Chapter VII
Soil Absorption Systems

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INTRODUCTION

In Kansas surface discharge of effluent or wastewater or from any onsite wastewater systems is illegal without a discharge permit. These permits are not issued for individual onsite systems. Thus, regardless of the treatment system used, ultimately the effluent must go into the soil or be evaporated. A wide range of options and products are available to distribute the effluent to the soil for final treatment. Likewise, seepage and water surface evaporation are the mechanisms for dispersal of lagoon water. The soil beneath a mound or a lagoon system is its own absorption field thus no additional field is needed for these alternatives.

A properly functioning septic tank changes the composition of raw sewage by removing solids that will settle to the bottom or float to the surface and partly digest these. Septic tank effluent is still sewage with abundant pollutants and harmful microorganisms. Effluent applied underground in suitable soil at appropriate rates provides good treatment and is safe for the environment. When the absorption field is shallow (near the surface) plant roots will take up some of the nutrients, especially nitrogen, during active growth periods. This helps reduce nitrate movement through the soil to the groundwater. In soils with appreciable clay content, adsorption removes much of the phosphorous in the wastewater.

Regardless of the type of wastewater treatment system chosen, inspection of the installation is essential before a local permit can be issued. Suggested inspection protocols for both new and existing systems are provided on pages VII-31 and VII-34 later in this chapter.

KDHE Bulletin 4-2 states that four feet of suitable, aerated soil is required between the bottom of the wastewater absorption area and the most shallow restrictive layer. Four feet of soil helps ensure adequate treatment and removal of pollutants. As discussed in Chapter IV, *Site and Soil Evaluations* restrictions such as an impermeable soil layer; high water table; rock; or other feature may limit downward water movement and adequate treatment.

When excessive phosphorous and nitrogen reach surface water, especially lakes or ponds, these nutrients contribute to accelerated eutrophication and degraded water quality. Because sandy, gravelly, or rocky soils are more limited in capacity to remove nutrients, septic tank and soil absorption can contribute to excess nutrients at the shore or in branches off of the main lake body. In these sensitive, ecologically critical areas, greater separation distances or designs that more reliably remove nutrients may be required.

An important consideration for an absorption field location is the possibility of future connection to public sewers. Where future central sewer systems are possible, the home's plumbing should be designed to facilitate a future connection. When public sewer service becomes available, the private system should be removed from service and properly abandoned. See K-State Research and Extension publication *Plugging Cisterns, Cesspools, Septic Tanks, and Other Holes*, MF-2246 for additional information.

Choosing the Soil Absorption System

By far the most common system is a traditional septic tank followed by a lateral absorption field. Traditional absorption fields are well suited to deep, sandy and loamy (medium to coarse texture) soils. Soil profile layers must be moderate or well drained and have adequate capacity to absorb and transmit water. On relatively flat sites laterals of the same elevation are commonly supplied by a manifold or distribution box (also called a “D” box). Where surface slopes exceed 1½ percent, it is strongly recommended to use serial distribution laterals with drop boxes. Regardless of whether a level system or a serial distribution system is used, individual absorption laterals should always follow the surface contour, be level, and have a uniform depth of cover.

When soil conditions are restrictive due to high groundwater, flooding, slowly permeable soil, shallow bedrock, or inadequate lot size, advanced treatment as discussed in Chapter VI, and/or alternative soil absorption systems are often used. They provide fundamentally sound solutions when correctly designed, installed as planned, well managed, and adequately maintained. When choosing the system, consider long-term sustainability, installation and maintenance cost, availability of service, and continued use of the home as well as public health hazards, environmental pollution, and prevention of nuisance conditions.

Onsite wastewater system component features must be carefully considered and matched to the suitability of specific site and soil conditions. Selecting the most suitable soil absorption system depends primarily on site and soil conditions as discussed in Chapter IV, *Site and Soil Evaluations*. When poor soil conditions make traditional laterals infeasible and space is available, lagoons, discussed in Chapter IX, may be a good choice. When a lagoon is unfeasible, alternative soil absorption as discussed in this chapter may be an option or the site is unbuildable.

Design and construction must consider management for efficiency and regular service for long life with a minimum of problems. An experienced designer and/or installer should be used for an alternative soil absorption system. Traditional tanks and laterals need only simple maintenance. Conversely, service of alternative systems requires knowledge of pumps, controls, timers, and how they must operate together. Regular field checks are essential. Choose a system that can be constructed properly, has maintenance access, and can be maintained locally.

Alternatives Soil Absorption Systems

Alternative soil absorption systems include shallow in-ground, at-grade, bed, low pressure pipe, drip, and mound systems. Mounds, also a treatment component, are discussed in Chapter VI, *Enhanced/Advanced Treatment*. Design and installation guidelines for alternative soil absorption systems are discussed in this chapter. Soil profiles with moderate or greater depths to restrictions are suitable for traditional, shallow, and at-grade systems are shown in Figure VII-1. Remember it is essential to know, understand, and comply with the local sanitation code.

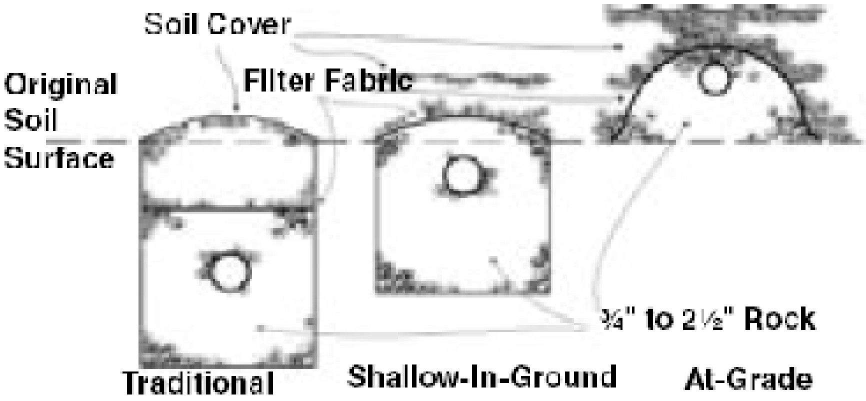

Figure VII-1. Soil Absorption Options for Moderately Shallow Soil

As wastewater percolates through the soil pores, many bacteria and pathogens are filtered out. Viruses may be adsorbed onto clay or organic particles where they can remain until they are inactivated by harsh environmental conditions. Soil particles also trap other chemicals, including phosphorus and ammonia (a form of nitrogen). When the loading rate does not exceed the soils capacity to treat wastewater, the treatment processes are most effective. Equal distribution of wastewater to the field aids both absorption and treatment.

EQUAL WASTEWATER DISTRIBUTION

All wastewater, both from septic tank and from enhanced treatment components, must receive final treatment by the soil absorption system. Treatment works most efficiently when the loading is uniformly distributed among laterals and along the length of laterals. The principles to help achieve uniform distribution include:

- bottom of all lateral trenches level
- laterals at the same, uniform depth, with equal cover
- wastewater distributed equally among all laterals

Uniform distribution is aided by the biomat and by intermittent low-pressure dosing of laterals.

Effluent from a septic tank causes a clogging layer (biomat) to form within months at the soil/water interface in laterals. The biomat has a high concentration of microbes that filter suspended solids, such as organic matter and other microbes, from the effluent. Research shows that as much as 90 percent of the treatment occurs in the biomat layer. As the biomat develops and becomes thicker, the absorption, or long-term acceptance rate, of the lateral is reduced. When flow through the biomat is less than the wastewater load, backup into the structure or surfacing in the yard typically results and the absorption field is said to be failing. Saturated soil surrounding the laterals of failed systems limits the oxygen transfer needed for microbial decomposition.

Two types of absorption fields are in common use. The most common is used for level sites (slope up to 1 percent) with all laterals the same elevation and supplied by a distribution box or manifold. The other type is a serial distribution or step down system where the next lateral is lower than the one above and is used when slopes exceed 1½ percent. The type of soil absorption system, location, design, construction, and maintenance help to minimize the chance of failure.

With gravity flow, it is extremely difficult to achieve equal distribution even when using a distribution box. The typical flow from a tank is just a trickle which can not practically be equally divided in the D box even when it is carefully leveled and regularly checked. Flow levelers in each lateral of a D box helps to equalize flow when they are carefully adjusted several times a year. Thus a D box or manifold pipe is only suitable for a level site with all laterals at the same elevation. Even when flow is equally divided between laterals wastewater still enters one end and distribution along the lateral requires a level lateral and development of the biomat.

With the serial distribution or step down system, the first lateral is filled and fully utilized, before excess effluent overflows to the next lateral. Thus, the capacity of each successive line is utilized before flow reaches the succeeding lateral. With this system, to prevent capillary action from causing the soil above the lateral to be saturated, the invert of the overflow line should be at least 2 inches below the top of the lateral rock fill as shown in Figure VII-2.

The most accurate way to achieve uniform distribution is by pressure flow. This has been done by small diameter, low-pressure pipe with small orifices; drip lines; and pressure manifold delivering to gravity laterals. A pump or dosing siphon produces the pressure and hydraulic design assures that it will work as required. As with all mechanical and electrical equipment, care of the system is important and maintenance (much more than for traditional laterals) is essential.

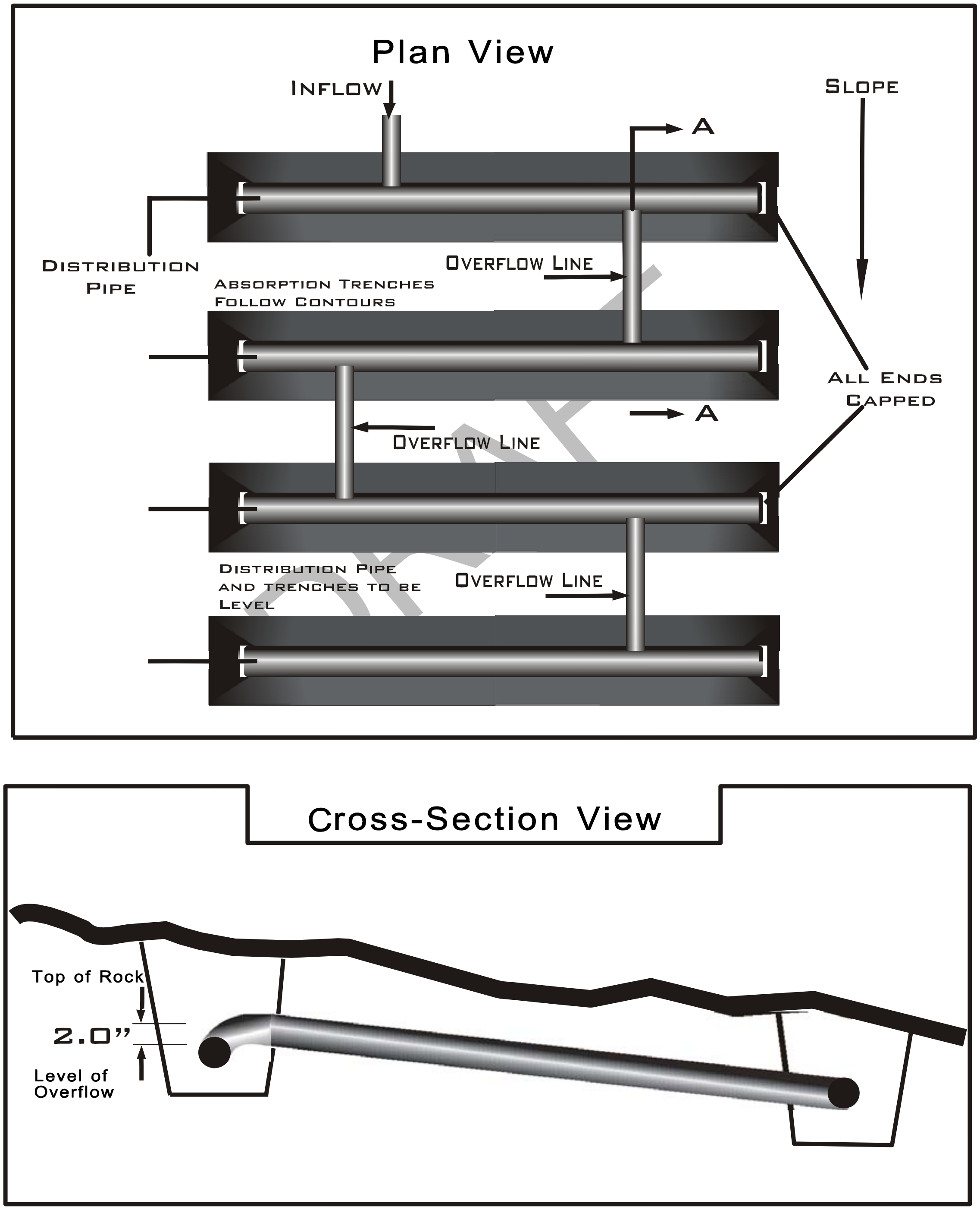

Figure VII-2. Typical Serial Distribution System for a Sloping Site

TRADITIONAL ABSORPTION FIELD

A traditional absorption field is a system of narrow trenches partially filled with a bed of clean gravel, crushed stone, or similar material surrounding perforated pipe, Figure VII-3. In place of gravel, gravelless components are available and are discussed in this chapter. Septic tank effluent is delivered to the field via the perforated pipe and enters the gravel and then the surrounding soil.

Soil absorption fields should be sited far enough from wells, streams, and impoundments to minimize the chances of contamination. The design should plan for regular maintenance and construction must provide for easy access so service and repair can be efficient. The minimum and recommended separation distances for absorption fields from other facilities are given in Table VII-1. Also, it is always wise to plan for a replacement field in an accessible area of suitable soil.

In order to achieve minimum separation distances, site features may require pumping septic tank effluent to reach the most suitable soil absorption field location. In this case, as for all onsite systems, during design and construction provide for easy access for maintenance and repairs, including service of the septic tank by the septage pumper/hauler.

Once a soil absorption system has been sited, it is essential for contractors and the owner to understand the importance of preventing site improvements from interfering with the operation of the soil absorption field or the replacement area. Driveways, walkways, additions to buildings, a swimming pool, or other improvements should **never be constructed** over or downslope of the absorption field or replacement area. Also surface water should always be diverted from the vicinity of the soil absorption field. Always avoid utility easements because future installation or repairs of the utility may damage the field.

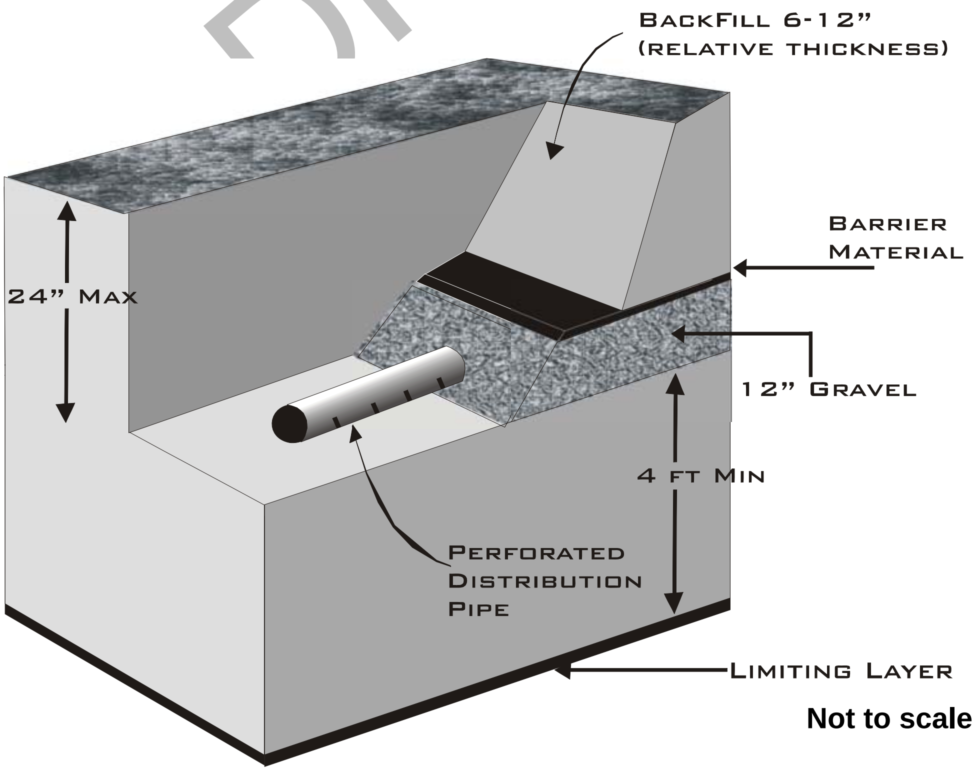

Figure VII-3. Traditional Rock and Pipe Absorption Trench

Table VII-1. Required and Recommended Separation Distances from Absorption Field*

	Required Minimum	Recommended Minimum
Public Well or Pump Intake Line to Field	100 feet	200 feet
Private Well or Pump Intake Line to Field	50 feet	100 feet
Public Drinking Water Line to Field	25 feet	50 feet
Private Drinking Water Line to Field	10 feet	25 feet
Property Line to Absorption Field	10 feet	50 feet
House Foundation to Absorption Field	20 feet	50 feet
Surface Water or Water Course	50 feet	100 feet

** To meet these separation distances, a lot size of at least two acres may be needed. Always comply with local codes. These and other minimum distances are listed in Table IV-7 and KDHE Bulletin 4-2 Table 5.*

Pressure Distribution

Dosed low head, pressure pipe is ideal to achieve uniform distribution of wastewater in soil absorption laterals. Pumped distribution also provides the opportunity to do timed dosing with resting cycles. Dosing helps assure that the soil stays aerated and helps to limit the thickness of the biomat. Pumping also allows the absorption field placement at a higher elevation than the septic tank, which maximizes the area and design options on sites. Because the biomat provides much of the treatment, maintain it; do not attempt to eliminate it.

A pressure distribution system has the advantage of enabling equal flow between all laterals and also along the lateral length. Regular maintenance is an essential component of pressure distribution. Annual maintenance must include the following:

- check components for damage and blockage
- clean all filters and screens
- clean distribution pipes and orifices
- test floats, controls, and pumps to verify they operate as designed; adjust as needed
- verify correct dosing times and volume

ABSORPTION LATERALS

Wastewater distribution in lateral fields by gravity depends on careful elevation control during construction and few solids in the effluent to limit clogging of absorption lateral pipes. Standard practice has been for a maximum gravity fed lateral not to exceed 100 feet and preferably should be less than 60 feet. If a lateral is supplied from the center, the total length shall not exceed 200 feet (100 ft to each side) and a maximum of 120 feet is preferred. Likely this is based on limitations of elevation controls rather than physical constraints. When an effluent screen controls solids carry-over to laterals, elevation control is accurate, and there is regular maintenance longer runs may be feasible. All laterals that are at the same elevation must be connected at each end with a level manifold or connector pipes to avoid dead ends.

Absorption field area is dependent on two factors: wastewater flow and the soil loading rate discussed in Chapter IV, *Site and Soil Evaluations*. The wastewater flow is based on the house being fully occupied with two persons per bedroom. Thus the wastewater design flow is based on the number of bedrooms at 150 gallons per day (gpd) per bedroom (75 gpd per person). The absorption lateral bottom area is obtained by dividing the wastewater flow in gpd by the loading rate in gallons per day per square foot (gpd/ft^2).

Although the absorption trench width may vary from 18-36 inches, 24 inches is the preferred width (see trench design in Figure VII-4). A minimum of 6 inches of gravel is placed under the 4 inch diameter distribution pipe, followed by enough gravel to cover the top of the pipe by at least 2 inches. The soil cover over the trench should be at least 6 inches to provide adequate rooting depth for perennial grass, and no more than 12 inches to maximize water and nutrient use by vegetation as well as oxygen transfer to the lateral.

To enable aeration and promote plant uptake of water and nutrients, the lateral trench bottom should be as shallow as practical, but at least 18 inches deep unless additional cover is added over the lateral. The lateral should follow a level grade (on contour of the ground surface) rather than a straight line. On sloping sites a step down distribution arrangement is preferred. To maintain a level bottom on uneven site surfaces, the trench depth may need to be vary within a range of no more than plus or minus (±) 2 inches of the average.

With shallow lateral depth, the issue of lateral lines freezing during an extreme or prolonged cold period is sometimes raised. In Kansas freezing is not normally a problem in a carefully constructed system with ground cover that continues in daily use during the cold period. Freezing

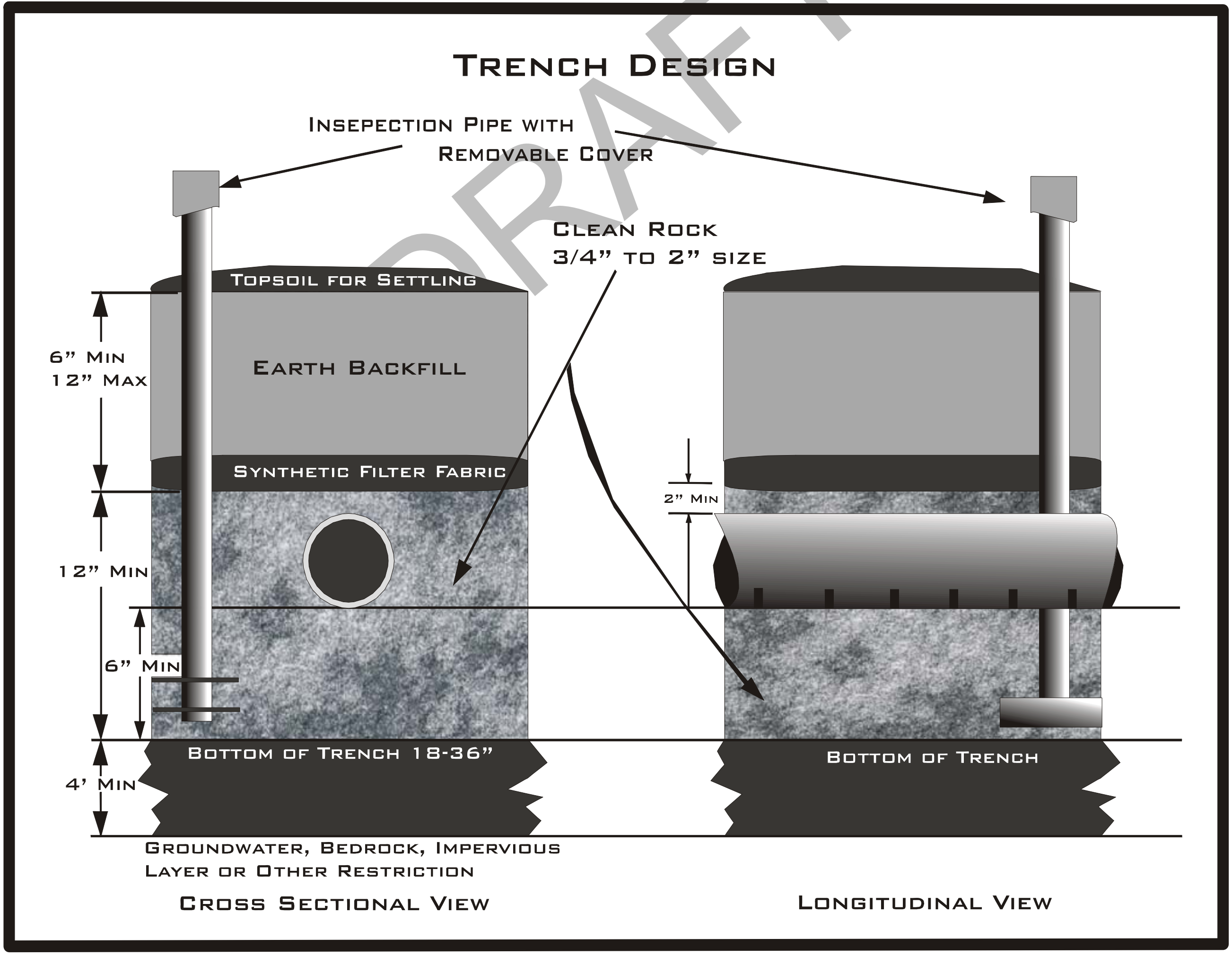

Figure VII-4. Traditional Rock and Pipe Lateral: a) Section View, b) Longitude View

is more likely to be a problem where water stands in lines and may be a problem when there is no water use during a cold period. The lines should be designed and constructed to allow water to drain. The use of check valves or other features to retain water in the piping is not recommended unless the pipes are below the maximum frost depth.

When space permits, adjacent absorption laterals should be separated by at least six feet of undisturbed soil. Table VII-2 shows the minimum spacing for a range of trench widths to achieve the 6 feet separation. When space is limited, the separation can be reduced, but this may make construction more difficult. Individual laterals should be constructed parallel to surface contours uniform depth with a level trench bottom, and curved to best fit the topography; avoid abrupt changes in direction.

Table VII-2. Trench Separation Distances

Trench Width (Inches)	Minimum Distance Between Trenches, Ft	Minimum Distance Between Trench Centerline (Ft)
18-24	**6.0**	**8.0**
24-30	**6.0**	**8.5**
30-36	**6.0**	**9.0**

Absorption Field Materials Guidelines

Perforated distribution pipe is commonly used and, where dosing is not required, 4-inch diameter pipe is standard. Typical designs for absorption laterals are shown in Figures VII-3 and VII-4 and a typical layout for serial distribution is shown in Figure VII-2.

Rigid PVC or corrugated polyethylene plastic pipe, meeting American Society for Testing and Materials (ASTM) standards D2729-93 and F405-93 or latest edition, respectively, is the minimum standard for use as gravity distribution lines. All materials used in the plumbing, wastewater line, and lateral fields shall meet standards specified by ASTM. In gravity flow lateral pipes, perforations are round, ½-inch diameter and are located at 4 and 8 o'clock positions on the pipe circumference and with 6 inch spacing along the pipe. In no circumstances would slotted pipe be acceptable because the narrow slot openings plug easily.

Washed gravel or washed crushed stone is commonly used as the porous media for the trench. The media gradation shall be ¾ inches to 2 inches in diameter. Smaller sizes are preferred because they reduce masking of the infiltration surface. It is best to have a uniform size because more void space is created. Rock having hardness more than three on the *Mohs hardness scale* is required. Mhos hardness is used for geologic materials. Rock that can scratch a penny without crumbling or flaking generally meets this criterion. Larger diameter and smaller diameter material or soft aggregate such as calcite limestone are not acceptable and shall not be used.

Fines must be eliminated as much as possible to prevent clogging of the void space. Fines shall not exceed 5 percent by volume, so unwashed material is normally not acceptable. A test should be done to confirm that the media is adequate. To test for fines, place five inches of material in a clear container. Fill the container with water and wash. Remove the washed gravel and let the fines settle. Five inches of gravel should produce less than ¼ inch of fines.

The porous media must be covered with a non woven filter fabric (at least 3 ounce nylon or 5 ounce polypropylene) before backfilling to prevent soil from sifting through the media. Traditional untreated building paper or a 3 inch layer of straw are not recommended because they deteriorate over time and allow soil to work through the rock media material. Filter fabric (also known as geotextile, geotextile fabric, and landscape fabric) materials shall be fully permeable to air and water.

Geosynthetic aggregate media that is similar in size to the gravel and that is inert in wastewater may be used for laterals. Chunks of shredded, tires can be a suitable substitute for rock. Ninety percent of the pieces should be ½ to 4 inches in size with no fines. Wire strands shall not extend more than ½ inch from the pieces.

When suitable rock or gravel is not locally available, is expensive, or access to the site is restricted, gravelless systems may be a suitable option for laterals. Gravelless options include chambers and large diameter pipe.

Because chambers have a large open space, they have the advantage of large liquid storage capacity when the entrance pipe invert is at the level of the top of the sidewall perforations. This allows for storage in the lateral that reduces the effect of high flows in short time intervals. Because gravelless systems do not have rock media they are lightweight making installation easier at sites with restricted heavy equipment access. Before using gravelless pipe, consult the local authority to identify requirements.

Field Construction Guidelines

Protection of the absorption field area should begin before any activity on the site. The site and soil evaluation identifies the best soil absorption area and a reserve area. All traffic, especially heavy equipment such as loaded trucks, should be kept away from the absorption fields by marking the site (fencing is preferred). Compaction from weight of such equipment can permanently alter soil characteristics. Excessive traffic from equipment or livestock can compact even relatively dry soils.

Construction of soil absorption field laterals when the soil is too wet, causes compaction and smearing of the soil. This destroys soil structure which greatly reduces the soils capacity to absorb water, and reduces treatment efficiency of the field. A test to determine appropriate soil moisture is to work the soil into a ball and roll between the hands. If it can be rolled into a ½ inch in diameter rope shape, without falling apart, it is too wet and construction should be delayed until the soil is dryer. Depending on season and rainfall, drying may take weeks or even months.

Before beginning construction, contours should be located using a surveyor, contractor, or laser level and lateral locations should be marked on the contour by paint, flags, or stakes. Lateral trenches shall not be excavated deeper than the design depth or wider than the design width.

Following excavation, the trench sides and bottom shall be raked to remove any smearing, and graded to assure the bottom has less than 1 inch difference in elevation along the full lateral length, or in the complete field for a level system. The lateral pipe and rock cover shall not vary more than 1 inch in elevation along the lateral length when checked by a contractor, surveyor, or laser level.

When the trench bottom has been adequately prepared, it should be promptly filled with at least 6 inches of gravel or the gravelless distribution line placed. Distribution pipes are carefully placed on the rock, and leveled with perforations aligned at 4 o’clock and 8 o’clock positions for all pipes. Rock is placed around and over the pipe to a cover depth of at least 2 inches. After rock and pipe have been placed into the trench, the filter fabric shall be placed to cover the rock and prevent downward soil movement. If gravelless chambers are used, the backfill along the sides should be compacted following the manufacturer’s guidelines.

The lateral should be backfilled as soon as possible after inspection to prevent rainwater from filling it, sidewall collapse, and washing sediment into the trench. Earth backfill shall be carefully placed to completely fill the trench cavity. The backfill shall be mounded 2-3 inches (20 percent of the soil fill height) above the trench to allow for settling. If shallow in-ground or at-grade placement is used, topsoil must be placed between laterals as well as over the lateral to level the site. After settlement, the entire disposal area should be graded and seeded with grass. Heavy equipment should not be used to cover lateral trenches. Grading should be limited to handwork or very small equipment.

ABSORPTION FIELD INSPECTION

Inspection is one of the most important tasks associated with the construction of new wastewater absorption fields and evaluation of existing wastewater systems. The sanitarian should inspect the absorption field after the materials have been placed but before the laterals have been covered. In most cases the sanitarian will do the inspection to evaluate whether the system meets the minimum standards of the local code. This involves assuring that components meet minimum requirements for type, quality of material, dimensions, and construction; that the location meets setback distance and configuration requirements (slope, position, elevation); the design and sizing have been satisfied; and that construction meets requirements.

Existing systems must be evaluated using most of the same requirements as used for new systems. Suggested protocols for evaluating new and existing systems are included together with inspection forms at the end of this chapter. A full inspection of an existing septic tank is only practical when it is empty; meaning the tank must be pumped, see Chapter V, *Septic Tanks*. Evaluation of sludge and scum accumulation in the tank is the responsibility of the owner and is discussed in Chapter V. Figure V-5 depicting how measurements may be done.

GRAVELLESS SYSTEMS

Gravelless systems typically have an open bottom structure, resembling half of a large diameter pipe, to create an underground chamber to distribute and “store” effluent. Sidewalls are slotted with louvers to allow lateral movement of effluent. Figure VII-5 shows a typical gravelless chamber diagram. Chamber systems do not require piping to distribute wastewater within the lateral. Also gravelless systems do not require rock or gravel to maintain an open trench for contact with the soil. Installation criteria emphasize that the trench bottom must be level to allow for even distribution of wastewater. Manufacturers claim that the lack of material in the trench means that wastewater is in contact with a greater surface area on the trench bottom compared with a rock filled trench. This means that the effluent contacts the entire bottom surface and not just the voids between the aggregate materials. Manufactures claim that because of the absence of rock that masks the surface, less bottom area is required for chambers than for rock laterals so an increased loading rate can be used. This has not been universally accepted; many states allow some reduction in bottom contact area when chambers are used while others do not.

Based solely upon the use of gravelless systems, KDHE does not recommend a reduction in lateral area. Each local permitting authority should carefully consider any request for reducing the lateral area based upon industry claims, local experience, and available information. Manufacturer claims are typically in the 40-50 percent reduction range. Since 1995, Kansas Health Departments and Local Environmental Protection Groups have granted reductions ranging from 0-40 percent. When given, the most common reduction is 20-30 percent. Reducing the absorption area for chambers should be done with caution. Wastewater permits typically contain a statement that owners are responsible for the future performance of their wastewater system and they will be required to make corrections in the case of failure, regardless of the cause of that failure. It has been proposed that the manufacturer should guarantee that if the reduced area granted for chambers is inadequate that installation up to the unreduced design levels will be done at no cost to the owner.

Before using a gravelless system, the installer should be familiar with the manufacturer's limitations for the use of their system and all recommendations for installation. Some manufacturers recommend a maximum trench depth of 36 inches for their chamber. The type of gravelless system used depends upon factors such as: availability, site considerations, contractor preference, and cost. Some chamber designs allow lateral flexibility, allowing them to be more easily installed along the curved elevation contour of a sloped lot. Manufacturers make or imply

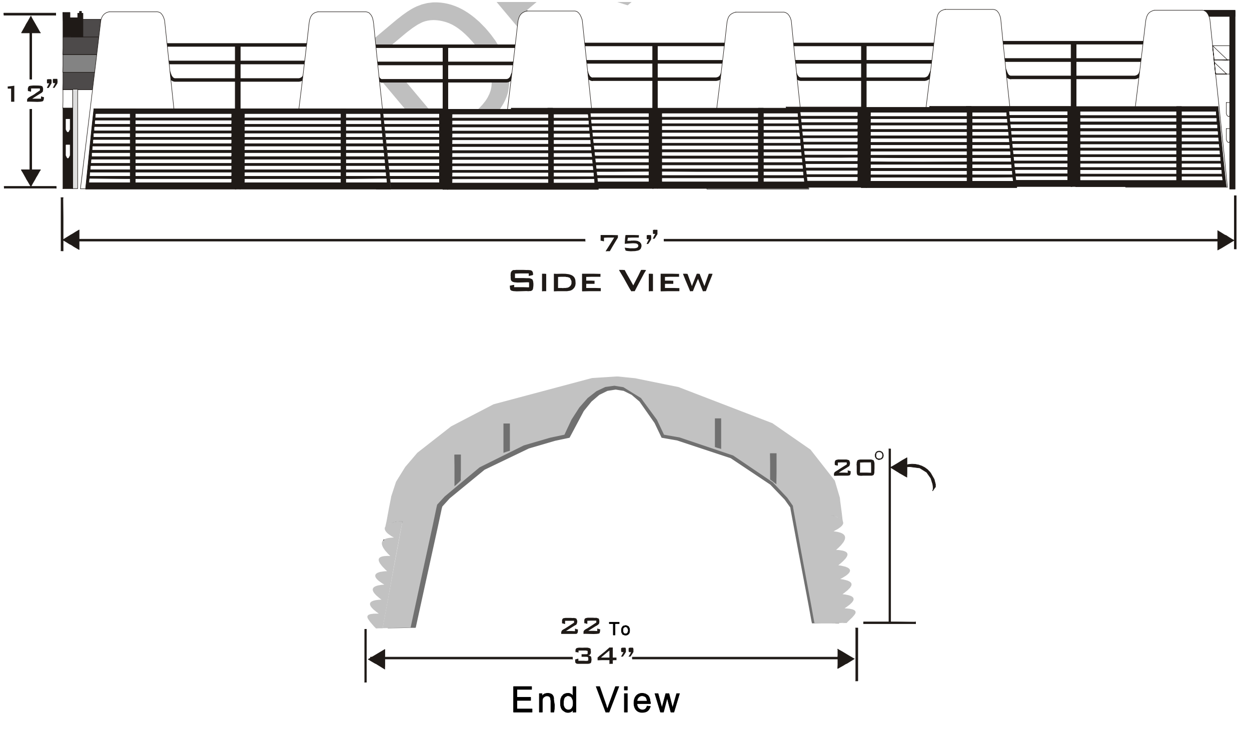

Figure VII-5. Typical Configuration of Gravelless Chambers claims of lateral reductions that vary by chamber design or model. This claim is based on the increased side-wall area of some designs by making the chamber narrower and taller. At present, KDHE recommends that any reduction be based only on the amount of open bottom area for each design; do not consider the extra side-wall "benefit". This is especially important when considering lateral field sizing between two or more brands and designs.

A small limitation to gravelless chambers is the impermeable top that may limit the evapotranspiration potential of the lateral field. This typically shows up during a dry summer when cool season grass is stressed or goes dormant and there is a green strip on each side of the chamber but not over the top. In contrast a rock pipe lateral will typically have green grass across the full width indicating water available to the grass from the lateral.

A recent modification to gravelless lateral design is the use of a narrow chamber (usually less than 24 inches wide) in a full 36 inch wide trench. The space on each side of the chamber to the trench sides are filled with clean rock or gravel as in rock laterals. Be sure that the manufacturers warranty is not affected before choosing to do this. The full 36 inch lateral width should be counted when calculating the size of the resulting lateral field. The gravel in these laterals must be covered with filter fabric to prevent soil from filling rock void spaces.

Large Diameter Pipe

Another gravelless distribution option is large diameter corrugated, perforated pipe. Manufacturers make this pipe in 8 or 10 inch, diameter or larger. This pipe is similar to distribution lateral pipe, except that it is a larger size. Systems using this pipe have been widely tested by manufacturers, but relatively few tests have been conducted by independent researchers. No design criteria have been developed other than that provided by the manufacturer. The potential user is advised to follow manufacturer's recommendations. The outside of the pipe is covered with geotextile fabric. Experience suggests that this pipe may work better for fine textured soils than coarse ones

SHALLOW IN-GROUND LATERALS

This type of lateral system is basically the same as conventional soil absorption laterals, except that trench depth is often 6 to 12 inches—more shallow than a conventional lateral depth of 18 to 24 inches. The shallow in-ground design raises the laterals up about a foot higher than in a conventional trench, increasing the soil depth beneath the bottom of the laterals. This design variation is useful for sites having a reduced soil depth to a restricting layer (only 4½ to 6 feet instead of the normal 6 feet or more for traditional laterals). It allows normal placement of the rock in a trench beneath and around the lateral pipe. The laterals and the space between them are covered with topsoil comparable to topsoil on the site. As for all rock laterals, it is essential that filter fabric cover the tops and sides of the rock that extends above the top of the trench. Figure VII-6 shows the lateral cross-section for shallow in-ground lateral systems. All other design criteria for this system would be the same as for the traditional systems.

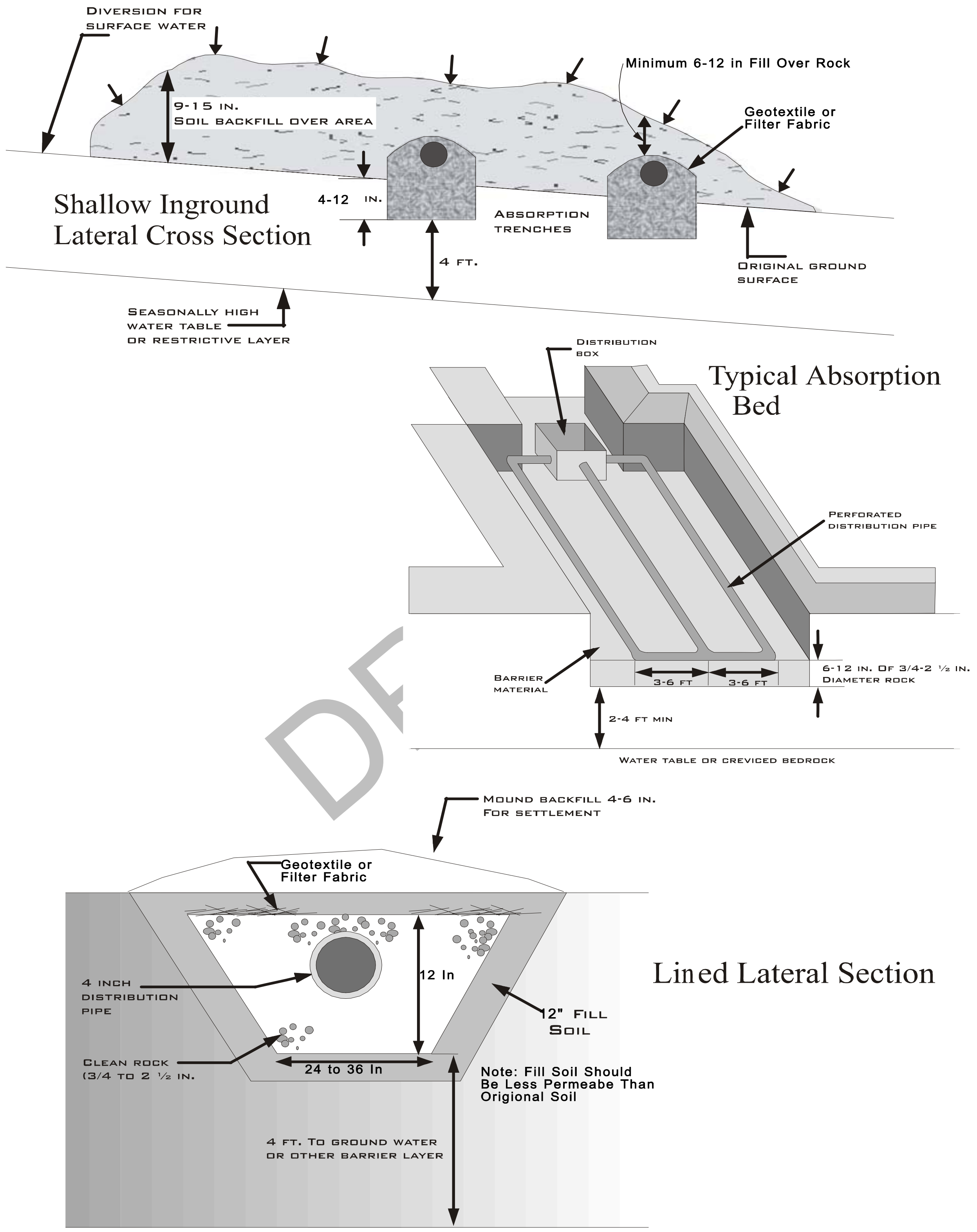

Figure VII-6. Typical Shallow In-ground, Absorption Bed, and Lined Lateral Sections

In the construction process, the vegetation should be removed from the soil surface to be covered with topsoil. The surface should also be roughened to a depth of 3 to 4 inches as described for mounds in Chapter VI. The contractor should be careful to avoid driving equipment over the absorption field site during construction because traffic on the site will compact the soil and reduces its capacity to absorb water. Mark the site with the need to protect the field area in mind and consult with contractor before beginning the installation. Construction should only be done when the soil is dry enough that when rolled between the palms the soil should not roll out to a rope shape less than ½ inch in diameter without falling apart.

AT-GRADE LATERALS

As the name implies an at-grade lateral system is constructed on the natural ground surface; thus no trench is excavated. This system is ideal for sites where the limiting condition provides only 4 feet of suitable soil below the surface. Protection of the original soil surface from disturbance by equipment during all phases of site construction is essential. The natural soil surface becomes the lateral bottom or soil absorption surface. The maximum site slope should be no steeper than about 6 to 1 (16 percent) to simplify construction, especially aggregate placement. This also enables the use of normal construction equipment without excessive hand labor and helps ensure proper long-term operation.

Because water movement into the soil is essential to prevent lateral movement (especially on sloping sites) and seepage at the toe, natural soil surface, an at-grade system requires greater care during construction than traditional laterals. The soil must be dry enough that equipment does not cause either tracks or compaction. A good rule is that a ½ inch soil rope can not be formed without falling apart (soil can not be rolled into a smaller rope shape).The site must be level along the laterals and the surface must allow water to infiltrate.

The construction of an at-grade system is similar in many respects to construction of a mound except that no sand fill is used. Prior to installing an at-grade lateral line, all vegetation is removed. All grass, brush and trees are cut just above ground level and removed; tree stumps are left in place. A tracked vehicle should be used in all phases of construction to help avoid soil compaction.

A level soil surface contour is laid out using a surveying level. Minor cuts and fills along the contour may be used to smooth surface irregularities. The soil surface under the laterals and at least 5 feet to the sides is roughened to a depth of a few inches by using the teeth of the excavator bucket or chisel plow, as is done for a mound (see Chapter VI). The lateral location is carefully marked using a contractor, surveyor, or laser level to maintain a level grade.

Six inches of aggregate is placed on the prepared soil surface, following the marked contour. The distribution pipe is placed on the rock fill again using the level to ensure the level grade is maintained. Additional aggregate is placed around and over the pipe covering it by at lest 2 inches. Figures VII-1 and VII-7 show a cross section of an at-grade lateral line for rock and pipe (chambers would be similar). On sloping sites, the pipe should be placed on the upslope side of the aggregate. The aggregate should have maximum side slopes of 1 to 1, minimum thickness of 1 foot (9 inches for low pressure pipe), and maximum width at the soil surface of 3 feet.

When laterals have been placed with at least one inspection pipe in each lateral, the aggregate is covered with filter fabric as described earlier. Finally, the entire absorption area, including laterals and space between laterals, is covered with topsoil to a depth of 8-12 inches over the lateral aggregate. Properties of the topsoil used for cover should be similar to the natural topsoil of the site.

The loading rate and design procedures are essentially the same as for conventional laterals. On a level site, the laterals would all be level and distribution pipe would also be level with the lateral ends connected by solid pipe. The standard minimum spacing between laterals is 6 ft as shown in Figure VII-7, the same as for conventional lateral system. On sloping sites, a drop box system may be used, but is only recommended for slopes up to 1½ percent. Low pressure, dosed distribution lines are recommended for slopes exceeding 1½ percent.

A low-pressure distribution system using a few doses per day would be suitable for any site and is strongly recommended for all sloping sites. The improvement achieved by a pressure dosing system will help assure a long, viable operating life. For sites with slopes exceeding 1½ percent, a pumped low pressure distribution system is essential to assure even distribution of wastewater across the absorption field. When a pressure dosing system is used on a site where laterals are at different elevations, care must be taken to equalize pressure, and thus equalize the loading rate for all laterals. A simple way of doing this is to put a gate or globe valve at the inlet to each lateral. A standpipe of clear plastic or a sensitive pressure gauge can be used to equalize the pressure when the system is installed. Once the pressure is set, the extra equipment can be removed until it is checked or needs to be reset. The following design example will help the reader understand the application of these principals.

Construction of an at-grade lateral field requires careful procedures. Small tracked equipment (such as a loader) should be used to reduce the soil pressure during construction. The topsoil cover must be placed over the aggregate before equipment crosses it. It is best to do machine passes parallel with the laterals. Minimize machine traffic as much as possible.

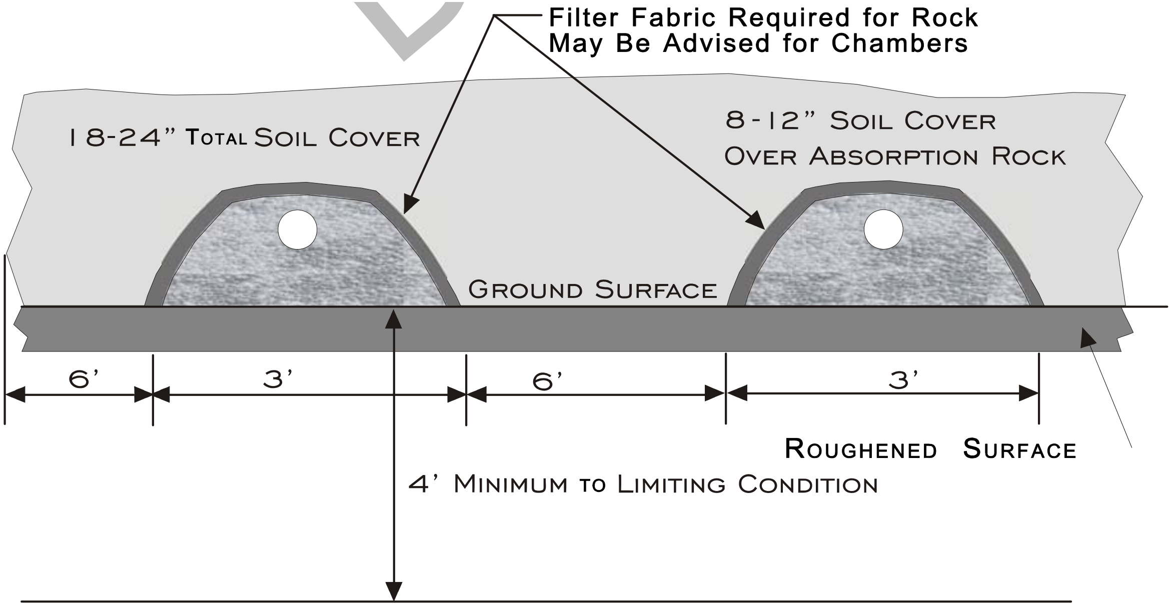

Figure VI-7. Typical At-Grade Lateral Section
(Rock and Pipe Shown; Chambers Would be Similar)

At-grade Design Procedure

Designing an at-grade system is somewhat similar to designing an engineered mound except that a mound may use a distribution bed while the at-grade system uses multiple laterals. The number of laterals depends on the maximum linear loading rate as discussed in more detail in the engineered mound section of Chapter VI.

Horizontal and Vertical Separation. Horizontal set backs will be dictated by local code and should be followed for all soil absorption systems receiving septic tank effluent. Most codes have required separation distances between the bottom of the aggregate and the limiting soil condition, such as bedrock or high water table. In Kansas, the minimum standard for vertical separation distance below the bottom of the absorption lateral is four feet. Thus, the at-grade system would only be suited to sites where there is at least four feet of suitable soil to a restriction.

Slope. The maximum slope on an absorption field site should not exceed 16 percent.

Linear Load Rate. The linear loading rate is defined as the amount of effluent applied (gallons) per day per linear foot (gpd/lf) along the natural contour. The mound section of Chapter VI (p VI-12) has more discussion about linear loading. Table VI-4 and Figure VI-7 illustrate general limiting soil and site conditions and suitable research based linear loading rates. The design linear loading is a function of the soil and geologic material that allows effluent to move vertically through the profile and laterally downslope away form the absorption area. If the movement is primarily horizontal, a low linear loading rate (3-4 gpd/lf) is extremely important. If the flow is primarily vertical, then the linear loading rate can be higher, but still should be limited to a maximum of 8-10 gpd/lf. A linear load rate greater than 10 gpd/lf may result in a very wide absorption area, especially when the soil surface limits infiltration into the soil.

Soil Loading Rate. The soil loading rate is based on the surface soil layer that is in contact with the aggregate or the most restrictive layer within 2 feet below the surface. For an at-grade system, the aggregate is in contact with natural soil surface. Refer to Table IV-4 in Chapter IV for the recommended loading rates for various soil texture and structure conditions.

System Configuration. The system configuration must meet the soil site criteria and should typically be laid out long along the contour and narrow parallel with the slope. A system that is too wide may leak at the downslope toe or at any toe on a level site. Other factors, such as oxygen transfer and exchange beneath the absorption area, are also affected by the width of the system. If there is not sufficient length along the contour, but there is sufficient distance along the slope, more than one at-grade system can be used to achieve the desired or required effective absorption area. As for all lateral fields, a terrace should be installed on the upslope side to prevent upslope runoff from entering the field area.

Effective Absorption Area. The effective absorption area is that which is available to accept effluent. The effective length of the absorption area is the actual length of the aggregate along the contour. The effective width on sloping sites is the distance from the distribution pipe to the downslope toe of the aggregate and on level sites it is the total aggregate width.

Total Length and Width. Once the effective length and width of aggregate/soil contact area is determined, it is necessary to add about 6 feet to each side and at the end of the absorption area to shape the cover soil into the existing soil surface. Greater widths are acceptable if additional landscaping is desired. The recommended maximum slope for the sides of the absorption area cover is 4 to 1 (4:1) but flatter is more desirable.

Pressure Distribution. To assure uniform effluent distribution and to avoid leakage at the toe, pressure distribution is recommended for dispersing effluent in at-grade systems. With site slopes greater than 1½ percent, pressure distribution should always be used. Pressure dosing distributes the effluent evenly along the lateral through the small diameter orifices. After it is dosed the water moves vertically downward through the aggregate to the soil surface. As effluent comes into contact with the soil, it will move laterally (downslope on sloping sites and in all directions on level sites) as needed to infiltrate the soil. The pressure distribution network configuration will vary depending upon the size and dimensions of the absorption area. For level sites with absorption laterals up to 3 feet wide, a single lateral pipe in the center along the system length will suffice. Though not recommended, a wider absorption bed could be used on a level site. For a bed, equally spaced lateral pipes fed by a center manifold are used. The outside lines are placed half the spacing width between the lines from the edge of the aggregate.

On sloping sites, the distribution network may consist of a single perforated pipe on the upslope edge of the aggregate lateral with a center feed preferred. The lateral pipe is installed nearest the upslope edge and water will move downslope by gravity. Multiple laterals, spaced parallel 6 feet apart as Figure VII-7 shows and supplied by a short manifold are recommended when the linear loading allows more water than a single lateral can supply.

Cover. After the aggregate, distribution pipe, and observation tubes have been installed, a synthetic geotextile fabric (or filter fabric) is placed over the aggregate. Approximately one foot of soil cover is placed on the fabric and extended/tapered to a distance of at least six feet beyond the aggregate edge. The surface is seeded with perennial cool season grass to control erosion and to maximize evapotranspiration.

At-grade Design Example

Because an at-grade system involves more detailed site specific design than traditional laterals an example is presented here to help readers understand the design steps and calculations.

Given information:

- Typical 3-bedroom house with standard features and no unusual uses
- Soil and Site Criteria:
  - Site slope is 8 percent in proposed absorption field area
  - Proposed absorption area is 175 ft along the contour and 30 ft with the slope
  - Soil profile description:

0-12 in. silt loam; 10YR 2/1 color; moderate, blocky structure; friable consistence

12-24 in. silty clay loam; 5YR 3/1 color; moderate, blocky structure; firm consistence

24-48 in. silty clay; 10YR 5/3 color; strong, blocky structure; very firm consistence

48 plus in. silty clay; massive structure; very restricted drainage; many medium, prominent mottles indicates a seasonal perched water table in this zone

Design Step 1. Determine the design flow rate (DFR). Because this is a typical 3 bedroom house, use 150 gallons per bedroom per day (based on occupancy of 2 people/bedroom) to calculate the design flow rate. Use: 3 x 150 ***DFR = 450 gpd.***

Design Step 2. Select the linear loading rate (LLR) based on evaluation of the sites soil profile. Because the profile consists of a permeable surface soil horizon over a slowly permeable subsoil horizon with a seasonal perched water table, the subsurface flow must be primarily horizontal with negligible vertical flow below 4 feet. Since the slope is moderate, a narrow lateral is most appropriate. The perched water table and very restricted drainage in the area necessitates a low LLR as discussed in the engineered mound section of Chapter VI.
Therefore use: ***LLR = 4.0 gpd/lf.***

Design Step 3. Choose the soil loading rate (SLR) for laterals on the site based on the properties of the soil layer that is the infiltrative surface. Use Table IV-4 (page IV-7) for selecting the appropriate SLR that matches the soil conditions. Because this is a silt loam texture with moderate structure and friable consistence, use the value: ***SLR = 0.6 gpd/ft^2.***

Design Step 4. Determine the required width (W) of the absorption surface. This is obtained first by dividing the linear loading rate by the soil loading rate to find the effective width (EW)

or EW = LLR / SLR

On a level site or one with very slight slope (less than 1½ percent), the effective width (EW) is the required width (W) of the aggregate. On a sloping site, aggregate upslope of the distribution pipe is not effective for infiltration. On slopes the total aggregate width must be about 1.5 ft wider to support the upslope side of the distribution pipe network and to allow for the natural slope of the aggregate. When the width is more than 4 feet it should be divided into multiple laterals with a separation space between them to approximate standard lateral spacing. Using the linear loading rate of 4 gpd/lf and the soil loading rate of 0.6 gpd/ft^2 from steps 2 and 3 then:

EW = 4 gpd/ft / 0.6 gpd/ft^2 = 6.7 ft **and** ***W = 6.7 + 1.5 feet = 8.2 ft.***

To maintain the desired narrow lateral this would best be done using 2 laterals with a six feet spacing between them so each lateral would be ***EW = 3.4 ft*** **and** ***W = 5 ft.***

Design Step 5. Determine the required length (L) of the absorption area by dividing the design flow rate (DFR) by the linear loading rate (LLR)

L = DFR (gpd) / LLR (gpd/lf)

For this at-grade example the design flow rate is 450 gpd from step 1 and the linear loading rate is 4 gpd/lf from step 2 so the required length is:

L = 450 / 4 = 112.5 use 113 ft.

Thus the effective absorption area is 113 ft by 3.4 ft times 2 or 768 square feet.

Design Step 6. Determine the system configuration that best fits the site. Once the effective width and length of the absorption area are determined, the designer must determine if and how it will best fit on the site. When there is not sufficient length along the contour on the site, it may be possible to divide the absorption area into multiple zones. The required length of the absorption area is less that the available 175 ft along the contour so it fits the site.

Design Step 7. Determine the height of the lateral. Design for a minimum of 6" of aggregate beneath the distribution pipe and about 2" covering the pipe. Using small diameter low pressure pipe the aggregate would be 9 to 10 inches deep. The aggregate will taper to zero at the edges. Place synthetic fabric over the aggregate and 8 inches of soil cover over the fabric. The total fill height over the lateral above the original grade will be about 1.5 foot at the distribution pipe and taper to zero at the edges of the dispersal field.

Design Step 8. Determine the total length (TL) and total width (TW) of the absorption field by adding the sloping fill to each side and each end of the absorption area. This allows the soil cover to slope gradually from the top of the soil covered lateral to the natural surface. A standard 5 feet can be added to each side and each end of the area. However, it is preferable to calculate the upslope and downslope width additions using design steps 12 and 13 in the engineered mound section of Chapter VI, pages VI-19 and VI-20 respectively. When desired, wider slope widths can be used to achieve flatter slopes for landscaping purposes.

TW = absorption width (W) + upslope width + downslope width

TW = 2 x (lateral width) + space between laterals + upslope width + downslope width

= (2 x 5) + 6 ft + (4 x 1.5 x 0.76) ft + (4 x 1.5 x 1.47) ft

TW = 10 + 6 + 4.6 + 8.8 = 29.4 ft; use 29 ft.

TL = absorption length (L) + average of upslope and downslope widths. Simply adding the upslope and downslope widths together is the same as 2 times the average of these widths.

TL = 113 + 4.6 + 8.8 ft = 126.4 ft; use 126 ft.

The total width and total length calculated in this step are less than the 175 ft length and 30 ft width of the available area for the wastewater system. Thus no adjustment in the system design is needed.

Design Step 9. Design a pressure distribution network. Because the absorption laterals are relatively narrow and on a moderate slope, a single distribution line along the length of each lateral is adequate. The distribution line would be located 3.4 ft upslope of the aggregate downslope toe. On a level site, the distribution pipe would be located in the center of the lateral aggregate. The pressure distribution will be designed according to the procedure discussed in Chapter X, *Pump Systems*.

At-grade System Construction

Construction Step 1. Check for proper soil moisture prior to construction. When the soil can be rolled between the hands to form a rope shape ½ inch in diameter without falling apart, it is too wet for construction. Do not begin construction until the soil dries out.

Construction Step 2. Cut all grass, brush, and trees as close to the soil surface as practical. Do not remove tree stumps. Rake clippings and loose organic debris from the absorption area. Avoid heavy vehicle traffic especially over and downslope of lateral absorption areas. Using a contractor or laser level mark the level lines for the lateral locations.

Construction Step 3. Bury the force main (or delivery pipe) from the pump tank to the upslope side of the absorption area, ideally prior to roughening the soil surface. Bring the pipe in at a right angle to the absorption area and connect to the upslope end of the manifold, the line connecting to all laterals. Avoid traffic on the tilled area, especially beneath and downslope of laterals.

Construction Step 4. Working from the upslope side to avoid compaction of the absorption area and downslope side, roughen the soil surface using the teeth of the backhoe. If a backhoe is not practical use a chisel plow at a 4-6 inch depth. Avoid doing this step if the soil is too wet as identified in Step 1. If compaction or ruts occur in the upslope or downslope area during construction, re-till the compacted or rutted area. Minimize subsoil disturbance beneath and downslope of the absorption area.

Construction Step 5. Install at least one observation tube in each lateral to observe the condition at the infiltrative surface. Use two observation tubes for long laterals fed from a center manifold. Observation tubes are usually 3 or 4 inch PVC pipe extending from the infiltrative surface (aggregate – soil interface) to a few inches above the ground for easy access. They should be placed at points approximately one quarter and three quarters along the length of the absorption area. The observation tubes provide easy access to verify that effluent is reaching the area and to detect any ponding. The bottom six inches of the observation tubes must have perforations (holes or slots) in the sides to allow ponded effluent to enter. Observation tubes must be anchored securely. A toilet flange, tee, or reinforcing rods through the pipe can be used as illustrated on Figure VI-9, page VI-25 in Chapter VI.

Construction Step 6. Place a 6 inch depth of lateral aggregate on the level contour in the designated tilled area. Work from the upslope edge of the system being careful to avoid compaction of the absorption or adjacent areas. A conveyor mounted on a truck or a mixer tank on a truck has been used to deliver the rock.

Construction Step 7. Place the distribution network pipe level along the length of the absorption lateral aggregate and connect it to the distribution manifold pipe. On sloping sites place lateral pipe as close as practical to the upslope edge. On level sites place lateral pipe in the center of the aggregate. Place aggregate to the sides and cover the distribution pipe with at least 2 inches of rock.

Construction Step 8. Place the geotextile fabric to completely cover the lateral aggregate surface. Where needed, trim or fold back the fabric so it does not extend more than 2 inches beyond the edge of the aggregate.

Construction Step 9. Cover laterals to a depth of 8 to 12 inches over the absorption rock with topsoil having properties similar to natural topsoil on the site. Where multiple laterals are used, the soil cover must fill the space between laterals so no depression remains to collect water. Taper the soil fill on all sides of the absorption area lateral to the design distance from step 8 above or at least 5 feet. Finish grading around the system to divert surface runoff away from the upper edge and away from the site.

Construction Step 10. Immediately after construction, seed permanent cool season grass over the entire disturbed area and mulch the site for erosion control.

SOIL LINED LATERALS

Some sites may have such coarse soil (sand and/or gravel) that water may infiltrate and percolate too rapidly through the profile. The biomat may not form or would form slowly and not be consistent throughout the area. There is little chance of failure because of surfacing or backup in the facility. However, coarse soils are not suitable for traditional gravity absorption systems because they may produce inadequate treatment and do not protect groundwater. Alternative absorption designs are recommended for coarse textured soils that provide inadequate treatment.

A finer textured soil lining across the bottom and sides of the lateral has been used to slow infiltration and help distribute the wastewater evenly. A lined lateral works with gravity distribution and has the low maintenance of a traditional lateral system. The key to the successful longevity of lined laterals depends on the lining selection. As water moves from a fine textured soil to an underlying coarser one, the fine texture soil must be nearly saturated before water can move into the coarser material. This means that the fine texture soil will be continuously wet and this may cause changes in soil structure and low oxygen transfer. A good lining might be a sandy soil with little structure that is not too permeable. It would not be as subject to damage by continually wet conditions and would have some spaces for oxygen transfer. Of course the lateral must be over excavated by at least a foot in depth with sloping sides to allow placing the lining. Some of the lining soil should be mixed with the top several inches of the natural soil to avoid an abrupt transition. Place at least a foot of the lining soil on the bottom and sides of the lateral as shown in Figure VII-6.

Other suitable alternatives could also include an enhanced pretreatment component and/or time-dosed pressure distribution. Using enhanced pretreatment reduces the amount of treatment the soil needs to do. Time-dosing maximizes wastewater contact with the soil enabling treatment. These alternatives require considerably greater attention to maintenance as well as greater detail during design and construction. In rural areas, it may be difficult to find service providers who can provide the maintenance that is essential for alternative treatment or alternative absorption systems.

ABSORPTION BEDS

Absorption beds are typically much wider and shorter than laterals and contain multiple distribution pipes as shown in Figure VII-6. The primary advantage of absorption beds is that less surface area is required for a bed than for a traditional lateral absorption field. However, a lateral system is preferred because it provides a greater sidewall area with increased absorption surface and oxygen transfer under the laterals is much improved compared to the bed. A bed should only be installed on a level site for an existing home. The site should not be leveled to permit the construction of the bed. Laterals are more easily adapted to the contour of the land surface and can be used on steeper sites. Laterals may be constructed with less damage to the soil structure. Absorption beds are not recommended for permanent systems following a septic tank because of inferior treatment and shorter life expectancy compared to laterals.

A major limitation of a wide soil absorption area is that oxygen transfer is inadequate to the middle of the area under the bed. As a result, the soil often becomes anaerobic (septic) beneath the bed and treatment efficiency is substantially reduced. With oxygen more limited in areas away from the edges, the biomat growth becomes thicker and of a different consistency. With a thicker biomat growth, percolation through the bottom of the bed is proportionately reduced. The long term outcome can be such low long term acceptance rates that the bed system ultimately fails. For this reason absorption beds are discouraged in favor of laterals no wider than 3 feet.

A bed system may be suitable for locations where central sewers are not presently available but are expected in the near future. When beds are used for dispersal of septic tank effluent, a larger bottom area is recommended than would be used for laterals. Recommendations vary widely and some state and local codes or regulations prohibit absorption beds because of deficiencies of this option. In Kansas when beds are used for septic tank effluent, a 50 percent greater bottom area is recommended.

Comparing 600 square feet of lateral trench 2.5 feet wide with a 900 square foot bed 20 feet wide shows slightly more total bottom plus sidewall area for laterals. The lateral system would have 4 trenches each 60 feet long making a total length of 240 feet. Using a rock depth of 1 foot the lateral system would have 600 square feet of bottom and 500 square feet of sidewall area for a total of 1100 square feet. The bed system would be 20 feet by 45 feet and would have 900 square feet of bottom area and 130 square fee of sidewall for a total of 1030 square feet. Thus, even when a bed is 50 percent larger, the laterals have more absorptive surface (bottom plus sidewall) and would be expected to have better aeration. The lateral system would be expected to provide better treatment and greater absorptive capacity through a longer life.

An at-grade bed system is very similar to at-grade laterals and can be used for level sites when soil conditions similar to those for at-grade laterals exist. Low pressure, time-dosed distribution should always be used for an at-grade bed system. The design this type of system would have many similarities to a mound system design.

SUBSURFACE DRIP DISPERSAL

Subsurface drip dispersal (SDD) is a method of applying effluent to the soil at very low rates which may be used in place of traditional soil absorption systems. Drip systems are well adapted to sites having a severely limited soil absorption capacity, shallow soil, or a very restricted area for soil absorption. Drip systems typically receive enhanced treatment effluent from aerobic treatment unit (ATU) or other pretreatment component. Drip lines are placed quite shallow (no more than 8-10 inches) and can easily be installed around trees, shrubs, and other landscape features with minimal disturbance to them.

The concept of using subsurface drip to disperse effluent is adapted from the irrigation industry where fresh water sources are used for crops. Subsurface drip irrigation (SDI) systems became more feasible with the advent of plastic tubing after World War II. Initially (1960s) they were used for high revenue orchard or horticultural crops. The first U.S. field trials of SDI on field crops began in the 1970s. About 1990, Texas A&M University started experimenting with distributing domestic wastewater effluent through drip lines. Since the mid 1990s, SDD for household type effluent following enhanced treatment has evolved into a widely accepted and effective option for dispersal of wastewater for final treatment in soil.

Drip Description

Drip systems disburse effluent 8-10 niches below the ground surface through small emitters in ½ inch diameter tubing. The shallow placement by SDD systems puts effluent into the active root zone, maximizing evapotranspiration and nutrient uptake. The system is designed using the grid concept with supply and return/flush manifolds at the ends, creating a closed loop system. The result of a proper grid design is a complete subsurface wetted area. Each emitter delivers less than a gallon of water per hour usually with a spacing of 2 foot along the line and a 2 feet spacing between lines. The goal of drip is to apply the effluent at an approximately uniform rate, as safely as possible and distributed throughout a 24-hour period. Small, uniform effluent doses are applied throughout the day in the root zone where the moisture can be absorbed and taken up by plants or transmitted downward. The installation and use of SDD has important advantages shown in Table VII-3.

Because drip systems normally include an enhanced treatment component following the septic tank, they ensure water entering the system is high quality. An aerobic treatment unit (ATU) is often used for enhanced pretreatment but this is not the only option.

Table VII-3. Some Advantages and Limitations of Subsurface Drip Dispersal (SDD)

Feature	Advantage or Possible Limitation
Small (½ in) diameter flexible pipe	Flexible pipe allows placement around obstacles. Because the footprint of a drip dispersal field can be formed to any configuration, it is a good option to use in tight areas, around existing buildings, trees, and small lots.
Shallow water placement	Because of shallow placement, as much as 75 percent of the water is taken up by plants and transpired by leaves. During the active growing season, plants use some nutrients (nitrogen and phosphorous) in the effluent.
Placement with insertion plow	Because the drip line is installed with an insertion plow, as is used to place telephone cable, or by a narrow trench machine, minimal soil disturbance occurs during placement.
Empty lines between doses	In the Kansas climate, drip systems are designed to provide complete drain back at the end of the dose cycle. Because water is not held in the drip lines, this prevents freezing of the water and also helps minimize root intrusion.
Herbicide impregnated lines	Two brands of drip system are currently available. One uses Treflan™ herbicide impregnated in the plastic pipe and can be installed in areas with trees or vegetation without undue concern about root intrusion.
SDD is a new technology	Designers, installers, component suppliers, and service providers may not fully understand concepts, needs, and have onsite wastewater experience.
Maintenance needs	Regular service is required to insure that the system functions properly and has good longevity. SDD systems are unforgiving regarding delayed maintenance; system failures may be unrecoverable.

Suitable Drip Applications

High Water Table. When the soil evaluation indicates that there is a shallow seasonal or perched water table a subsurface drip system helps provide the vertical separation since it can be installed as shallow as 8 inches or even on the surface and then covered with 8 inches of topsoil.

Rocky Terrain. Shallow installation can keep the system out of shallow rock conditions.

Steep Slopes. Since the field is precisely dosed by time and area, steep slopes do not pose the problem they would in a conventional gravity system. The drip field can be lengthened along the contour or spacing between lines can be increased to limit “water stacking”, the accumulation of water moving laterally through shallow layers from each successive downslope lateral.

Tight Soils. When a site has tight soils with slow permeability, subsurface drip dispersal may be a good alternative. Usually, the soil layers near the surface where drip lines are installed can take more water. On sites with tight soil conditions the emitter application rate (dose per square foot) can be reduced and the field enlarged accordingly. Using uniform small doses in the area minimizes over-wetting of isolated areas in the field. Timed doses prevent the field from being hydraulically overloaded during peak usage in the mornings and evenings.

Drip System Components

Several manufacturers of drip line currently have products on the market. They are similar in size and incorporate both pressure compensating and turbulent flow emitters. One product has a process to reduce root interference, Rootguard®, using the herbicide, Treflan®, incorporated in the exterior of the pipe and a bactericide impregnated in the interior to inhibit bacterial slime growth in the drip line. This technology helps minimize plugging or clogging of the emitters.

A pump supplies effluent under pressure, to the drip lines. The pump must be sized for the flow and pressure requirements. A high quality pump and controls that can be serviced by a local service provider is recommended. The pump control panel houses the dosing timer, the high water alarm, the electrical wiring to the pump, and is connected to power from the house main electrical breaker box.

The pipes from the enhanced treatment component to the pump tank, tank to the drip field, and manifolds supplying the field must be Schedule 40 PVC. The manifold lines are sized for the flow, and often are 1¼ inches in diameter. The drip lateral lines are connected at 2 foot intervals along the manifolds. The manifold line should be installed on a grade that allows total drain back of contents to the pump tank after each pump cycle to prevent possible freezing.

The supply manifold valve box is rectangular, large enough to easily accommodate the necessary components, and located on the supply manifold, just below the first drip line. This box houses the supply manifold shut-off valve, the pump pressure test gauge connection and valve, the injection port ball valve, and the filter system and flush line. Because of very small emitter orifices filtration of all water delivered to a drip system is essential. A self-flushing vortex filter with a stainless steel screen (150 mesh or 100 micron size) element is often used for final treatment before the effluent enters the field.

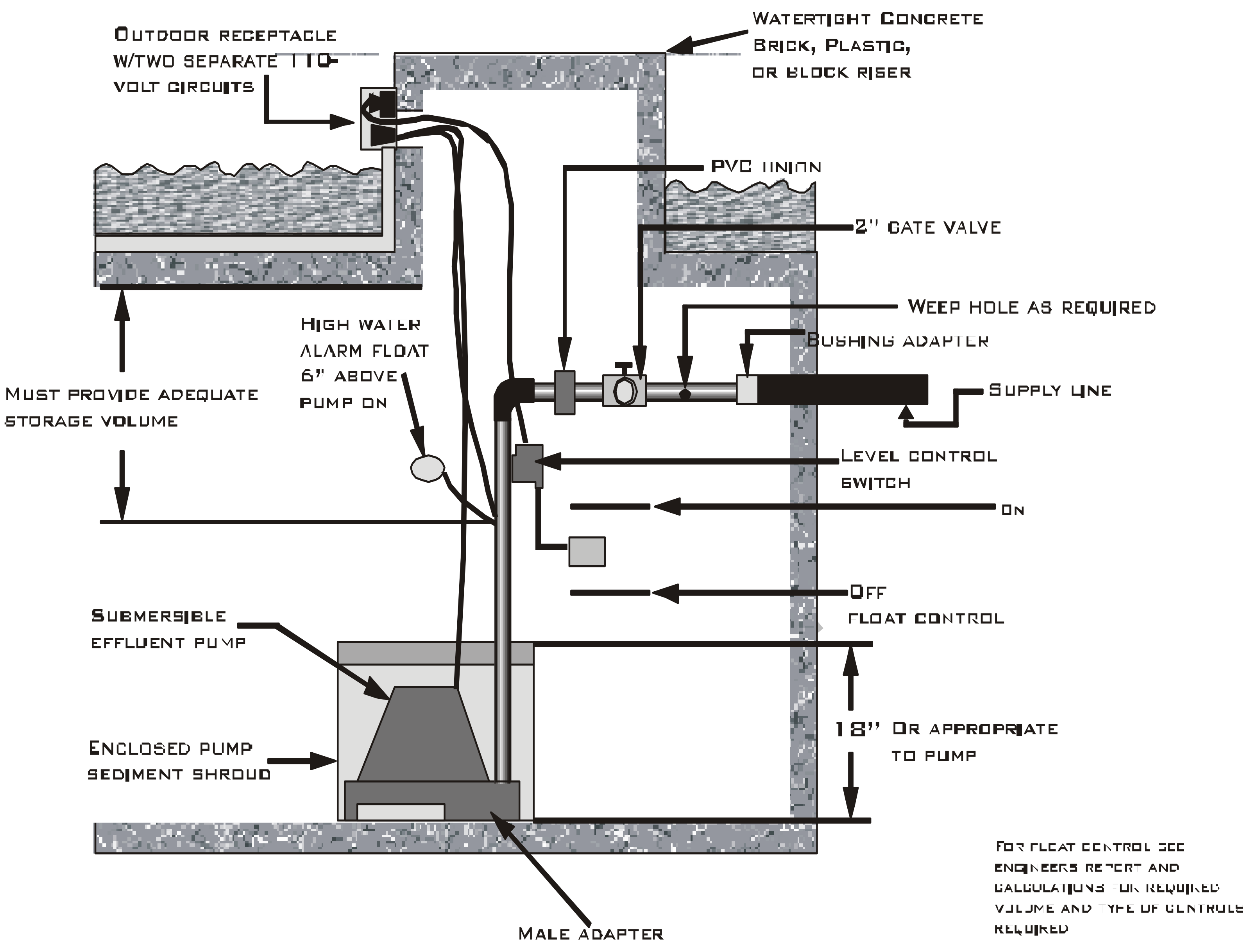

Figure VII-8. Dosing Pump Tank

The return manifold on the opposite end of the drip field or on the same side, is the same diameter pipe. This carries the effluent that was not dosed out of the emitters back to the pump tank. The drip lines are connected to the return manifold on spacing the same as the supply manifold. This line must also be installed on a grade that allows total drain back to the pump tank after each pump cycle, to prevent freezing.

The return manifold pressure valve is a 1¼ inch PVC ball valve located in a valve box just a few feet past and below the last drip line in the return manifold. This important valve controls the operating pressure in the field, usually at 20 psi. The pressure is set using a glycerin filled gauge installed in the return manifold, just up-stream of the return manifold pressure valve and housed in the valve box. One manufacturer's manual recommends a factory pressure regulator pre-set at 20 psi located in the supply manifold control box. However, in freezing conditions, regulating the pressure on the return manifold with a partly closed valve has proven to be less troublesome than a regulator. The manufacturer has agreed that in specific situations, such as freezing conditions, this would be a recommended method of regulating pressure.

Vacuum breakers are installed at the high points of the field to prevent vacuum in the supply and return lines that would suck soil into emitters when flow stops. With subsurface drip it is an absolute necessity to have a vacuum breaker at the high points. Most systems will have only two high points; the tops of the supply and return manifolds.

Designing the Drip System

Select the area with careful consideration for the best soil available and suitable topography. The system can usually be installed on sites with steep slopes, small and irregular lots, or wooded areas by using careful planning for line locations. However, the topography must permit the manifolds to drain to the tank when the pump is off.

Note: The following paragraphs about design are taken from *Subsurface Trickle Irrigation System for Onsite Wastewater Disposal and Reuse* by B.L. Carlile and A. Sanjines.

Even though the drip system maximizes the soil absorption rate through the low rate of application, thus keeping the soil below saturation, there will be times when the soil is near saturation from rainfall events. The design must account for these periods and assume the worst condition of soil saturation.

Using a safety factor of 12, a suitable design criterion would be to load the system at the estimated hydraulic conductivity, but apply water for only a total of 2 hours per day out of the available 24 hours. The wastewater should be applied in "pulses" or short doses several times per day. Since the driplines are near the surface where the soil dries the quickest, the soil absorption rate is usually a higher value and the potential of water surfacing is minimized. This design criterion should avoid an overload except when the soil is near saturation from rainfall.

Table VII-4 shows the recommended loading rates in gallons per day per square foot (gpd/sq ft) for various soil types, hydraulic conductivity, and perc rate conditions. The loading rates shown are based on treated effluent with BOD and TSS values less than 20 mg/L. The size of the dispersal field can be calculated by dividing the total daily flow in gallons by the "hydraulic loading rate." For example, a daily flow of 450 gallons in a soil with a loading rate of 0.2 gal/sqft/day would require a field area totaling 2,250 square feet.

"Soil Type" should be based on the most restrictive layer within two feet of the bottom of the dripline. In many cases, a one-foot separation has proven successful; however, local regulations should be followed.

Drip System Installation

- During very dry conditions, the soil should be conditioned with water a few days before installing the drip system. It is much easier to install the system in moist soil. The best preparation is to apply a few inches of water to the soil at least 3 days before installing the dripline so the soil has time to drain. When the soil is very dry, 2-3 inches of water should wet the soil below the dripline depth. The soil surface should be moist but not wet so the tractor pulling in the drip line maintains traction.
- Many parts are needed, so be sure to have all supplies required before opening trenches. Before opening the trenches, pre-assemble in a comfortable place as many sets of components as will be needed.
- Handle the dripline and components with care. To help assure a long life, store the dripline in a shaded, cool place. Avoid hot temperatures, especially when handling and placing the tubing.
- Mark the four corners of the field with stakes. The top two corners should be at the same elevation and the bottom two corners should also be at the same elevation. On irregularly shaped areas, more markers may be required to maintain required grades. Be sure to maintain a positive grade at the planned manifold locations.
- Locate the watertight pump dosing tank to receive pretreated effluent by gravity flow. To prevent freezing of lines, the tank must be positioned to allow the manifolds to drain back after each pump cycle, thus the tank must be at the lowest elevation of the system. Install a watertight riser from the dosing tank to the ground surface for easy access for service.

Table VII-4. Loading Rate Guide for Soil Types and Properties

Soil Type	Approximate Hydraulic Conductivity, in/hr	Perc Rate min/in	Loading Rate gpd/sq ft
Coarse Sand	>22.0	<5	Not Recommended
Fine Sand	1.5 - 21.6	5 - 10	Not Recommended
Sandy Loam	1.0 - 1.5	10 - 20	1.3
Loam	0.75 - 1.0	20 - 30	0.9
Clay Loam	0.5 - 0.75	30 - 45	0.6
Silty Clay Loam	0.3 - 0.5	45 - 60	0.4
Clay Non-swelling	0.2 - 0.3	60 - 90	0.2
Clay Swelling	0.1 - 0.2	90 - 120	0.1
Very Tight Clay	<0.1	>120	0.075

- Based on the flow rate required for the SDD field, size the pipeline to assure minimum velocity for scouring and to achieve acceptable friction loss (this is often 1¼ inch pipe).
- On the supply side of the field the dig a trench at least 12 inch wide and 12-15 inch deep from the dosing tank to the bottom stake and then to the top stake on the same side. See Figure VII-9. Run the supply pipe from the tank to the field's lower corner of supply side.
- On the opposite end of the field, paint a line on the surface from the other bottom corner to the other top corner.
- Using the insertion plow, install the dripline at the design depth from the trench to the painted line on the other end. When the dripline reaches the painted line, raise the plow and cut the dripline, leaving about 1 foot above ground level. Continue this process on 2-foot centers until the required length of dripline has been installed.
- Place the supply manifold pipe in the trench and attach the dripline extending out of the trench wall to the pipe. Make this connection following the manufacturer's guidelines (see Figure VII-9).
- Attach the pump to the supply line manifold, and pressurize the system. The pump should be left on long enough to see water flow from each of the driplines sticking up from the ground on the other end. This will assure there are no obstructions in the dripline and flush any debris from the line.
- Dig the trench for the return manifold pipe on the other end of the field, next to the exposed driplines and repeat the process for attaching the driplines to the return pipe.
- Install a vacuum breaker at the top of both the supply and return manifolds in accessible valve boxes with enough air space so debris could not be sucked into the line. See detail on Figure VII-9.
- Install a large valve box on the supply line just below the corner of the drip field. Install in it the filter, the flush line returning to the pretreatment tank, and a ball valve with pressure gauge port to check pump.
- Install a small valve box on the return manifold just below the last dripline and install the inline pressure adjustment valve (ball or gate type) for the field. To make it more convenient to adjust the pressure, install a T with a shut off valve and port to connect the pressure gage on the field side of this valve.

Follow manufacturer or distributor information about choosing and installing pump tank, pump, timer control panels, and floats. This information should be available from the local dealer.

Maintenance of Drip Systems

Maintenance is essential for drip systems. It is strongly recommended that the entire system be cleaned and checked by a licensed service company every 6 months. The filters in the system including the tank effluent filter must be checked regularly and cleaned as needed. The components of the pump tank that distribute the flow, require periodic maintenance as expected from any mechanical equipment. The system should be installed with an alarm system to notify the homeowner if the system is not operating correctly.

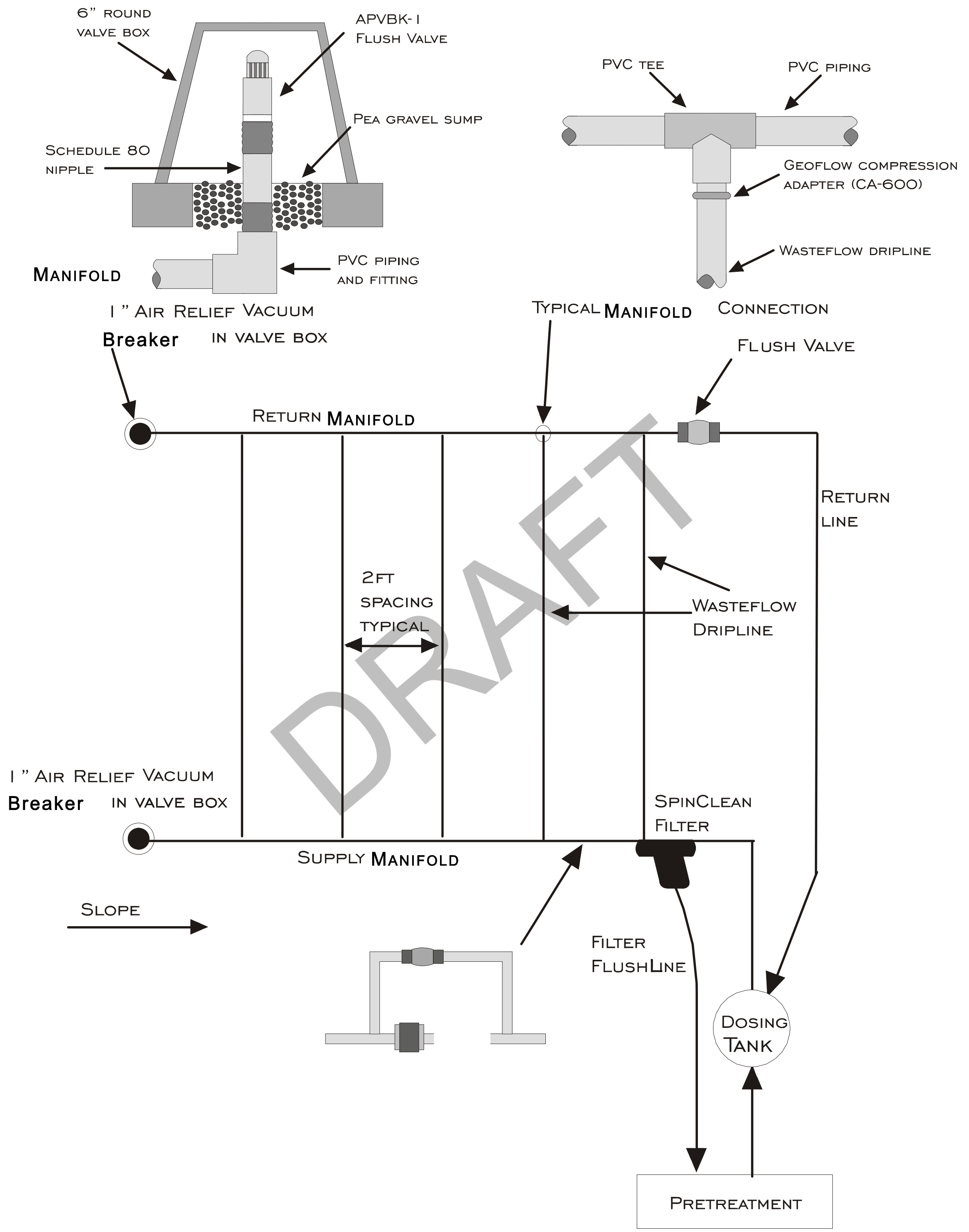

Figure VII-9. Typical Drip Field Layout

REFERENCES AND READING MATERIAL

Publications Regarding Soil Absorption Systems and Related Topics

Available from K-State Research and Extension, Distribution Center, 34 Umberger Hall, Manhattan, KS, 66506-3402, www.oznet.ksu.edu/library/ (search by title or number).

Onsite Wastewater Publications

A Spreadsheet for Lifecycle Cost Analysis of Individual Septic Tank-Soil Absorption and Lagoon Wastewater Treatment Systems, on the web at www.oznet.ksu.edu/olg/programs/enviro_mgmt/pvhwts

Environmental Health Handbook, 2nd Edition, on KDHE web site at www.kdheks.gov/nps/lepp

Get to Know Your Septic System (Onsite Wastewater Treatment), MF-2197, October 2000

Minimum Standards for Design and Construction of Onsite Wastewater Systems, KDHE Bulletin 4-2 (also K-State Research and Extension, MF-2214), November 1997

Plugging Cisterns, Cesspools, Septic Tanks, and Other Holes, MF-2246, July 1998

Selecting and Onsite Wastewater or Septic System, MF-2542, August 2004

Septic Tank Maintenance: A Key to Longer Septic System Life, MF-947, August 1998

Site and Soil Evaluation for Onsite Wastewater Systems, MF-2645, March 2004

Soil Compaction – Problems and Solutions, AF-115, July 1996

Why Do Onsite Waste\water (Septic) Systems Fail?, MF-946, November 2005

Your Wastewater System Owner/Operator Manual, S-90, September 2004

Subsurface Drip Irrigation (SDI) Publications

Design Considerations for Subsurface Drip Irrigation (SDI) Systems, MF-2578, July 2003

Drip Irrigation for Vegetables, MF-1090, October 1993 Note; gardens must not be grown in wastewater absorption fields.

Filtration and Maintenance Considerations for Subsurface Drip Irrigation (SDI) Systems, MF-2361, January 2002

Maintaining Drip Irrigation Systems, MF-2178, April 1996

Management Considerations for Operating a Subsurface Drip Irrigation (SDI) System, MF-2590, November 2003

Subsurface Drip Irrigation (SDI) Components: Minimum Requirements, MF-2576, July 2003

Subsurface Drip Irrigation System (SDI) Water Quality Assessment Guidelines, MF-2575, July 2003

Subsurface Drip Irrigation (SDI) with Livestock Wastewater, MF-2727, May 2006

Available from MidWest Plan Service, 122 Davidson Hall, Iowa State University, Ames IA 50011, phone 800-562-3618, web address www.mwps.org

Residential Onsite Wastewater Treatment Systems: An Operation and Maintenance Service Provider Program, Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT), January 2006.

PROTOCOL

INSPECTION OF NEW ONSITE WASTEWATER (SEPTIC) SYSTEM

GOAL: Ensure system integrity to protect drinking water supplies, to prevent contamination of ground and surface water of the state, and to treat and disperse human waste in a sanitary manner to protect public health and meet state standards.

POLICY: The evaluation of the installation of a new wastewater system (pretreatment and soil absorption field) will be completed as requested when the necessary paperwork has been completed and essential fees paid by the landowner, contractor, lending agency, or their representative. The inspection shall address all evaluation points listed here and will occur before the backfill of the underground portions are completed. An assessment report summarizing the inspection shall be provided to all persons who have legal interest in the outcome. A file of all original documents including: letters, data, supporting information, etc. shall be maintained by the administrative agency.

EVALUATIONS:

1. Septic tank: verify the tank condition and that the dimensions, capacity, manufacturer, and model is approved by KDHE, and meets state and local standards for septic tanks.

   A. Check that tank manufacturer's name, phone number, month and year of manufacture, capacity, and model are displayed on the tank. Verify that this model meets state minimum standards and is approved by KDHE.

   B. Check the tank for possible damage from handling.

   C. Using a contractors or carpenters level, check that the tank is set level on a gravel base in the excavation as specified in EHH, Chapter V, *Septic Tanks*.

   D. Check that the tank access ports and manhole risers meet all requirements. Assure that access ports and manholes extend to surface grade for easy access and are watertight.

   E. Check dimensions of length, width, depth below outlet invert, and verify tank capacity.

   F. Check distance to bottom of inlet and outlet tees or baffles from the bottom of tank.

   G. Check effluent filter (if present) to be sure that it is easily accessible for service via riser at the surface.

   H. Use a contractors or laser level to measure and record elevations of the sewer pipe where it exits the building, inlet to the tank, outlet from the tank, and absorption field lateral(s). Verify that the slope on the sewer pipe from the house to the tank is1/4 inch per foot or 2 percent. Verify that the elevation difference from the tank inlet to the outlet has a minimum 3-inch fall.

   I. It is appropriate to verify that the tank is water-tight by filling it with water and measure loss over several hours.

2. Other tank related items:

   A. The inlet and outlet pipes of the tank meet the minimum standards (Schedule 40), and are properly installed, adequately supported, and are either securely connected to T's or terminate on the outlet side of the baffle.

   B. Two-way clean-outs are provided every 100 feet along sewer lines that exceed 100 feet in length and carry solids from the building to the tank. It is easier to clear clogs when these clean outs are no more than 100 feet apart.

   C. Two-piece tanks are joined with an approved sealant so the joint does not leak and the joint is grouted inside and outside to make a smooth durable finish.

   D. When the soil cover over the tank exceeds 12 inches, extension risers to the ground shall must be installed over all openings. When tanks have multiple compartments, each one must be accessible for service and inspection. The manhole for each compartment must have a minimum dimension of 20 inches and should be centered.

   E. When backfill is complete, use a probe to verify that fill around tank is adequately compacted.

3. Absorption field area - verify the field condition, dimensions, and capacity, and that the quality of materials used meets the minimum standards. If conditions are suitable (sufficiently dry, no compaction, and no traffic) proceed to verify the following:

   A. Measure and record for each lateral: length, width, and undisturbed distance between laterals.

   B. Approved perforated distribution pipe or chambers are used for all laterals.

   C. Material separation (filter) fabric covers aggregate and meets the required minimum.

   D. Inspection ports (observation pipes) installed appropriately in laterals as required.

   E. Fill around piping, distribution box, manifold pipe, and drop boxes is compacted.

   F. If a subsurface perimeter drain is used, measure and record the separation distance from soil absorption field, depth, length of drain lines, and location of lines and outlets.

   G. Check and record the following elevations (where possible, use the pipe invert):

      - Check elevation of distribution manifold pipe at each lateral tee or elbow and at least one point between. Elevations should vary no more than ½ inch or 0.05 feet.
      - Check lateral trench and distribution pipe (elevation of trench bottom, top of distribution pipe, and top of rock). Trenches shorter than 50 feet, check at least 2 locations. Trenches longer than 50 feet, check at least 3 locations.

      Note: It is difficult to check elevation of trench bottom after rock has been placed. Recommend requiring contractor to make a record of trench bottom elevations and inspector makes random check for minimum depth of rock under pipe.

H. Reserve absorption field area with length, width, and all setback distances is defined and has been protected during house and septic system construction on the site.

Additional requirements for stepdown (serial) distribution system.

A. Determine that drop-box (or crossover pipe used in place of preferred drop box) inlet invert elevation is at least 1 inch higher than the overflow invert and lateral outlet inverts are at least 3 inches below overflow invert.

B. Top of the gravel in laterals is 2 inches above the of the drop-box overflow invert elevation. This prevents continuously saturating the soil above the lateral by capillary action.

C. Check drop-box or crossover pipe elevations as follows (use the pipe invert when possible or top of pipe when it is the same diameter): drop-box inlet invert, trench lateral pipe outlet invert, overflow pipe invert, top of lateral gravel.

4. Measure and record setback or separation distances as follows: (Note: make drawing of system layout on the site including measurements and calculate square footage of absorption and reserve field.)

A. Septic tank to building foundations (existing and planned buildings).

B. Septic tank to all existing (and unused) wells or planned new water well locations.

C. Absorption field to existing (and unused) wells or planned new water well locations.

D. Absorption field to buildings (existing and planned).

E. Absorption field to property line.

F. Absorption field to any surface water or water course.

G. Absorption field to important topography features such as a drop off.

H. Reserve absorption area available for replacement of existing system in the event of failure or expansion. Also, verify all setback measurements for the reserve area.

PROTOCOL

EVALUATION OF EXISTING ONSITE WASTEWATER (SEPTIC) SYSTEM

GOAL: Ensure system integrity to protect drinking water supplies, to prevent contamination of the ground and surface water of the state, and to treat and disperse human waste in a sanitary manner to protect public health and meet state standards.

POLICY: Evaluation of an existing septic tank and soil absorption system will be completed at request of the landowner, lending agency, complainant, or other interested party. The inspection should address the evaluation points listed below. An assessment describing the evaluation should be provided to all individuals who have legal interest in the outcome of the evaluation. A file of all letters, data, supporting evidence, and documents shall be maintained by the administrative agency.

EVALUATION:

1. Obtain all known information about the system from the file, property owner, contractor, and/or complainant. Supplement this with all available information from other readily available sources especially the County Soil Survey (web soil survey).
2. Conduct a visual survey of the site. Note any discharge areas, effluent surfacing, or evidence of previous effluent surfacing. Note any odors, wet soil, vectors, and damaged or burned vegetation.
3. Locate the point where the household sewer pipe(s) leave the house. This can be aided by the following:
   - In the basement trace the sewage pipes to the point where they exit the house.
   - Where there is no basement or where household sewer lines are not visible, locate the household sewer stack vent on the roof; it is often above the pipe exit.
   - Look for a clean out just outside of the house foundation.
4. Locate the septic tank and absorption field using the office file, information provided by property owner, grass patterns, surface depressions, and if possible verify location with a probe. Radio operated tank location devices may also be used to locate septic tanks.
5. All household wastewater must enter the septic tank. The only exceptions are potable water, backwash of potable water filter, or air conditioner condensation. Roof drains and sump pump must never enter the wastewater system. Because water softener recharge is backwash of potable water, it can be surface discharged.
6. Perform dye test, if necessary, to verify source of surfacing flow. Monitor the absorption field and surrounding area, including nearby streams, tilled fields, ditches and embankments for surfacing of dye. There shall be no discharge of wastewater to the ground surface or any surfacing in the absorption field area or downslope from it.

7. Septic tank evaluation:
    - Record tank construction, size, condition, and if possible age from records. If necessary determine tank size from measured dimensions or from tank pumping records.
    - Record the last date the system was pumped and the name of the septage pumper/hauler. If the tank has not been pumped within the last three years, pumping is required.
    - Open the tank and observe the contents. If water level is below the outlet pipe invert, suspect leakage — this represents a cause to replace the tank.
    - When tank is pumped inspect condition of tank and components - baffles, tees, effluent filter, and check that lids are in place and in good condition. Measure and record the dimensions, construction, and size of the tank.
8. Using visual indicators and probe attempt to locate absorption field and verify length, width, number of laterals, and total square feet. Probe for rock/gravel and observe vegetation changes to help identify lateral locations.
9. If a map of the system on the site does not already exist, sketch a map of the system showing locations, setbacks, and dimensions. Clearly show date and mark that this is based on field probing and may not be accurate.
10. If necessary obtain the required registration permit application and fee from the owner and properly record this in the county files.
11. To complete the evaluation, avoid any written statement regarding expectations for future performance. Remember to compare all conditions with local code, state minimum standards, and recommendations. The evaluation should note any inconsistencies and state whether the system was in active use and the number of users at the time of evaluation.
12. Notify owner and other interested parties in writing of final evaluation and of any necessary course of action.
13. File copies of all pertinent information with the local permitting agency.