet No. 3
Household Wastewater Treatment and Septic Systems

NOAA

DEQ Virginia Department of Environmental Quality

DCR Department of Conservation & Recreation
Conserving Virginia's Natural and Recreational Resources

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Virginia Tech
Invent the Future

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INTRODUCTION TO THE VIRGINIA FARMSTEAD ASSESSMENT SYSTEM

Water wells and springs are the most common sources of private household water for rural homesites and farmsteads in Virginia. However, activities related to these environments may contribute to contamination of the groundwater which so many rural residents depend upon for household water. For example, farm facilities such as chemical and fuel storage tanks, livestock and poultry holding areas, irrigation systems, and septic systems are sometimes located near the farmstead well or spring. Retail agribusinesses and enterprises such as nurseries, greenhouses and direct farm markets are unique operations that may have production, storage, and sales areas close to a water well which may be also exposed to the general public. Inadequate maintenance of well-head and farmstead facilities and/or poor farmstead management practices can contribute to contamination of groundwater and drinking water supplies. Rural residents need to be aware of threats to water quality and of measures that will reduce or eliminate contamination of household water supplies.

To meet these challenges, as a part of a nationwide effort, the Virginia Farmstead Assessment System (Virginia Farm *A* Syst) was developed. This voluntary, educational/technical program is mainly a preventive program designed to: (1) provide safe, drinking water and thereby protect the health of Virginia's rural residents; (2) reduce potential land owner liability due to groundwater contamination which may result from farmstead or retail agribusiness activities; and (3) maintain or enhance farm property values throughout Virginia.

The Farm *A* Syst program is designed to guide an individual through a step-by-step evaluation of factors such as soils and geologic properties of the site, well-head or spring condition, and farmstead management practices that may impact the quality of his/her groundwater/drinking water supply. The program participant can identify potential pollution sources, and make an assessment of pollution risks to existing water supplies. Based on identified risks, corrective measures and/or management practices can be selected to reduce the likelihood of contamination.

This assessment is conducted by using a series of fact sheets and worksheets. A fact sheet /worksheet set deals with a specific pollution factor or source such as household wastewater, chemical storage, etc. Fact sheets are explanatory materials that contain background information on factors that affect groundwater quality, and legal requirements which address water quality and environmental protection. Worksheets are provided to determine ranking of potential pollution risks for each problem described in the fact sheets.

Each worksheet consists of a series of questions related to a specific farmstead feature or management practice such as well-head condition, fertilizer/chemical use, soils and geology of the site, etc. Based on the response to each question, a numerical ranking which indicates relative groundwater pollution risks is calculated. These rankings can then be used as a guideline to identify and prioritize corrective measures that will reduce or eliminate the potential for groundwater/drinking water pollution.

Users of this package need only to select those fact sheets/worksheets which are applicable to his/her activities or specific situations. For example, those evaluating rural, non-farm, homesite water supplies may select Fact Sheets/ Worksheets No. I -No. 5. Fact sheets/worksheets that will be important to many agribusinesses are No. 1 - No. 7. Some farming operations may relate to all worksheets. It is strongly recommended that the fact sheet corresponding to each worksheet be reviewed before using the worksheet itself. After developing a good understanding of each fact sheet, it will take about 15-30 minutes to complete each worksheet except for Worksheet No. 1 (Soils and Geology). To accomplish the task one needs only a pencil and a simple calculator. Each worksheet provides directions for completing the task. In addition, all users will need Worksheet No. 13 (Overall Risk Assessment). Fact Sheet/Worksheet No. 14 (Management of Irrigation Systems) was developed as an addendum chapter to the original Virginia Farm *A* Syst package and can be used in a stand alone manner or incorporated into the Overall Risk Assessment (Worksheet No. 13) as part of a complete farm assessment.

The Virginia Farm * A * Syst package contains the following Fact Sheets and Worksheets:

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FACT SHEET NO. 3

Household Wastewater Treatment and Septic Systems

Fact Sheet and Worksheet No. 3 were modified by Joe Hunnings (Virginia Cooperative Extension, Montgomery County), and Ray Reneau (Crop and Soil Envornmental Science Department, Virginia Tech).

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Household wastewater contains some contaminants that degrade water quality for such uses as drinking, stock watering, food preparation and cleaning. Potential contaminants in household wastewater include disease-causing bacteria, infectious viruses, household chemicals, and nutrients, such as nitrate. Viruses can infect the liver, causing hepatitis or infect the lining of the intestine, causing gastroenteritis (vomiting and diarrhea). If coliform organisms (a group of indicator bacteria) are found in well water, they show that the water is potentially dangerous for drinking and food preparation. Virtually all farmsteads use a septic system or similar on-site wastewater treatment system.

Groundwater and water supplies are least likely to be contaminated if appropriate management procedures are followed A properly installed and maintained system for treating and disposing of household wastewater will minimize the impact of that system on groundwater and surface water. The Virginia State Board of Health has published a document entitled "Sewage Handling and Disposal Regulations." Installation, permitting, servicing, and operation of private sewage systems are addressed in these regulations. All requests for a sewage disposal construction permit must bedirected initially to the district or local health department. The district or local health department will evaluate soil, geological, and site conditions to make sure that installation of a sewage disposal system would not create any actual or potential health problem.

I. SEPTIC TANK/SOIL ABSORPTION SYSTEM

The most common form of on-site wastewater treatment is a septic tank/soil absorption system. In this system, wastewater flows from the household sewer into an underground septic tank.

- In the tank, waste components separate - the heavier solids (sludge) settle to the bottom and the grease and fatty solids (scum) float to the top.
- Bacteria partially decompose and liquefy the solids.
- The septic tank must have a minimum detention time of 48 hours. The minimum size for a septic tank is 750 gallons. The inlet and outlet structures of the tank function as baffles, preventing inlet and outletplugging and rapid wastewater flow through the tank.
- The liquid portion (effluent) flows through an outlet to a distribution box where the effluent is directed to individual subsurface trenches in the soil absorption field.
- The absorption field is usually a series of trenches, placed on the contour, each containing a distribution pipe or tile line embedded in drainfield gravel or rock.
- The effluent drains out through holes in the pipe, then through the drainfield gravel and into the soil.
- The soil filters out remaining solids and pathogens (disease-producing micro-organisms). Excess water and dissolved substances slowly percolate down toward groundwater.

Figure 1 shows a typical household system for wastewater generation, collection, treatment and disposal. Note the lists of options below each part shown in the diagram. You may wish to circle the parts found in your system. The "leakage," "overflow," "infiltration" and "clearwater" components represent possible problems with the system. Unfortunately, these problems are often difficult to recognize. Overflow from systems may be noticed as wet spots, odors and some changes in vegetative cover. Water entry (infiltration and clear water) will be more difficult to detect, involving tracing where floor drains, roof drains, foundation drains and sumps are directing water that does not need treatment into the treatment system. Leakage from the collection and treatment system - as well as infiltration of water into the system through unsealed joints, access ports and cracks - can be very difficult to assess. The flow chart at the bottom of the box follows the flow of wastewaters and sludge through the treatment system.

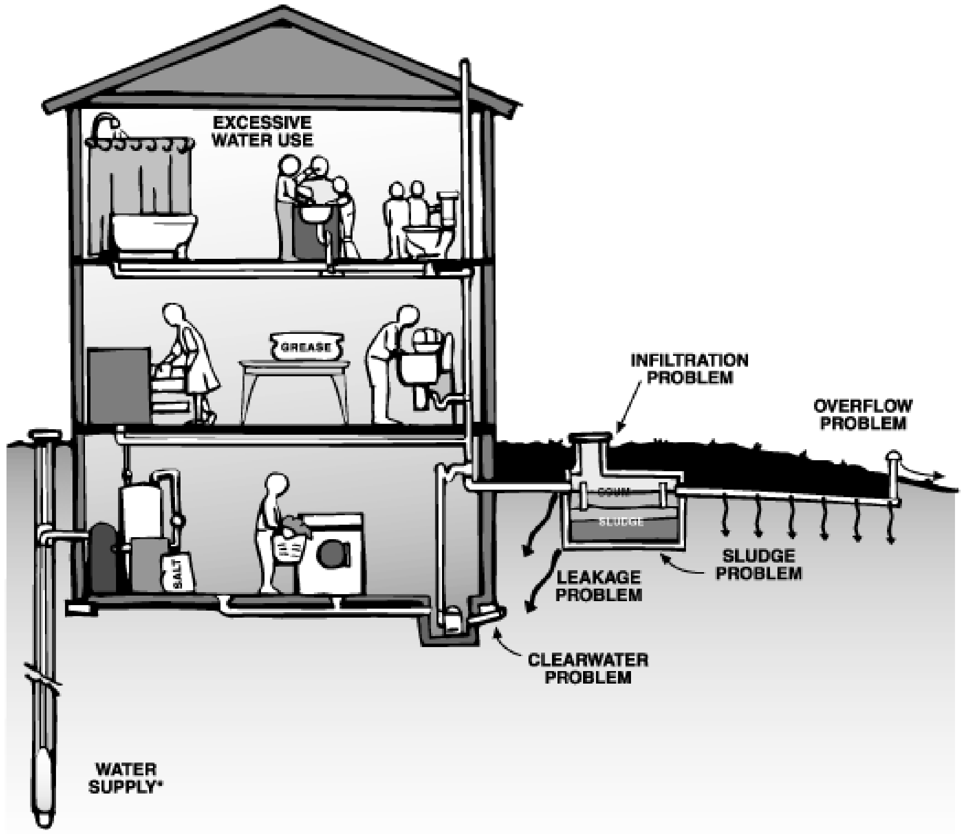

*Figure 1. A Typical Household System for Wastewater Generation, Collection, Treatment and Disposal. (Source: National Farm*A*Syst Package)*

WATER USE	*COLLECTION*	*PRETREATMENT*	*ADDITIONAL TREATMENT*	*DISPOSAL*
Quantity, Quality**	*Leakage*, Clearwater, Infiltration*	*Septic Tank*, Holding Tank, Aerobic System*	*Sand Filter, Nitrogen Removal, Disinfection*	*Soil Absorption*, In Ground, Bed, Trench, Mound, At Grade, Pump and Haul*

**= Elements Illustrated*

II. QUANTITY OF WASTEWATER

Reducing the volume of wastewater entering the treatment system is important because less flow (volume) means improved treatment, longer system life and less chance of overflow. For septic tanks, less volume lowers costs by reducing the number of times the tank must be pumped.

The quantity of water used depends upon the number of people using the dwelling, how water is used, and maintenance of the water supply system. Average water use in rural households is estimated at 75 gallons per person per day. With low water use fixtures and individual awareness, the life of the subsurface soil absorption system can be lengthened. However, only permanent water saving plumbing services such as low flush toilets shall be considered in reducing the size of the absorption field.

Reducing the volume of water entering the system will also improve the treatment efficiency by increasing the time the waste is retained in the system, thus providing more time for settling, decomposition, aeration, and soil contact.

Consider the following ways to minimize water use:

- Eliminate non-functional uses, such as flushing toilets to dispose of tissues or other wastes that should be handled as solid waste. Turn off water between uses and fix plumbing fixture leaks. Try to eliminate sources of infiltration into the system; for example, divert roof drains away from the soil absorption field.
- Consider which actions use the most water. Toilet flushing usually ranks the highest. Low-flow models could decrease water use by more than half. In

the United States, 35-40 percent of the population has plumbing codes that require a 1.5-gallon-or-less net flush volume of toilets in all new construction. Composting type toilets allow even greater reductions, but they can presentother waste disposal challenges.

- Bathing and clothes washing are next in order of water use. For bathing, consider such reduction options as installing low-flow or controlled-flow showerheads and taking shorter showers. For clothes washing, use a suds saver and run full loads. Front loading washers use much less water. When running small loads, be sure to use the reduced water level setting.

- Modern efficient plumbing fixtures, including 0.5 to 1.5 gallon/flush toilets, 0.5-2.0 gallons per minute (gpm) showerheads, faucets of 1.5 gpm or less, and front loading washingmachines of 20 to 27 gallons per 10-12 pound dry load, can result in substantial reduction in residential water use and wastewater generation. These reductions have commonly amounted to between 30 and 70 percent of total in-house water use.

- In hard water areas, the water softener may be a significant user of water. Proper adjustment and timing of the softener's regeneration mechanism can reduce excessive water use.

- Keep in mind that your awareness of your family's water use and how each of you can reduce it is as important as the use of water conservation devices.

III. QUALITY OF WASTEWATER

Domestic wastewater usually contains relatively small amounts of contaminants - less than 0.2 percent - but their reduction can make a big difference in the efficiency of waste treatment.

Contaminants found in wastewater include:

- Bacteria and viruses, some of which can cause disease in humans. Most microorganisms are large enough to be removed by settling, or through filtration in beds or soil. Many will die from the adverse conditions or aging in the system.

- Suspended solids, or particles which are less dense (e.g. grease scum) than water, and can be removed by filtration. Most can be separated from liquid waste by allowing enough time in a relatively slow flowing tank. Filtration beds and absorption systems can be clogged by wastewater high in suspended solids.

- Oxygen demand. The microorganisms that decompose organic wastes use oxygen. The amount of oxygen required to "stabilize" wastewater is typically measured as biochemical or chemical "oxygen demand." Wastes such as blood, milk residues, and garbage grindings have high oxygen demand. Aeration and digestion processes, in the presence of oxygen and organisms, can cause problems for soil absorption fields, groundwater, streams, and lakes by reducing levels of oxygen in the water.

- Organic solvents from cleaning agents and fuels may not be degraded or removed through soil treatment and can contaminate groundwater and drinking water supplies.

- Nutrients. Nitrogen from human wastes and phosphorus from machine dishwashing detergents and some chemical water conditioners are the most notable. Nitrate-nitrogen is a common groundwater contaminant, and phosphorus can over-fertilize surface waters such as lakes and rivers.

Consider the following ways to improve wastewater quality:

- Minimize use of the garbage disposal unit. Garbage disposals use a large volume of water and contribute a large load of suspended solids and organic matter to wastewater.

- Do not put items down drains that may clog septic tanks (fats, grease, coffee grounds, paper towels, sanitary napkins, tampons, disposable diapers).

- Do not put toxic substances in drains that might end up in the groundwater, such as solvents, degreasers, acids, oils, paints, disinfectants and pesticides.

- Do not use chemicals to clean the system. They may interfere with the biological action in the tank, clog the drain field by flushing sludge and scum into the field or add toxic chemicals to groundwater.

IV. COLLECTION OF WASTEWATER

Leaking pipes or treatment tanks (i.e., leakage losses) can allow wastewater to return to the groundwater without adequate treatment. Infiltration of clear water overloads the septic system and dilutes the wastes. Don't allow water that doesn't need treatment (basement floor drain sumps, foundation drains, infiltration of rain water, roof drainage) to add to your wastewater volume. Divert clear water, which doesn't require treatment, away from the house, and wastewater treatment system.

V. TREATMENT SYSTEM

Septic tanks retain most of the suspended solids (sludge and scum) from wastewater. In the tank, bacteria digest and compact the sludge. The partially treated water moves on to additional treatment or disposal (for example, in the soil absorption field).

Design and construction of septic tanks influence treatment effectiveness of sludge and scum removal. Multiple tanks or chambers in series can improve sludge and scum removal. Gas deflectors and filter screens or inclined-plate settling units help to minimize solids carryover. Tanks should be sized to accommodate at least 24 hours of wastewater flow, while still allowing for sludge and scum retention. Pumping the tank before it is more than one-third filled with scum and sludge improves functioning of the system. This is generally recommended every 3-5 years depending on amount of use. When the tank is pumped, you should also have the baffles checked and also check for tank leaks.

Aerobic (oxygen using) biological systems (packaged systems) provide more extensive treatment of wastewater than the typical anaerobic (no oxygen) septic units, while improving solids separation and reducing sludge volume. These systems are, however, more expensive to operate and maintain and are more subject to problems caused by changes in wastewater quality or environmental conditions.

VI. ADDITIONAL TREATMENT

Aerobic systems, described in the previous section, may be used for additional treatment of septic tank effluent, yielding a better quality effluent suitable for more disposal options.

Sand filters improve the quality of wastewater after septic tank pretreatment. Filters consist of 2 to 5 feet of sand (or other media) in a bed equipped with a distribution and collection system. Wastewater is applied by dosing, and it may be recirculated to improve treatment.

Constructed wetlands improve the quality of the wastewater by using plants to introduce air into the otherwise anaerobic liquid. Organisms associated with the plant roots are also beneficial in reducing levels of many contaminants. Wastewater treated in such systems is generally lower in bacteria, nitrogen, phosphorus, oxygen demand, suspended solids and organic matter.

Nitrogen removal can be achieved through denitrification (conversion of nitrate to nitrogen gas) or ion exchange. Denitrification requires anaerobic conditions in the presence of more decomposable organic matter for bacteria to reduce nitrate to nitrogen gas for removal from wastewater. Denitrification and ion exchange processes are not used extensively at this time, as they are quite expensive to install, operate and maintain.

Disinfection systems kill disease-causingmicroorganisms in wastewater and are used where discharge to surface water is permitted. Chlorine, iodine, ozone and ultraviolet light systems are available for treatment of good quality effluent, such as those from properly functioning aerobic units and sand filters.

VII. DISPOSAL OF WASTEWATER AND PUMPAGE

Subsurface treatment and disposal using soil absorption is the common practice for household wastewater after pretreatment in a septic tank or aerobic system. There are, however, sites where soil absorption systems are not acceptable because of high or low soil permeability, depth to bedrock or the saturated zone, or other factors. Deep, well-drained, well developed, medium-textured soils (such as silt loam and loam) are desirable soil absorption sites.

Holding tanks collect and store the entire wastewater flow. Disposal is generally done by a licensed contractor who spreads the waste on the land at an approved site or hauls it to a municipal waste treatment facility. Land application of wastewater provides an opportunity to recycle nutrients and to further reduce the contaminant content of wastewater in a safe manner. Disposal of pumpage from septic tanks and other treatment systems on-site should follow similar rules as for wastewater. Sludges are more concentrated than treated wastewater, so lower application rates are recommended.

VIII. FAILING SEPTIC SYSTEMS

If you suspect your household wastewater treatment system is backing up or your distribution system is clogged, first contact your plumber or treatment system installer, who may have suggestions for extending the life of your system. Your county health department office should be contacted for permits to repair or replace your wastewater treatment system.

- Do not use septic tank cleaners that contain degreasing solvents like TCE. They can contaminate groundwater.
- Do not place more soil over a surfacing soil absorption field; this does not fix the system, and it will eventually surface again.
- Do not pipe sewage to a road ditch, storm sewer, sink hole, drainage well, stream, or drain tile; this pollutes the water and creates a health hazard.
- Do not wait for the system to fail before pumping the septic tank. Once a system fails, it is too late to pump the tank.

If existing septic systems are to be used by farm workers or the general public, e.g., retail sales operations, take into account the ability of the present system to handle the increased waste load. Even if the drainfield is adequate, this consideration will require at least more frequent pumping of the septic tank.

A properly designed, constructed and maintained septic system can effectively treat wastewater for many years, but requires routine maintenance. For additional information on septic systems, contact your county Extension agent or local health department.

CONTACTS AND REFERENCES

For additional information, consult the Virginia Farm*A*Syst directory. For technical assistance, you may contact your local Extension Office or local health department.

GLOSSARY

Approved: A site for land application of wastewater or tank pumpage that meets state standards of

Disposal site: the Virginia Department of Soil and Water Conservation.

Clear water: Entry of water that does not need treatment, such as rainfall or tile drainage into a

Infiltration: system, through unsealed joints, access ports, and cracks.

Decomposition: Breaking down of organic wastes, such as sewage, by bacteria and other microorganisms.

Design capacity: Maximum volume of liquid that can be treated in a particular wastewater treatment system. For systems that include subsurface wastewater disposal and distribution, capacity is also based on the soil's ability to accept and treat sewage effluent. In filling out the worksheet, if you don't know the design capacity of your system, use 150 gallons per bedroom per day as an estimate.

Effluent: Liquid discharged from a septic tank or other treatment tank.

Holding tank: An approved watertight receptacle for the collection and storage of sewage.

Off-site disposal: Disposal of wastewater or sludge, as at a municipal treatment plant or approved disposal site.

Scum: Floatable solids, such as grease and fat.

Sludge: Settleable, partially decomposed solids resulting from biological, chemical or physical wastewater treatment.

WORKSHEET NO.3 HOUSEHOLD WASTEWATER TREATMENT AND SEPTIC SYSTEMS

Read Fact Sheet No. 3 Household Wastewater Treatment and Septic System before completing this worksheet. How will this worksheet help you protect your drinking water?

- It will take you step by step through your drinking water well or spring condition and management practices.
- It will rank your activities according to how they might affect the groundwater that provides your drinking water.
- It will provide you with easy-to-understand rankings that will help you analyze the "relative risk" to your drinking water well or spring.
- It will help you determine which of your practices are reasonably safe and effective, and which practices might require modification to better protect your drinking water.

Follow the directions below. Focus on the well or spring that provides drinking water for your home or farm. If you have more than one drinking water supply on your farmstead, take the time to fill out a worksheet for each one.

Note: You will probably want to make a print-out of this worksheet to complete it.

1. Use a pencil. You may want to make changes.
2. For each category listed on the left that is appropriate to your farmstead, read across to the right and circle the statement that best describes conditions on your farmstead. (Skip and leave blank any categories that don't apply.)
3. Then look above the description you circled to find your "rank number" (4, 3, 2, or 1) and enter that number in the blank under "your rank."
4. Directions on overall scoring appear at the end of the worksheet.
5. Allow about 15-30 minutes to complete the worksheet and figure out your risk rank.

Quanity/Quality (See Fact Sheet No. 3, Sections I, III, IV)					
	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK NUMBER
Quantity	Conservative water use (less than 20 gallons per person per day). Good maintenance of water-conserving fixtures. Whole house use is less than design capacity.*	Moderate water use (20-60 gallons per person per day). Fair maintenance of fixtures. Some water conservation fixtures. Water softener recharges twice a week or less. Whole house use is near design capacity.*	High water use (60-120 gallons per person per day). Poor maintenance of fixtures. Water softener recharges more than twice a week. Whole house use occasionally exceeds design capacity.*	Excessive water use (greater than 120 gallons per person per day). Leaking fixtures. No water-conserving fixtures. Whole house use frequently exceeds design capacity.* Regular use of restroom facilities by workers and others.	
Settleable solids	No use of garbage disposal unit in kitchen sink.	Minimal use of garbage disposal unit (1-2 times per week).	Minimal use of garbage disposal unit (1-2 times per week).	Daily use of garbage disposal unit.	
Collection of wastewater	All wastewater collected for treatment. No clear water collected. No leakage loss of water that should be treated. Collection system (pipe) more than 50 feet from well or spring.	All wastewater collected for treatment. Some clear water collected. No leakage loss of water that should be treated.	Some wastewater diverted, some leakage of water that should be treated, or some clear water collected.	Clear water collected. Leakage loss of water that should be treated. Collection system (pipe) less than 25 feet from well, spring, or sink hole.	

* If design capacity of your treatment system is unknown, estimate at 150 gallons per bedroom per day.

Treatment System (See Fact Sheet No. 3, Sections V, and VI)					
	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK NUMBER
Septic tank	-------	Multiple tanks or added solids retention system. Pumped at least every 3 years and maintained. Baffles checked. Tanks checked; no leakage.	Single tank. Pumped at 4-6 year intervals.	Leakage losses. Seldom pumped out (greater than 7-year interval). Less than 25 feet from well. Less than 3 feet from sinkhole, groundwa- ter table, or bedrock.	
Packaged aero- bic system or	Maintenance program fol- lowed. Loaded at less than design capacity.*	No mechanical failures. Loaded near design capacity.*	Occasional failures.	Frequent system failure. Load exceeds design capacity.*	
Holding tank	Excess capacity for usual pump- ing interval. More than 50 feet downslope from well. Tanks checked; no leakage.	Excess capacity for usual pump- ing interval. More than 50 feet downslope from well. Tanks checked; no leakage.	Occasional over- flow or leakage.	Less than 25 feet from well. Leakage losses. Upslope from well.	
Treatment in Addition to Septic System	Aeration, denitrification, filtration, dis- infection, and/ or constructed wetland.	Aeration and/or denitrification.	Filtration and/or disinfection.	More than 50 years old.	

* If design capacity of your treatment system is unknown, estimate at 150 gallons per bedroom per day.

Disposal of Septic System Wastewter				
Subsurface applicatioon	------	Pressure or gravity-fed distribution to trench system.	Bed or seepage pit.	Field or silo tile drainage system. Pipe to surface.
Horizontal separation of wastewater disposal site from water suply.	------	Subsurface disposal downslope more than 50 feet from well or spring.	Subsurface disposal downslope less than 50 feet from well or spring.	Subsurface disposal upslope from well or spring.
Vertical separation of wastewater disposal site from water supply	------	More than 6 feet to groundwater table or bedrock.	More than 3 feet but less than 6 feet to groundwater table or bedrock.	Less than 3 feet to groundwater table or bedrock.
Subsurface application rate	------	Below design capacity.	At design capacity.	Above design capacity.
Soils	------	Medium- or fine-textured soils (silt loam, loam, clay loams, clay).	Medium- to coarse-textured soils (sandy loam, sands).	Very coarse sands or gravel.
		Use this total to calculate risk rank:		Rank Number Total:

CALCULATE RISK RANK

Step 1:

Sum up the rankings for the categories you completed and divide by the total number of categories ranked. Carry your answer out to one decimal point.

Rank Number Total _______ ÷ No. of categories ranked _______ = Risk Rank _______

Risk Categories
3.6-4.0 = low risk
2.6-3.5 = low to moderate risk
1.6-2.5 = moderate to high risk
1.0-1.5 = high risk

This ranking gives you an idea of how your well or spring management practices as a whole might be affecting your drinking water. Later you will combine this risk ranking with other farmstead management rankings in Worksheet No. 13, "Overall Risk Assessment." This ranking should serve only as a very general guide, not a definitive indicator of contamination. Because it represents an averaging of many individual rankings, it can mask any individual rankings (such as 1's or 2's) that should be of concern (see Step 2.).

Step 2:

Look over your ranking for each category:

- Low-risk practices (4's): ideal; should be your goal despite cost and effort.
- Low-to-moderate risk practices (3's): provide reasonable groundwater protection.
- Moderate-to-high-risk practices (2's): inadequate protection in many circumstances.
- High-risk practices (1's): inadequate; pose a high risk of polluting groundwater.

Any individual rankings of "1" require immediate attention. Some concerns you can take care of right away; others could be a major-or costly-project, requiring planning and prioritizing before you take action. Note the activities that you identified as 1's to be listed later under "High-Risk Activities" in Worksheet No. 13.