

SMALL SCALE WASTE MANAGEMENT PROJECT

Recirculating Sand/Gravel Filters for On-Site Treatment of Domestic Wastes

by

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RECIRCULATING SAND/GRAVEL FILTERS
FOR
ON-SITE TREATMENT OF DOMESTIC WASTES

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The conventional septic tank/soil absorption system utilizes both anaerobic and aerobic treatment concepts. The septic tank, operating under anaerobic conditions, serves primarily as a settling unit and provides partial treatment of the wastewater. The soil provides most of the treatment and serves as the dispersal unit for the effluent.

With increased pressure on developing sites not suitable for the conventional system, new treatment process units are being developed that provide a higher degree of treatment than does the septic tank. This allows for sites to be developed that have soils not suitable for soil dispersal systems requiring the 3 ft separation distance. These new systems include aerobic units, sand filters, peat filters and constructed wetlands, all of which utilize both aerobic and anaerobic treatment.

Sand filter technology has been available for many years but new advances, as well as increased environmental regulations, have made the technology more attractive and reliable. With increased interest in filter media technology, it is imperative that the designer, installer and regulator/inspector have a good understanding of design, installation and maintenance concepts.

This paper provides a basic knowledge of recirculating sand/gravel filter principles, design, construction and maintenance. Converse (1997) discusses single pass buried sand filters. The main difference between the recirculating sand filter (RSF) and recirculating gravel filter (RGF) is size of the filter media. The principles of operation are the same. Differences will be pointed out through out the paper.

The recirculating sand/gravel filter is smaller than the single pass filter. It must also be elevated so that the effluent flows back by gravity to the recirculation tank or an additional pump chamber (external or internal) is required to pump the filter effluent to the recirculating tank. The internal

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Note: Names of products and equipment mentioned in this publication are for illustrative purposes and do not constitute an endorsement, explicitly or implicitly.

pump vault is the same as used in the single pass filter (Converse, 1997). An external pump chamber is similar to other pump chamber but can be smaller.

The primary reasons for using a recirculating sand/gravel filter over a single pass sand filter are:

1. Smaller filter size.
2. Higher strength wastes requiring larger media size.
3. Removal of more nitrogen through denitrification.

A. System Components

On-site treatment systems employing recirculating sand/gravel filter technology consists of 1) wastewater source and characteristics, 2) septic tank, 3) recirculation tank, 4) recirculation sand/gravel filter, 5) a settling tank for sloughed solids in gravel filter only, 6) pump chamber and 7) dispersal unit (Fig. 1). The septic tank effluent mixes with filter effluent in the recirculation tank. The pump distributes mixed effluent on the surface of the filter with the effluent recycled 3 to 5 times. A splitter/diverter valve in the recirculation tank diverts all or a portion of the effluent to the dispersal area depending on the type of valve.

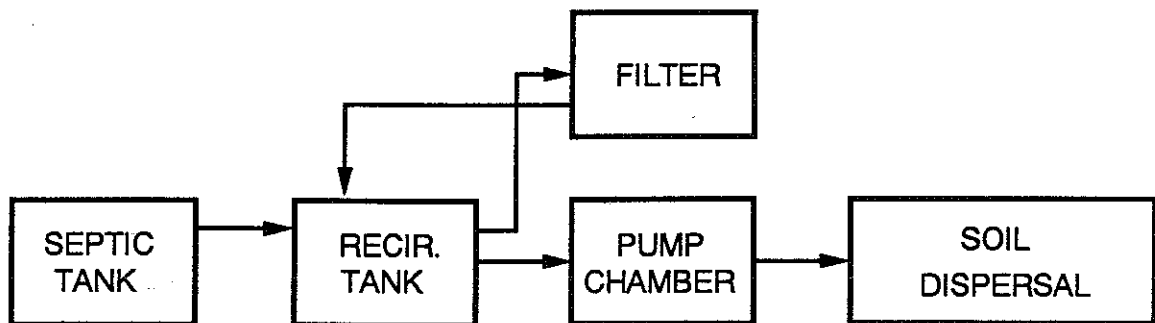


Fig. 1. Components of on-site treatment system utilizing a gravity flow recirculation sand/gravel filter which requires some topographical relief. For level sites, the gravel filter could have an internal pump chamber similar to a single pass filter with pump chamber or the recirculation tank is buried deeper or sand filter elevated or combination of both occurs to allow effluent to flow to the recirculation tank. **For the gravel filter, a settling tank (not shown) with effluent filter for sloughed solids is recommended between the recirculation tank and the pump chamber.** This could be a combination tank with the settling tank and effluent filter in the first compartment and the pump chamber in the second compartment.

1. Source of Wastewater

The source and characteristics of wastewater is an important consideration when selecting the treatment alternatives. Recirculating sand/gravel filters can be designed to accept wastewater of varying strength characteristics. There is considerable difference in strength between septic tank effluent from homes and from commercial sources such as restaurants. **This paper assumes that the wastewater strength is equivalent to or less than domestic septic tank effluent from homes.** If the strengths are greater than normal septic tank effluent from homes, other design considerations must be implemented such as reduced loading and increased filter area or a coarser media as found in RGF. Filters have limits as to the amount of organic matter they can assimilate.

2. Septic Tank/Pump Chamber

All recirculating sand/gravel filters require a septic tank upstream to remove settleable solids. The tank is sized according to state code (i.e. 1000 gallon tank for a 3 bedroom home). A tee outlet baffle instead of a screen/filter is satisfactory. Surge capacity in the tank is not necessary as the recirculating tank handles the surges. As with all on-site systems, water tight tanks are essential.

3. Recirculation Tank

The recirculating tank receives both septic tank effluent and the filter effluent. The tank contains 1) a pump which pumps, at specified intervals, the mixed effluent to the sand filter and 2) a splitter/diverter valve which diverts a portion of the flow to the dispersal area. A typical 1000 gallon septic tank is used for the recirculating tank serving a 3 and 4 bedroom home. Some codes may require surge and reserve capacity of approximately 1.1.7 times the daily wastewater flow (Proposed Wisconsin Code, 1999). This increases the size of the recirculation tank to 1500 - 1750 gallon tank for 3 and 4 bedroom homes.

Fig. 2 and 3 show cross sections of two types of valves used to divert flow from the recirculation tank. Fig. 2 shows a splitter valve that diverts a portion of the flow to the soil absorption unit. When the liquid level reaches a certain level in the recirculation tank (ball pushes up against the vertical pipe), a portion of the effluent is diverted to the soil absorption unit (20%) with the remaining effluent (80%) flowing in the recirculation tank. When the ball is down, all the flow goes to the recirculation tank. **The outlet of the sand filter must be set at a certain elevation above the inlet to the splitter valve (Fig. 2) as per instructions for the valve to work properly.** The valve in Fig. 3 diverts all the flow to the soil absorption unit when the recirculation tank is full (ball pushed up into opening) otherwise all the flow returns to the recirculation tank to be recycled. The diverter valve, shown in Fig. 3, is also commercially available.

There are several other methods of splitting and diverting flow. One such method is directing the flow to a effluent ratio box (Fig. 4) where a portion (can be adjusted) returns to the recirculation tank and a portion goes to the dispersal unit (American Manufacturing, 1998). For RSF housed in a concrete box the flow can be diverted by installing a permanent partial wall divider across the box at, say, 60% of the length of the sand filter box. Effluent is uniformly distributed across the surface with 60% returning to the recirculation tank and 40% diverted to the dispersal unit Fig. 9 illustrates this. Other ratios can be built in to design. **With these two types of diverters, the filter rests during low flows as the effluent level drops to the low water float level in the recirculation tank.**

The recirculation ratio is set for 4:1 or 5:1. However, the recirculation rate will vary depending on the flow rate from the septic tank. Higher recirculation ratios and lack of flow from the septic tank will create aerobic conditions in the recirculation tank causing the system to lose some of its denitrification ability. However, it is important to keep the filter wet.

The recirculation pump should be set to cycle relatively small dose volumes. Dose time of 1-2 minutes and cycle frequencies of 30-45 minutes are common. Flow rates of less than 3 gallons/orifice (1.5 gallons/orifice preferred) and a minimum of 24 minutes between doses have worked well (Loudon, 1995).

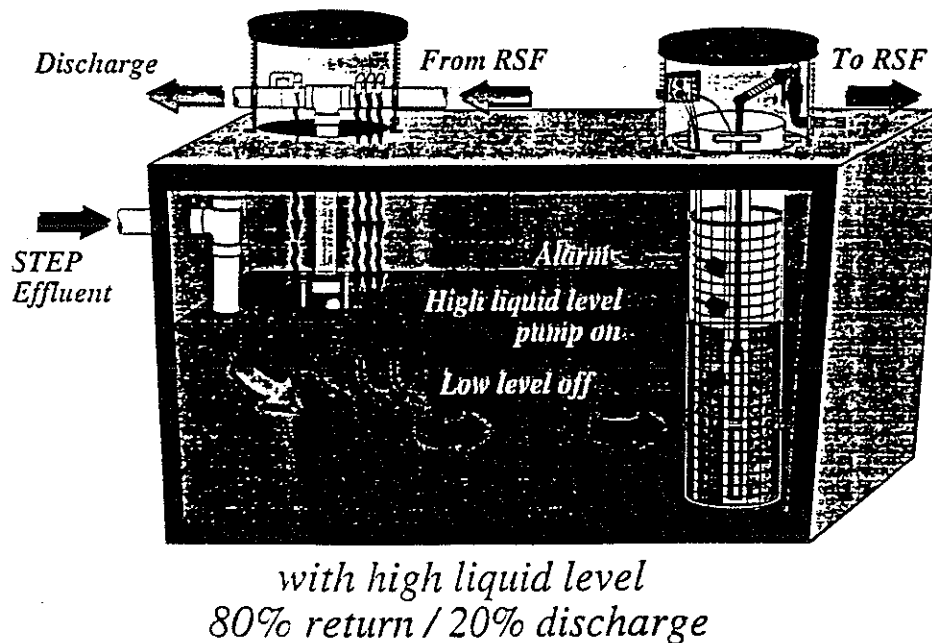


Fig. 2. Flow splitter for diverting flow from recirculating sand filters (Orenco Inc.).

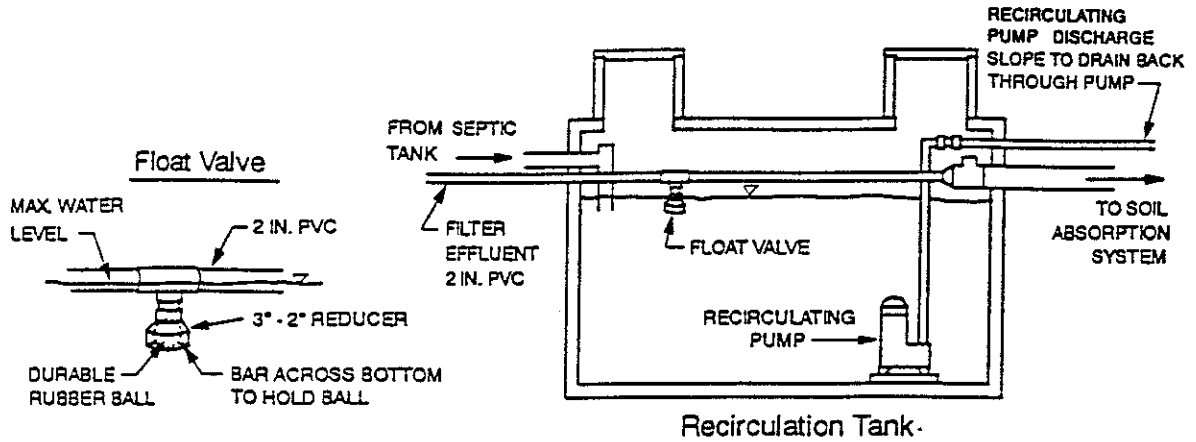


Fig. 3. Diverter valve used for diverting flow from the recirculation tank.

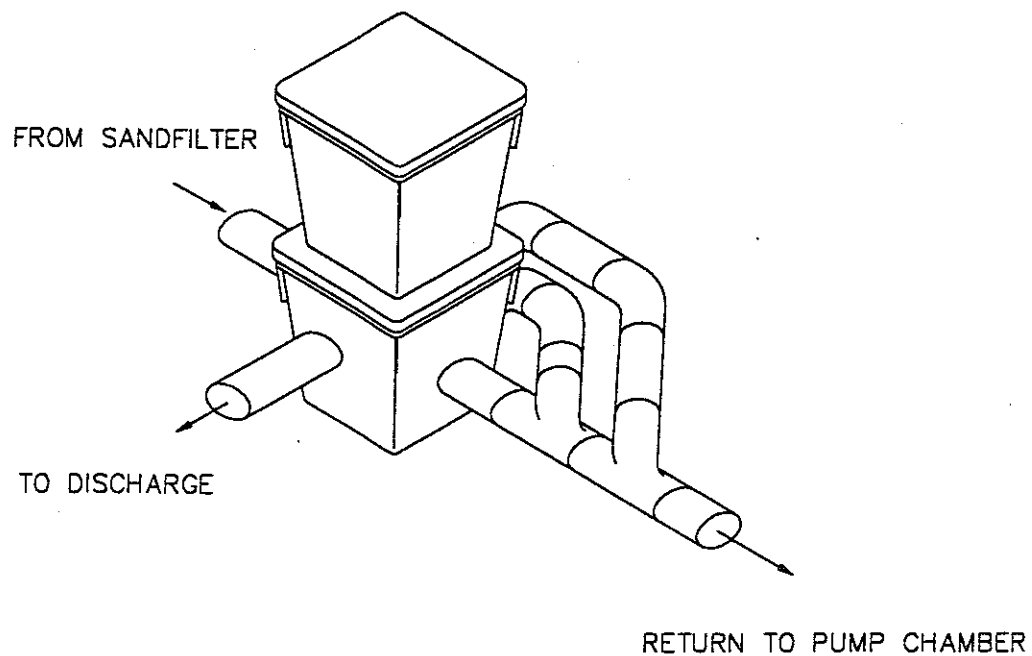


Fig. 4. Effluent ratio box for diverting recirculating sand filter effluent. This unit shows a 4:1 ratio (4 units into box and 1 unit discharged). Other units have 3:1, 2:1 and 1:1 ratio. The ratio in each box can also be varied.. (American Manufacturing Co. Inc.).

4. Sand Filter

Fixed film aeration is a unit process in which wastewater passes through a porous media such as fine or coarse aggregate or synthetic media. The bacteria attach themselves to the media and extract food and nutrients as the wastewater flows through the porous media. Oxygen diffuses

into the thin film of water as the air passes through the media by convection due to temperature differences and air is also drawn in as the wastewater moves through the media. The system must be designed to encourage passive air movement throughout the unit.

As the effluent passes through the filter, various physical, chemical and biological reactions take place. Suspended solids are filtered out. Bacteria convert organic matter to carbon dioxide and water. Organic nitrogen and ammonia are converted to nitrate under aerobic conditions. Recirculating sand/gravel filters have the following components. RSF/RGF are commercially available or they can be designed and built locally. Components may vary between manufacturers.

a. Container

A water tight container, such as a concrete tank or durable 30 mm membrane liner, is required. Since the recirculating filter is small compared to the single pass filter, concrete tanks may be large enough to accommodate the filter. The filter is elevated so the effluent flows by gravity to the recirculation tank. If not, then an internal or external pump chamber is required. Surface waters must be diverted away from the filter.

Membrane Lined Filter: A plywood/wafer board box is constructed to form the filter. The box, minus a bottom, serves to support the membrane during construction. Sand is placed between the wall and soil to protect the membrane after the wall has decomposed. A two inch layer of sand is placed on the bottom. Building a membrane lined filter above ground is a greater challenge than using a concrete tank. Figure 5 and 6 shows a cross section and plan view of a recirculating sand filter utilizing a membrane liner. These filters can be sized to handle from a few hundred to thousands of gallons wastewater per day.

Concrete Lined Filter: It may be difficult to find precast tanks that have sufficient surface area to meet design specification except for small flows. Fig. 7, 8 and 9 show commercially available units using a concrete tank. Parallel tanks may be used to obtain sufficient surface area with appropriate equal distribution of effluent to each filter. These types of filters are commercially available. They will not be discussed in detail in this publication but much of the discussion is applicable for these units (American Manufacturing, 1998; Crest Precast Inc. 1999, Piluk, 1998). The concepts are very similar. Cast-in-place tanks are also an option.

b. Effluent Collection

A 4" collection pipe (slotted or holes) is placed on the membrane or on the concrete tank bottom to collect the filter effluent. The perforated pipe is connected to a solid PVC pipe and extended through the membrane or concrete wall to the recirculation tank. Water tight joints are required. If an internal pump vault is used to pump the effluent to the recirculation tank, because of elevation restrictions, then the collection pipe extends into the

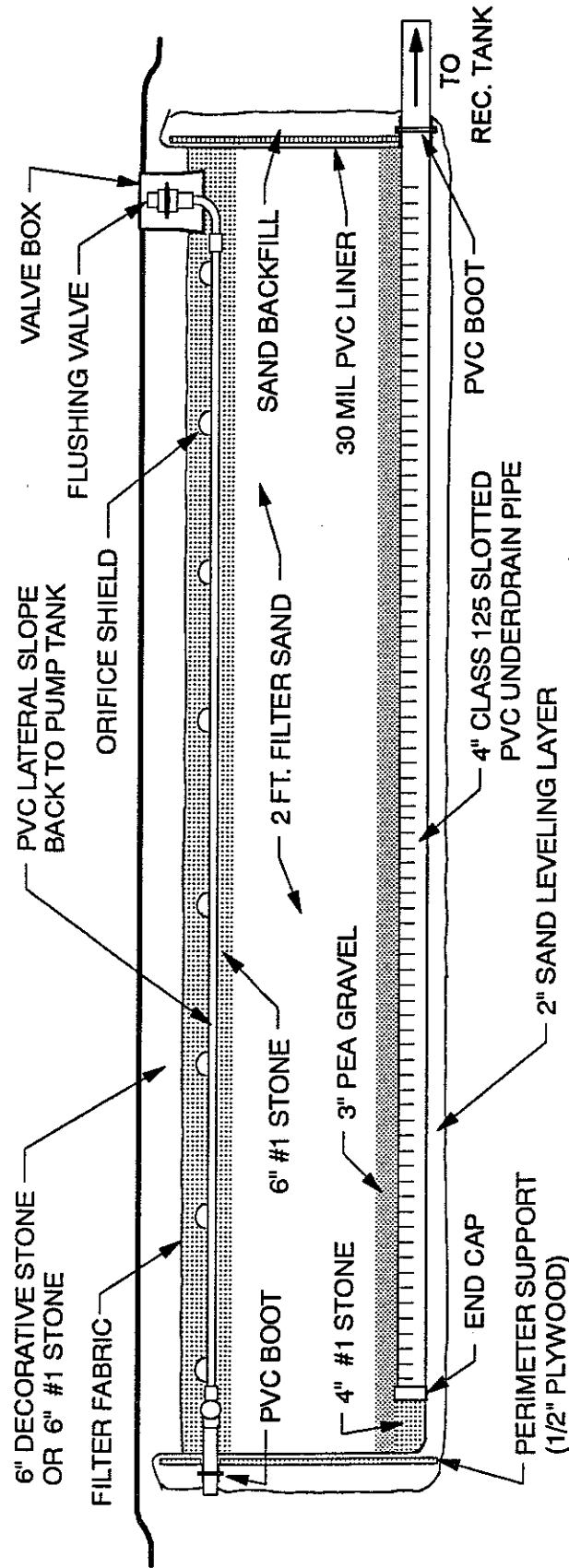


Fig. 5. Cross section of a recirculating sand filter with a membrane-liner. These filters do not have a soil cover and are normally gravity flow to the recirculation tank. The top of the collection pipe must be covered with 1" of stone to keep the pea gravel out of the pipe which is accomplished by mounding the stone over the pipe. Gravel filters are identical except the filter sand is replaced by a gravel media (adapted from Orenco).

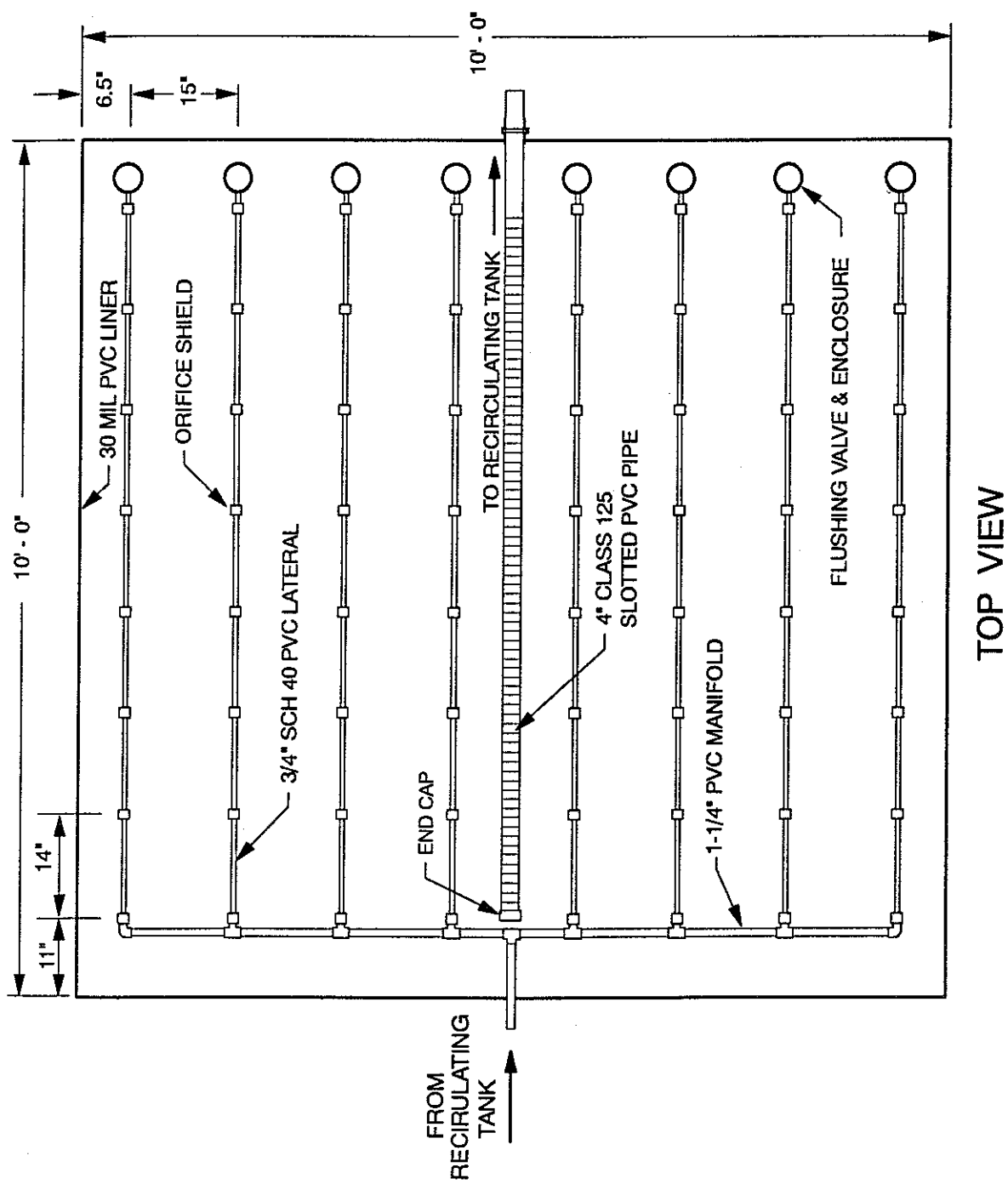
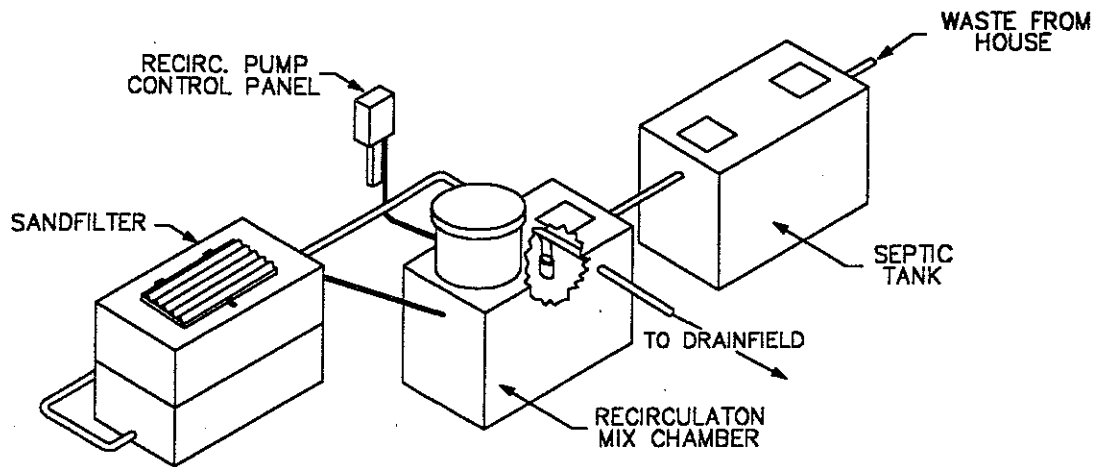
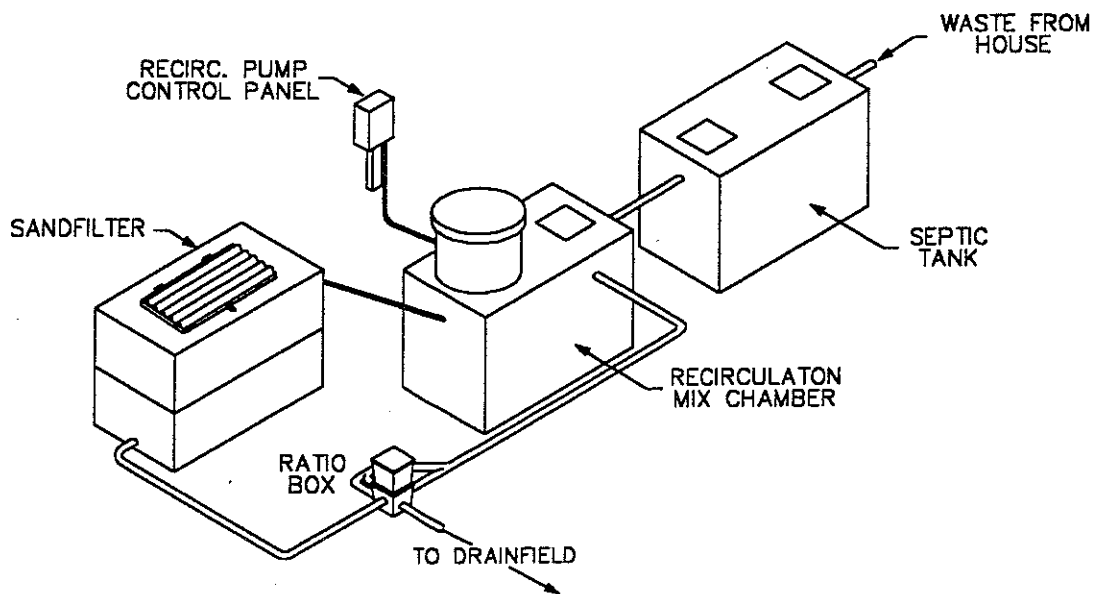


Fig. 6. Plan view of a recirculating sand/gravel filter with a membrane-liner (adapted from Orenco).



RECIRCULATING SAND FILTER SCHEMATIC
RECIRC-VALVE CONTINUOUS OPERATION
GRAVITY DISCHARGE
NTS



RECIRCULATING SAND FILTER SCHEMATIC
RATIO BOX-LOW FLOW RESTING
ELEVATED DISCHARGE
NTS

Fig. 7. Recirculating sand filter in a concrete box. The main difference between the two configurations is that the top one has a valve in the recirculation mix chamber which allows for continuous circulation during low/no flows. The bottom unit has a ratio box which discharges flow during each cycle and the system will rest during low/no flow periods (American Manufacturing).

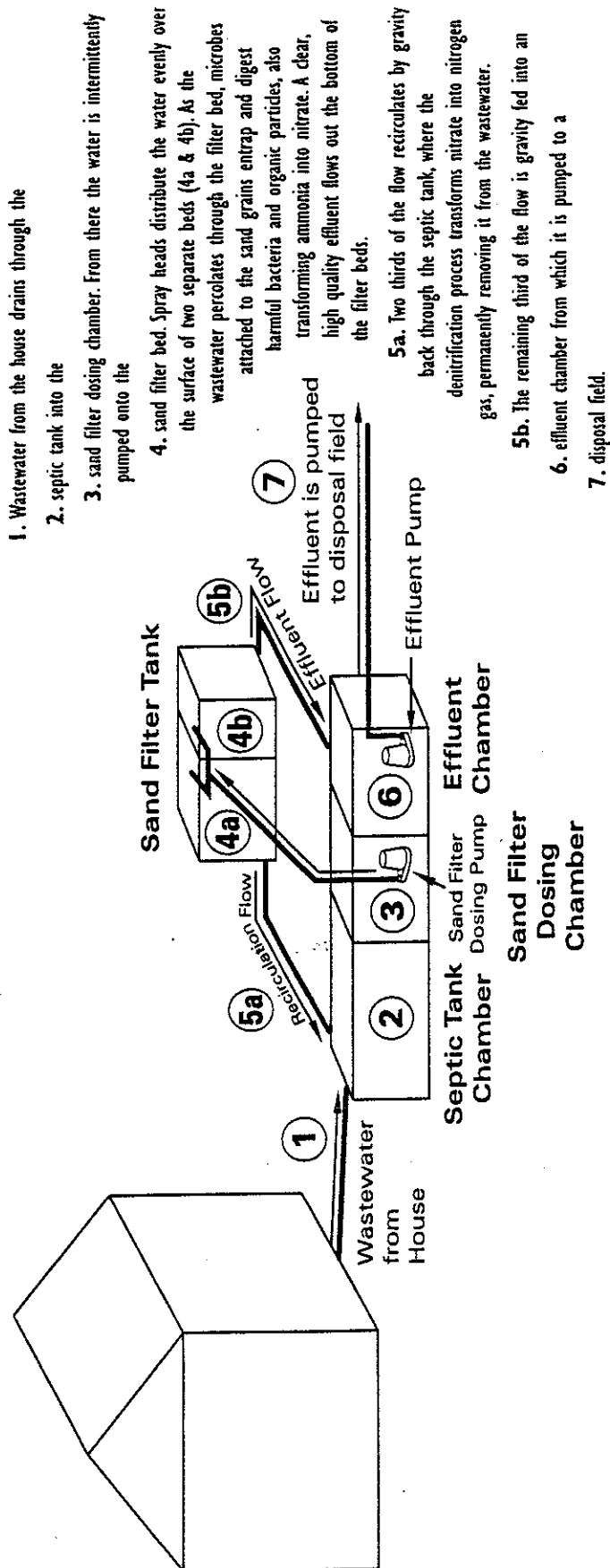


Fig. 8. Schematic of a recirculating sand filter system showing the septic tank, dosing chamber, sand filter and effluent chamber (Crest Precast, Inc).

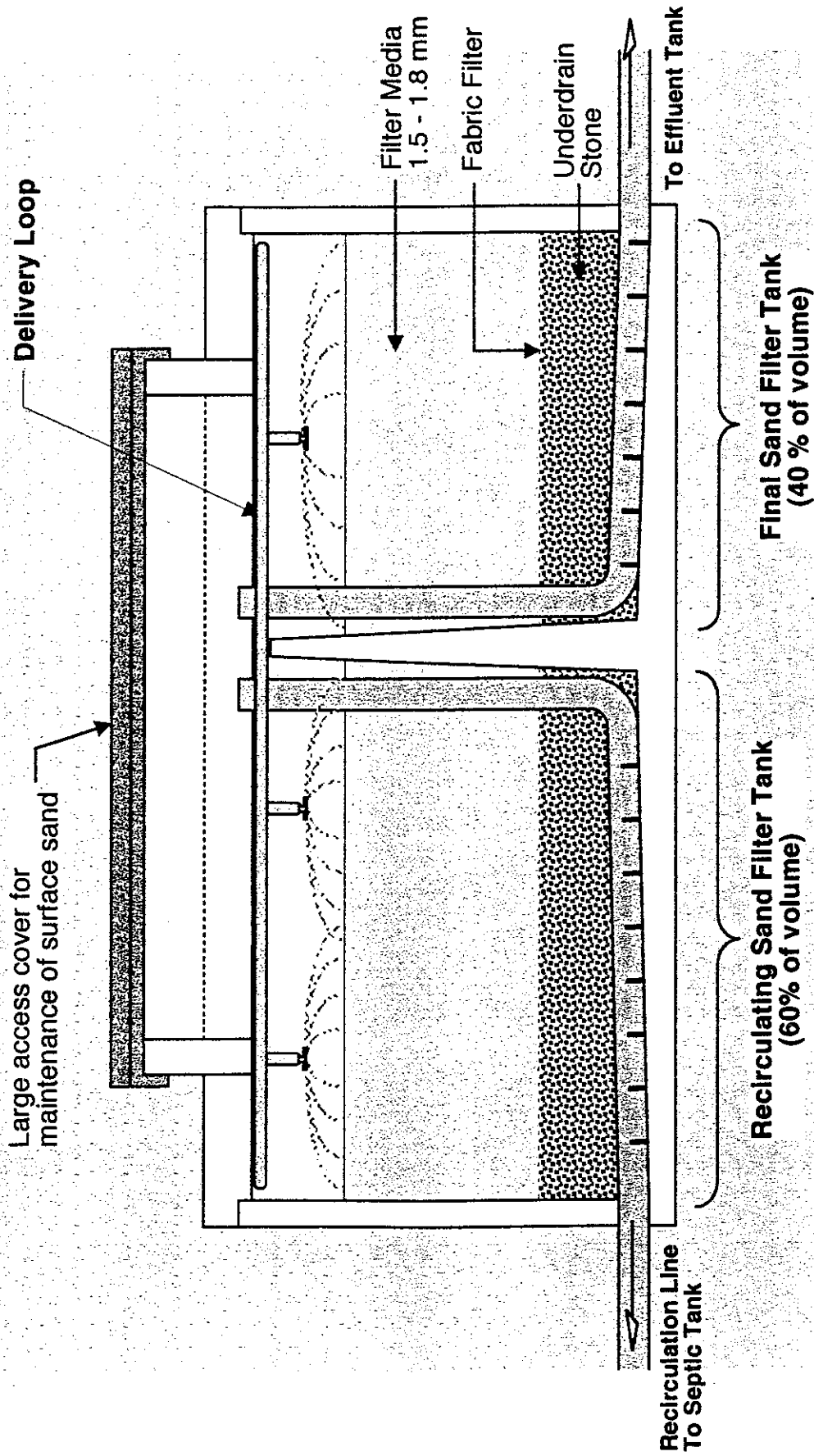


Fig. 9. Cross section of a recirculating sand filter in a concrete box. The recirculation ratio is preset at 60% return to the septic tank and 40% discharging to effluent tank where it is pumped to the dispersal unit (Crest Precast, Inc.).

pump vault. For membrane containers an internal pump vault can be installed by placing a 4' by 4' excavation, 18" deep with sloping sides in the center of the filter and lined with sand prior to placement of the membrane liner. For concrete containers an extra 12-18" of depth is required to provide some draw down capacity. The liquid level in the bottom of the filter must stay below the bottom of the filter media.

c. Aggregate

A four inch layer of 3/4 to 1 in. dia. (No. 1) washed aggregate is placed on the bottom and mounded over the collection pipe. A three inch layer of washed pea gravel (3/8") is placed on top of the aggregate to keep the sand from infiltrating into the larger aggregate and into the collection pipe. If a gravel media is used, the pea gravel is not needed on top of the stone. Loudon (1995) shows that No. 1 stone is not needed on the bottom but just extend the sand/gravel media to the bottom.

d. Filter Media

RSF: A two foot layer of sand media is placed on top of the pea gravel layer. The top of the media is leveled. Filter media size, septic tank effluent quality and loading rates are interrelated. In general, for a given wastewater strength (BOD and SS), the hydraulic loading rate can be higher on coarser filter media but the effluent quality (BOD and SS) will be less. Recirculating the effluent several times improves the effluent quality. Higher loading rates on finer media will lead to a clogging mat.

Figure 10 gives the recommended filter media for recirculating sand filters receiving typical septic tank effluent serving residences. The recommended design loading rate is 5 gpd/ft² forward flow. With a 4:1 recirculation rate, the actual loading is 20 gpd/ft². For a 3 bedroom home with a design loading rate of 450 gallons per day, the filter surface area is 90 ft².

For the concrete box filters, the manufacturer also requires a media meeting a certain specification. Contact the manufacturer for specification.

If the specified media is not locally available, it is very tempting to use available media which is either finer or coarser rather than pay the transportation costs of getting the specified media. That could be a costly mistake. Finer media has greater risk of clogging.

RFG: The media for recirculating gravel filters range from a fine gravel (1/8") to a coarser gravel (3/8"). Whatever size is used, it should have minimal amount of fines and a low uniformity coefficient. A number of medias have been used such as gravel and expanded shale and bottom ash.

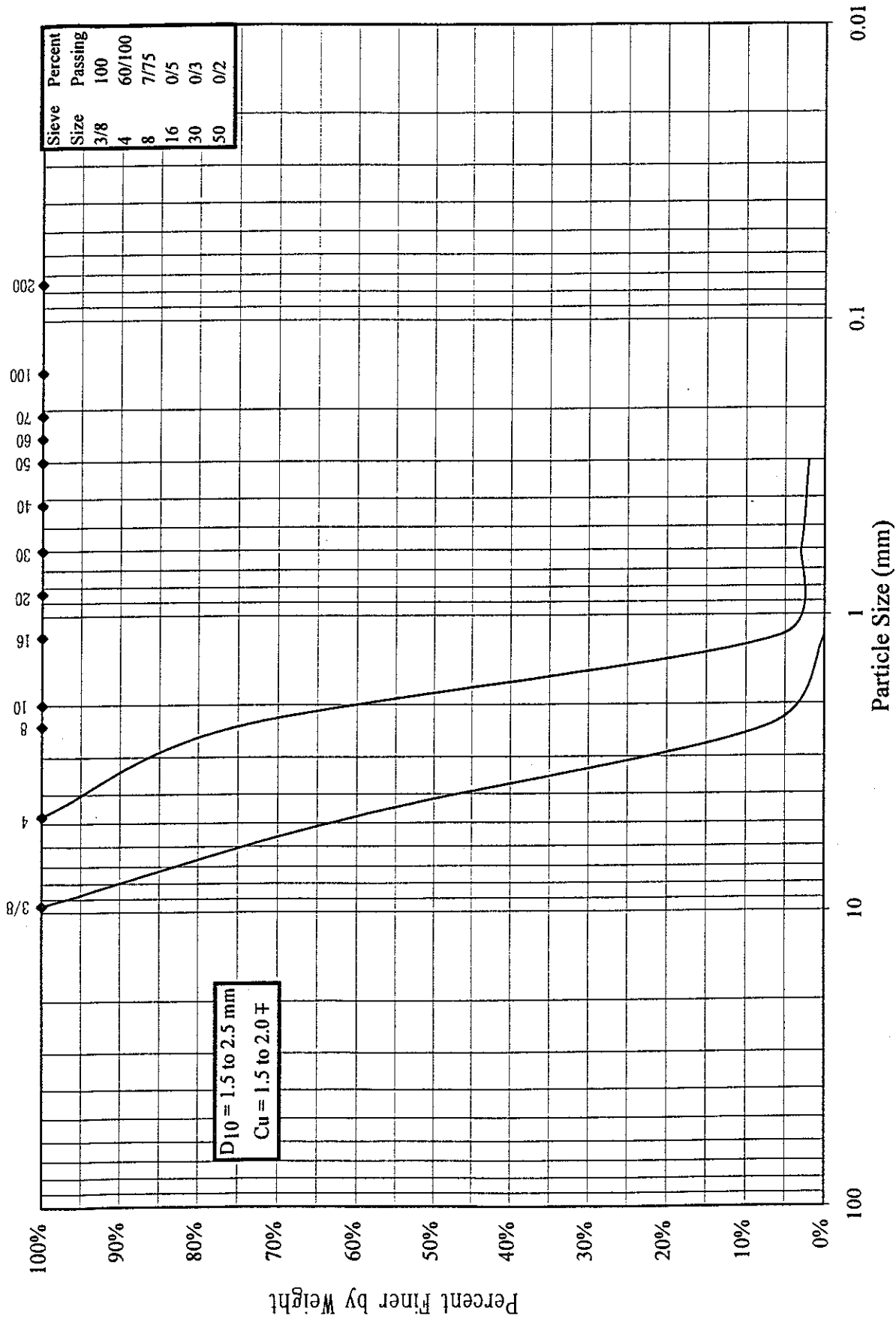


Fig. 10. Specification for media for a recirculating sand filter (Oreco). The design loading rate for this media is 5.0 gpd/ft² forward flow with a recirculation ratio of 4:1 to 5:1. For gravel filter the media is usually a 1/8 - 3/8" diameter gravel with low uniformity coefficient. This specification is for the membrane liner described. For the units in concrete tanks described here, consult with the manufacturer for media specification.

e. Distribution Network

The distribution network spreads the septic tank effluent as uniformly as possible over the filter surface. The network consists of 1) of a manifold and series of PVC lateral and a manifold with small diameter orifices or 2) spray nozzles normally associated with concrete units. Spray nozzles are used in the smaller units so as to better utilize the surface area. Orifice size and spacing, lateral spacing and diameter may vary but the network must be balanced with the pump. The spray nozzles must be balanced with the pump and available area.

A representative design for distribution network consisting of laterals, manifolds and orifices consist of the following:

- Orifices - 1/8" orifices spaced maximum of 2 ft apart with orifices located upward with orifice shields.
- Laterals - 3/4-1" dia. PVC pipe , spaced 2 ft apart, with an upturned sweep elbow and valve for clean out. The lateral must uniformly slope back to the manifold with distal end elevated 1 to 1 1/2". Lateral lengths should not exceed those given in Table 1 for various diameters.
- Manifold - 1 1/4" PVC pipe with center feed with ends elevated 1" for flow back to force main.
- Valve boxes - Circular valve boxes for access of valves at end of laterals.
- Pump - Sized to meet flow rate and lateral pressure of 5-7 ft.

If the force main slopes toward the filter, then the orifices must be placed downward and the orifice shields eliminated. The laterals and manifold are laid level. If this situation occurs, then the recirculating tank is at a higher elevation than the filter and a pump is used to move the filter effluent to the recirculation tank. **In all cases the force main and distribution network must drain after each dose.**

Two inches of No. 1 (3/4 -1") washed aggregate is placed on the surface of the leveled filter media. The distribution network is placed in the aggregate with laterals and manifold sloping back to force main. Additional aggregate is placed on top of the network with minimum of 1" cover.

The orifices can be replaced with 4" diameter half pipes over the top of the laterals. Chambers placed over the top of the laterals is also appropriate. Both of these techniques will provide more spreading of effluent over the infiltrative surface than will orifices. Aggregate would be placed over the half pipes but not the chambers.

The force main is placed through the plywood wall and membrane. A boot should be glued to the membrane and attached to the pipe to eliminate the intrusion of groundwater through the opening or ponded effluent from exiting the sand filter. For a concrete tank, a gasket is used to make a water tight joint.

f. Observation Tubes

At least one 4" observation tube should be placed to the filter media/aggregate interface to monitor for ponding/clogging formation. The tubes must be secured and perforated near the bottom.

Table 1. Maximum length of distribution laterals for Schedule 40 PVC pipe sizes having 1/8 in. orifices spaced 2 ft with 5 ft of head at distal end (Loudon, 1995).

Lateral Diameter (in.)	Maximum Length (ft)	No. of Orifices	Total Flow (gpm)	Input Head (ft)
1.0	52	26	11.0	6.1
1.25	84	42	17.8	6.2
1.5	108	54	22.9	6.1
2.0	66	83	35.1	6.2

g. Cover

The filter must be covered with aggregate or decorative stone to allow sufficient air movement into the filter. Recirculation filters require more oxygen and placement of soil on top of the filter will limit oxygen transfer. All surface waters must be diverted away from the sand filter. For RSF in a concrete tank, the surface of the media usually exposed with no aggregate. A wooden, concrete, translucent fiberglass cover is essential to filter out sunlight to avoid algae growth. Air must be allowed to freely move in and out of the tank.

h. Control Panel

Flow to the filter is controlled from a control panel with a programmable timer. Circuit breakers, event recorder, running time meter, alarms are also part of the panel. Commercial units are available and should be used instead of designing your own. Most are very user friendly.

5. Settling Tank

Gravel filters may slough bacterial growth periodically which will add to the BOD of the effluent and may clog components downstream. A 500 gallon settling tank with effluent filter in between the recirculation tank and the pump chamber will allow the solids to settle. A combination tank to house the settling tank and the pump chamber may be appropriate.

6. Pump Chamber

The pump chamber accepts overflow from the recirculation tank. The tank contains a pump which discharges the effluent to the dispersal unit. A 500-750 gallon pump tank is sufficient for a 3-4 bedroom home as it is best to discharge small doses (50-60 gal) to the dispersal unit.

7. Sand Filter Effluent Dispersal

The sand filter effluent will be very low in BOD and TSS (<10 mg/L), low in fecal coliform (<2000 counts/100 ml) and moderate nitrogen concentrations (15-20 mg N/L). Upwards of 60-70% of the input nitrogen is removed via nitrification/denitrification. These values will vary depending on loading to the filter and performance of the filter. The effluent can be dispersed into the environment in the following manner:

- a. **Disinfected and surface discharged to a ditch.** Some nitrogen remains and may cause surface water degradation. Health/environmental codes may not allow surface discharge.
- b. **Dispersed through a soil absorption unit.** The soil will polish the effluent to remove the remaining fecal coliform and potential pathogens with the effluent passing to the ground water. Since the BOD is very low, a clogging mat will not develop so the infiltration rates can be increased over septic tank effluent. However, the system must be designed to hydraulically accept the wastewater. Converse and Tyler (1997) describes several systems available for soil dispersal of highly pretreated effluent.

B. Sand Filter Design

Design a recirculating sand filter for a three bedroom home. (Design of a recirculation gravel filter is similar). **This design will concentrate on membrane-lined units.** However, many of the same design concepts apply to those housed in concrete tanks.

1. Determine the Design Flow.

The design flow for a 3 bedroom home is 150 gpd/bedroom or 450 gpd.

2. Select a Septic Tank.

A 1000 gallon septic tank with baffles and manhole riser at the outlet end.

3. Select a Recirculation Tank.

Select a 1000 gallon tank with two manhole risers. If surge and reserve capacity is required, specify a 1500 gallon tank or what the code specifies. Specify a diverter valve as described in Fig. 2 or 3 in the inlet end of tank. Specify a screened vault with pump in the manhole riser on the outlet end of the tank. Select a pump that matches flow and pressure requirements of the distribution network.

4. Design the Sand Filter.

a. Media Selection

Select a media that meets the specification shown in Fig. 7. The $D_{10} > 1.5-2.5$ mm with a $C_u = 1.2-2$. Use a forward flow of loading rate of 5.0 gpd/ft^2 for this media.

Proper media selection is critical to the operation of the sand filter.

b. Filter Surface Area

With a design loading rate of 450 gpd and sand loading rate of 5.0 gpd/ft^2 , the required surface area is :

$$\begin{aligned}\text{Surface Area} &= 450 \text{ gpd} / 5 \text{ gpd/ft}^2 \\ &= 90 \text{ ft}^2\end{aligned}$$

c. Surface Dimensions and Configuration

Use a 10 by 10 ft filter or an 8 by 12 ft unit. Other configurations can be used. For this example use a 10 by 10 ft unit.

d. Media Depth

Specify 5" of washed No. 1 (3/4 - 1") stone in the bottom. Mound at least one inch of No. 1 stone over the collection pipe.

Specify 24" of filter media (See Fig. 1).

Specify 6" of washed No. 1 (3/4 - 1") stone on the surface of the filter media. The

distribution network will be placed in this layer.

e. Filter Container and Elevation

Specify a 30 mm membrane liner. The bottom of the unit must be above the top of the recirculation tank by at least 6" depending on the flow splitter specified.

f. Collection Pipe in Bottom of Filter

Use either:

- a. 4" Class 125 PVC slotted drain pipe with 1/4" slots 2 1/2" deep and spaced 4", located vertically.
- b. 4" PVC perforated sewer drain pipe with holes located at 5 and 7 o'clock.
or
- c. 4" corrugated perforated agricultural drain tile without sock.

Specify the pipe to be 9' long and placed in the center of the unit. Cap one end and connect the other end to a solid PVC schedule 40 pipe and extend it through the membrane and plywood. Glue boot to membrane wall and place 4" pipe through boot and clamp. The joint must be water tight. The pipe elevation must be higher than the inlet to the flow splitter in the recirculation tank. If not, then an internal or external pump chamber must be installed to lift the effluent to the recirculation tank. If an internal pump vault is necessary, use the same design as used for single pass filters with internal pump vaults (Converse, 1997, Orenco Inc.).

g. Distribution Network

The distribution network must be matched to the pump in the recirculation tank. The more uniform the application the better the treatment and longevity of the sand filter.

The following is recommended for home size units. For larger units, the recommended orifice and lateral spacing may be increased to 2 ft but other orifice sizes and spacings can be used.

- Orifice diameter and spacing: 1/8" holes on 14" on centers.
- Lateral diameter and spacing: 3/4" - 1" dia. pipe and 15" spacing.
- Lateral distal pressure: 5 ft. (Assume 6 ft at inlet end).
- Orifices located upward.
- Orifices located downward when force main drains into filter.
- Orifice shields for upward orifices.
- No orifice shields for downward orifices.
- Manifold: 1 1/4" diameter with center feed.

- All laterals and manifolds are schedule 40 PVC pipe.

For a 10 by 10 ft sand filter.

- Lateral length - 8' - 6"
- Lateral diameter - 1" (Table 1)
- Number of orifices - 8 per lateral (14" spacing and 2" from ends)
- Number of laterals - 8 with 15" spacing
- Number of orifices - 64
- Manifold diameter and length - 1 1/4" and 8' - 10" with center feed
- Flow @ 6 ft of head - 29 gpm (0.45 gpm @ 6 ft head)
- Pump capacity:
 - Flow: 29 gpm
 - Head: Elevation lift
 - Force main friction loss
 - Network pressure - 6 ft

h. Pumps, Run Time and Controls

1. Septic Tank Effluent Pump and Run Time.

a. Pump Type and Size

There are basically two types of pumps available for pumping effluent to the sand filter; namely, centrifugal effluent pumps, or turbine well pumps. The centrifugal effluent pump provides a relatively high flow volume against a low head with a flat performance curve. The turbine pump provides a smaller flow volume against a large head with a steep performance curve. The turbine pump is preferred as it provides a high head to help keep the orifices open and maintains relatively constant flow when the head changes. The turbine pump has greater on/off cycle life than centrifugal effluent pumps.

Fig. 11 shows performance curves for several turbine type pumps. For this example, the pump must be capable of pumping at least 29 gpm (see section on distribution laterals for 10 by 10 ft unit) against a total dynamic head determined from the following components:

- Static head - elevation difference between pump and laterals.
- Residual head in laterals - minimum of 5 ft.
- Friction loss in force main and manifold -

Plot the system performance curve on the pump performance curves and

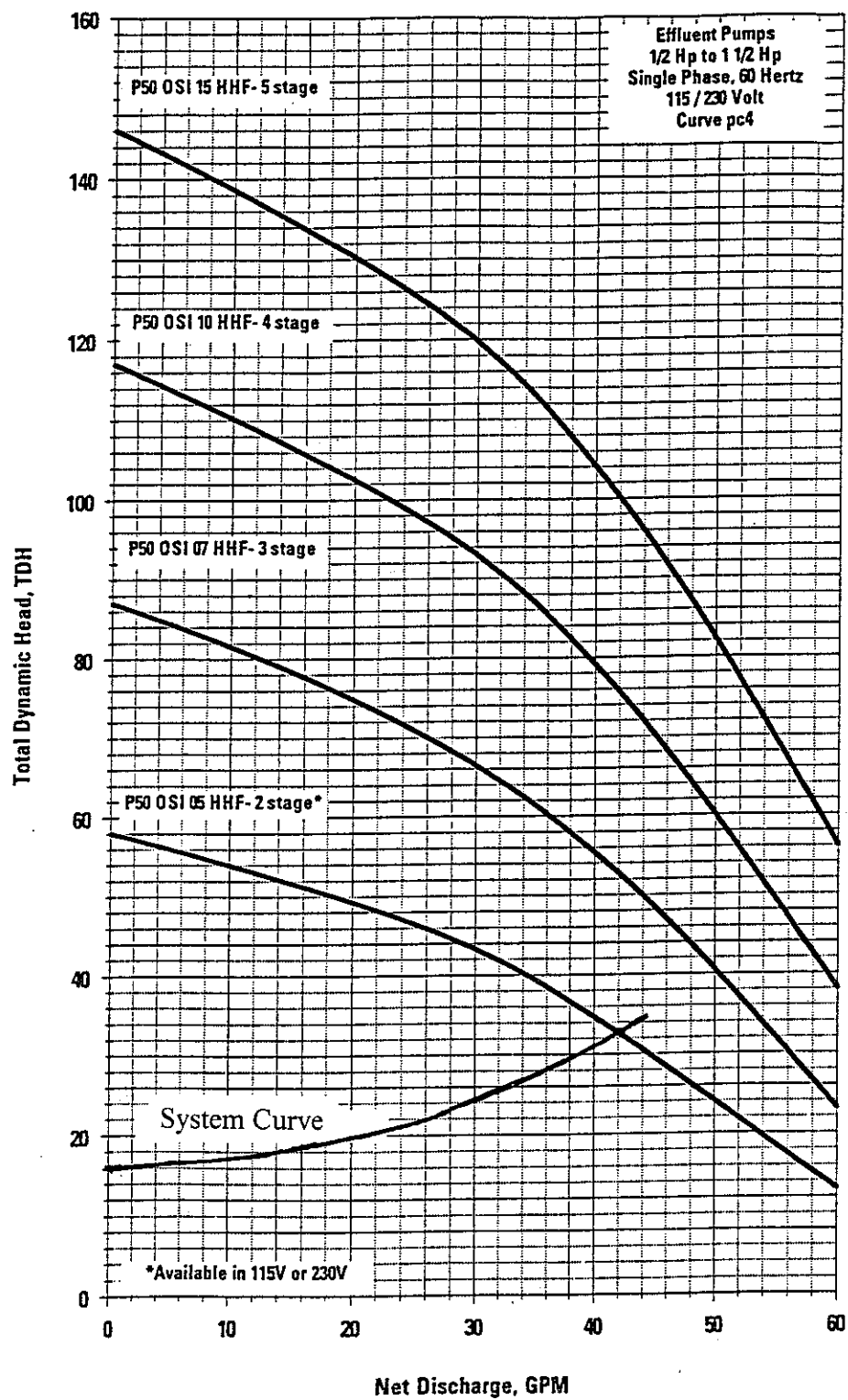


Fig. 11. Pump performance curves for several turbine type pumps showing a system performance curve for example illustrated in text (Orenco, Inc.).

determine the flow rate. Use standard procedures for determining the various heads and system curve. (Assume system performance curve on Fig. 87 is for this example).

The system will operate at 42 gpm at total dynamic head of 33 ft.

b. Pump Controller and Pump Run Time:

Small frequent doses, controlled by a programmable cycle timer, will provide better treatment than large infrequent doses controlled on demand by a float switch. Time dosing is recommended.

Use the following to set the timer initially, adjustments may need to be made later based on actual flow.

Dose volume = 0.5 gallons/orifice (smaller volumes better)

Number of orifices = 64 (For this example, there are 64 orifices).

Dose volume = 32 gpdose + 12 gpdose (assumed flow back)
= 44 gpdose

Initially set up the times using the design flow rate and then adjust the time for the average daily flow rate or you can estimate the average daily flow rate based on 50 gpd/person. For this example use the estimated average flow rate and 4 people which give a average flow rate of 200 gallons per day. Fine tuning of the pump time is necessary.

Using a recirculating ration of 5:1 and the estimated flow of 200 gpd, the effluent pumped to the filter is 1000 gpd.

Doses per day = $1000 \text{ gpd} / 32 \text{ gpdose} = 31 \text{ doses/day}$

Using a pumping rate of 42 gpm (See system curve on Fig. 8):

Pump on = $44 \text{ gpdose} / 42 \text{ gpm} = 1 \text{ minute.}$

Using a 24 hour day and 31 doses/day yields a dose every 45 min.

Set repeat cycle timer to 1 minutes on every 45 min.

Pump cycle timing must be adjusted after the system has been in operation to establish a realistic recirculation rate.

2. Effluent Pump in Pump Chamber

This pump is controlled by a float switch on demand. Typical dose volume should be about 50 gpdose so the soil will retain the effluent and not be loaded with a big slug for final polishing. Select a pump based on flow rate and head to match the pressure distribution network in the dispersal unit. Use standard procedures for determining head.

I. Sand Filter Cover

Use decorative rock over the No. 1 stone or bring the No. 1 stone to the ground surface. The membrane walls should extend to above ground surface so surface waters can be diverted away from the filter. Excess membrane should be folded down along the side wall. It must not be laid on the filter surface as it will restrict oxygen transfer. **DO NOT PLACE SOIL ON TOP OF THE RECIRCULATING SAND FILTER AS IT REQUIRES MUCH MORE OXYGEN.**

5. Pump Chamber

Select a 750 gallon pump chamber. Install a pump that meets the distribution network requirements for the dispersal unit.

6. Design a Soil Dispersal Unit

Refer to publication by Converse and Tyler (1997) for design of the dispersal unit.

C. Sand Filter Maintenance

All on-site soil absorption systems need to be maintained, some more than others. Annual maintenance is as follows:

1. Monitor solids and scum build up in septic tank.
2. Monitor build up of solids in the retention basin. Sand filters may slough slimes and solids which will end up in the recirculation tank or in the pump chamber. Clean the vault screen in the recirculation tank.
3. Flush all laterals.
4. Monitor pressure in laterals. If it is considerably different than initial measurement, unplug orifices.
5. Observe ponding at media/aggregate interface in the filter through observation tubes.

6. Observe ponding in the observation tubes for soil dispersal unit.
7. Monitor water appliances for leaks on monthly basis and repair as needed.
8. Protect the gravel filter area and dispersal area from heavy equipment, excavations etc. Minimize accumulation of organic matter such as leaves on surface of filter.

D. Modifications to Recirculation Sand Filters

The above design is one approach to designing a recirculating sand filters. Other approaches can be used. Larger media can be used which will allow for smaller filter areas. For better nitrogen removal, through denitrification, the effluent can be recycled through the septic tank or through an anaerobic filter following the septic tank.

As with all new technologies, there is a learning curve that the installer will have to work through. As the installer gets more experience with the unit, modifications can be made and fine tuning will have to be done. This technology is much more advanced than the standard septic tank and absorption unit and should not be undertaken unless the installer is committed to it and willing to invest the time in understanding it and providing the follow up fine tuning and maintenance involved.

E. References

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