A SunCam online continuing education course

An Introduction to Drip Irrigation Septic Systems

by

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Introduction:
This course presents an overview of an alternative type of septic system design known as a drip irrigation system. More conventional septic systems depend on percolation into the soil and, therefore, are reliant on at least relatively permeable underlying soil material. In some locations these conventional types of systems will not function properly due to a variety of soil characteristics. To address the issue of marginally permeable soils a number of alternate septic system designs have been developed. One of these is known as a drip irrigation septic system. There are several references that can be consulted on this subject. Some of the material in this course is based on the following publications:

1. The New York State Department of Environmental Conservation Division of Water manual entitled "New York State Design Standards for Intermediate Sized Wastewater Treatment Systems".
2. The New Jersey Department of Environmental Protection's "Standards for Individual Subsurface Sewage Disposal Systems".
3. The United States EPA's publication "Drip Distribution System" found on their website: https://www.epa.gov/septic/types-septic-systems#dripdistribution.
4. Product brochures from various manufacturers of system components.

It should be pointed out that this course can only present an outline (and a descriptive one, at that) of these types of systems and that the engineer must familiarize himself or herself with all design criteria prior to actually designing a drip irrigation septic system.

When you complete this course you should be familiar with drip irrigation septic systems and understand the basic components and workings of these systems. You should also know the relative advantages and disadvantages of employing drip irrigation septic systems vs. more traditional types of septic installations.

Traditional Septic Systems:

Traditional septic beds typically are made up of a combination of a sandy fill material, gravel, perforated PVC pipes and a topsoil layer. The fill material (which is not always required, depending on the nature of the underlying soils) is the main filter medium for the septic effluent. However, the long-term success for these types of systems is dependent on the underlying soil being permeable enough to accept this effluent.
In a typical septic bed installation, the bed itself consists of four feet* of a zone of disposal and at least two feet of a zone of disposal. Ordinarily the zone of treatment (and sometimes part or all

of the zone of disposal) is made up of fill sand (known either as “select fill” or “suitable fill”) which is brought onto the site from a commercial quarry. This suitable fill has specific gradation and permeability characteristics. The laterals and gravel are placed above these zones.
*The four feet may vary depending on the jurisdiction and other factors.

The photograph below shows the installation of a traditional septic system. This system is a pressure-dosed system with a manifold (visible in the foreground) that feeds the individual laterals.

Septic beds can also be constructed with permeable, plastic infiltrating units such as shown in the installation below.

In some cases (for instance if there is very high ground water) the system must be raised in what is known as a mounded septic system. A photograph of a typical septic mound is shown below. Note that a mound like this can be unsightly and can greatly detract from the curb appeal of a home. In addition, the mound, itself, cannot really be used even for passive recreation and is a "sore spot" in the yard.

Another mounded system is pictured below along with the pump and septic tank manholes. It can be seen that this particular system is immediately adjacent to the gravel driveway for the dwelling.

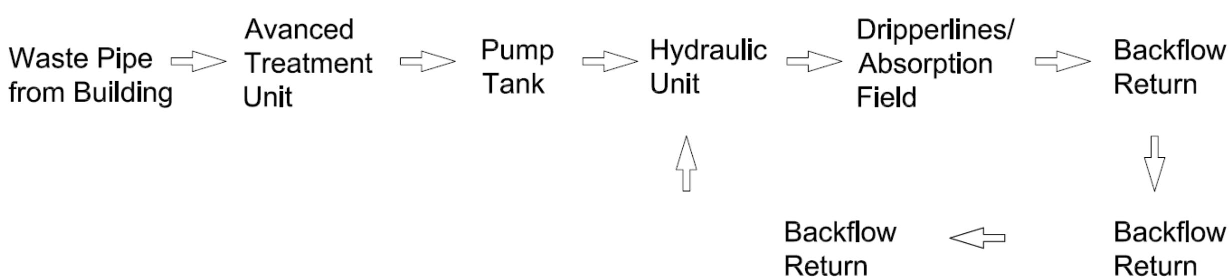
These photographs show that a mounded system is not always an ideal solution. This is one of the reasons that various alternative types of systems have been developed. In fact, perhaps the main advantage of the drip irrigation system is that it can be used in areas of questionable soil or high groundwater but does not require nearly as high a mound as a more traditional system.

What is a Drip Irrigation Septic System?

A drip irrigation septic system is a type of alternative septic installation that does not rely as heavily on soil permeability for its performance. (However, the soil must have at least a certain minimum permeability for any type of septic system to work long-term). Unlike a traditional septic system, in a drip irrigation system, the wastewater moves slowly through "drips" using techniques that were originally developed for agricultural irrigation systems. The system uses

polyethylene tubing with built-in turbulent flow emitters to spread the effluent into the absorption field. Because of this tubing design, these systems can be used in irregularly-shaped lots and on properties with marginally-permeable soils.
One of the most innovative things about a drip irrigation system is that the use of the pumps, flow metering devices, and emitters, spread the effluent out (both in space and in time) over the entire absorption bed. This can be seen when the system is being tested just prior to backfilling, In a conventional pressure-dosed system, when the pump is turned on the water flies out through the holes in the laterals at a very great rate. However, in a drip irrigation system, when the pump is turned on the emitters only allow the water to drip out through the holes at a very slow rate. Anyone watching the testing has to stand right next to an emitter to actually see the water dripping out. This more gradual and more even distribution of the effluent is what leads to less reliance on the overall permeability of the soil.

A schematic of a typical drip irrigation system is shown below. There are several variations to this layout but the typical arrangement shown below indicates the raw effluent coming from the building into the advanced treatment tank and, from there, being sent to a pump tank and the hydraulic unit before finally heading out to the dip field for ultimate treatment. Note the backflow return which send excess effluent back into the hydraulic unit to re-do the final portion of the treatment cycle.



Drip Irrigation Septic System Schematic

There are quite a number of manufacturers who provide the various components involved in drip irrigation septic systems. Not surprisingly, many of these manufacturers provide products (e.g. advanced treatment units) that work is somewhat unique ways. For instance, some advanced treatment units make use of coconut fiber filter media, whereas others utilize a combination of aeration, anoxic, and clarification chambers. Once again it is up to the individual design engineer to decide which type of advanced treatment unit is correct for the particular design under consideration. No individual products are referenced by name in this course.

Components of Drip Irrigation System:

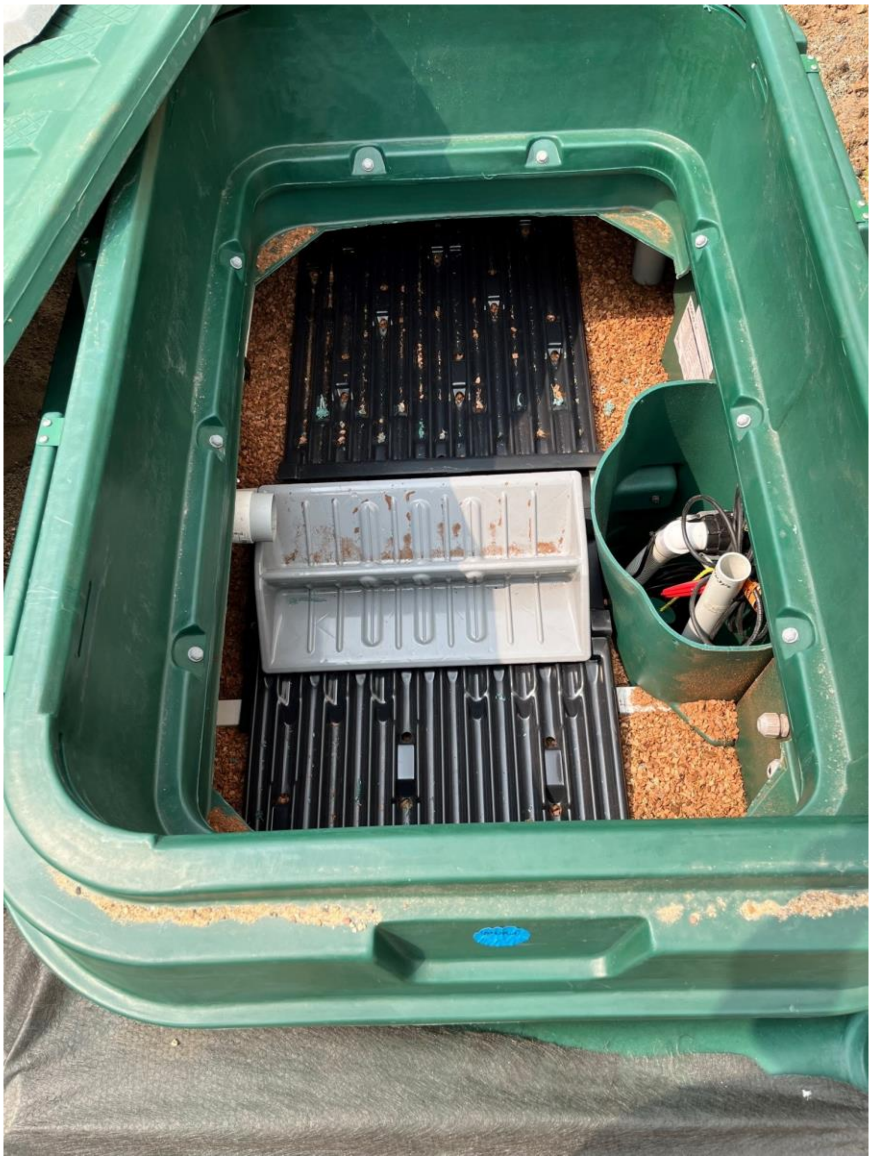
A drip irrigation septic system includes several different components including the following:

1. Pretreatment devices and a treatment tank.
2. A pump tank including a pump and controls.
3. A flow metering device.
4. An hydraulic unit, sometimes known as a filter unit.
5. The drip irrigation absorption system.

Each of these components will be discussed in some detail below:

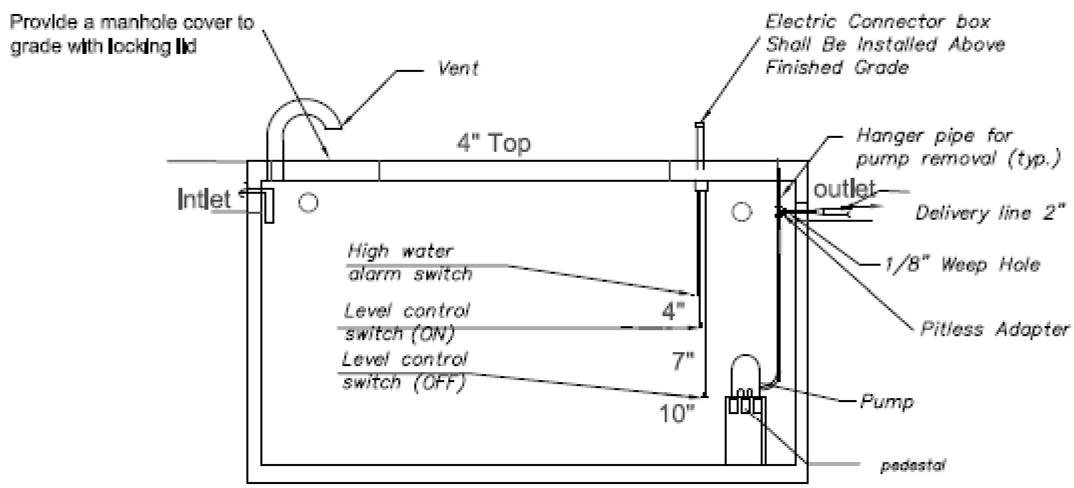
1. The pre-treatment unit is often known as an advanced treatment unit. There are several different suppliers of these units and many varieties of the units themselves. An advanced treatment unit is a product that is certified by the NSF (The Public Health & Safety Organization) to provide additional advanced treatment prior to the effluent reaching the septic field. Advanced treatment units provide pre-treatment of the raw effluent prior to sending this effluent into the remainder of the septic system. It should be noted that drip irrigation systems are often designed in locations where there is a high water table. For this reason, the engineer should always check for buoyancy with the advanced treatment unit and with the septic and pump tanks. If buoyancy calculations indicate that one or more of these tanks might be subject to flotation, then addition measures need to be taken. These measures can include: (i) using a heavy duty tank with a traffic-loaded lid which is much heavier than a non-traffic bearing unit, (ii) placing concrete ballast in the bottom of the tanks (be sure to check to see that there is still adequate volume available after subtracting the volume of the ballast), or (iii) providing tie-downs with some heavy ballast (e.g. concrete blocks, etc.) outside the tanks to prevent flotation.

   The photograph below shows a coco-nut-fiber advanced treatment unit. As stated above, this is only of many types of advanced treatment units that are available. The inflow pipe is on the left side of the photo and it flows into the gray “balancing tray” which flips back and forth after each pump cycle to evenly distribute the effluent into the coconut fiber filtering media. (The coco fibers media is visible as the orange material that can be seen in the lower portion of the tank0. The balancing tray delivers effluent into the black trays visible in the photograph, which have holes dispersed at different locations to effectively distribute the effluent into this media. The pump is located on the right-hand side of the unit. Once the effluent reaches a sufficient depth it will be pumped from the advanced treatment unit into the pump tank and then into the hydraulic filter unit and, finally, into the drip field.



2. Pump tanks are used in a variety of septic system installation and certainly not just in drip irrigation types of systems. A schematic diagram of a typical pump tank is shown below. Obviously, the pump needs to be designed to pass the required dosage across whatever head is involved (including elevation difference

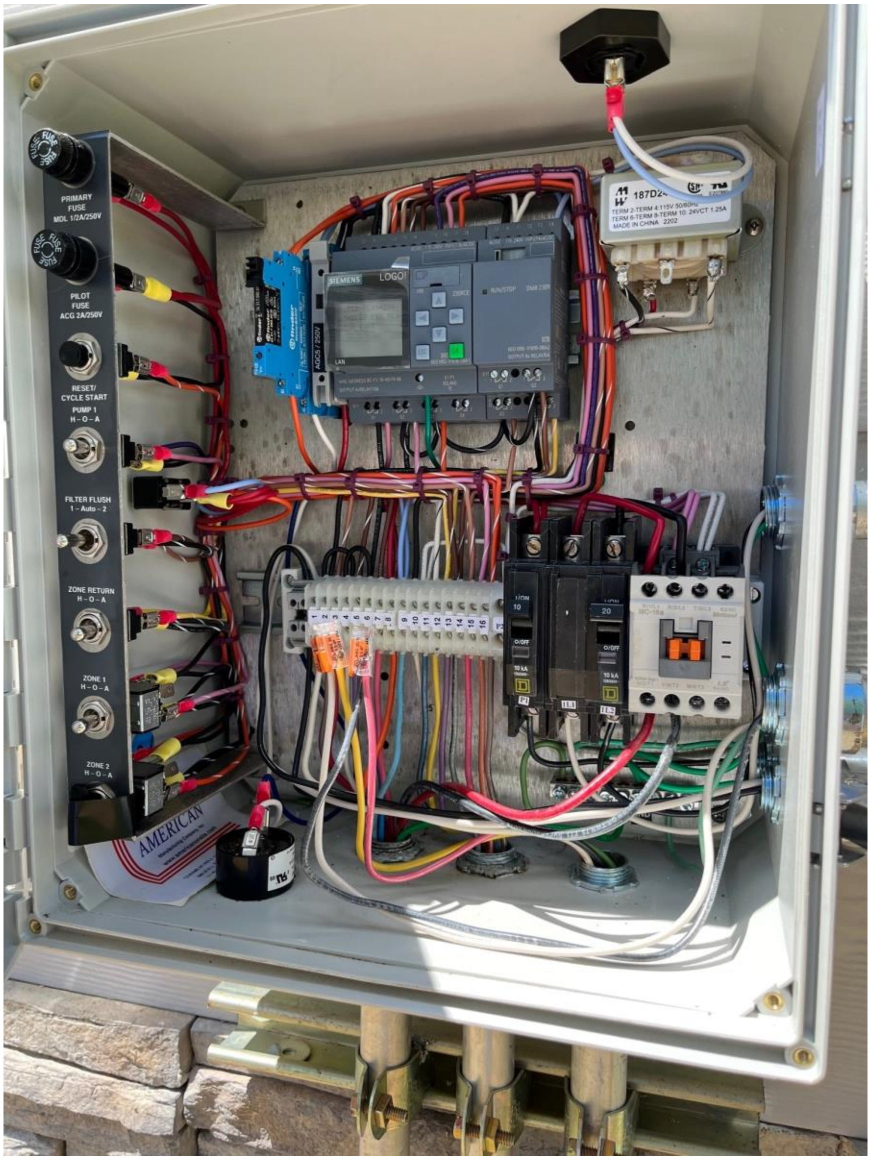
and friction losses). The pump tank should have sufficient storage volume in case of a malfunction of the pump. In some cases, dual pumps are utilized to prevent back-ups.



Section View
Schematic Pump Tank Detail

3. The flow metering device should be able to accurately calculate flows, count the pump cycles, determine the elapsed pump time, count automated flushing events and report any times that the alarm sounds. This is generally accomplished by providing a system control panel that includes the following:
   - A programmable timer capable of regulating and recording the dosing frequency and volume.
   - Manual capability to determine filter flushing, dosing, and flushing.
   - Components that are all UL listed.
   - A schematic and manual that is provided to the property owner.
   - Telemetry or an auto dialer for alarm conditions related to drip dispersal components (as well as any alarms required in the pump system). Note that these are alarms are wi-fi connected and automatically contact both the property owner and the maintenance company in the case of a problem.
   - Switches that are clearly identified and all wiring that is factory installed.

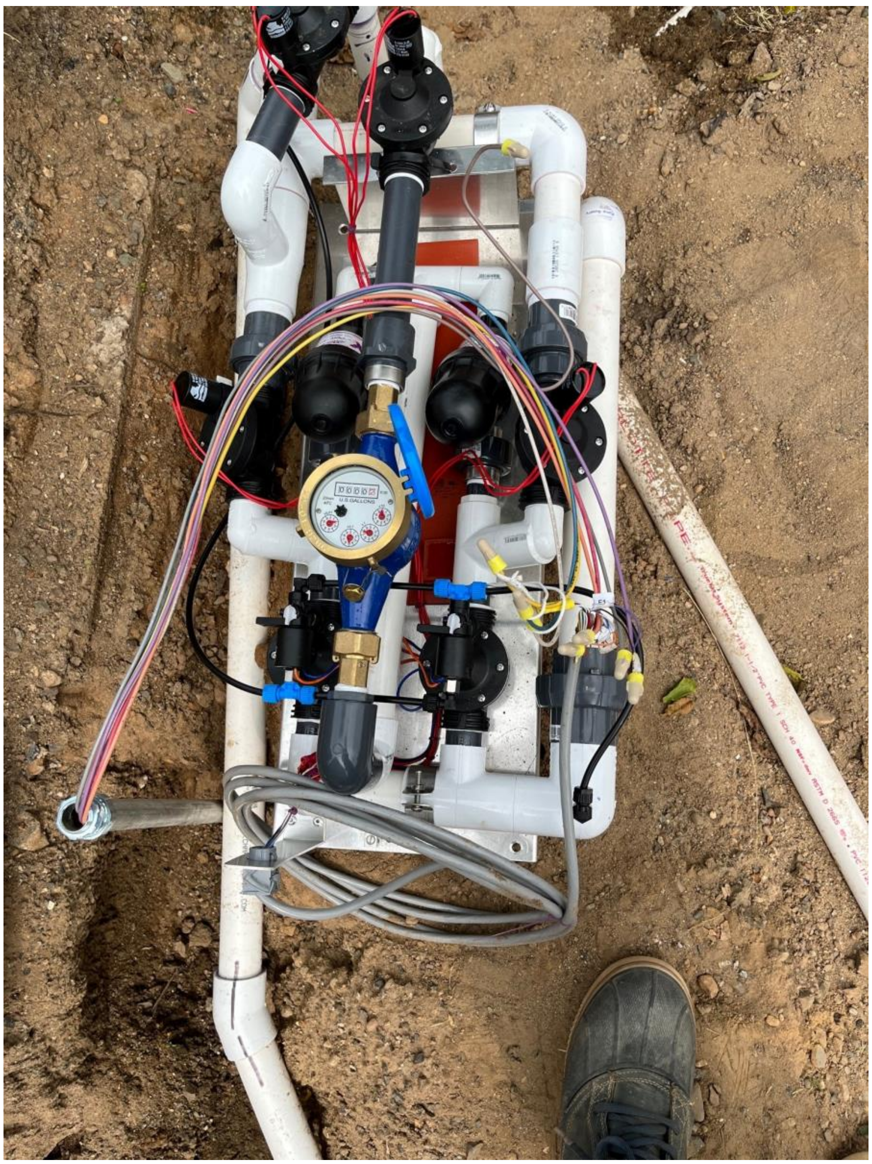
A photograph of a typical control panel is shown in the photograph below. This panel has all of the above-named features (and more) included. Obviously, a control panel like the one pictured here needs to be monitored and maintained by a qualified professional.



4. The hydraulic unit provides final filtration (prior to the effluent reaching the absorption field) using in-line screen or disk filters to remove total suspended solids that could clog the emitters in the dripperlines. The system should be designed to return filter and drip tube flush residuals to the head of the settling tank for primary settling prior to the dosing station. In no case shall the filter and drip return flush return volumes exceed the hydraulic capacity of the pre-treatment device. It is important to keep in mind that the hydraulic unit (and

other system components, for that matter) must be protected from freezing in accordance with manufacturer's recommendations (where climatic conditions warrant such protection).

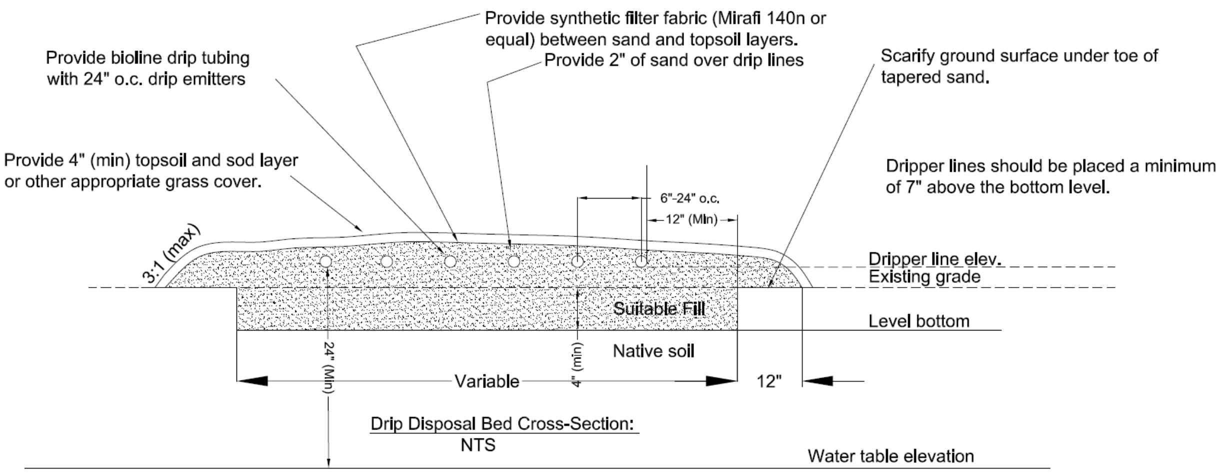
A photograph of the interior of a typical hydraulic filter unit is shown below. This unit is set up for a single zone and includes a water meter, pipes for the supply and return lines, valves, and other components. The red pad visible towards the bottom of the unit is actually a heating unit which comes on automatically in winter in cold climates to prevent freezing within the hydraulic unit.



5. The drip tubing (or dripper lines) are part of the actual absorption field. They can be thought of as analogous to laterals in a more conventional type of system. The dripper lines can be installed using a variety of methods. They can be installed below the ground surface using a standard trenching device, a vibratory plow, or by hand installation. The lines can be at most 12 inches below the surface, with a slightly lesser depth (approximately 6 to 8 inches) considered optimum. The lines can be dug into the ground (as in the photograph below) or they can actually be plowed into the surface. They should be placed at least 24" above any "limiting zone" (e.g. groundwater table, bedrock, clay layer, or other unsuitable soil stratum) and they can be placed between 6" and 24" apart, horizontally. In the photograph, the purple lines are the actual dripper lines whereas the white pipes are simply temporary devices to keep the dripper lines in place while the installation proceeds. A close look at the photograph reveals that this system is set up for two zones. (The purple lines are not continuous). There will be separate feeder and return lines for each zone.

A close-up photograph of a dripper line is shown below. The line has been cut open to show the drip emitter apparatus. As was mentioned earlier, these emitters are designed to allow "drips" of effluent into the septic field. This process distributes the effluent very slowly and evenly throughout the field in a way that is similar to the way an irrigation systems provides water to crops.

A typical drip irrigation bed absorption field schematic detail is shown below:



The drip tubing will distribute the effluent into the septic field where it will slowly make its way into the native soil layer.

It is important that the "suitable fill" or sand material that goes into the absorption field meets the proper gradation. A typical requitement for this fill is as follows:

- Between 80% and 100% passing a no. 8 sieve (2.36 mm)
- Between 50% and 85% passing a no. 16 sieve (1.18 mm)
- Between 25% and 60% passing a no. 30 sieve (0.6 mm)
- Between 10% and 30% passing a no. 50 sieve (0.30mm)
- Between 2% and 10% passing a no. 100 sieve (0.15 mm)

The permeability of the material should be between 6 and 20 inches per hour. While the quarry providing the fill material can often provide certification of the gradation of the sand, it is desirable (and, in some jurisdictions, required) for the engineer to do an independent sieve analysis on the material before it is placed into the absorption field.

The photograph below shows a typical suitable fill sand sample collected in a bag at a drip irrigation construction site for testing by a sieve analysis. Only a relatively small sample (about 200 grams) ordinarily needs to be collected for this type of test.

The photograph below shows a drip pump tank in the background and a septic tank/advanced treatment tank in the foreground prior to backfilling. The advanced treatment portion of the tank is shown to the right and the more standard septic tank component (where the solids will settle out) is shown to the left in this picture. The advanced treatment tank shown in this photograph is the same one pictured on page 9.

After backfilling, the systems pictured above will look more the photograph shown below:

Despite the fact that so far the individual components of the system have been described separately, the entire system should be configured as a complete pre-engineered package from a system integrator.

All drip irrigation septic systems should be designed with necessary check valves, piping configurations or elevated loops to prevent re-distribution of the effluent in the dispersal area by gravity when the pump is shut off. The system integrator's package should include head loss tables, charts, and/or formulas for the filtration headworks and for various drip tubing lateral lengths, during a dosing and flushing cycle and should also include minimum and maximum zone size for proper dosing and flushing of the drip dispersal system. The minimum scouring/flushing velocity (which should never be less than 2 feet per second) for the distal end of the drip tubing should also be specified, along with the maximum and minimum operating pressures.

Sizing the System:
As with any type of septic system the components have to be sized in accordance with applicable state and local regulations. Prior to designing the system, the engineer should check with the governmental agency having jurisdiction to determine the exact design criteria to be utilized. In New Jersey, for example, septic systems for single family dwellings are designed based on the following:
Estimated daily flow is determined based on the number of bedrooms. A one-bedroom dwelling is assigned a flow of 200 gallons per day (GPD) and, for each bedroom after the first, the flow is increased by 150 GPD. Therefore:

- 2 bedroom dwelling: estimated flow = 350 GPD
- 3 bedroom dwelling: estimated flow = 500 GPD
- 4 bedroom dwelling: estimated flow = 650 GPD
- 5 bedroom dwelling: estimated flow = 800 GPD, and so on.

For multi-family buildings and for non-residential, uses the New Jersey Department of Environmental Protection (NJDEP) has tables to determine the estimated flow in gallons per day.

Once the flow rate is established, and the permeability of the underlying soil is determined, the actual loading area can be determined by referring to the following table:

Percolation Rate (Minutes per inch)	**Area Loading Rate (gallons/ft^2/day)**
5	0.303
10	0.278
15	0.253
20	0.228
25	0.211
30	0.203
35	0.196
40	0.189
45	0.180
50	0.173
55	0.162
60	0.154

The disposal field is then sized based on the table above and the minimum amount of tubing required is the area given in the table above divided by two (based on two foot center). A simple example will suffice in illustrating how to size the system:

Design Example: A drip irrigation system is being designed for a three bedroom dwelling in Morris County, New Jersey. The soil has been determined to have a perc rate of 20 minutes per inch. The dripper lines will be placed at 2 feet on center. What is the amount of tubing required?

Solution: First determine the anticipated flow in gallons per day. As indicated above, a 3 bedroom dwelling is assigned a flow rate of 500 GPD. Next, determine the size of the disposal field. From the table above, the loading rate (in gallons per square foot per day) is 0.228 for a perc rate of 20 minutes per inch.
Therefore, the area of the disposal field must be: 500GPD/0.228 gallons/ft^2/day= 2193 SF.
The required amount of tubing is 2193/2 = 1097 feet of tubing required.

Soil Testing:
As with any septic system a drip irrigation system design must be based on soils data which comes from on-site investigations. Although this type of system can be used in marginal soils, there must still be at least a minimal amount of permeability for the system to work properly. In addition, there should not be any "limiting zones" (i.e. groundwater, bedrock, or hydraulically restrictive soil horizons) within 24 inches of the surface. However, with a drip irrigation system the soil tests can generally be done at a relatively shallow depth.

The photograph below shows a drip irrigation septic bed being dug. Note the very shallow depth of the excavation.

Locating the System:
Properly locating any septic system is an important aspect in the overall design. The engineer should be aware of, and comply with, any state or local regulations regarding the location of the septic system. Generally, there are minimum distances specified between a septic bed (of any type) and the following improvements:

1. A potable well.
2. A swimming pool.
3. A dwelling.
4. Drainage features.
5. Wetlands.
6. Property lines.

The engineer should check with the governmental agency having jurisdiction to determine the exact distances required.

Installation:

Installation of this type of system should only be undertaken by a competent installer, experienced in drip irrigation systems. The same type of excavation equipment is required for this type of system as is used for any septic (although, as stated above, sometimes the dripper lines are actually plowed into the system). Of course, an electrician is required for the pump and control panel.
There are several limitations that should be kept in mind when installing the system:

1. The dripper lines should not be crimped, pulled, or stretched in any way during installation.
2. The dripper lines should not be installed when soil moisture conditions are unsuitable. If the soil consistency is finer than sand or loamy sand, then the dripper lines should only be installed when the soil moisture content is below the lower plastic limit in the top 12" of the soil. (If a soil sample can be rolled with the fingers to form a wire-like shape of one-eighth inch in thickness, and does not crumble when handled, then the soil moisture content is above the lower plastic limit, and the installation should be delayed until the soil is dryer).
3. Because the dripper lines are so close to the ground surface, the system shall be designed to prevent freezing. This should be done in accordance with the recommendations of the system integrator and the dripperline manufacturer's recommendations.

Maintenance:

On-going maintenance is essential to the proper long-term operation of this type of system (or of any septic system, for that matter). However, it is even more imperative in a drip irrigation system because of the various component parts which need regular visual inspection and maintenance. Ordinarily, this maintenance is carried out by a licensed firm specializing in installing & maintaining the various components of the system. In fact, most jurisdictions require that the property owner enter into a renewable contract with a licensed maintenance firm for jus this reason. If the property is sold, this requirement passes to the subsequent property owner. While, on one hand this requirement might seem onerous, it is actually beneficial to the property owner and will ensure that he or she has a properly functioning septic system in the long-term. Some of the basic maintenance required for the various components are as follows:

1. Pre-treatment units: Depending on the type of unit, the exact nature and frequency of the maintenance of these units can vary significantly. At a minimum, the units should be maintained in accordance with the manufacturer's recommendations. Note that routine maintenance of these units is generally not too expensive. However, when component parts need to be replaced (i.e. the coconut filter media needs to be replaced) then the maintenance costs can be quite considerable.
2. Hydraulic units and pumps: Common sense considerations (for instance: not letting solids build up in the pump tank, etc.) are a good place to start with the maintenance of these systems. However, as with the advanced treatment unit, these units should be maintained by a qualified, licensed operator in accordance with any recommendations by the manufacturer.
3. Drip tubing and absorption fields: If the other components of the drip irrigation septic system are properly maintained, then the actual absorption field (and associated dripper lines) should need relatively little maintenance. However, the absorption field should be checked regularly for any evidence of leakage, subsidence, or other indication of failure.

Advantages of drip irrigation:

There are several obvious advantages to these drip irrigation septic systems. These include the following:

1. Drip irrigation systems can eliminate large, unsightly mounds. (This may be the main advantage to these systems).
2. The drip system makes for an even distribution of water over the grass which allows for re-use by landscape plants.
3. This type of system provides better treatment of the effluent before allowing it to enter back into the soil.
4. The system includes a control panel that monitors (i) flow rates, (ii) temperature, (iii) pressure, and (iv) the overall operation of the system. This is invaluable information to the property owner.

Disadvantages of drip irrigation:

Despite the advantages that a drip irrigation septic system can provide, it is not the preferred method of effluent treatment in the majority of situations. This is because of the following disadvantages of drip irrigation:

1. It contains more components than a typical septic system does.
2. Installation is generally more intricate than a typical system and, consequently, the installation cost is often higher.
3. These systems require more maintenance than does a typical septic installation.
4. As mentioned earlier, in order to run and maintain the system, the property owner will have to enter into a maintenance contract with a certified firm.

Concluding Remarks:

It can be seen that drip irrigation certainly have a use and are very beneficial in some situations. At the same time, it must be pointed out once again that these systems are not the easiest or cheapest to install or maintain and are not to used in most cases. More conventional types of septic systems continue to be the norm in the majority of applications. Also, it should be noted that drip irrigation septic systems are not the only type of “alternate” system that can be employed. The engineer has a variety of choices including, but not limited to, the following:

1. An evapotranspiration system.
2. A constructed wetland system.
3. Recirculating sand filter system.
4. An aerobic treatment unit.

All of these types of alternate systems that have been developed to deal with problematic soil conditions have their own strengths and weaknesses and a discussion of each of these is beyond the scope of this course. However, the engineer should always bear in mind that he or she has a number of options when dealing with on-site soil disposal. Drip irrigation is a very good option when the underlying soils are not very good and a mound system is not the desirable option.