EPIC LEACH SYSTEMS

"A Matter Of Choice"

Jonas Z. Sipaila,C.E.M.
Senior Public Health Sanitarian

PATENTED PROPRIETARY INFORMATION FOR REGULATORS AND INSTALLERS OF INDIVIDUAL HOME SEWAGE DISPOSAL SYSTEMS

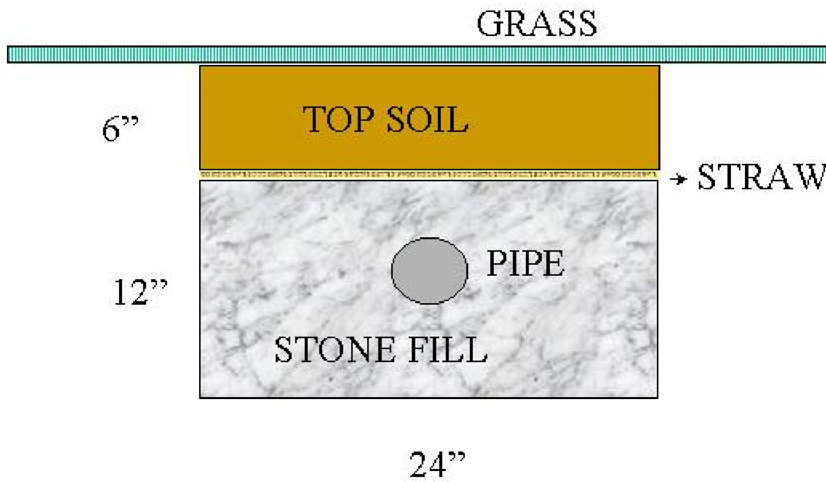
CONVENTIONAL LEACH LINE , PERSPECTIVE AND DYNAMICS

As a result of acceptable initial reliability, plus statutory “encouragement” through sanitation regulations, the design specifications for leach lines has changed very little over the past sixty years, apart from occasional variations in physical dimensions and structural components. A trench is dug, and then partly filled with stone. A perforated pipe is laid on top of the stone, which is then covered by additional stone. A semi-permeable membrane such as building paper or a layer of straw is placed over the stones, followed by a topping layer of soil.

A typical leach line is twenty-four inches in width and eighteen inches in depth. While seemingly quite shallow, at eighteen inches, sufficient oxygen is expected to be present in the native soil to support aerobic microorganism decomposition. Such organisms and processes are considerably more efficient in breaking down the semi-solid sewage materials than is the decomposition that occurs in a deeper, anearobic (no oxygen) environment. In addition, most homogenous soils are also less permeable to water as the soil depth increases. The increasingly compressed soil structure at soil depths results in slower rates of water flow through the soil, and less efficient dispersal of the sewage effluent along the leach line.

In addition to providing support for the distribution pipe, the stone fill in the leaching trenches was expected to increase the effective decomposition surface area and create effluent storage volume within the trench. At three-quarter inch to one-and-a-half inches in diameter, “Number 2” stone provided a sufficient number and size of void space to efficiently retain and distribute the sewage effluent throughout the leach line. One cubic foot of #2 stone provides a maximum of 3.25 gallons or 43% of the available storage volume for sewage effluent. For a typical twenty-four inch wide by fifty-foot long leach line, this results in aproximately 6.5 gallons per foot, or 325 gallons of effluent storage volume. In addition to providing capacity for surges in liquid flow, this pore void volume is also expected to enhance the effective area for fluid dispersion at the soil-stone interface.

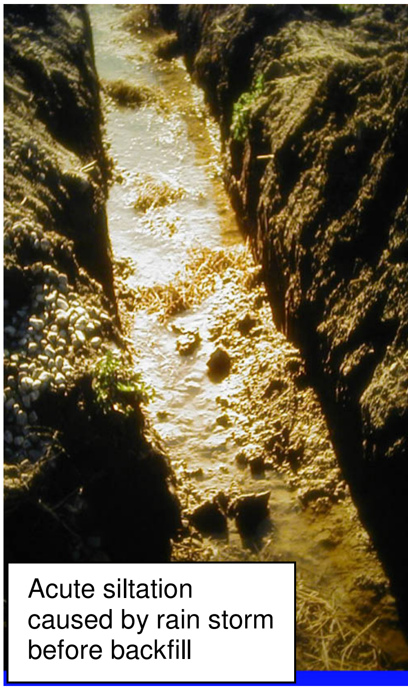
Conventional Leach Line Cross Section

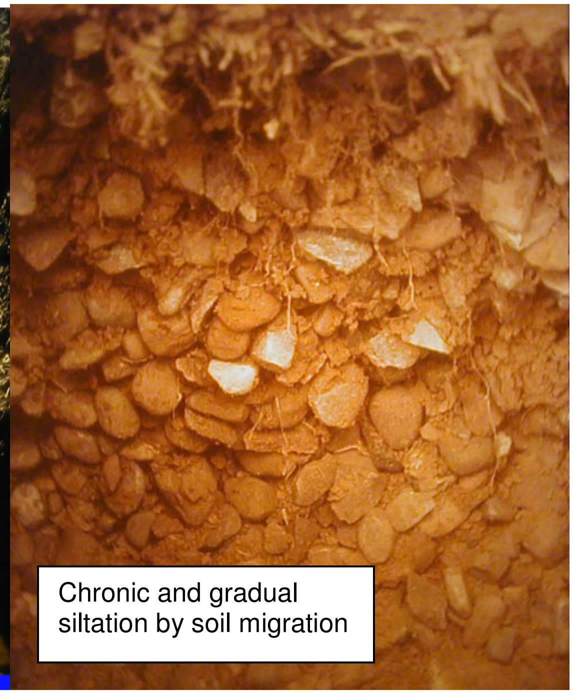


As initially installed, the effluent discharge surface area can be considered to be the “wetted” area of the sides and bottom of the stone-soil interface. At a preferred width of twenty-four inches, the resultant stone-soil interface consists of the bottom, twenty-four inch width and that lower”wetted” portion of the two, twelve-inch side walls. Since the side walls provide equivalent absorbency to that of the bottom area, the 50:50 proportion of soil contact area, as between the twenty-four inch bottom width and the two twelve inch sidewalls, is expected to maximize the absorption efficiency between the leach line volume and the available soil contact area. Additionally, as the bottom layer becomes plugged (for reasons discussed below), an additional side wall surface area becomes available for liquid absorption as the liquid level rises in the leach line.

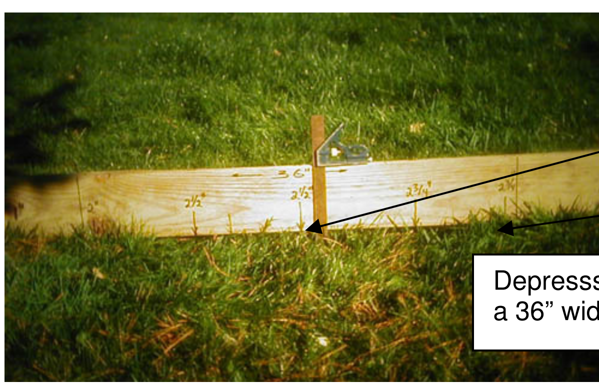
The final layer of the leach line consists of the top soil cover. A six inch depth of soil represents a satisfactory compromise between providing pathogen-to-atmosphere separation as well as providing an optimal soil matrix for grass development. While a deeper top soil layer would beneficially increase the atmosphere-to-sewage separation distance, it would detrimentally decrease the evaporative loss rate from the leach line as well as result in the formation of an unstable layer of soil immediately above the semi-permeable membrane. Lying too deep to be stabilized by the grass roots, this layer of soil would tend to gradually silt into the stone filled layer below, increasing an erosion problem that is inherent in stone layer leach lines.

In addition to its often being costly to obtain and labor-intensive to properly install, stone fill is not a stable component of subsurface soil structure. The voids within the stone fill, while beneficial for liquid storage, are subject to a slow siltation process, whereby the surrounding soil gradually invades and fills these interstices.


Acute siltation caused by rain storm before backfill


Chronic and gradual siltation by soil migration

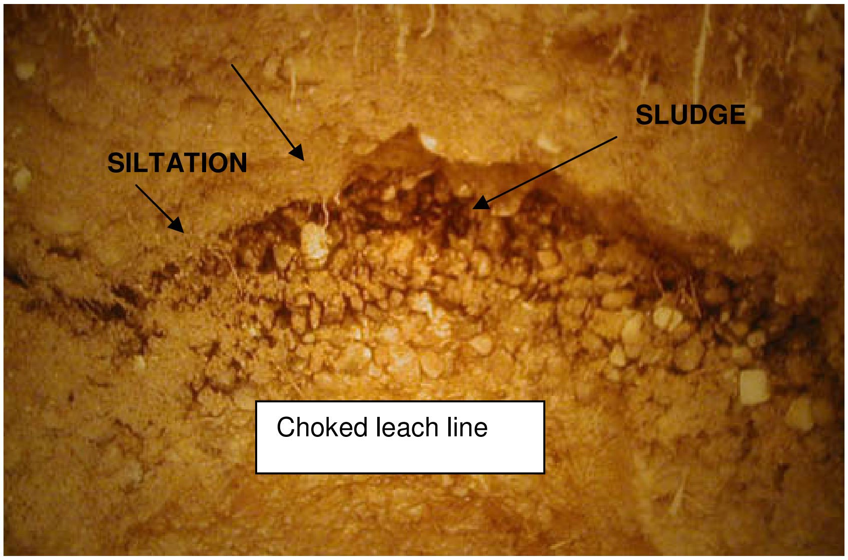
This slow collapse of the trench walls and ceiling into the stone voids reduces both the available pore space as well as the effective effluent discharge area. Further, this siltation process itself establishes subsurface liquid flow channels that tend to accelerate the siltation process. As one example, the gradual collapse of the trench walls and overlying soil of the original leach line creates a depression along the length of the leach line. Once formed, an increased volume and flow of surface rainwater is channeled into this depression, further accelerating the siltation of the surrounding soil into the stone bed.



Depresssion distances across a 36” wide leach line

In addition to siltation, the traditional stone fill leach lines present other inherent steady-state operational problems. Typically, the perforated leach line pipe is a four inch (diameter) PVC pipe that passively delivers sewage effluent to the stone fill. The void spaces permit liquid sewage to flow throughout the field, and with no capillary action within the stone fill, the liquid sewage settles over time to occupy the lowest portions of the leach line.

Additional sewage effluent flowing into the field will then accumulate on top of the initial fluid flows. The passive stone fill leach line provides no active mechanism to either evenly distribute this sewage (horizontally) throughout the field or to draw water upward (vertically), and thereby permit its interface with the upper portions of the trench. Over time, stagnation results and the lowest portions of the leach line become anaerobic. This further slows the decomposition of organic material in the lower sewage layer, as well as results in the production of incomplete decomposition by products (sludge) that plug up additional soil interface areas. With the lower portions of the trench no longer able to absorb additional sewage flows, adding additional effluent only results in an increasingly deep anaerobic stagnant layer. The leach line slowly "dies".

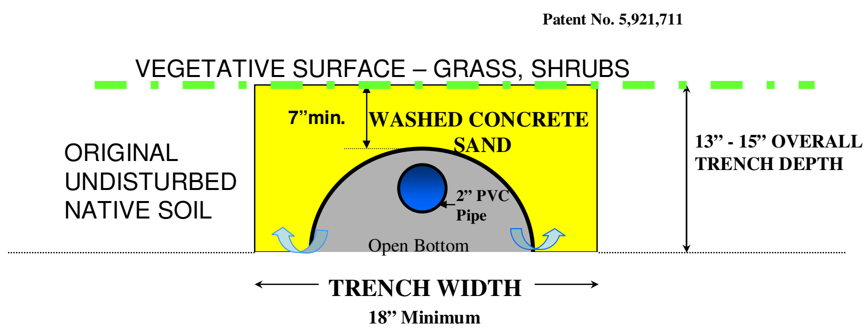


Although ultimately susceptible to these unavoidable **siltation** and **stagnation** processes, the leach line design does offer effective pathogen containment and waste water disposal by three separate mechanisms: (1) A reserve fluid storage capacity is provided by the stone voids; (2) the soil-stone interface establishes a machanism for fluid absorption in the surrounding soil; and (3) Some evapo-transpiration fluid loss is expected through the shallow construction and the grass root absorption.

ENVIRONMENTALLY PASSIVE INTEGRATED CHAMBER (EPIC) DISTINGUISHED

The EPIC system provides an enhanced subsurface fluid distribution system in a manner that avoids previous design deficiencies in conventional leach line construction. The storage capacity of the EPIC design makes use of one or more interconnected chambers instead of the stone fill voids, with such chambers providing enhanced stability in terms of fluid capacity over the siltation prone stone fill. With the sewage effluent distributed into the surrounding soil through such a chamber, the active soil interface area for absorption of the fluid is more than doubled.

ECS UNDERGROUND LEACH LINE DRAINAGE SYSTEM CROSS SECTION DETAILS



TRENCH LEVEL AND PERPENDICULAR TO SLOPE TOPOGRAPHY
LINE SEPARATION 6' (+)

Additionally, these chambers are received within a sand bed, which itself provides an exceedingly active capillary action mechanism to withdraw water from the chambers. Moreover, this sand bed provides an excellent medium for supporting root growth, which in turn enables an increase in the evapo-transpiration rate by a full order of magnitude. **Soluable nitrates, created by soil bacteria from septic effluent ammonia, now have the tendency to be directed upward for absorption as a nutrient for overlying plant growth instead of being forced unused into groundwater formations**.

Also, this sand envelope virtually eliminates siltation as a problem by preventing soil incursion into the sand bed, which otherwise comprises a stable underground soil formation. The capillary action provided by the surrounding sand bed not only distributes the sewage effluent evenly, both laterally and vertically, but also enables the quick dewatering of the sewage effluent. Unlike the stagnant fluid found in the lower layer of stone filled leach lines, the resulting dewatered leach line of the EPIC design enhances oxygen availability, and gas exchange, to the sewage solids - and therefore of aerobic microorganism activity. This greatly speeds the decomposition of the organic matter remaining after transport of the water from the chamber.

The shallow construction, the use of sand, the open design, and the elimination of all the problems associated with stone fill structures (see ***Problems Associated with the use of Gravel in Septic Tank Leachfield Systems***, Randy May, **Environmental Health,** September, 1996) , makes the ECS design unique in soil absorption dynamics, efficiency and **nitrate removal**.

COMPARATIVE DATA

While the gravel fill leach line has been a long time mainstay for sewage disposal, several alternative designs are now available including the newly patented EPIC design. As such to the installer and homeowner the issue of choice is no longer just a matter of cost, but also one of performance.

Cost factors will vary in terms of cost per unit length, installation manhours, delivery time, and productivity of the installer. Although these factors can vary, they can be individually calculated and estimated. On the other hand the long term performance characteristics and anticipated failure of any sytem depend on:

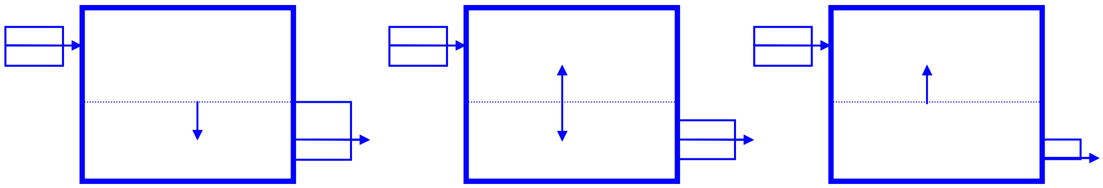
a. Soil percolation rates.
b. Soil structure and its stability.
c. Household flow, surge loading rates, and resting rates.
d. Size of septic tank.
e. Condition of septic tank and pumping frequency.
f. Weather conditions, seasonal variations, temperature, rainfall.
g. Sewage quality.
h. Surface topography, and obstructions.
i. Leach field size, and distribution network.
j. Surface runoff influence.
k. Construction damages, etc.

It is obvious that due to the vast number of variables, which can occur from installation to installation, the long term performance prediction of any individual system is nearly impossible. Scientific **full scale** research is unrealistic because the variables cannot be controlled from household to household, the biomechanics are difficult to observe once the system is backfilled, and few people have the patience to continue even minimal observations for 10 or more years (the minimum expected life expectancy of even a crude, conventional, properly installed leach line system).

As such, given that all variables remain equal, the logical progression is to choose designs that have the physical parameters and can demonstrate functional features that are known to be useful to leach line performance. Furthermore, these features must be based on **biological and physical realities.**

Regardless of design, an absorbtive field has two physical characteristics: **A)** It provides a sewage storage cavity to receive septic tank effluent, and **B)** It provides an interface area with the surrounding soil where settleable and suspended solids are filtered at the interface allowing water and soluble compounds to pass through to the soil.

Absorbtion fields are essentially nothing more than underground filters. As such, the **effective filter area** is the most paramount feature that will determine a field's functional reliability. Storage volume capacity is secondary. This reality can be illustrated by the following figures:



A **B** **C**

In **Figure C**, regardless of the volumetric capacity, the liquid level will rise since the outflow rate (as determined by the available openings) is smaller than the incoming flow. In **Figure B** the liquid level is stable because the inflow rate matches the outflow rate, and in **Figure A**, the liquid level drops quickly because the outflow exceeds the inflow rate.

All leach field designs have the **Figure A** configuration in mind, however due to the clogging effects at the filter interface (**the biological mat**) all leach field designs start to degenerate to **Figure B**, then to **Figure C** levels, and probable failure. This degeneration time is dependent on:

A. The available initial interface area, and
B. The ability to decompose (unclog) the biological mat.

The decomposition (unclogging) mechanism is a complex biological and chemical process where a number of **micro** (bacteria and fungi), and **macro** soil organisms (worms, insects and invertebrae) use the organic compounds present in the biological mat as nutrients and convert the insoluble products to simpler, soluble compounds and gases. However for this process to occur, certain prerequisites are required:

1. The biological mat must be in or near an aerobic state. Anearobic states (absence of oxygen) do not support the activity of the organisms which are effective in the decomposition process.

2. The biological mat must be easily accessible to the soil organisms.

3. Airflow around the biological mat must not be impeded such that decomposition gases can be removed and replaced with oxygen.

4. The biological mat must be dewatered quickly. Biological mats that are covered with liquid effluents remain in the anaerobic state because septic tank effluents lack dissolved oxygen.

The **EPIC** design offers one of the largest interface areas, and is the only design that effectively addresses the prerequisites for biological mat decomposition.

1. **By design, the EPIC system allows the formation of the biological mat at the shallowest depth where soil absorption qualities are better and soil organisms more abundant. In soils, porosity and organism concentration can change drastically within a few inches.**

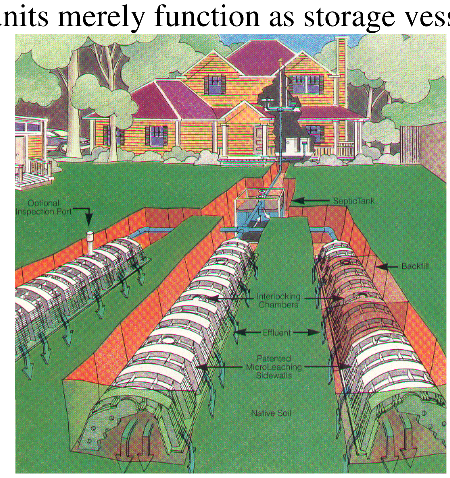
2. **A shallow depth, the open chamber design, and porous sand envelope allow efficient oxygen transfer to the "biological mat".**

3. **The sand envelope through capillary action effectively moves water vertically to the roots of plants for transpiration, and horizontally to other subsequent chambers and the unclogged side walls for lateral absoption. This dewatering action leaves the biological mat in an aerobic environment. The EPIC systems assure even and concentrated mat formation progressively from chamber to chamber.**

These demonstrable parameters are not found in any of the other alternatives and much less:

1. Besides the inherent problems of siltation and sludge entrapment, **stone-fill designs** actually restrict air flow and evaporation, do not provide capillary action, and increase the liquid depth of sewage per given volume due to space allocation taken up by the stone. The increased depth increases the time the biological mat remains in an anaerobic state.

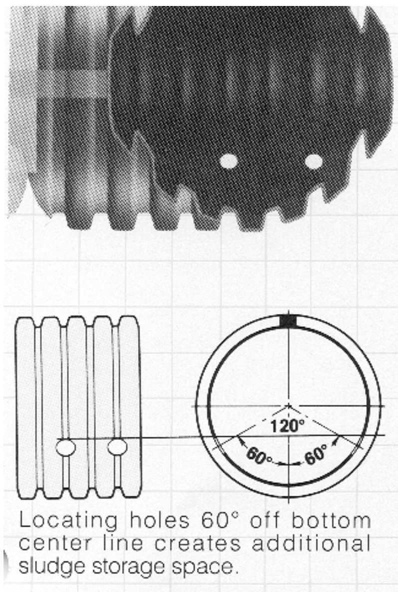
2. Over the past decades **concrete "flow diffusors", "igloo domes"** on some local scenes, and **"infiltration chambers"** on the national scene weaned away totally or partially from the procurement problems of stone by providing **large storage volumes** without the need of stone voids. However the interface areas by design are very deep, and the structures limit evaporation loss and gas exchange due to the inherent impermeable cap. There is no mechanism of dewatering, the biological mat stays anaerobic, and is not attractive to macroorganisms. Once the bottom interface becomes clogged, the units merely function as storage vessels.

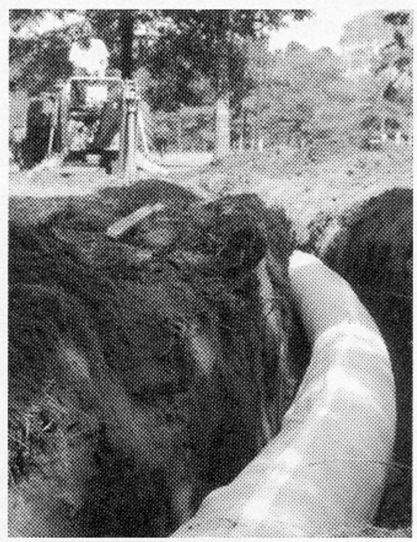


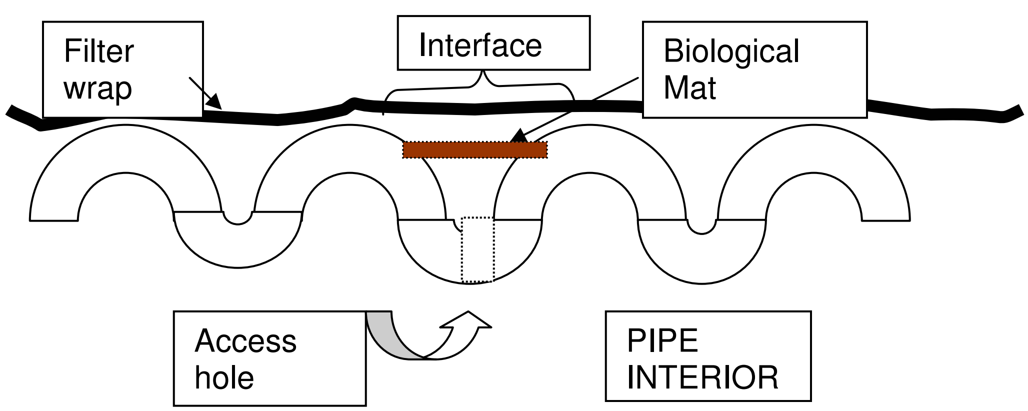
3. Due to the settling and pervasive properties of soils to fill voids, "**gravelless pipe"** without filter wrap cannot be considered an effective design for sewage disposal. In a

relatively short time frame even convoluted or bunched perforated pipe structures will achieve an intimate contact with surrounding soil, leaving only the small perforation openings as areas of interface. In very coarse, gravelly soils, built up pressures may force the liquid sewage into the surrounding gravel such that the units will remain operational, however in most soils exhibiting a finer soil structure, gravelless pipe will quickly seal itself as the biological mat plugs form at the limited perforations.

4. Assuming that **geotextile filter wrap** will withstand soil pressure (will not tear), and maintain a taught straight line bridge across all of the convex peaks of the convoluted plastic ridges (a difficult reality with loosely fitting wrap), we can then theoretically significantly increase the available interface of a gravelless pipe system.



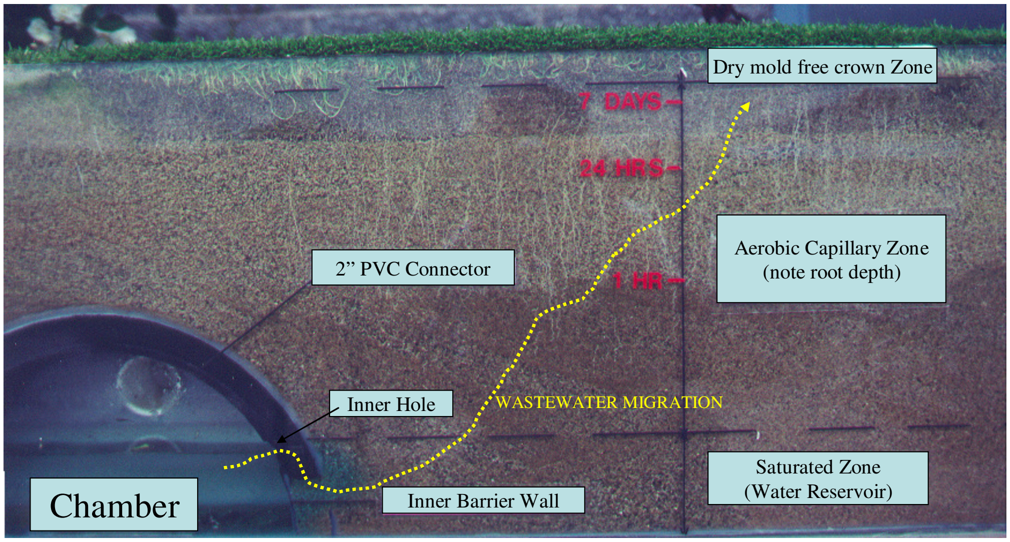




Nonetheless, gravity will limit the initial interface to the lower third of the pipe (area below the 120 degree offset perforations). The biological mat is trapped between the plastic pipe and the filter wrap where it is not accessible to free air flow and macroorganisms, and constanly aggravated by liquid sewage since the interior of the pipe cannot dewater itself.

Few systems are total failures “at the starting block”, **EPIC** systems are just better performers primarily because they interact with the physical and **biological processes** that take place in the soil environment.

CROSS SECTION OF AN ECS GROWTH CELL



Recommended leach line length for Household systems

Percolation Rate Min/inch	Sewage Application GPD/SQ.Ft.	GPD/24" wide/ Lineal ft.	300 GPD 2 Bdr	450 GPD 3 Bdr	600 GPD 4 Bdr
0-5	**1.20**	**3.0**	100	150	200
6-7	**1.00**	**2.5**	120	180	240
8-10	**0.90**	**2.3**	130	195	260
11-15	**0.80**	**2.0**	150	225	300
16-20	**0.70**	**1.8**	166	250	333
21-30	**0.60**	**1.5**	200	300	400
31-45	**0.55**	**1.4**	214	321	428
46-60	**0.45**	**1.1**	272	409	545
Over 60	**0.30**	**0.7**	428	642	857

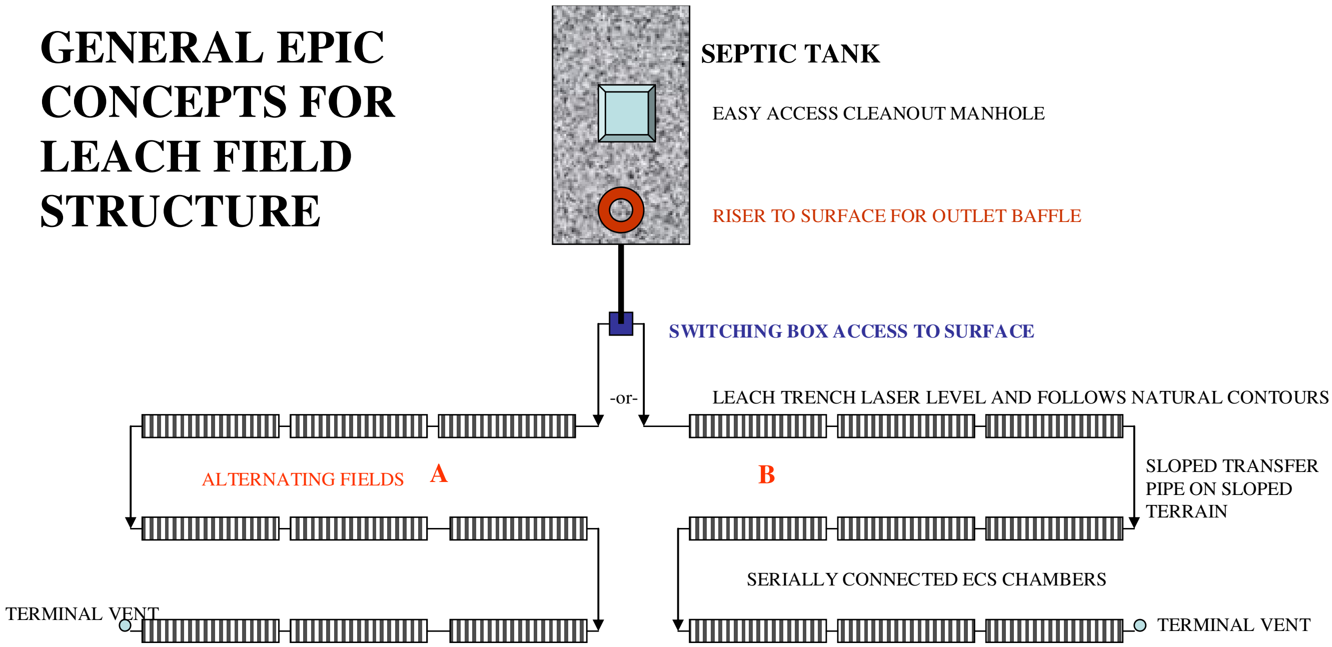
Table based on flow rate of 75 gallons / person / day, and maximum housing occupancy of 2 people / bedroom. Size fields as to county standards or anticipated maximum flow rate in table.

Divide entry numbers by five to determine number of EPIC units required.

EPIC LEACH LINE INSTALLATION PRINCIPLES:

- **Total leach line length divided into two separate leaching areas.**
- **Fields are alternated on a yearly basis (or every six months) through appropriate switching box or valve.**
- **Leach line structure follows contours of original ground topography with level construction of 15" deep and 18"- 24" wide trenches. Use of transit to set leach line locations is mandatory.**
- **Minimum center-to-center (leach line) separation 6', however separation is dictated by natural slope flow of land.**
- **Serially connected EPIC chambers have no minimum or maximum length per leach line segment as long as level is maintained within segments.**
- **Transfer pipes between segments are non-perforated sch40, 2" PVC or ABS pipe and appropriate fittings.**
- **Grass or shrubs are allowed to develop in leach field areas.**
- **Lot size is adequate to accommodate 50% expansion area.**
- **Minimum distance to well is 100'. Minimum distance to ground water is 2' below unprotected EPIC leach line bottom.**

GENERAL EPIC CONCEPTS FOR LEACH FIELD STRUCTURE



LEACH FIELD SIZE DETERMINED BY COUNTY STANDARD APPLICATION RATES AND PERCOLATION DATA.

RECOMMENDED FIELD AREA DIVIDED BY TWO INTO TWO DISTINCT ALTERNATING FIELDS.

FIELDS ARE ALTERNATED ON A YEARLY BASIS THROUGH SWITCHING BOX OR VALVE.

SLUDGE DEPTH IN SEPTIC TANK MEASURED ANNUALY WHEN FIELD SWITCHING MADE, PUMPED AS NEEDED.

LINE SEPARATION 6’-10’(+), BUT ACTUAL SEPARATION DETERMINED BY SLOPE OF LAND.

LINED EPIC CELLS ARE USED IN HIGH GROUND WATER SITUATIONS OR IF TOTAL CONTAINMENT IS PREFERRED.