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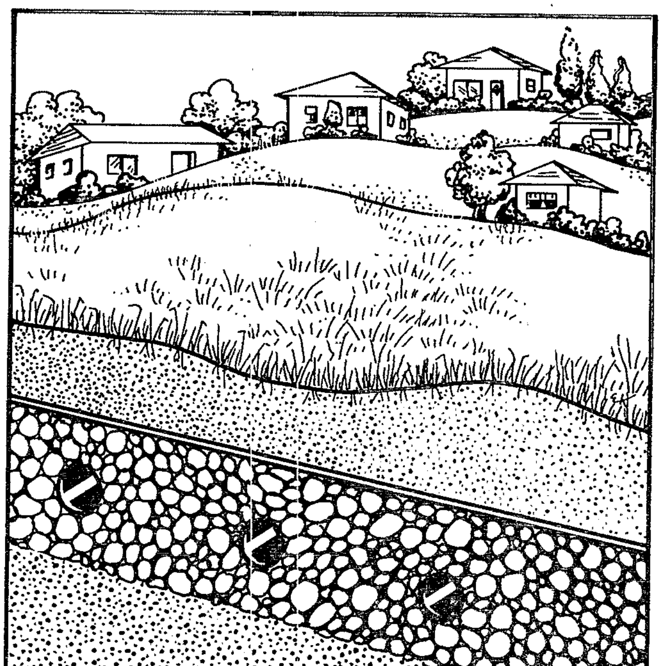
Large Soil Absorption Systems

Design Suggestions for Success



Operating Tips

- One resting absorption module should be rotated into service annually in late spring, when soil temperatures are increasing.
- At least once per month, the absorption units should be inspected for operational status and continuous ponding. Whenever continuous ponding is noted, the absorption module should be rested.
- A regular inspection and preventive maintenance schedule for all mechanical equipment should be established and implemented.
- If septic tanks are the form of pretreatment, the septage must be removed periodically and the tanks inspected for leaks.

Monitoring

- The composition of the applied wastewater should be characterized during the first quarter of operation and then annually thereafter. The parameters of concern may include COD, TSS, TDS, TKN, NO_3-N, and pH.
- The ground water quality should be monitored at least semi-annually. Monitoring parameters may include COD, TDS, TKN, NO_3-N, pH, and fecal coliform.

Design Techniques References

Several references are available which outline the design options for LSAS in more detail. Four of these references are:

1. *High Rate Soil Absorption Systems*, Task Force Final Report, Minnesota Pollution Control Agency, Roseville, MN.

2. Cogger, C. G., Carlile, B., Osborne, D. J., and Holland, E., *Design and Installation of Low-Pressure Pipe Waste Treatment Systems*, University of North Carolina (UNC) Sea Grant College Publication UNC-SG-82-03, Raleigh, NC, (1982).

3. *On-Site Wastewater Treatment*, Proceedings of the 4th National Symposium on Individual and Small Community Sewage Systems. American Society of Agricultural Engineers. Publication No. 07-85. St. Joseph, MI, (1985).

4. *Technology Process Design Manual for Land Treatment of Municipal Wastewater - Supplement on Rapid Infiltration and Overland Flow,* U.S. Environmental Protection Agency, Center for Environmental Research Information, EPA Publication 625/1-81-013a, Cincinnati. OH, (October, 1984).

Introduction

Millions of homes in the United States use septic tanks and leach fields to treat and dispose of their wastewater. In these systems, the individual homeowner is responsible for the cost of installation and maintenance. By combining the wastewater from several homes, the cost-effectiveness of these systems can be improved. The result is a large soil absorption system (LSAS). Hospitals, apartment and office complexes, recreational areas, and small communities are examples of situations where LSAS may be used. The EPA Design Manual for Onsite Wastewater Disposal Systems (EPA-625/1-80-012) provides design guidance for small (single home) soil absorption systems. Experience has shown that this guidance is not necessarily appropriate for LSAS, which treat substantially greater volumes of wastewater. A brief overview of some key design and constuction considerations for LSAS are presented herein.

The Concept

An LSAS consists of two components: a pretreatment system and the soil absorption system. Septic tanks are currently the predominant form of pretreatment used. In a community LSAS, each house may discharge into an individual septic tank which in turn discharges into a sewer system leading to the soil absorption or leach field. On the other hand, the use of one large septic tank may be more economical than the use of single septic tanks. In the soil absorption component of an LSAS, the effluent from the septic tank or other pretreatment system is discharged to a subsurface absorption field or leach field. The absorption field consists of trenches into which perforated pipe is placed in a porous medium, typically clean gravel. A filter fabric is placed over the gravel and the trenches are then backfilled. A typical trench system layout is presented in Figure 1. A cross-section of a typical trench is presented in Figure 2.

Treatment Mechanisms

Since a septic tank produces only primary quality effluent, the soil absorption system must provide the remaining treatment. In a municipal wastewater soil absorption system, nitrogen, pathogens, metals, phosphorus, and organics are the primary contaminants of concern. Septic tank effluents are typically high in ammonia. In a properly functioning LSAS, nitrification will convert almost all of the ammonia to nitrates. Since denitrification is minor, most of the nitrates may pass readily through the soil. LSAS systems must therefore be designed to ensure that adequate dilution of the nitrates is obtained in the ground water. Selective control of the dosing and resting cycles in uniformly dosed systems can improve

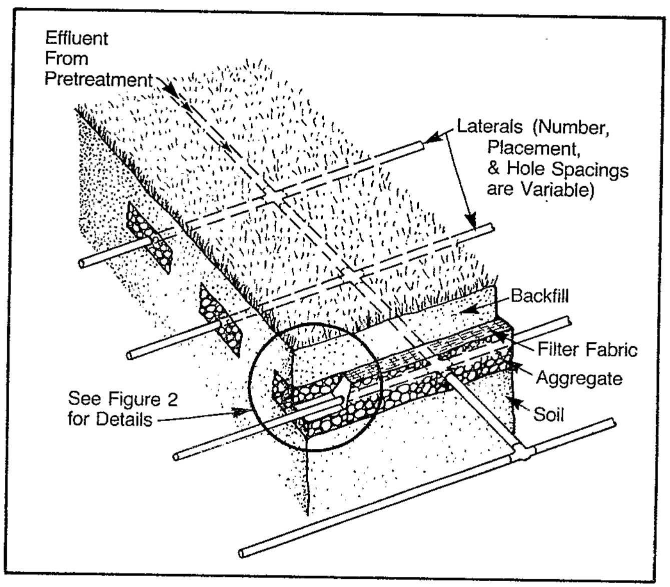


Figure 1. Typical Trench System Layout

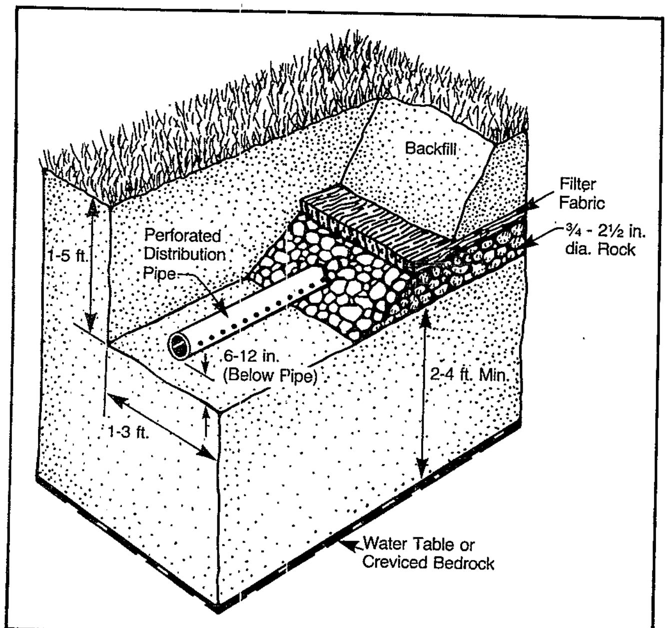


Figure 2. Typical Trench System Cross-Section

nitrogen removal. Pathogens are removed primarily by filtration and adsorption. Unsaturated soil conditions enhance pathogen removal, and at least 3 to 4 feet of unsaturated soil must be maintained beneath the bottom of the LSAS during operation. Metals and phosphorus are removed primarily by soil adsorption and precipitation, and treatment performance will depend upon the soil characteristics.

Detailed Site Evaluation: A Necessity

- The site evaluation should be performed by a professional soil scientist / hydrogeologist experienced in the siting and design of large wastewater absorption facilities.
- Detailed inspections of the soil morphological characteristics to a depth of at least 6 feet below the infiltrative surface should be conducted. Special attention should be given to both the vertical permeability characteristics and the horizontal flow potential of the site. Detailed procedures for this type of evaluation are given in EPA's 1981 Process Design Manual for Land Treatment of Wastewater.
- The depth to restrictive layers or ground water affects treatment performance. While supportive data are lacking, a minimum vertical separation of approximately 3 feet (depending on soil type) from the top of the ground water mound is recommended. Seasonal changes in the ground water depth should be taken into consideration.
- Sites with convex contours are preferred. Sites with concave slopes or which receive drainage from the surrounding area should be avoided.

Design Suggestions

- The design flow should be based upon accurate population projections.
- Seasonal or diurnal changes in flow rate should be considered in the design of the dosing system.
- Alternating operating and resting cycles are a necessity for good performance. Dosing frequencies of 2 to 4 cycles per day have been found to be most satisfactory. The selection of dosing frequencies are usually related to soil types, with more permeable soils being able to accomodate higher dosing frequencies.
- Trench orientation should be parallel to ground contours, and the trenches should be as shallow as possible to maximize aeration and to ensure that treatment occurs in the most chemically and biologically active soil zone.
- Recommended design loadings, based upon trench bottom area, for different soil textures, are presented in Table 1. Design infiltration rates should be selected cautiously based upon the soil morphology and hydraulic capacity.
- Pretreatment through multiple chambers in series generally provides the highest degree of pretreatment.
- At least four separate absorption modules should be provided for alternating service, with two resting at any one time.
- Pressure distribution is required to uniformly dose each module.
- LSAS systems are most suitable for flows under 30,000 GPD.
- The capability for flow measurement and for influent and ground water sampling should be included in the design of an LSAS.

Soil Texture	Application Rate ($gal/ft^2/day$)*
Gravel, Very Coarse Sand	Not Recommended
Coarse to Medium Sand	0.79 - 0.98
Fine Sand, Loamy Sand	0.61 - 0.74
Sand Loam, Porous Loam	0.52 - 0.61
Loam, Silt Loam	0.25 - 0.52
Clay Loam and Clay	Not Recommended

* To convert $gal/ft^2/day$ to cm/day, multiply by 4.07.

Table 1. Recommended Application Rates for LSAS.