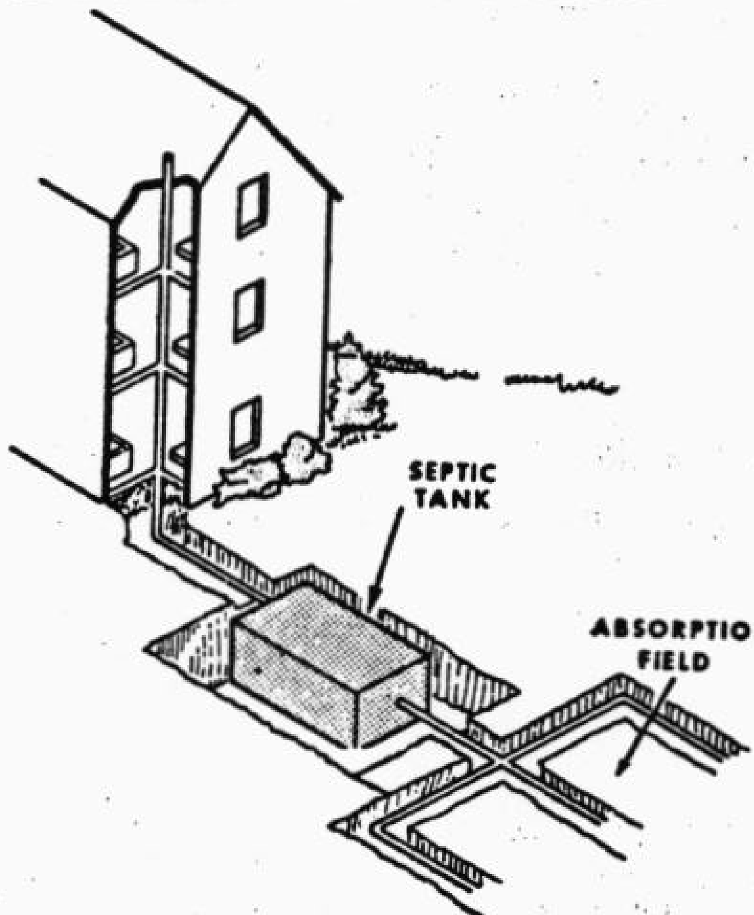
MINIMUM GUIDELINES for the CONTROL of INDIVIDUAL WASTEWATER TREATMENT & DISPOSAL SYSTEMS



CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

MINIMUM GUIDELINES FOR THE CONTROL
OF
INDIVIDUAL WASTEWATER TREATMENT & DISPOSAL SYSTEMS

PREPARED BY
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UNDER THE DIRECTION OF
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GRIFFITH 1. JOHNSTON
AND
FRED H. DIERKER, EXECUTIVE OFFICER

APRIL 1979

STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD SAN FRANCISCO
BAY REGION

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. 79-5

Minimum Guidelines for the Control of Individual Wastewater Treatment & Disposal Systems

I. Whereas, on July 18, 1978, the Board adopted a Policy on Discrete Sewerage Facilities, Resolution 7b-14, and;

II. Whereas, the Board within Policy 3B of Resolution 78-14 expressed its intent to adopt guidelines by which it will judge the adequacy of local ordinances for the control of individual wastewater treatment and disposal systems, and;

III. Whereas, this Regional Board finds the report entitled "Minimum Guidelines for the control of Individual Wastewater Treatment and Disposal Systems" fulfills the expressed intent of provision II above.

IV. Whereas, this Regional Board, as part of its Policy on Discrete Sewerage Facilities prepared a negative declaration in accordance with the California Environmental Quality Act (Public Resources Code, Section 21000 et seq.) and the State Guidelines, and determined that there should be no substantial adverse change in the environment as a result of the project.

V. Whereas, on March 20, 1979, this Board held a public hearing and heard and considered all comments pertaining to this matter, and;

VI. Whereas, this Regional Board has determined that there are no State mandated local costs under. Section 2231 of the Revenue and Taxation Code as a result of the foregoing regulation because such regulation is not an executive regulation by virtue of Section 2209 of the Revenue and Taxation Code, and;

VII. THEREFORE, BE IT RESOLVED that this Regional Board adopts the guidelines set forth in the attached document entitled "Minimum Guidelines for the Control of Individual Wastewater Treatment 6 Disposal Systems."

I, Fred H. Dierker, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of a Resolution adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on April 17, 1979.

FRED H. DIERICER
Executive Officer

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PREFACE

As the population of the Bay Area increases, demand for new development increases. In many cases, new development is occurring in close proximity to existing urban areas and within the service areas of existing municipal sewerage agencies. In an increasing number of instances, however, development is being proposed in outlying areas which cannot easily be served by existing sewerage agencies. In those instances new discrete sewerage systems (1970-approximately 94,000 [16] septic tanks & cesspools) are being proposed (i.e. new systems separate from existing public sewerage systems). The San Francisco Bay Regional Water Quality Control Board in 1978 adopted a Policy on Discrete Sewerage Facilities which sets forth the actions the Board will take with respect to proposals for Individual or community sewerage systems serving new residential development. An important provision of that policy requires the development of guidelines for the control of Individual wastewater treatment and disposal systems. The guidelines which are being proposed concentrate on septic tank - leachfield systems. The development of the guidelines involved the review of existing regulations, past practices, and the literature. Recommendations are made for technically defensible minimum guidelines for regulation, design, construction and operation and maintenance of septic tank-leachfield systems.

MINIMUM GUIDELINES FOR THE CONTROL OF INDIVIDUAL WASTE TREATMENT AND DISPOSAL SYSTEMS

RECOMMENDED MINIMUM GUIDELINES FOR THE CONTROL OF INDIVIDUAL WASE TREATMENT DISPOSAL SYSTEMS

Introduction

Section 13269 of the California Water Code provides that a Regional Board may waive the filing of reports of waste discharge for certain specific types of discharge where such waiver is not against the public interest. Such waiver shall be conditional and may be terminated at any time by the Board. In the early 1960's the Board adopted waivers for reporting certain septic tank discharges in all Bay Area counties except San Francisco and Marin. The Policy on Discrete Sewerage Facilities states the Board's intent to review the matter of septic tank system discharge waivers.

These guidelines have been developed to provide recommended minimum uniform regional criteria to protect water quality and to preclude the creation of health hazards and nuisance conditions which could result from the use of individual wastewater treatment and disposal systems (mainly septic tank systems). These guidelines will be used by the Regional Board to assist in deciding whether to renew, amend, or rescind existing waivers, or to issue new ones. Since the waivers must not be against the public interest, the Regional Board will examine many factors in addition to compliance with these guidelines. Some of these factors are:

1. How at effectively are septic tank systems being regulated in the area under consideration, i.e. are they causing or threatening to cause water quality problems, nuisance, or health hazards.

2. If septic tank systems are causing or threatening problems that are unacceptable, what mitigation measures are required to reduce impacts to acceptable levels and what are the impacts of the mitigation measures?

3. If a waiver were not adopted in a specific area, what would be the probable effect on septic tank system regulation and on Regional Board workload?

4. Evaluation of the capability of individual systems to achieve continuous, safe disposal of wastes requires detailed local knowledge of the area involved. The experience and recommendations of local agencies will, therefore, be an important input to the information upon which the Board will base its decision.

There are great differences in the geology, hydrology, geography, and meteorology of the nine counties which lie partially or wholly within the San Francisco Bay Region. These guidelines represent minimum criteria generally acceptable for the construction and use of new individual wastewater disposal systems for single family residences. Sections of these guidelines may also be used to determine soil suitability for land divisions as well as for the construction and use of individual systems for other types of domestic discharges (i.e. church, school, etc.). Adherence to these guidelines does not guarantee acceptable operation of a system.

These guidelines do not discourage a local agency from adopting and enforcing comparable or sore stringent regulations. Local Agencies are encouraged to adopt more stringent criteria when warranted by local conditions • Where local standards are more stringent they would take precedent over the minimum guidelines proposed by the Board. The Board does not intend to preempt local authority and will support local authority to the fullest extent possible.

Scope

The provisions of these guidelines apply to the regulation, design, construction, installation, operation & maintenance of septic tank and soil absorption systems • Guidelines are also provided covering the areas of cumulative impacts and the use of alternative systems.

I. Design:

A. Septic Tanks

(1) Septic tank design shall be such as to produce a clarified effluent consistent with acceptable standards (Part 1 -Section of a Septic Tank, USPHS Manual ref. 6 or the Uniform Plumbing Code ref. 34) and shall provide adequate space for sludge and scum accumulations.

B. Soil Absorption Systems

(1) Dual leachfields shall be required for all new disposal systems.

(2) The dual system shall consist of two fields each sized separately according to section I-B-5 and constructed according to section II-B (below).

(3) The two fields shall be connected by a diversion valve which allows alternate use of the fields. It is recommended that each field use be alternated on a 6-12 month basis. A post card system may be used to inform the homeowner to turn the valve.

(4) In addition, a reserve area, coinpatiablo with the life of the discharge, may be required by the Health Officer.

(5) Absorption area, in terms of effective infiltrative surface, can be calculated from the following table.

Maximum Effluent Loading Rates of Soil Absorption systems

Percolation Rate mm/in (in/hr)		Maximum Loading Rate (gal/Ft ^{2}/day)
less than 1		system prohibited
1	(60)	1.58
2	(30)	1.24
3	(20)	1.0
4	(15)	.86
5	(12)	.82
10	(6)	.64
20	(3)	.45
30	(2)	.3
40	(1.5)	.26
60-120	(l-.5)	.22

*effective infiltrative surface includes the bottom area plus all but the upper six inches of gravel for the sidewall area. The minimum depth of gravel in the trench shall be twelve inches.

(6) When non-standard percolation test holes are used adjustments to the percolation rates must be made using the adjustment factor contained in the following table.

Percolation Rate Adjustment Factors

Hole diameter	Adjustment factor for. (hole diameter)	Adjustment factor for hole diameter plus pipe & gravel)
4 inches	2.5	3.61
6 inches	1.8	2.32
12 inches	1.1	l.43
14 inches	1.0	l.24

1) 3 inch O.D. 1/4” perforated pipe
2) 5 inch O.D. 1/4” perforated pipe
3) 10 inch O.D. 1/2” perforated pipe
4) 12 inch O.D. 1/2” perforated pipe

example calculation

If a 6” augured test hole measures 10 mm/inch, this corresponds to a 18 mm/inch standardized per. rate (10 x 1.8 18)

C. Wastewater Generation for Individual Dwellings

(1) To calculate the required absorption area, the minimum design shall be for 150 gallons per day for a one bedroom dwe11ing~ for each additional bedroom or potential bedroom, add 150 gallons per day.

(2) The use of water saving devices is encouraged. Where permanent devices are used, reduction of the 150 gallon per day per bedroom flow may be granted by the Health Officer where the Health Officer can enforce the continued use of the permanent water saving device.

II. Construction Techniques

A. Septic Tanks

U) On-site disposal system construction plans shall be submitted to the Health Officer (as amended *) for review and approval.

B. Soil Absorption Systems

(1) Surface smearing of the infiltrative surfaces during construction shall be corrected by scarifying the infiltrative surfaces after excavation is complete.

(2) Surface runoff shall not be permitted into open trenches during construction to limit siltation of the bottom area.

(3) An effective barrier such as untreated building paper shall be provided to limit the entrance of fines from the soil backfill into the drainfield gravel.

(4) Backfill shall be placed so as to maximize surface runoff and not crush drain lines.

(5) Leachfield lines should be arranged in conformance with the USPHS - Manual of Septic Tank Practice (Section -Serial Distribution).

C. Construction Inspection

(1) All systems shall be inspected during construction by the Health Officer before the system is backfilled.

III. Field Observations for Installation

A. Percolation Test

(1) A standardized procedure as discussed below shall be used to measure percolation rate.

(a) Percolation tests are to be carried out (in soils in their native state) at the proposed depth of the soil absorption field. Percolation tests may be conducted at the bottom of backhoe or other excavation holes where deeper testing is required by the Health Officer.

* Hea1th Officer: means either the County Health Officer, other responsible administrators, or a regulatory agency approved by the Regional Board.

(b) Individual tests are to be run in 12” square or 14” diameter holes dug or bored using hand tools. If power based tools are used remove any smeared soil surfaces from the sides of the hole. Although not recommended, where different diameter holes are used the percolation rate adjustment factors in Section 1(B) (6) must be used.

(a) Remove loose material from the bottom of the hole and add 2 inches of coarse sand or fine gravel to protect the bottom from scouring.

(d) If soils tend to collapse, place a perforated pipe (at least 12 inches in diameter) in the hole and carefully pack gravel around it between the pipe and the hole wall. (The percolation rate adjustment factor in Section 1(8) (6) must be employed when this method is used.)

(e) Presoaking will be required in all tests. The water shall be carefully placed within the hole. Water must be added to at least 8” in depth over the gravel and maintained at this level for at least 4 hours and preferably overnight. If the soil is known to have a low shrink—swell potential (clay content 15% or less) testing may proceed (Section F) after the 4 hour presoak. Soils with higher shrink-swell potential are to be tested the following day but within 24 hours of presoaking as follows.

(f) Fill the hole with c lean water (no chemical additives) exactly 6 inches above the soil bottom (do not consider the gravel). With a float gauge or secure fixed reference and time piece determine the time for the water to recede exactly one inch or determine the drop of water after exactly 60 minutes whichever takes less tine. Refill and repeat the process until subsequent tests indicate a stabilized rate has been attained (i.e. three consecutive rates are within 10% of each other). Time lapse between test intervals should be minimal (5-10 mm.). Test results should be reported in units of minutes per inch.

(2) At least three percolation tests shall be made in separate test holes spaced over the proposed absorption field. The average of the three tests shall be used for determining the appropriate loading rate from the table in Section I (B)(5).

B. Septic Tank and Soil Absorption System Setbacks

(1) The minimum distance (feet) between the septic tank -soil absorption system and various physical site features shall be as shown in the following table:

	Septic Tank	Disposal Field
All wells	50	100
All streams and waterbodies*	50	100
reservoirs*	100	200***
cuts or embankments**	10	4h**
drainageway	50	50

* Distancesare as measured from the top edge of stream banks or high water mark of lakes & reservoirs.

**Distances in feet equals four times the vertical height of the cut or fill bank. Distance is measured from the top edge of the bank. Where an impermeable layer intersects a cut bank the setback shall be 100 feet.

***See Section V (A) (1) for watershed protection requirements.

(2) The minimum distances between the septic tank — soil absorption system and structures or legal site conditions should be consistent with the USPHS recommendations or other distances as determined by the Health Officer.

C. Depth to Groundwater

(1) Depth to the highest seasonal elevation of the water table, below the bottom of the leachfield trench, shall be as shown in the following table.

Percolation Test Rate (min/inch)	Minimum depth (ft) to seasonally high water table
greater than 5	3
between 1 and 5	20
less than 1	system prohibited

(2) Demonstration of meeting -the depth to water table requirement should be through the use of (at least one) field observation hole (in the area of the proposed field) or through historical records acceptable to the Health Officer.

D. Depth to Impermeable Layer

(1) Depth to an impermeable layer (i.e. clay to solid granite), below the bottom of the leachfield, shall be 3 to 5 feet.

(2) Demonstration of meeting this depth requirement should be through the use of a field observation hole, historical records acceptable to the Health Officer or a backhoe hole.

E. Slope

(1) Ground slope of the field shall not exceed 20%.

(2) Variances may be granted by the Health Officer on a case-by-case basis

where it can be demonstrated, through a technical report prepared by a State registered civil engineer (with soils and a geological background) or geologist, that use of a soil absorption system will not surface in the absorption field, or reserve area, create water quality problems, jeopardize contiguous properties, and affect soil stability.

F • Trench Spacing and Depth

(1) The minimum spacing between trench walls shall be calculated as twice the effective depth (effective depth being the depth of drain rock below the pipe).

(2) Because of potential construction hazards, design questions and questionable operation, the maximum depth of the disposal trench should not exceed 8 feet.

IV. Operation and Maintenance

A. Septic Tank - Soil Absorption System

(1) It is the responsibility of the Health Officer to assure that all systems within the county are maintained and operating satisfactorily.

(2) All new systems shall be inspected at a frequency of at least once every two years to determine sludge and scum depths, observe evidence of surfacing effluent, and to assess general system operation. This inspection frequency may be waived on a case-by-case basis to a frequency of not less than once every five years where the health officer has determined that adequate operation and maintenance will be assured through other means.

B. Septage Disposal

(1) Continue existing practice of septage disposal at approved class II landfill sites and to wastewater treatment plants which will accept it.

C. Correction of System Failures Utilizing Alternative Systems

(1) Approval to use alternative systems to correct existing septic tank - soil absorption system failures may be allowed under the following conditions:

(a) Where the Health Officer has approved the system pursuant to criteria approved by the Regional Board Executive Officer;

(b) Where the Health Officer has informed the Regional Board Executive Officer of the proposed system correction; and

(c) Where a public entity assumes responsibility for inspecting, monitoring and enforcing the maintenance of the system.

D. Abandoned Individual Systems

(1) Every individual system which has been abandoned or has been discontinued from further use or to which no waste or soil pipe from a plumbing fixture is connected shall:

(a) Have the sewage removed from and disposed of in a manner approved by the Health Officer; and

(b) Be either completely filled with material (concrete, etc.) approved by the Health Officer or be removed and disposed of in a manner approved by the Health Officer.

V. Cumulative Impacts & Alternative Systems

A. Watershed Protection

(1) *A* cumulative impact assessment approach shall be considered for watershed areas which are susceptible to development utilizing septic tank — soil absorption systems.

B. Mounding of the Groundwater Table

(1) When considering a single septic tank — soil absorption system, the requirements of Section Ill-C depth to groundwater, Section III—D depth to impermeable layer, and Section Ill-F trench spacing are sufficient.

(2) When considering areas where the ultimate density of systems is such that adverse impacts on water quality and/or public health may occur, a cumulative impact assessment approach should be considered.

C. Lot Size (Density of Systems Within a Given Area)

(1) A cumulative impact assessment approach should be utilized in establishing an allowable upper limit on the number of systems.

D. Cesspools & Drainage Wells

(1) Cesspools are prohibited from use.

(2) Drainage wells are prohibited from use by the Regional Boards Resolution No. 01.

E. Holding Tank

(1) Holding tanks are prohibited from use.

(a) Exceptions to this prohibition may be granted by the Health Officer:

1. If it is necessary to use a holding tank in abating a nuisance and health hazard.

2. If an area is within a sewering agency, sewers are under or proposed for early construction, there is capacity at the wastewater treatment plant the severing agency assumes responsibility for maintenance of the tank and contracts have been let.

(b) Where exceptions are granted, the Health Officer must also approve the tank pumper.

F. Alternative Systems (with subsurface disposal)

(1) The Regional Board Executive Officer may authorize the Health Officer to approve alternative systems when all of the following conditions are set:

(a) Where the Health Officer has approved the system pursuant to criteria approved by the Regional Board Executive Officer;

(b) Whore the Health Officer has informed the Regional Board Executive Officer of the proposal to use the alternative system and the finding made in (a) above; and

(c) Where a public entity has met the responsibility for the inspection, monitoring and enforcing the maintenance of the system through:

1. Provision of the commensurate and the necessary legal powers to inspect, monitor, and when necessary to abate/repair the system; and

2. Provision of a program for funding to accomplish 1 above.

G. <u>Disclosure of the Wastewater Disposal System</u>

(1) There exists a genuine need to inform the potential or unknowing buyer of the homes wastewater disposal system.

(2) The. following program is suggested in order to fulfill this needs

(a) Prior to entering into an agreement of sale of any residential building, the owner o r, authorized representative should obtain from the City or County a copy of the original and any modifications of the septic tank - soil absorption system plans (where available);

(b) The septic tank soil absorption system plans should be delivered by the owner, or authorized representative to the buyer or transferee of the residential building prior to the consummation of the sale or exchange.

(3) Implementation of such a program could be through the adoption of a local ordinance by the septic tank system permitting authority, which imposes such conditions as part of a building permit, septic tank system permit or any renewal of the septic tank system permit.

(4) To further encourage disclosure and to provide long term integrity of the individual wastewater treatment and disposal system, any county or other public entity which approves a subdivision or other division of land should require as a condition of its approval that the proponent, of the development provide assurances by way of covenants, conditions and restrictions or drainage or other easements that the septic tank—soil absorption system (including any reserve area) will be available solely for its original intended purpose for the lit, of the development. Regarding currently existing individual parcels, any county or other public entity which issues a septic tank system permit should include as a condition of the permit or otherwise by ordinance that the property owner provide assurances by way of covenants, conditions and restrictions or drainage or other easements that the septic tank-soil absorption system (including any reserve area) will be available solely for its original intended purpose for the life of the development.

TECHNICAL SUPPORT

I. DISPOSAL FIELD DESIGN

I- (1) The Septic Tank and Soil Absorption System

A schematic of a typical septic tank and soil absorption system is shown in figure 1-1. Wastewater flows from the home normally by gravity to a septic tank, which is a rectangular box constructed of a watertight material. The tank is basically or primary treatment facility where heavier solids settle to the bottom and accumulate as sludge, and the grease and lighter particles rise to the surface and form a scum. The clarified effluent then flows to a soil absorption field.

A cross sectional view of a disposal trench is shown in figure 1-2. Most commonly, trenches are about two feet wide and three feet deep. In typical construction (LJPC Appendix I, section 1-6), coarse gravel is placed in the lower 12 Inches of the trench. A perforated distribution line with an additional 6 inches of gravel. The gravel is covered with permeable building paper and the excavation is backfilled.

Infiltration vs. Percolation

To minimize health risks the soil mantle must be able to accept and transmit household wastewater such that surfacing of effluent does not occur and microorganisms are rapidly eliminated from underground flows. Proper design of a soil absorption system requires an understanding of the rate of movement of water out of the trench and also through the soil mantle. These are quite different phenomena.

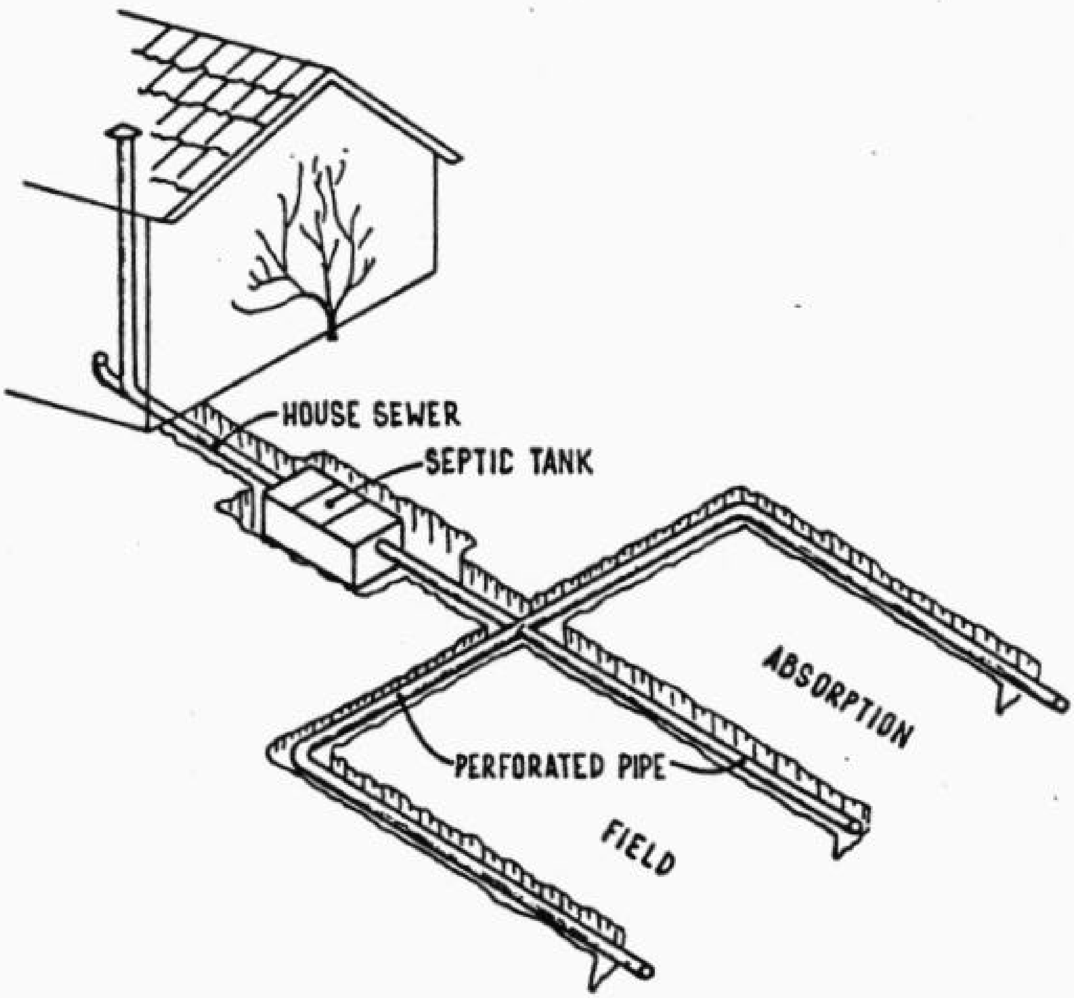
McGauhey (3) has defined the rate at which liquid passes through the soil-water Interface at the trench wall as the infiltrative capacity of the soil, and the rate of movement of water in the soil system as the percolative capacity. McGauhey and Winneberger (2,3) indicate that the only time the two rates are the same is at the beginning of operation of the system and that the Infiltrative rate ultimately governs the outflow of water.

A typical infiltration rate curve, showing the three phases of the infiltration process over time is presented in figure 1-3 (3). Phase 1, the initial decrease in permeability, is generally agreed to result from initial wetting of the soil (i.e., reduction of initial moisture potential).

Phase 2, the temporary Increase in soil permeability, has been shown to result from the removal of entrapped air by solution In the percolating water. Phase 3, the long term decrease In permeability has been demonstrated to result primarily from microbial activity at the soil-water interface; note In figure 1-3 that the use of sterile soil and water shows no decrease in the percolation rate. This latter phase is highly important in the design of soil absorption systems as the long term infiltration rate governs the size of the trench needed to dispose of given household wastewater flows.

FIGURE I-1

SEPTIC TANK SEWAGE DISPOSAL SYSTEM



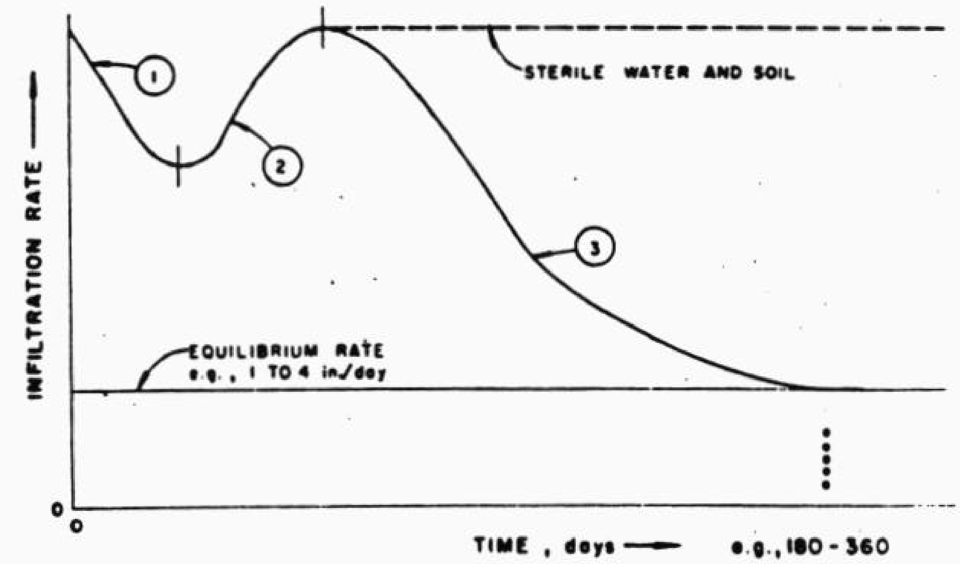


FIGURE I-3 TYPICAL TIME-RATE INFILTRATION CURVE FOR WATER (3)

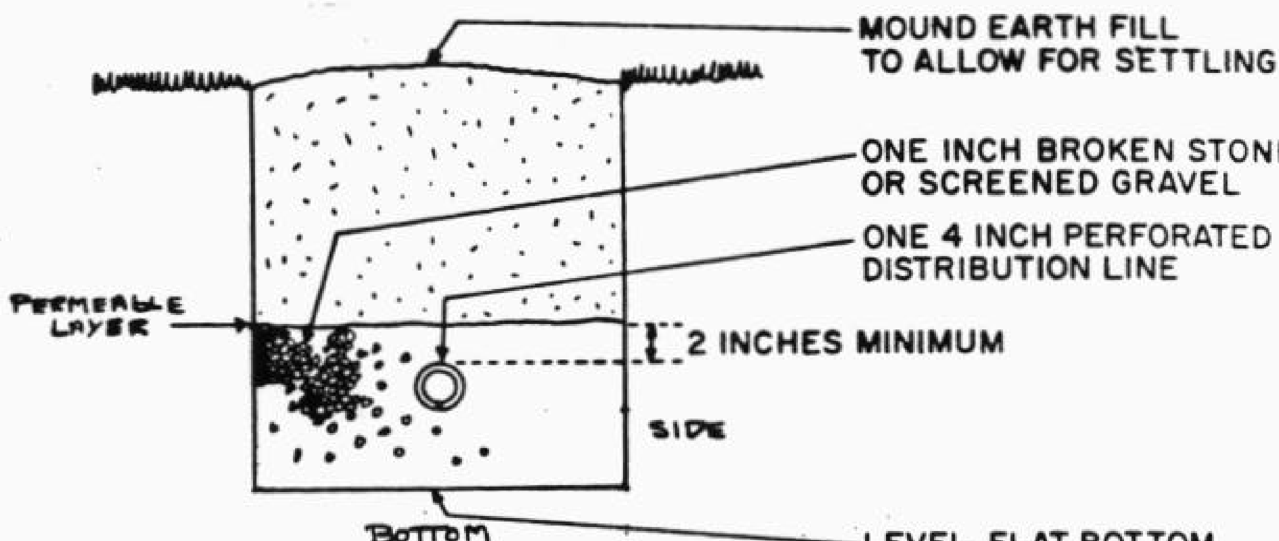


FIGURE I-2 CROSS-SECTION OF DISPOSAL TRENCH

Microbial growth at the soil-water interface occurs within the first two i nches of soil. This growth results in a slime layer which greatly reduces the soil permeability within the zone. The filtration of suspended solids adds to this reduction of the naturally occurring soil permeability. These processes occur on a time scale of weeks while another biological process, the reduction of sulfate to ferrous sulfide, develops over months and years. This latter process can ultimately lead to highly impermeable conditions and to failure of the soil absorption system.

Because of the reduction in the infiltration rate, the maximum percolative capacity of the soil is not maintained. In effect, the larger pores in the soil behind and under the clogged layer no longer transmit water as only the smaller flow channels are needed to carry the Infiltrating water. The movement of water only in the finer pores of a soil is synonymous with unsaturated flow, which is a characteristic of all percolating waters whether from a wastewater disposal trench or from rainfall.

Thus far it has been implied that only the permeability of the slime layer determines the infiltration rate. To a large degree this is true. However, two other related factors are involved in fixing the infiltration rate from a disposal trench. One is the depth of water within the trench and the other is the moisture potential (suction) In the unsaturated zone. Logically the deeper the water is within a trench the greater the downward driving force and the faster the Infiltration rate. The manner by which moisture potential in the unsaturated zone affects the infiltration rate is not as straightforward. At saturation the moisture potential of a soil is zero, however, it increases as the soil water content decreases. In an operating soil absorption system the unsaturated zone is generally at field capacity with a corresponding moisture tension. This suction of water through the relatively impermeable slime layer can be an important factor in establishing acceptable infiltration rates particularly in fine grained soils.

The infiltration rate in a soil absorption system is thus determined by three interdependent factors; 1) permeability of the slime layer, 2) moisture tension in the unsaturated zone, and 3) depth of water in the disposed trench. To work properly the soil absorption system must operate such that these three parameters are in dynamic equilibrium and wastewater does not overflow the

Design Criteria

To design a soil absorption system properly it is clear that some estimates must be made of the long term infiltrative capacity of the soil. Because this infiltrative capacity is highly dependent upon soil particle sizes and their distribution, the method used to predict long term infiltrative capacities must be site specific. In addition, due to the widespread usage of septic tanks and to individual installation, the test must be both simple and inexpensive. The only procedure which meets these requirements is the percolation test. This test simply involves digging or auguring a hole several feet deep, partially filling it with water, and observing the rate at which the water level drops. When standardized this testing procedure has proved to be quite adequate to characterize, the infiltrative capacity of a given site.

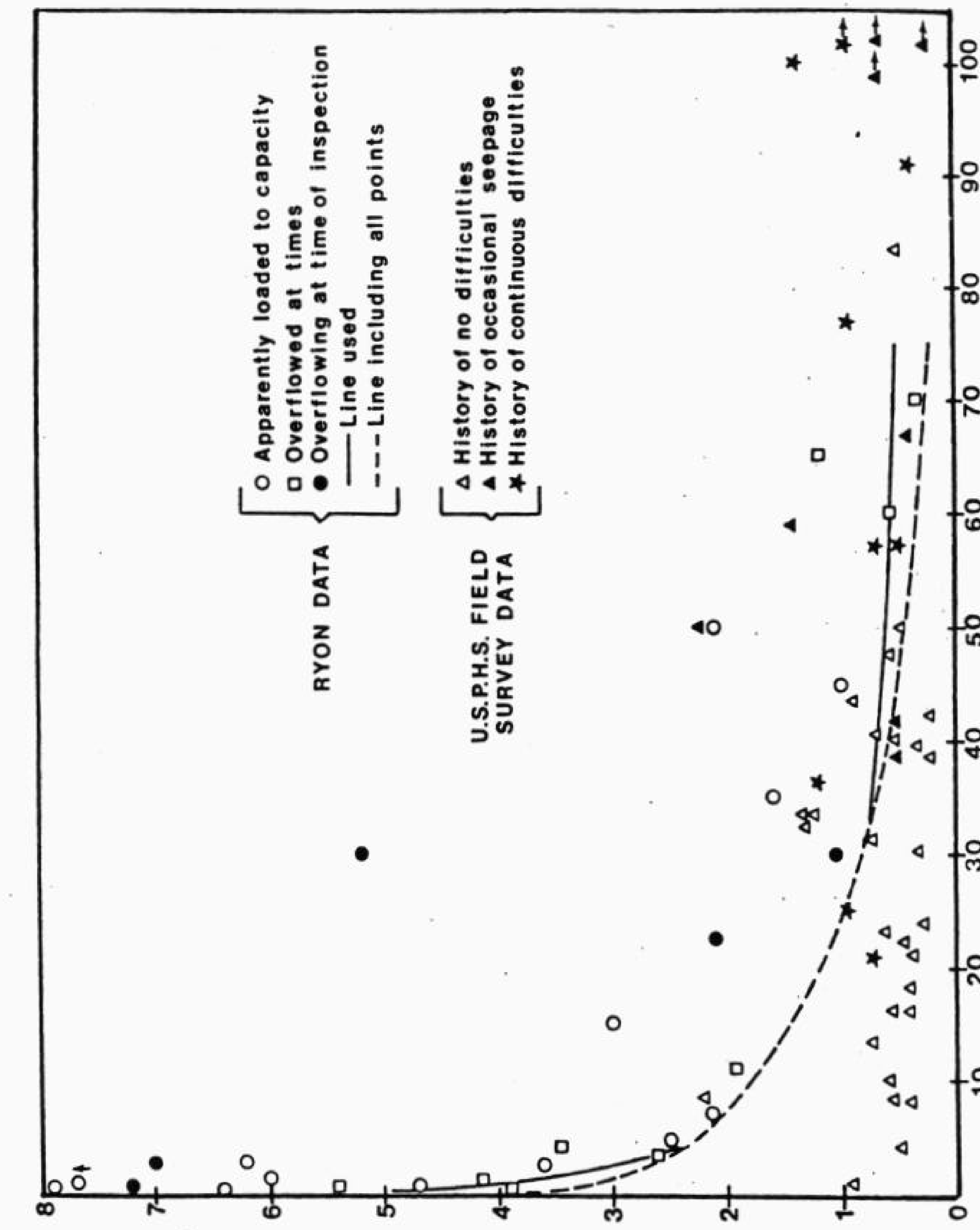
Referring to figure 1 -3, it should be noted that the percolation test provides an estimate of infiltration rates occurring in Phase 1. Therefore, if a standard percolation test is used in sizing a disposal trench, a correlation must be made between Phase 1 infiltration and the long term acceptance rate in Phase 3.

The rapid change in infiltration rates occurring in Phase I shows the need to standardize percolation testing procedures. This will be discussed in more detail in Section III—(l).

The most important work that has drawn a correlation between percolation testing and long term infiltration rates was done in 1926 by Henry Ryon, an engineer with the New York State Engineers office. His results were subsequently verified by the U. S. Public Health Department in 1947-48 (6). Ryon simply went to communities in which soil absorption systems were failing and performed percolation tests at various sites. He also determined the loading rate of each system in terms of gallons per square foot of trench bottom per day. From this information he was able to correlate initial percolation rates with long term acceptance rates. Ryon’s correlation as well as USPHS data are shown in figure 1-4.

This early work of Ryon’s and that of the USPHS imply that the bottom surface of a disposal trench is the important infiltrative surface. As shown in figure 1—2, the soil absorption system has two infiltrative surfaces; the horizontal bottom of the trench and the vertical sidewalls. A significant portion of the literature with respect to soil absorption systems has centered on a discussion of which infiltrative surface is the more significant and which should be used as a basis of design.

FIGURE I-4


RYON DATA
Apparently loaded to capacity
Overflowed at times
Overflowing at time of inspection
Line used
Line including all points
U.S.P.H.S. FIELD SURVEY DATA
History of no difficulties
History of occasional seepage
History of continuous difficulties
TIME FOR WATER SURFACE TO FALL ONE INCH (MINUTES)
SEWAGE LOAD APPLIED (GALLONS/SQ.FT./DAY)
0
1
2
3
4
5
6
7
8
10
20
30
40
50
60
70
80
90
100

In general these researchers have concurred that sidewalls are an effective infiltrative surface. However, recommendations for design run the spectrum from use of only sidewall, to only bottom, to a combination of the two. For example, Winneberger recommends that only sidewalls be used since he has concluded that the bottom surface becomes clogged (3). On the other hand Bauma argues that only bottom should be used particularly in areas in which soils are saturated for extensive periods as lateral moisture tensions are lowered during these periods (12). Finally, Healy and Laak (28) support the use of the total wetted perimeter (bottom plus sidewall surface) based on their concept of long term acceptance rates.

To pursue investigation of this divergence of opinions, let us assume that infiltration is approximately the same for bottom and sidewalls. It would then be possible to make use of Ryon's Correlation by adjusting his bottom loading rate calculations to include sidewalls. Investigation by Winneberger (21) found that the typical disposal trench in Ryon's time was about 1 foot wide and had a gravel depth of 16 inches. This corresponds to an effective infiltrative area of 2.67 square feet per lineal foot of trench. Using this adjustment factor on Ryon's original design curve, figure 1-5 shows a plot of loading rates for the entire infiltrative surface area versus percolation test rates.

The assumption of approximately equal Infiltration rates of bottom and sidewall is not without substantiation as Bauma (12) has shown in field work that infiltration through bottom and sidewalls of disposal trenches are nearly equal. A plot of his data for bottom versus sidewall infiltration rates gives a slope of 0.96 with a correlation coefficient of 0.94. This is highly significant and strong evidence that the assumption is correct.

Further substantiation of the reasonableness of the recommended adjustment of Ryon's design curve comes from the work of various Investigators who have estimated long term infiltration rates of wastewater Into soil systems. The data points shown in figure 1-5 provide a comparison of Ryon's adjusted curve to estimates given by these investigators. Data is taken from infiltration studies of wastewater spreading ponds (3), lysimeter work of McGauhey and Winneberger at SERL (23), and a literature review by Healey and Laak at the University of Connecticut (4).

The fact that Ryon's adjusted curve fits the data of these other Investigations together with the evidence that bottom and sidewall infiltration rates are approximately equal, gives strong credence to the reasonableness of using total Infiltrative area in the design of soil absorption systems and the appropriateness of adjusting Ryon's design curve.

It now appears that a reasonable design curve expressing loading rates vs. percolation rates exists. Howe in applying such a curve it becomes readily apparent that a factor of safety is necessary to prevent lar amounts of ponded wastewater, within the trenches, from coming close to the ground surface. It appe reasonable to keep the ultimate ponding level within the trench at least 6 inches below the top of the gra and ultimately 1.5 feet below the ground surface. This then leads to use of the effective infiltrative surfa Figure 1-6, for design purposes.

The fact that large amounts of ponded wastewater could exist within soil absorption systems also rais number of concerns relative to the public health and potential water quality impacts. In trying to address th concerns one may ask the question: Will designing the soil absorption system at the suggested loading ra provide for long term operation of the system?

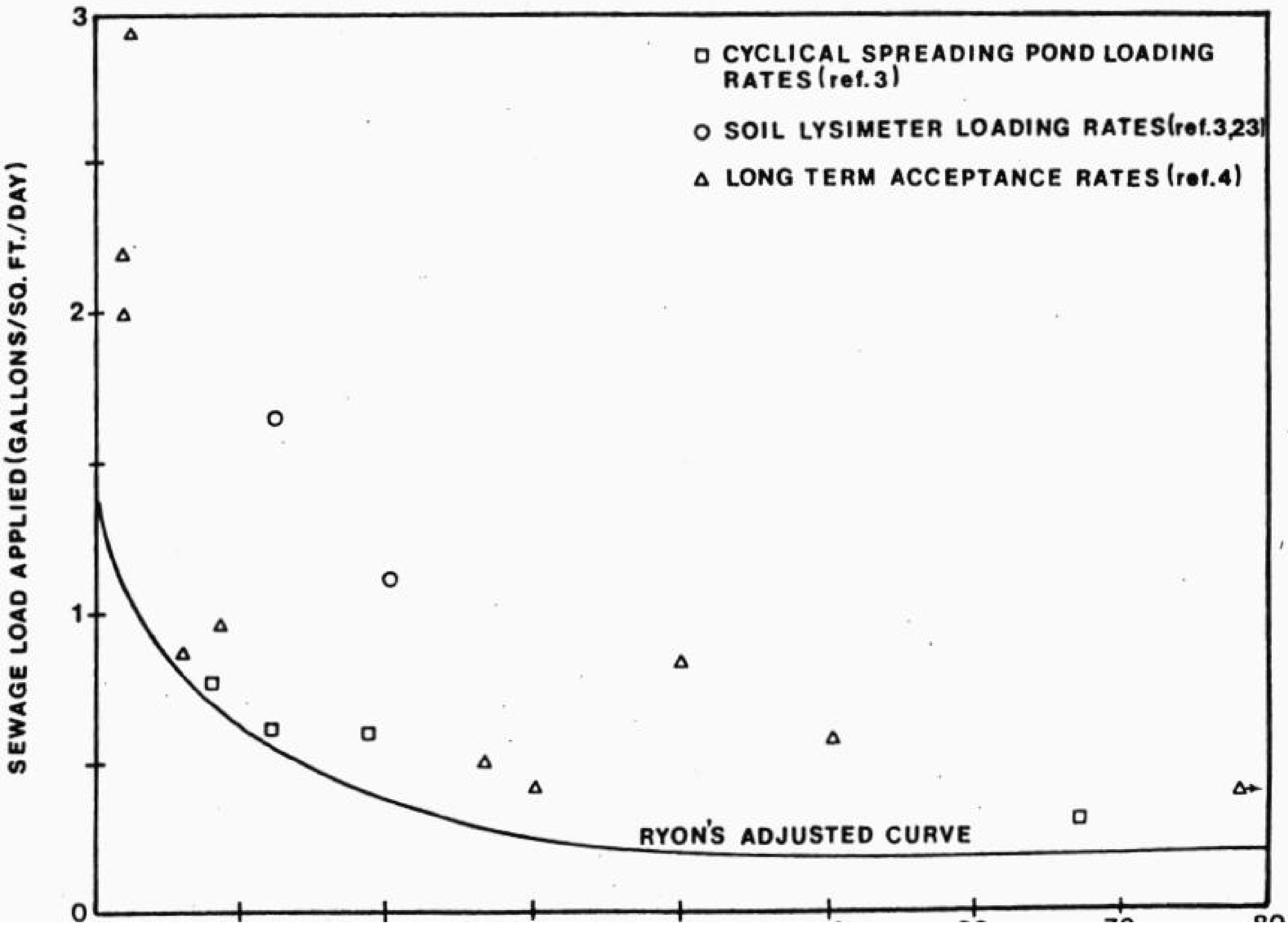
A review of the literature on this subject indicates that system performance is usually expressed in the forr survival curves, showing the percentage of failures of the soil systems in relation to the age of the system studies conducted by the United States Public Health Services (13) the Robert A. Taft Engineering Ce reported the results of numerous detailed surveys of existing septic tank systems in various parts of t county. As indicated by their survival curves, the best survival rate was 70% after 12 years. Along this s line of thinking, Hill and Frink (33) evaluated the longevity of 2,845 septic tank systems within Connecti They found the average half—life to be 27 years. Based on this discussion it appears that there is a finite to continually loaded systems.

At this point one now wonders how to achieve a system that could potentially provide for long term operat A review of the literature indicates that there are two key points which could allow for indefinite operati

(1) System Maintenance; and (.2) Dual Systems

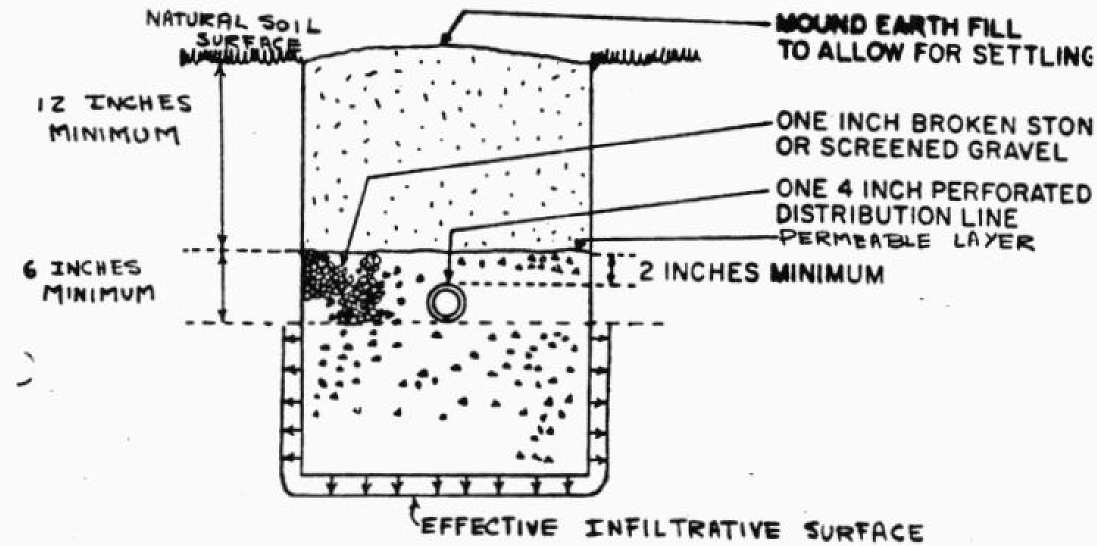
(1) <u>System Maintenance</u>

Although a septic tank can normally function for several years without pumping, the sludge and sc accumulation will eventually build up to a point at which detention time is reduced, suspended solids ineffectively removed and the soil system is clogged to a further degree by carryover of solids. Stud (13) have indicated that removal of accumulated sludge by pumping at intervals of from 3 to 5 ye with wore frequent removal of scum, will normally be required for proper performance., Variation sludge and scum accumulation rates, however, indicate that the pumping period should be establishec system inspections. The concept of system maintenance will be further discussed in section IV



□ CYCLICAL SPREADING POND LOADING RATES (ref. 3)
○ SOIL LYSIMETER LOADING RATES (ref. 3,23)
△ LONG TERM ACCEPTANCE RATES (ref. 4)
RYON'S ADJUSTED CURVE
SEWAGE LOAD APPLIED (GALLONS/SQ. FT./DAY)
3
2
1
0

FIGURE I-6 EFFECTIVE INFILTRATIVE SURFACE



(2) Dual Systems

Most data pertinent to the relation of loading and soil clogging has been developed from studies of surface infiltration ponds. Field observations (3) have led to the conclusion that approximately equal periods of loading and resting are required for surface spreading ponds. The effect of alternate weekly periods of loading and resting of infiltration ponds applying sewage effluent (primary) to Yolo loam at Lodi, California (3) again demonstrated the fact that soil resting (i.e. draining and reestablishment of an aerobic system) will lead to recovery of a large percentage of the soil's original infiltrative capacity. Reestablished infiltrative rates averaged 7 to 10 times the observed equilibrium infiltration rates.

Experiments by McGauhey, et al (3) under anaerobic conditions (continuous soil loading) produced clogging of the type observed in the field. In his work Winneberger discovered that the black layer at the surface of the soil system was due to Ferrous Sulfide precipitated by anaerobic degradation of sulfates and did not represent, as previously assumed, the depth to which the organic matter penetrated the soil. The organic mat itself was found to be confined to a layer of .5 to 1cm as compared to the 5 to 10cm penetration of ferrous sulfide. A key finding of Winneberger's work was that when the soil system was allowed to drain, ferrous sulfide clogging was quickly overcome by the oxidation of sulfide to sulfate In the presence of atmospheric oxygen and that during subsequent loading cycles the soluble sulfate was carried away by the percolating water.

In conclusion, with regard to soil absorption systems, Winneberger et al (23) found resting to be beneficial in restoring the infiltrative capacity. Their findings indicate that partial recovery of the initial infiltrative capacity of a soil does not require drying, but that draining is necessary to reestablish the aerobic system. Full recovery capacity required days rather than hours in the resting cycle, just as observed with surface ponds.

Conclusions

Review of studies on water and sewage spreading on the surface of soils has led to a number of conclusions.

1. Any soil continuously inundated with either fresh water or with sewage effluents exhibits a typical die-away curve of percolation rates with time. (3)

2 The time-percolation rate curve reaches essentially the same steady-state magnitude regardless of whether water or sewage effluent is the percolant (3) and a reduced long term acceptance rate ensues (4).

3. Soon after a septic tank system is put into use, ponding of effluent continues to rise because of decreased Infiltration vertically and horizontally, caused, by the development of a slime layer on the soil surfaces (3).

4. Clogging of a soil is essentially a surface phenomenon and drying and resting of

a spreading ground restores much of its infiltrative capacity (3).

5. The bottom Infiltrative surface area of a soil absorption system is an effective Infiltrative surface, figure 1-6.

6.. The total wetted perimeter of the soil absorption system should be used as the effective infiltrative surface for design.

7. The flow of wastewater effluent through the soil surrounding the soil absorption system is unsaturated (12). Only during extended rainfall events will soils at the effective sidewalls of a disposal trench become saturated.

8. The expected life of the soil system is finite and that It appears this life may be extended through the use of dual systems.

Recommendations

Based on the above conclusions, it is recommended that the following criteria be used as minimum guidelines for the design of soil absorption systems.

(1) Design curve as shown in figure 1-5 (utilizing the wetted perimeter-effective Infiltrative surface figure 1-6).

(2) The ultimate ponded level of wastewater within the trench be kept 6” below top of gravel and that there be a 12” backfill above top of gravel. (i.e. the effective sidewall infiltrative surface does not include the first 6” of gravel, figure 1.6.)

(3) Dual fields be utilized and operated on a 6-12 month cycle.

I-(2) Wastewater Generation

If a soil absorption system is to have an equivalent degree of reliability as a sewerage system it must be designed for the largest potential flow. The number of individuals residing in a specific home and their personal water use habits determine the amount of wastewater generated. Since a number of different families will most probably occupy a given home it has proven most efficient to require that soil absorption systems be designed according to the number of bedrooms in the home.’ A design basis of 150 gallons per day per bedroom as recommended by the Public Health Service (6), has proved satisfactory in practice.

Estimation of flow from public buildings, commercial establishments, and recreational facilities is more difficult to predict. Aids for estimating these flows are included in a number of readily available references (6, 17, 31).

Recommendation

It is recommended that a value of 150 gallons/bedroom/day be used for design of s oil absorption systems. Potential bedrooms should also be considered for design purposes.

I-(3) Drainfield Replacement Area

The probability of disposal field failures requires that provision be made for correction of such failures and/or replacement of the disposal field. An area equivalent to 100% of the initial disposal field should be set aside for this purpose. This area should be so defined and reserved for this specific purpose and all incompatible uses should be permanently prohibited.

Recommendation

Since it was recommended in the section covering absorption capacity of the soil that at a minimum a dual soil absorption system be utilized (i.e. 100% design per side) it does not appear necessary to have any reserve area.

II. CONSTRUCTION TECHNIQUES

II-(l) Construction Techniques

Careful construction is important in obtaining a satisfactory septic tank-soil absorption system. The standardization of septic tank construction requirements and the use of precast concrete septic tanks has essentially eliminated construction caused difficulties with this unit. It is the soil absorption system which is most ‘susceptible to damage through poor construction practices.

Recommendation

The USPHS manual (6) provides a good discussion of construction practices and it is recommended that as a general rule they be followed. However, listed below are the four key points which should be followed in the construction of a soil absorption system.

(1)Surface smearing of the infiltrative surfaces during construction shall be corrected by scarifying the trench walls and bottom after excavation is complete.

(2)Surface runoff shall not be permitted into open trenches during construction to limit siltation of the bottom area.

(3)An effective barrier such as straw or untreated building paper shall be provided to limit the entrance of fines from the soil backfill into the gravel.

(4)Backfill shall be placed so as to maximize surface runoff and not crush drain lines.

II- (2) Construction Inspections

Adequate inspection and control of septic tank system construction Is necessary. Since the system is completely buried, post-construction inspection is meaningless. Therefore, unless the system is inspected during construction, the entire responsibility for acceptable construction practices lies with the contractor. This is unacceptable.

While it is improbable that any one system would suffer from all the construction problems as described in section II-(l), nearly every system is affected to some degree. Adequate inspection during construction will serve to eliminate the worst problems.

Recommendation

It is recommended that every system be inspected during construction by personnel approved by the Health Officer before the system is backfilled.

III. <u>FIELD OBSERVATIONS FOR INSTALLATION</u>

Field Observations

A number of physical site characteristics affect leach field performance. These include soil permeability, depth to groundwater and depth to an Impermeable layer. Land slope and the proximity of an absorption field to wells or surface waters also affect performance. Each of these parameters are unique to a given site and must be measured in the field and evaluated relative to other existing and proposed contiguous developments before a disposal system can be properly designed. The following discussions with respect to each of these site characteristics are intended to provide the basis for recommendation which are made at the end of each section.

III- (l) Percolation Test

In order to determine if a leach field system is appropriate for a given site, some method must be employed to quantitatively measure the percolative capacity of the soil. If conducted carefully by experienced personnel, a standard percolation test will fulfill this need.

As is indicated in figure 1-3, the infiltration rate drops off rapidly when a soil is first wetted. Measurement of the infiltration rate during this initial period can lead to significant overestimates of a soil's percolative capacity. An initial period of wetting is therefore required to bring the soil to the quasi equilibrium point which separates phase 1 and 2 infiltration.

In developing a design curve of wastewater loading versus percolation test rate; Ryon used a standardized percolation testing method very similar to the procedure recommended below. In it a hole diameter of 14 inches is used. Other diameter auger holes significantly alter percolation test results. While we strongly recommend use of a standard test hole, other sizes could be used if a correction factor were incorporated to adjust observed percolation rates to those that would be obtained from a standard 14 inch diameter hole. This adjustment factor is based upon two items 1) The volume of water contained in one vertical inch of the test hole, and 2) the average Infiltration surface area. Also the assumption is made that infiltration rates per unit area are independent of hole diameter. The following equation can then be derived:

$$\text{Adjustment Factor} \quad \frac{T_s}{T_0} = \frac{V_s}{V_0} * \frac{A_o}{A_s}$$

S = subscript for standard test hole
0 = subscript for test hole used (observed)
T = time for water level to drop 1 inch
V= volume of water in 1 vertical inch of the auger hole
A = average infiltrative surface area.

The adjustment factors for various diameter test holes have been calculated using the above equation and our contained in the table below.

Aside from adjusting percolation rates for various hole diameters, adjustments must also be made to percolation rates where recommendation (d) below is utilized. That is, where a pipe and gravel backfill are used to stabilize the test hole in soils that tend to collapse, the water volumes in the vertical inch must be adjusted accordingly. Adjustment factors to account for use of pipe and gravel are also included in the table below.

While at best these adjustment factors are estimates, their use is much better than making no correction for test hole diameters.

Percolation Rate Adjustment Factors

Hole diameter	Adjustment factor for. (hole diameter)	Adjustment factor for hole diameter plus pipe & gravel)
4 inches	2.5	3.61
6 inches	1.8	2.32
12 inches	1.1	l.43
14 inches	1.0	l.24

1) 3 inch O.D. 1/4” perforated pipe
2) 5 inch O.D. 1/4” perforated pipe
3) 10 inch O.D. 1/2” perforated pipe
4) 12 inch O.D. 1/2” perforated pipe

example calculation

If a 6” augured test hole measures 10 mm/inch, this corresponds to a 18 mm/inch standardized per. rate (10 x 1.8 = 18)

Recommendation

It is recommended that a standard percolation test be utilized to measure the percolative capacity of the soil. It is further recommended that the following be the standard percolation test (21).

(a) Percolation tests are to be carried out (in soils in their native state) at the proposed depth of the soil absorption field. Percolation tests may be conducted at the bottom of backhoe or other excavation holes where deeper testing is required by the Health Officer.

(b) Individual tests are to be run in 12” square o r 14” diameter holes dug or bored using hand tools. If power tools are used remove any smeared soil surfaces from the sides of the hole. Although not recommended, where different diameter holes are used, the percolation rate adjustment factors noted above must be used.

(c) Remove loose material from the bottom of the hole and add 2 inches of coarse sand or fine gravel to protect the bottom from scouring.

(d) If soils tend to collapse, place a perforated pipe (at least 12 inches in diameter) in the hole and carefully pack gravel around it between the pipe and the hole wall. Percolation rate adjustment factors noted must be employed when this method is used.

(e) Presoaking will be required in all tests. The water shall be carefully placed within the hole. W ater must be added to at least 8” in depth over the gravel and maintained at this level for at least 4 hours and preferably overnight. If the soil is known to have a low shrink-swell potential (clay content 15% or less) testing may proceed (section F) after the 4 hour presoak. Soils with higher shrink-swell potential are to be tested the following day but within 24 hours of presoaking as follows.

(f) Fill the hole with clean water (no chemical additives) exactly 6 inches above the soil bottom (do not consider gravel). With a float gauge or secure fixed reference and time piece, determine the time for the water to recede exactly 1” or determine the drop of water after exactly 60 minutes which ever takes less time. Refill and repeat the process until subsequent tests indicate a stabilized rate has been obtained (i.e. three consecutive rates are within 10% of each other). Time lapse between test intervals should be minimal (5-10 mm.). Test results should be reported in units of minutes per inch.

(g) At least three percolation tests shall be made in separate test holes spaced over the proposed absorption field. The average of the three tests shall be used for determining the appropriate loading rate from Figure 1-5.

III- (2) Depth to Groundwater and Setback Distances

Proper performance of on-site wastewater disposal systems depends upon the ability of the soil mantle to absorb and purify the wastewater. Two distinctly different phases of travel are involved in the drainage of septic tank leach fields: (1) the movement of percolating water down through the unsaturated zone and (2) the lateral movement of water through saturated soils below the water table. The efficiency of bacterial and viral removals in each of these phases is quite different.

Unsaturated Flow

As noted in section I-i, the presence a. relatively impermeable biological slime layer at the soil/water interface establishes unsaturated flow through the soil mantle. Infiltration becomes a function of the permeability of the slime layer, the moisture potential (suction) in the unsaturated zone, and the head of water in the trench. In order f or the leach field to operate properly these interdependent variables must be in equilibrium such that water does not surface.

High water tables can affect this balance. In areas with a large depth to groundwater, the moisture potential down through the soil column stays constant at a tension corresponding to the field capacity of the soil until the capillary fringe above the water table is encountered. Below this point soil moisture increases to saturation at the water table and correspondingly moisture tensions decrease to zero.

For cases in which the capillary fringe is above the trench bottom, the reduction (n soil moisture tension results in decreased infiltration rates. This can be a problem particularly in fine grained soils where surface tension and capillary action principally control infiltration. In such instances maintenance of the capillary fringe below the trench bottom is very important. Without this provision, wastewater will rise in the trench to compensate for reduced suction. Ultimately, the system may fail with surfacing effluent.

The height of the capillary fringe is dependent on the soil particle size. For example, capillary rise ranges from a fraction of an inch in gravel, to a foot in sand, to several feet in clay. On this basis a minimum depth to groundwater of 2 to 3 feet is necessary to maintain the hydraulic capacity of the soil mantle.

From a hydraulics standpoint, the existence of a water table at the level of the leachfield in porous soils may be quite acceptable. However, the occurrence of a large volume of essentially unpurified septic tank effluent close to the surface of the ground, subject to surfacing under adverse conditions represents a public health hazard. This in itself is cause to require a minimum depth to groundwater.

Of more importance to either hydraulics or close proximity of contaminated water to the land surface is the effectiveness of bacterial & viral removals in the unsaturated zone. There are a number of factors which cause this phenomenon, all of which are related to the fact that flow only occurs in the finer pores.

(1) Flow of liquid in unsaturated soil proceeds at a much slower rate than in saturated soils. These longer detention times allow for substantial bacterial dieoff. For example, time to travel one foot in sandy loam at saturation takes about three hours whereas at field capacity eight days are required.
(2) Flow in only the smaller pore spaces enhances filtration of bacteria whereas many of the larger interstices used in saturated flow would allow organisms to pass through.
(3) Under unsaturated conditions air continues to migrate through the soil profile and thereby maintains, the oxidation processes in the zone which have been noted as being particularly important in bacterial kills. (4) Finally the large ratios of surface area to water volume occurring in the finer interstices increases bacterial and particularly viral adsorption onto soil particles.

A review of the literature shows that for most soils nearly complete bacteria and viral removal occurs in the first 3 to 5 feet of unsaturated soil. Thus, the zone of unsaturation is very important in soil minimizing the travel of pollutants.

The following graph taken from a review article by Romero (5) indicates that soils with particle sizes less than .0.08 mm show nearly complete removals of bacteria in the first several feet of soils. Bacterial removals in soils with particle sizes between 0.08 mm and 0.25 mm are variable, with effective removals occurring in the range of 5 to 20 feet. Soils with particle sizes greater than 0.25 mm do not show effective bacterial removals. Table 111-1 summarizes these travel distances and indicates the approximate percolation test rate which corresponds to each soil particle size. Recommendations with respect to minimum depths to groundwater will be made based on this data.

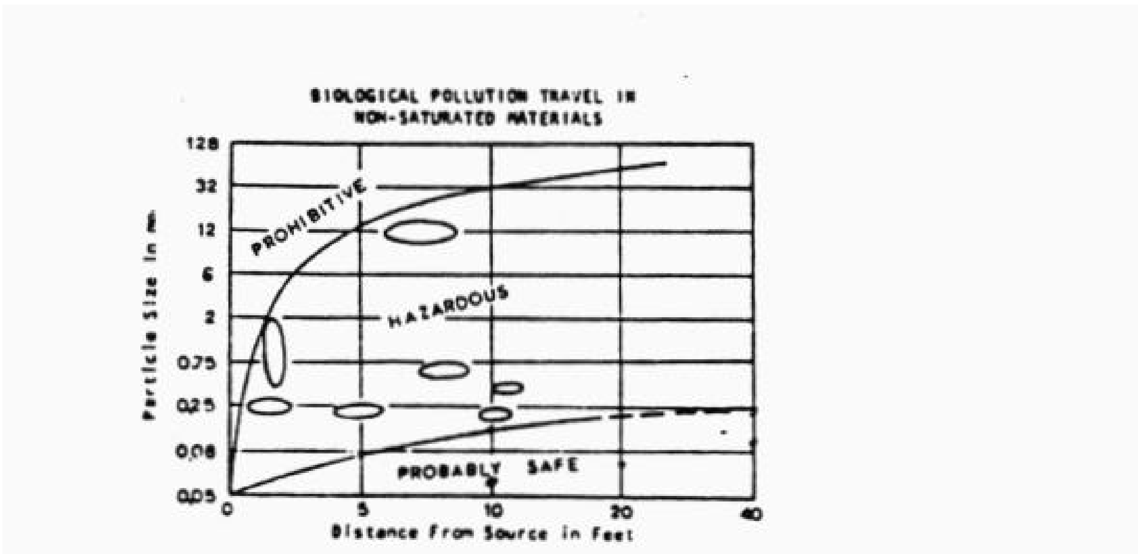


FIGURE 111-1 Biological pollution travel in nonsaturated materials (5).

Table 111-1 GRAIN SIZE AND BIOLOGICAL POLLUTION TRAVEL

Soil Particle Size (effective diameter*)	Travel Distance	Percolation Test Rate
0.08mm	less than 5 ft	5 mm/inch
0.25mm	between 5 and 20 ft	1 mm/inch

*Hazen's effective size is commonly used to characterize soils because it has been shown to be the hydraulically effective size. Hazen observed that the hydraulic resistance of unstratified sand beds was left relatively unaffected by size variation so long as the 10 percentile remained unchanged.

<u>Saturated Flow</u>

Once percolating wastewaters reach the groundwater table flow shifts horizontally. In the saturated phase bacterial end viral removals continue to be effective but to a considerably lesser degree than that possible in unsaturated flow. The distance bacteria travel through the saturated zone has been shown to be proportional to both the physical/chemical characteristics of a soil (filterability) and the initial concentration of organisms (3). Travel has been shown to be limited to less than 100 feet except in areas with coarse sand and gravel or where fissures allow channeled flow. Most septic tank codes, therefore, require a 100 foot separation between leach fields and water wells.

In establishing this setback requirement it was necessary to provide for the protection of public health while at the same time being reasonably fair to the landowner who wishes to have his own source of domestic water. With such a tradeoff there does exist a risk that pathogenic organisms will travel the 100 feet to a water well. To minimize this risk, the unsaturated zone between the leach field and groundwater table is important as the numbers of organisms reaching the groundwater can be greatly reduced if not eliminated in this region. The logic being to minimize the number of organisms reaching the saturated zone and consequently the distance they will travel in lateral groundwater' flows.

Recommendations

Depth to Groundwater

It is recommended that the depth to the highest seasonal elevation of the water table, below the bottom of the leachfield trench, be as given in the following table.

Percolation Test Rate (mm/Inch)	minimum depth (ft) to seasonally high water table
greater than 5	. 3
between 1 and 5	20
less than 1	system prohibited

Setback Distances

It is suggested that the setback distances presented in Table 111-2 be used as minimum standards. It is also suggested that setback distances from foundations, large trees, property boundaries, swimming pools, etc. be consistent with USPHS Recommendations or other distances as determined by the Health Officer.

TABLE 111-2 MINIMUM SETBACK REQUIREMENTS (FEET)

	Septic Tank	Disposal Field
All wells	50	100
All streams and waterbodies*	50	100
resevoirs*	100	200***
cuts or embankments**	10	4h**
Drainage way	50	50

*Distances are as measured from the top edge of streambanks or high water of lakes and reservoirs.

**Distance in feet equals four times the vertical height of the cut or fill bank. Distance is measured from the top edge of the bank. Where an impermeable layer intersects a cut bank the setback shall be 100 feet.

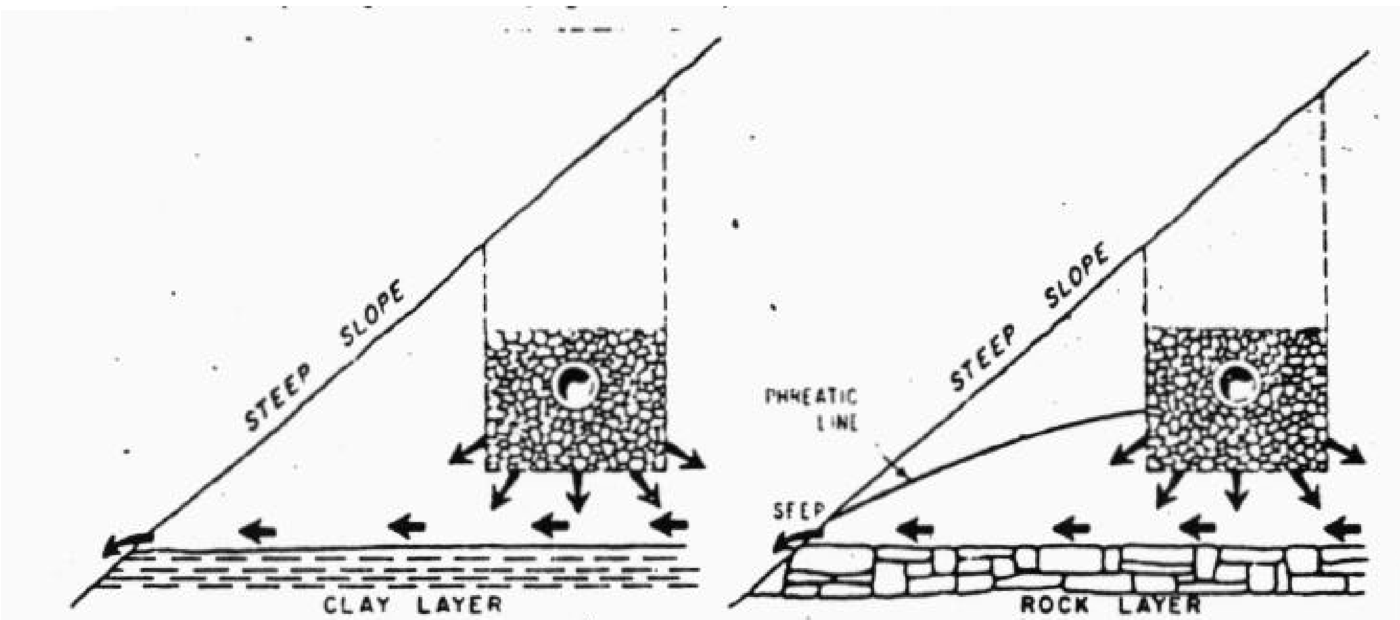
***See requirements for watershed protection.

III-(3) Depth to Impermeable Layer

At least three to five feet of good percolative soil should exist between the bottom of the disposal trench and any impermeable layer to allow for absorption, filtration and movement of the septic tank effluent in such a manner so as not to hinder the operation of the soil absorption system.

Recommendation

It is recommended that there be three to five feet of good percolative soil (1-120 mm/in) below the bottom of the disposal trench.



III- (4) Slope

Excessive slopes affect the initial construction of the soil absorption system and can create a number of serious problems in the subsequent operation and maintenance of the systems. It has been noted (14) that slopes of less than 15 - 20% usually do not create serious problems in either the construction or maintenance of the absorption field provided the soils are otherwise satisfactory. On steeper slopes, controlling the downhill flow of effluent may be a serious problem. Septic tank effluent may surface at the base of the slope creating a public health hazard. This type of situation may develop where an impervious layer exists near the surface and allows effluent to run laterally down the slope to subsequently surface (Figure 111-2)

FIGURE 111-2 A leach field on a steep slope where there is a layer of dense clay, rock, or other impervious material near the surface is unsatisfactory. The effluent will flow above the impervious layer to the hillside soil surface and run unfiltered down the slope (14).

Recommendation

It is recommended that the maximum ground slope not exceed 20%. It is also recommended that the Health Officer be allowed to grant variances on a case-by-case basis where it can be demonstrated through a technical report prepared by a State registered civil engineer or geologist, that use of a soil absorption system will not create a public health hazard, water quality problem or jeopardize contiguous properties.

It is further recommended that the recommendations of the United States Public Health Service Manual (6) (Section - Serial Distribution) be followed in arranging the leachfield trenches.

Where an impermeable layer intersects a c ut bank, effluent may surface at the intersection. To avoid public health and water quality problems, a setback of 100 feet based on bacteriological removals, should be required. This has been incorporated into the footnotes in the setback Table in section III- (2).

IV. OPERATION AND MAINTENANCE

IV- (l) Operation and Maintenance

It has been the experience of the Board that water quality and public health problems can result when soil absorption systems are used in unsuitable areas. Failure of such systems may occur due to use in unsuitable areas, inadequate design, faulty construction or to inadequate operation and maintenance. Adequate local ordinances establishing minimum standards for the control of soil absorption systems should help prevent the first cause of failure. However, relative to the second cause of failure, no matter how well the system is designed and constructed, it cannot be expected to perform satisfactorily unless adequate operation and maintenance is provided. At present, this operation and maintenance is provided by the homeowner. However, homeowner operation and maintenance Is generally inadequate since few owners are concerned with the functioning of the system so long as it is not causing problems. Since the chief source of trouble is failure to have the tank pumped regularly, it is obvious that failures resulting from inadequate operation and maintenance can be easily prevented. However, the question of who provides the adequate operation and maintenance still remains to be answered. Considering that failure of a septic tank soil absorption system creates both a public health hazard and water quality problems, or, at the very least, a public nuisance, it falls, in our opinion, within the public purview to regulate the operation of such systems to insure proper maintenance. In order for such public regulation to provide the desired results, both a qualified staff end a well thought out financing program are necessary.

Recommendation

Assurance that septic tank soil absorption systems are maintained in a satisfactory manner should be the responsibility of the Health Officer. It is recommended that the septic tank - soil absorption system be inspected at a minimum of once every two years. The recommended Inspection frequency is based on the fact that removal of accumulated sludge and scum usually occurs at intervals of from 3 to 5 years, with more frequent removal of scum. However, the variations in sludge and scum accumulation rates indicate that the pumping period should be established by periodic inspections. Therefore the biennial inspection frequency was recommended.

It is also recommended that the Health Officer be given the authority to waive the inspection frequency to not less than once every five years, on a case-by-case basis, where he/she determines that adequate operation and maintenance will be provided through other means (ie. large lots, proof of septic tank pumping etc.).

Finally, it is recommended that the Health Officer developed a program with appropriate staffing and financing to insure proper maintenance.

IV – (2) Septage Disposal

Septic tanks are emptied of excessive accumulations of sludge and scum by suction pumping through a hose into a tank truck affectionately referred to as a “honey wagon.” The pumped contents of the septic tanks has been given the name “Septage.”

Septage is a highly variable anaerobic slurry with characteristics that include large quantities of grit, grease, high offensive odor, the ability to foam, poor settling and dewatering, high solids and organic content, and quite often, an accumulation of heavy metals (32). Given these characteristics it is obvious that the improper disposal of septage can pose both public health and water quality problems. Responsible practice in communities utilizing septic tanks requires adequate planning for proper disposal of septage in order to avoid problems associated with unauthorized and unsupervised disposal.

Existing Disposal Practices

Septage (i.e. Septic tank pumpings) is classified by the California Administrative Code, Section 2521(a), as a Group 2 Waste of Municipal and Industrial Origin. Section 14020 of the California Water Code (CWC) requires all liquid waste haulers to be registered by the State Water Resources Control Board. Section 14040 of the CWC requires that the Regional Board approve sites suitable for the disposal of the different kinds of liquid wastes. Section 2500 - 25010 of the State Health and Safety Code requires the Health Officer to approve pumpers and disposal sites.

At present septage is disposed either at an approved sanitary landfill or a municipal sewage treatment facility capable of accepting such wastes. A list of the landfills within Region 2 which have been approved for accepting such wastes is shown in Table IV-l. Although these sites can accept such wastes, limits are imposed on the total quantity they may accept since septage has a high moisture content. A listing of the municipal sewage treatment facilities accepting septage is shown in Table IV-2. Although the listed facilities are accepting septage at the present time, their ability to accept septage should be checked with the Regional Water Quality Control Board or the municipality as their approval status changes from time to time.

Recommendation

Existing practices appear to be adequate. Therefore, at this time we do not recommend any changes.

TABLE IV-l
APPROVED CLASS II SANITARY LANDFILLS

Contra Costa County

(1) Acme Fill, End of Arthur Road, Martinez, CA

Marin County

(1) Borello Disposal, Pt. Reyes Station, CA
(2) Martinelli Sanitary Landfill Pt. Reyes, CA

Santa Clara County

(1) Mt. View Shoreline Park Mt. View, CA

Alameda County

(1) Eastern Alameda County - Livermore
(2) Turk Island Company - Union City

TABLE VI-2

MUNICIPAL SEWAGE TREATMENT PLANTS ACCEPTING SEPTAGE

Counties

Alameda - None

Contra Costa - Central Contra Costa S.D.

San Mateo - None

Santa Clara - San Jose/Santa Clara, Cities of

Solano - None

Sonoma - Sonoma Valley County S.D.
City of Petaluma

Marin - None

Napa - Napa S.D.
City of St. Helena

IV-(3) Correction of Soil Absorption System failures Trouble Shooting

A systematic method should be employed when trying to determine why the soil absorption system and/or the house plumbing fails to operate properly. A number of problems may be caused by the house plumbing and these should be corrected first. What follows is a list of problems and the most likely cause. Additional information will be found In the USPHS Manual (6).

Type of Problem	Most Likely Cause
Lush growth of grass and/or wet spot(s) in the leach field area.	Leach field located in poorly drained soil or in unsuitable type of soil. Field too small. Field improperly installed. Distribution box tipped so that only part of the field is working. Field partly blocked with solids from septic tank. Roots from trees or large shrubs blocking distribution line(s). Field in area that is too steep, has high water table, or is over impervious soil or ledge rock. One or more distribution lines crushed or tipped out of alignment.
Lush growth of grass and/or wet spot in area of septic tank.	Tank too small. Tank needs cleaning or servicing. Improperly designed tank. Obstruction in outlet to the distribution box needs cleaning. Leach field not operating properly (See above).
Waste Water drains slowly and/or trap. and/or Waste Water back up in drains and/or fixtures.	Obstruction in individual fixture drain from fixtures Obstruction in house sewer. Roof vent stack too small or may be partly blocked with frost in cold weather. Septic tank too small and/or needs cleaning. Leaching field not operating properly (see causes above).
Odor from sewage system in bathroom or laundry.	Roof vent stack too small or partly blocked with frost in cold weather. Seal on the toilet flange cracked or broken. Loss of water In the fixture traps. Roof vent stack too low or in a positions that at certain times the wind can blow down the stack.

As is evident from the above discussion on trouble shooting there are a number of different types of problems or failures. Along with this, there are a number of different causes of the problems. The causes can be broken down into two distinct classes:

(1) Failure due to improper design and or physical site characteristics; and

(2) Failure due to improper construction, maintenance and or operation.

Adequate local ordinances should help prevent the first cause of failure and periodic inspections by local agencies or establishment of maintenance districts should help prevent the second cause.

However, application of this approach to areas with existing soil absorption systems is complicated. For example, systems may have been installed in areas of poor physical site characteristics due to the lack of a proper local ordinance and the systems are now failing. In situations such as this, the most likely solution would be sewering the area. However, costs for such an alternative may prove prohibitive in which case other comparable less costly alternatives should be considered.

Recommendations

The following question usually arises in searching for a comparable less costly alternative: Can alternatives such as evapo-transpiration, mounding, composting, incinerating, and gray-water systems be used to eliminate system failures.

In answer to the above question, it is recommended, depending on the cause of the failure, that such alternative systems should be considered in searching for a solution to septic tank - soil absorption system failure. The final approval to use such systems should, however, be based on the following conditions:

(1) That the Health Officer approve the system pursuant to criteria approved by the Regional Board Executive Officer;

(2) That the Health Officer inform the Regional Board Executive Officer of the proposed system correction; and

(3) That a public entity assume responsibility for inspecting monitoring and enforcing the maintenance of the system.

V. CUMULATIVE IMPACTS & ALTERNATIVE SYSTEMS

V- (l) Mounding of the Groundwater Table

The natural drainage capacity of the underlying geologic material depends on the soil percolative capacity, the depth to the groundwater table (saturated soil), the depth to an impermeable layer, and the hydraulic gradient. The application of septic tank effluent to the soil system will increase the excess water percolating to the groundwater table and a groundwater mound will develop, as figure V-i shows. For example, a given site where the percolative capacity may seen reasonable may have a low gradient and a shallow groundwater table and the groundwater mound may reach the surface. Therefore, the buildup of the groundwater mound in relation to the soil surface should be known.

There are two general cases where the concern of surfacing effluent arises.

(1) Areas with a low density of soil absorption systems; and
(2) Area with a high density of soil absorption systems.

Low Density Areas

In areas where the density of soil absorption systems is relatively low (le. for all intents we are considering a single soil absorption system) the question of surfacing effluent is addressed through the use of trench spacing requirements, depth to groundwater and depth to impermeable layer. From both a treatment & hydraulic point of view we see the need for a minimum depth to groundwater (section 111-2) and a minimum depth to an impermeable layer (section 111-3). The final controlling factor is trench spacing. From a theoretical point of view (3), in an Idealized system, the infiltrative capacity would equal the percolative capacity of the soil and water entering the system on a vertical plane would leave the system through a horizontal plane, as figure V-2 shows. From a practical point of view, trench spacing depends on the ability of the soil column between trenches to remain stable during construction. In septic tank system practice this spacing has traditionally been 6 ft. on center. This fact can be shown by reviewing existing county practices, section VI.

Recommendation

It is recommended that the minimum trench spacing be calculated as twice the effective depth of the sidewall Infiltrative surface, as figure V.2 shows. This recommendation is also in general agreement with the USPHS recommendations.

FIGURE V-1 GROUNDWATER MOUND

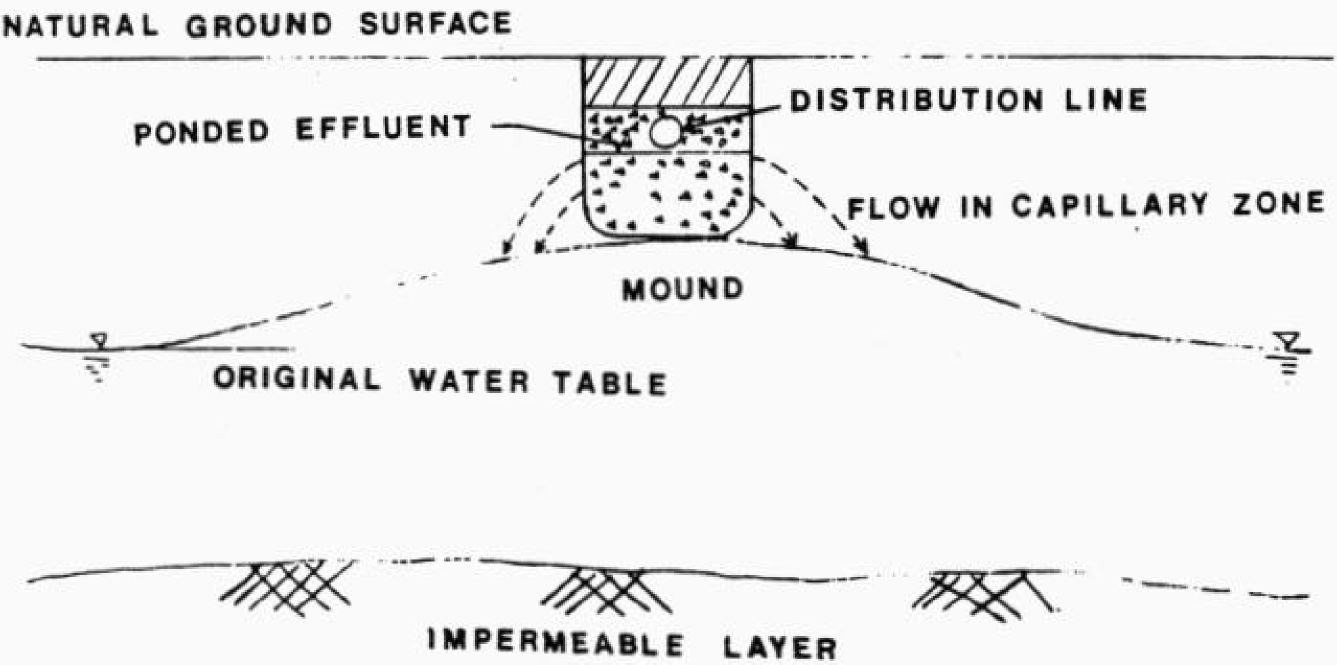
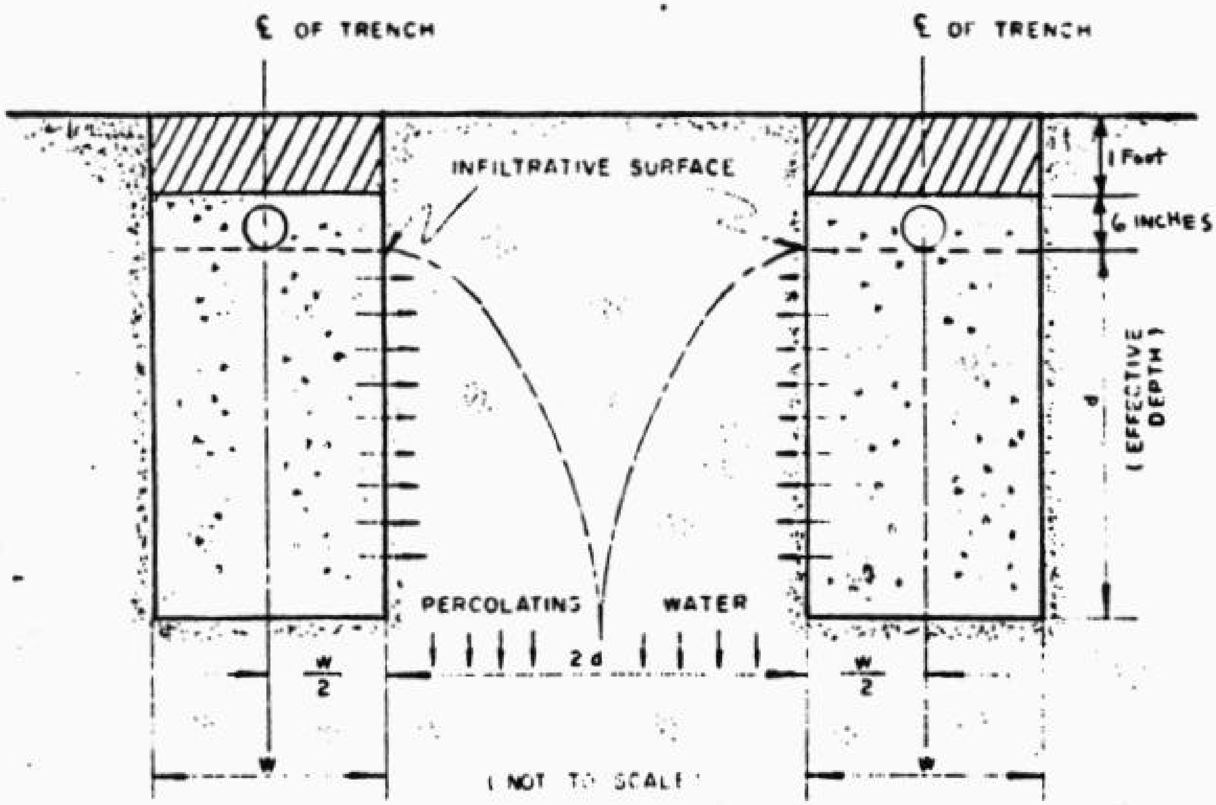


FIGURE V-2 SPACING OF TRENCHES



High Density Areas

In areas where the ultimate density of soil absorption systems is such that adverse impacts on water quality and/or public health might occur the need for an assessment of the cumulative impacts of these discharges arises. An approach to identifying candidate assessment areas as well as an approach for conducting these assessments is presented in Appendix D. The requirements of trench spacing, depth to groundwater and depth to an impermeable layer still apply.

V- (2) Lot Size Requirements

As shown by the comparison of county codes made in section VI all but one county requires a minimum lot size or presents a relationship between landslope and minimum lot size. This type of approach may be appropriate from the stand point of zoning or residential questions but such an approach is not appropriate from the stand point of determining allowable ultimate densities of soil absorption systems. A more suitable approach is to evaluate the affect or cumulative impacts of soil absorption systems on local groundwater, surface water resources and on the publics' health and thereby establish an allowable upper limit on the number of systems. This type of approach was suggested in section V-i covering mounding of the groundwater table. Further details are presented in Appendix B.

V-(3) Watershed Protection

Where septic tank systems are proposed for these lands, the potential hazard to a public water supply justifies the adoption of more stringent design criteria. Although the factors involved are highly variable and not amenable to precise definition, it is possible to establish criteria which are sufficiently conservative to justify their use in this situation (13). Of importance is the assurance that septic tank effluent will travel a sufficient distance through the soil mantel, over a long time, in order to eliminate any significant danger of reservoir contamination, that the capacity of the soil system is not overburdened by the number of soil absorption systems and that a public agency is responsible for the operation and maintenance of all the systems.

Assurance that the first concern is adequately controlled is covered by the recommendations of section 111-2 "Depth to Groundwater and Setback Distances."

Assurance that the second concern is adequately controlled can be given by conducting a cumulative impact assessment.

Recommendation

It is recommended that the cumulative impact assessment approach (Appendix B) be used in watershed areas which are susceptible to development proposing to utilize soil absorption systems.

V- (4) Cesspools and Drainage Wells

Cesspools are covered open-joint walled pits dug into the soil. Cesspools receive raw sewage from which solids settle to the bottom and undergo anaerobic decomposition. The liquid portion of the sewage seeps out through the walls of the pit. These pits require deep porous soils to provide sufficient absorption area. However, deep soils with deeper water tables or impermeable layers are rare occurrences.

The use of wells for the purpose of disposing of effluent from septic tanks or for disposing of surface. runoff from streets or highways was disapproved by the Regional Board in its Resolution No. 81 (Appendix C).

Recommendation

It is recommended that cesspools be prohibited since they provide inadequate treatment and questionable disposal of wastewater.

V- (5) Holding Tanks

Holding tanks are sealed tanks to which sewage is piped and retained. A truck equipped with a pump empties the holding tank and hauls the contents to a treatment plant or a land disposal site.

The holding tank concept originated as a temporary means of sewage disposal pending the Installation of public sewers, however, the concept has been considered for allowing development to take place in areas unsuitable for septic tank leachfield systems.

Holding tanks require regular service and maintenance to prevent their malfunction and overflow. The yearly cost for maintenance alone for a family of four ranges from $1,200 to 2,000. If a holding tank is used as a temporary facility and the sewerage facilities are not implemented then the homeowner is faced with and extremely high cost for waste disposal.

Recommendation

In view of the potential problems that could arise from the use of such systems It is recommended that holding tanks be prohibited from use.

Exceptions to this prohibition may be granted by the Health Officer:

(1) If it is necessary to use a holding tank in abating a. nuisance and health hazard.

(2) If an area is within a sewering agency, sewers are under or proposed for early construction, there is capacity at the wastewater treatment plant, the sewering agency assumes responsibility for maintenance of the tank and contracts have been let.

Where exceptions are granted, the Health Officer must also approve the tank pumper.

V- (6) Alternative Systems

Since large portions of the Bay Area have soils with severe soil limitations and therefore are not suitable for the Installation of conventional subsurface sewage disposal systems, a number of alternative systems are being proposed to allow for development. For a discussion of the various alternative systems being proposed one should refer to the State Water Resources Guidance Manual for Rural Areas (26). Whether or not any of these systems will be acceptable for a given application will depend upon the specific system proposal and specific soil and geohydrological characteristics of the proposed site. It should be kept in mind, however, that there are many sites where no individual sewage disposal system may be acceptable.

Recommendation

It is recommended that the Regional Board allow for the use of a1ternative systems under the following program:

(1) The Regional Board Executive Officer may authorize the Health Officer to approve alternative systems when all of the following conditions are met:

(a) Where the Health Officer has approved the system pursuant to criteria approved by the Regional Board Executive Officer;

(b) Where the Health Officer has informed the Regional Board Executive Officer of the proposal to use the alternative system and the finding made in (a) above; and

(c) Where a public entity assumes responsibility for the inspection, monitoring and enforcing the maintenance of the system through:

1. Provision of the commitment and the necessary legal powers to inspect, monitor, and when necessary to abate/repair the system; and

2. Provision of a program for funding to accomplish 1 above.

VI COMPARISON WITH COUNTY CODES

VI- (1) Comparison of County Codes with Staff Recommendations

Table Vii presents a comparison of existing county code requirements with those recommended by the staff as well as those recommended by the United States Public Health Service. The following conclusions of the key requirement elements of concern can be drawn from the comparison made in Table Vii. There are also a number of minor differences in some of the other requirement elements. However, discussion of these has not been included since it is expected they can be easily handled.

As pointed out in the introduction, the recommended guidelines represent minimum criteria generally acceptable for the use of Individual waste disposal systems. Adherence to these guidelines does not guarantee acceptable operation of a system and the guidelines do not preclude a local agency from adopting and enforcing more stringent regulations.

Percolation Test

None of the procedures are standardized. Changes are necessary in all existing codes to standardize the test.

Drainfield Requirements

One key point evident from review of Table VI-l Is the fact that four out of eight counties either require or strongly recommend the use of a dual system (alternating fields).

Table VI-2 has been developed to provide a comparison between the staff recommendations and existing practices within the counties of the Bay Area. In order to compare the design requirements on a fairly uniform basis a three bedroom home in a soil with a percolation rate of 10 mm/In was utilized. The different trench design requirements for each county make exact comparisons difficult, but, relative comparisons between the different code requirements can adequately be shown.

Table VI-2 indicates that when reviewing County codes on the basis of Total Square Footage of Infiltrative Area required (this includes reserve area), all county codes require equal or greater square footage staff recommendations. However, following the staff recommendations for use of dual fields and design based on both bottom and side infiltrative areas, may require a number of changes In existing codes.

Inspection and Maintenance

As shown within Table VII, only Mann and Solano counties require Inspection of the system on a continual basis. We consider the lack of such an inspection program a major weakness of the county codes. The staff recommendation for inspection on a biennial basis requires modification of a majority of the Bay Area county codes. However, without such a program health hazards, nuisance conditions and water quality problems will continue to prevail and hamper the suitable use of Individual wastewater treatment and disposal systems.

37A

COMPARISON OF SEPTIC TANK SYSTEM REQUIREMENTS IN THE BAY AREA,
STAFF RECOMMENDATIONS AND USPHS RECOMMENDATIONS

REQUIREMENT ELEMENTS \ AGENCIES	REGIONAL BOARD MINIMUM GUIDELINES	ALAMEDA COUNTY	CONTRA COSTA CO. (1)	MARIN COUNTY	NAPA COUNTY	SAN MATEO COUNTY	SANTA CLARA CO.	SOLANO COUNTY	SONOMA COUNTY (1)
● PERCOLATION TEST REQ'S									
Hole width, in inches	12"square 14" dia.	at least 12, in dia.	4 to 12	at least 6	6, in dia. in dia.	1 sq. ft. 12, in dia	12 in dia	4 to 12	6 to 8
Digging Method Digging Method	dig or bore, scratch surface	scratch surface	scratch surface	6" auger, scratch surface	dig or bore scratch surface	dig or bore scratch surface	- -	dig or bore scratch surface	dig or bore scratch surface
Number of test holes	3	5/parcel (15'-40' apart)	1/parcel in subdiv. 1+ parcel on bldg.	3 at two different locations	1/parcel in subdiv., 6/parcel on bldg.	2/parcel	- -	3/parcel	3 parcel minimum
Measurement tool	Float gauge & time piece	tape to 1/8" rechecked	-	yard stick or equiv.	stick	stick	–	stick	metal tape
Presoaking time	<15% Clay-no presoaking ≥15%-overnight	at least 24 hrs. continuously	4 hrs. to overnight	4 hrs. to 24 hrs.	4 hrs. to overnight	4 hrs. to overnight	overnight	4 hrs. to overnight	day before
Depth of hole	depends on depth of absorb. system	3½ - 5 ft.	to bottom of absorb. device	4 ft.	depends on depth of absorb field	5 ft. min.	5 Ft. Min.	depends on depth of absorb. dev	12" below pipe (min.) varies w/ slope
Presoaking water depth	8 inches over gravel	-	-	12 inches	12 in. over over gravel minimum	12 in. over gravel minimum	10 in from top	12 in. over gravel minimum	simulate operating conditions
Water level maintained	6 in. over bottom	6-12 in. over gravel	6 in. over gravel	12" over 2" gravel	approx. 6" over gravel	6" over 2" gravel	-	approx. 6" over gravel	3-12" over over gravel
● SOIL PROFILE HOLES (WAIVER)	(NO)	-	-	(YES)	-	-	-	-	-
Number of test holes	1/system	at least 1	-	1 (min.)	at least 1	1/parcel	-	-	at least 1
General Requirements	–	-	mat'l separated & inspected by health dept	required on discretion of health dept	dug by backhoe	-	-	-	-
Depth of Holes		8 feet	-	8 feet	8 ft. min.	132 inches	-	-	8 ft. min.
Information Collected	depth of hard pan & ground water	depth of ground water	-	-	-	depth of hard pan & ground water	-	-	depth of ground water & impervious rock
● MINIMUM SETBACK REQ'S. (Waivers)	(NO)			(YES)	(YES)	-	-	-	-
Septic tanks to:									
Buildings	USPHS	10	-	5	5	5	-	0	5
Adjoining Property	USPHS	10	5	5	5 (usually)	10	10	10	8
Wells	50 -	50	50	100	100	50 -	-	100-public 50-private	100
Natural water	All water bodies 50: Reservoirs-[illegible]	50	50	25	25 (200 if watershed)			50-lake 50-flowing	100-lake 100-flowing

	RWQCB	Alameda	CCC	Marin	Napa	San Mateo	Santa Clara	Solano	Sonoma	HEW Manual
Natural water courses	All Water Courses -50; Reservoirs-100	50	50	25	[illegible] watershed)			50-flowing 25-ephemeral	100-flowing 50-ephemeral	50
Cuts or embankments	10	See other	50	25	5 (200 if watershed)	20	-	10	-	50
Swimming pools	-	10 (rev.)	-	10	5	25	-	10	-	-
Water Lines	USPHS	5	10	10	5	-	-	10	5	10-varies
Walks and drives	-	-	5	5	10	can be under occasionally	-	0	-	-
Foundations	USPHS	-	10	-	5	5	5	-	-	5
Large trees	-	10	10	-	-	-	-	-	10	-
Other	-	5-disposal	-	-	5-disposal	-	-	0-easement	5-disposal field & distrib. box	-
Drainfields to										
Buildings	USPHS	10	-	10 (varies)	10 (varies)	5	-	0	8	20
Adjoining property	USPHS	10	5	5	10	10	10	25	5	5
Wells	100	100	50	100	100	75	100 (usually	100	100	100(min)
Natural water courses	All water bodies -100 Reservoirs-200	50	50	100	100 (200 if watershed)	20	100 (usually	200-lake 100-flowing 50-ephemeral	100-lake 100-flowing 50-ephemeral	50
Cuts or embankments	4 h	25 (rev.)	50	75	25 (200 if watershed)	20	50 (usually)	4xht. of cut		-
Swimming pools	-	25 (rev.)	-	25	25	20	-	-	-	-
Water lines	USPHS	10 (rev.)	10	10	10	-	-	25	5	25
Walks and drives	-	-	5	5	10	0	0	0	-	-
Foundations	USPHS	-	10	-	10	5	10	-	-	20
Large trees	USPHS	+4 (varies)	10	-	-	-	-	-	10	if within 10' 12" of gravel under tile
Other	-	5-distribution box, 4-disp. field, 5-seep. pit	5-septic tank	-	8-disposal field	-	-	0-easement	6-distribution box 15-Fill areas	-
• **DRAINFIELD REQ'S** (Waiver)	(no)	-	-	(YES)	(YES)	-	-	-	-	-
Max Trench Length (feet)	USPHS	100 (rev.)	-	-	Min. 50 100	-	-	-	-	100
Minimum percolation rate in inches/hour	.5	1.0	1.5 to 2.0 (varies with lot size)	0.5	1.0	0.75	-	1.0	1.0	1.0
Trench width, in inches	-	18-minimum 36-maximum	18	18	12-minimum	18-minimum 24-maximum	24-minimum	12-minimum 36-maximum	24-standard	12-36
Minimum spacing between trenches, in feet	2 times effective depth	4 + 2/foot below bottom of drainline 6' to center	10	-	6 or 2 times depth	2 times the depth 15 between trenches	8-level 12-hillside	6	8-typical center to center	6 between excavations if serial dist.
Drain rock	USPHS	rock	stone, slag or gravel	rock	stone, slag or gravel	rock or gravel	rock	rock	rock	rock/gravel
Drain rock mat'l size in(in)	USPHS	3/4-2 1/2	1-1 1/2	3/4-1 1/2	3/4-1 1/2	3/4-1 1/2	1-2	-	3/4-2 1/2	1/2-2 1/2
Barrier needed (pervious)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Soil backfill depth, in(in)	12	12-minimum 18-preferred	18	12	12-18	12-18	-	12-minimum	18-recommend	12, if serial
Min. depth of soil in the drainfield area, in feet	4' below trench	8-below surface	-	4-below surface	3-below trench	3-below trench	-	5-below trench (varies)	1-below trench (varies)	4-below trench
* varies with slope	-	no	-	no	no	no	-	no	no	no
Min. depth of ground water in the drainfield area, in feet	3-highest level below trench	5 below trench 8-below surface	4-highest level; below surface	3-highest levels below trench	3-highest levels below	3-highest levels below tiles	-	5 mean level below surface (varies)	1 highest level; below trench	4 - max. height below trench

	trench	surface				tiles		(varies)		
* vari.	varies with particle size	-	-	-	-	-	-	no	yes	
Drainfield replacement area required, in % of initial	o	100 (installed)	100	100	100	100	100	100	100	100 usually
Description of infiltrative surface requirements	wetted perimeter 95-682 sq. ft./ bedroom	70-330 sq. ft. of bottom area/ bedroom min 200	60-180 linear ft. trench per bedroom	600 sq. ft. per capita (or 112 lin. ft./bedrm. if 2'8" deep)	190-600 sq. ft./bedrm. 225 ft.^{2} per system min.	range from 1960-5040 sq.ft.(3 bedrooms)	decision of health dept. min. 125 ft. of trench	8000-1.000 sq.ft. of usable disposable area	0-165 lin. t./bedrm. if 3' deep with 12" gravel below pipe	trench bottom ar ... 70-330 sq. ft. pe bedroo
Dosing/Alternating (time, mo.)	-/yes (6-12)	-/yes (6-12)		-/yes(3)		-/yes			-/yes	
Max. percent slope, Field in %	20-waiver	25	20	Allow for reduction	See lot size requirements	50 max 20 w/o rept.	-	25	20% need Geol.rept.	50
• SEPTIC TANK REQ'S	USPHS									
Minimum size		1015 gal.	750 gal.	1200 gal.	1200 gal.	1500 gal.	700 gal.	750 gal.	810 gal.	750 ga..
Depends on bedrooms		yes	yes	yes	yes	yes	-	yes	yes	yes
Material specified Material specified		redwood, rein. concrete block or concrete w/bituminous coat.; fiberglass	not corrosive	concrete or synthetic; no wood	if concrete must have bituminous coating	concrete with bituminous coating	concrete or redwood	water tight and not subject to excessive corrosion	concrete	corrosion resistant and water tight; may be concrete if plaster coated
Compartmentation Rec.				Yes	Yes	Yes	Yes			Yes
• DISTRIBUTION SYSTEM REQUIREMENTS										
Box required	no	yes	not required	-	no	no	no	no	yes	no
Pipe size to field	-	4" min dia	4" min dia	4" min dia		4" min dia	-	-	-	-
Pipe material to field	-	vitrified clay, cast iron or plastic	not corrosive	-	-	-	-	-	-	-
Pipe size in field	-	4"	4" min dia	4" min dia	approx.4-5"	4" min dia	4"min dia	approx.4-5"	3-4" dia.	4"
Pipe placement in field	-	level, 24" from bottom; 2" from top	in filter	2" from top	2" from top; 12" from bottom	2" rock above	12" from top; 6" from bottom	2" from top; 6" from bottom	2" from top	6" from bottom; 2" from top
Serial distribution	USPHS	-	on both slopes and flat areas	on both slopes and flat areas	yes	recommended	typical hillside	recommended	yes	both slopes and flat areas
Parallel distribution	-	-	prohibited	prohibited	prohibited	-	typical flat	-	typical	-
• LOT SIZE REQUIRED (WAIVER)	-	-		(Yes)	-	-	-	-	-	-
Minimum	-	40,000 sq.ft.	10,000 sq.ft.	1 acre	1 acre	varies	varies	5 acres	-	-
Size dependent on	depends on cumulative impact assessments	-	increases to 1 acre if on well	design in - formation and slope 5%-1 acre 5-10%-1.25 10-20%-1.5	1 acre if to sewer in 5 years; 1-20%-1 ac. 2-050%-1-5 50%-5 ac.	geology, percolation rate, bldg. location, and available space	-	2½ acres if on public water supply	-	-
• OTHER DESIGN AND CONSTRUCTION REQ'S	-	minimum 15' horizontal distance to surface on slopes, no cuts or fills >18" ...	no slides, no 10-year floods, field almost flat, no hardpan	no springs, no fissures, no unstable slopes, no public hazard, dual fields	refers to 1976 UBC	no flooding, flat field, dual fields, requires a geotechnical report on slope	-	-	stable slopes, abandonment requirements wet weather percolation tests,	recommends soils and geologic information be used in determining min. stan-

[illegible]	-	[illegible]distance to surface on slopes, no cuts or fills >18", stable material, & uses 1973 UBC	floors, field almost flat, no hard-pan	no unstable slopes, no public hazard, dual fields		dual fields, requires a geotechnical report on slope stability, no fields in filled land	-	-	abandonment requirements wet weather percolation tests, allows curtain drains	[illegible] geologic information be used in determining min. standards; abandonment standards
● INSPECTION AND MAINTENANCE	inspection once during construction; & every two years	inspected: after installed & after connected	inspected: after excavated after installed (before backfilled)	inspected: after completion & every 2 yrs for systems installed since 1971	inspection depends on systems; varies with the individual lot	inspected: on day of excavation	-	inspected: after completed & every 5 yrs unless lot is larger than 10 ac.	inspected: after construction is complete	inspected: after constructed but before soil backfilled

(1) being revised
(2) adapted from reference (16)

DESIGN COMPARISON OF INFILTRATIVE SURFACE

TABLE VI-2

Agency / Design (1)	ALAMEDA *	SOLANO	NAPA	SAN MATEO	REGIONAL BOARD STAFF RECOMMENDATIONS	CONTRA COSTA	MARIN STANDARD	MARIN DUAL	SANTA CLARA
Ft^2 required extra available Total (initial installation)	496 (bottom) 825 (side) 1321 (single field)	(2)	750 (side) 84-250 (bottom) 834-1000 (single field)	1820 (side) 210 (bottom) 2030 (Dual system) 1015/side	703 (bottom & side) 201 (reserve side) 904 /side 2X904=1808 (Dual System)	990 (bottom) 2129 (side) 3029 (single field)	1800 (side) 1620 (bottom) 3420	1350 (side) 608 (bottom) 1958 979/side	1000 (bottom) 1665 (side) 2665
Total Ft^2 (including reserve Area)	2X1321=2642	(2)	2(834-1000)= 1668-2000	2X2030= 4060	1808 (4)	2X3029= 6058	2X3420= 6840	2X1958= 3916	2X2665= 5330

Agency / Design (1)	SONOMA STANDARD	SONOMA DUAL	RECOMMENDED REVISIONS TO SONOMA CODE
Ft^2 required extra available Total (initial installation)	360 540 900	540 810 1350 675/side	(350/side) 2 = 750 bottom plus = 700 reserve side 1450 (Dual System) 725/side
Total Ft^2 (including reserve area)	2X900= 1800	2X1350= 2700	2X1450=2900

Example Calculation: Alameda*

- Code requires design using bottom area, therefore, sidewall area can be considered extra available infiltrative area. This allows for a relative comparison to be made between Regional Board staff recommendations which are based on both sidewall and bottom area.
- Alameda Code requires 165 sq. ft. bottom area per bedroom, therefore, 3 bedrooms X 165 equals 495 sq. ft. bottom area.
- Alameda Code allows the trench width to be 36", therefore, there is 3 sq. ft./ft. of trench of bottom area available which equals (496/3) 165 ft. of trench.
- Alameda code requires 30" of drain rock, therefore, there is 5 sq. ft./ft. of trench of sidewall available or (5 X 165) 825 sq. ft. of sidewall infiltrative surface.

(1) Assumptions:

- 3 bedroom home
- Field percolation rate of 10/min/in
- 150 gallons/bedroom/day of wastewater
- 12" backfill

(2) Discretion of Health Officer

(3) Based on 400 gallons/home

(4) Reserve area is not required where a dual system is used.