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SUBSURFACE DRIP DISPOSAL SYSTEMS

DESIGN, INSTALLATION AND MAINTENANCE GUIDELINES

Subsurface drip disposal systems are specifically engineered for each site by a design professional and are constructed in compliance with state regulations and local codes.

Drip disposal fields are adaptable to irregularly shaped lots or difficult site constraints. The shallow depth at which the drip emitter tubing is installed allows more of the soil to be used for treatment. The controlled manner in which effluent is distributed allows the use of marginal soils and lots that would not be suitable for development using conventional wastewater disposal methods. Drip emitter tubing is installed using a trenching machine or vibratory plow so that existing trees and landscaping are not disturbed.

Distribution systems using drip technology should be maintained by a trained service technician. Performing routine service insures that all components operate at peak efficiency. Norweco treatment and drip disposal systems provide advanced wastewater treatment and effluent distribution for applications up to 1,500 gallons per day.

This guide provides general information regarding the design, installation and maintenance of Norweco Subsurface Drip Disposal systems following Singulair wastewater treatment systems. This document should only be used as a supplement, state regulations and local codes govern onsite effluent disposal.

DESIGN GUIDELINES

Properties with marginal soils can be economically developed using Norweco wastewater treatment systems and drip disposal technology. Engineered to uniformly apply treated effluent below the surface of the ground, drip distribution relies on proven techniques originally developed for agricultural irrigation. This method of pressure distribution is well suited for all types of subsurface wastewater disposal systems, as treated effluent is delivered directly to the infiltrative surface of the soil. The unique features of drip disposal increase the options available for onsite treatment system design. Even the most difficult sites can be utilized by taking advantage of gradual soil absorption, nutrient uptake by vegetation and evapotranspiration. USEPA and environmental protection agencies throughout the world have determined that subsurface drip disposal is a reliable and efficient method of effluent distribution.

SELECTING THE AREA

Select the disposal system area carefully, considering the soil texture, terrain, state regulations and local codes. Be sure the site selected for system construction is not in a flood plain or at the bottom of a slope where surface water may collect.

The site should be graded to direct surface water away from the proposed disposal system. Properly grading the site is critical to prevent hydraulically overloading of the soil in the effluent drip disposal system.

EFFLUENT QUALITY

Effluent concentrations of greater than 25 mg/L $CBOD_5$ and 30 mg/L suspended solids should not be allowed to enter the subsurface drip disposal system. The Singulair wastewater treatment plant produces an effluent that contains less than 10 mg/L $CBOD_5$ and 10 mg/L suspended solids. The flow equalization, effluent filtration and solids retention capacity, built into the Singulair Bio-Kinetic system, eliminates the need for complex electrical controls and automated backwashing equipment.

SOIL APPLICATION RATES

These guidelines provide general recommendations for soil application rates. State regulations and local codes for subsurface drip disposal may vary and should be carefully reviewed prior to beginning the design or construction of any drip disposal system.

When designing a drip disposal system, the instantaneous water application rate must not exceed capacity of the soil to absorb water. The absorption capacity of the soil is difficult to determine since the value varies with the water content of the soil. As the soil approaches saturation with water, the absorption rate reduces to an equilibrium rate called the “saturated hydraulic conductivity”. Wastewater application rates used to design the effluent disposal system should be less than 10 percent of this saturated equilibrium. Even though drip disposal systems maximize the soil absorption rate and keep the soil below saturation, there will be times when the soil is at or near saturation from rainfall events. The disposal system design must account for these periods and assume the worst case condition of soil saturation. By designing for a safety factor of 10 to 12, based on the saturated hydraulic conductivity, the system will be underloaded most of the time but should function properly during extreme wet weather periods.

Evenly applying wastewater in precise doses near the soil surface will keep the soil absorption rate at the highest value. Controlled doses of treated effluent dispersed into the upper most soil layer will minimize the potential of water surfacing in poor soil conditions.

The design criteria described in Table I will underload the system at all times except when the soil is at or near saturation from rainfall. When designing a drip disposal system that will also be used for irrigation, the water supply may not be sufficient to meet the demands of a lawn or landscaped area during peak water demand months. This problem can be overcome by either of two solutions: add additional fresh water to the system during the growing season; or split the system into two or more fields and only use one of the fields during the peak water demand months. If more than one field is used, they should be alternated during winter months or during extremely wet weather periods to prevent overloading the system.

TABLE I. SURFACE AREA REQUIRED TO DISPOSE OF SINGULAIR EFFLUENT

RECOMMENDED MINIMUM SURFACE AREA					
		Soil Absorption Rates			
Soil Class	Soil Type	Estimated Soil Percolation Rate (Minutes/Inch)	Hydraulic Conductivity (Inches/Hour)	Hydraulic Loading Rate (Gallons/Square Foot/Day)	Disposal Field Area Required* (Square Feet/Gallon/Day)
I	Coarse Sand	<5	>2	1.400	0.715
I	Fine Sand	5 – 10	1.5 – 2.0	1.200	0.833
II	Sandy Loam	10 – 20	1.0 – 1.5	1.000	1.000
II	Loam	20 – 30	0.75 – 1.0	0.700	1.430
III	Clay Loam	30 – 45	0.5 – 0.75	0.600	1.670
III	Silt-Clay Loam	45 – 60	0.3 – 0.5	0.400	2.500
IV	Clay Non-Swell	60 – 90	0.2 – 0.3	0.200	5.000
IV	Clay-Swell	90 – 120	0.1 – 0.2	0.100	10.000
IV	Poor Clay	>120	<0.1	0.075	13.340

***Disposal Field Area Calculation: Total area of disposal field = design flow divided by hydraulic loading rate.**
Table Source: “Subsurface Trickle Irrigation System for Onsite Wastewater Disposal and Reuse” by B.L. Carlile and A. Sanjines.

Table I shows the recommended hydraulic loading rates for various soil conditions, using a safety factor of at least 12 with regard to the saturated hydraulic conductivity rate of the soil. These loading rates assume a treated effluent with $CBOD_5 \leq 25$ mg/L and TSS ≤ 30 mg/L and that any unusual characteristics for domestic wastewater, such as iron bacteria, have been removed prior to disposal in the drip system.

Notes:

1. Table I is provided as a guide only. State regulations and local codes must be reviewed carefully prior to beginning the design or construction of any subsurface drip disposal system.

2. Problems with effluent drip disposal systems occur when soil texture is not properly interpreted. If in doubt, choose the more restrictive soil type from Table I.

3. Soil type should be based on the most restrictive layer within two feet of the emitter line. In many soils, designing the system with one foot vertical separation from the limiting layer has proven successful when the wastewater is being treated by a Singulair system.

4. Table I provides a general guidance that has resulted in tens of thousands of successfully operating effluent drip disposal systems. Where soil structure is a major consideration, the loading rates and disposal field area requirements in Table II provide a more comprehensive guide to system design.

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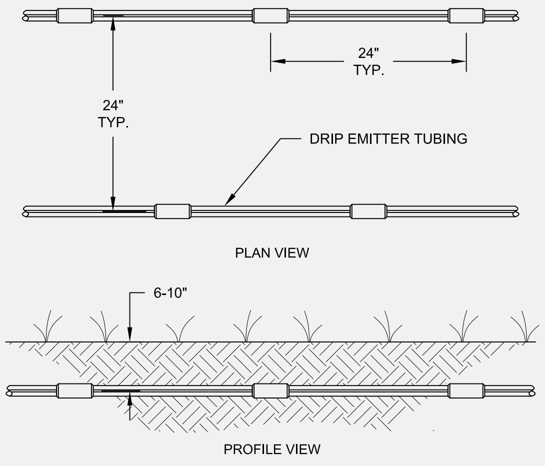
TABLE II. SUBSURFACE DRIP DISPOSAL LOADING RATES CONSIDERING SOIL STRUCTURE

Soil Textures	Soil Structure	Hydraulic Loading Rate (Gallons/Square Foot/Day)	Disposal Field Area Required (Square Feet/Gallon/Day)
Coarse sand or coarser	N/A	1.6	0.625
Loamy coarse sand	N/A	1.4	0.715
Sand	N/A	1.2	0.833
Loamy sand	Weak to strong	1.2	0.833
Loamy sand	Massive	0.7	1.430
Fine sand	Moderate to strong	0.9	1.111
Fine sand	Massive or weak	0.6	1.670
Loamy fine sand	Moderate to strong	0.9	1.111
Loamy fine sand	Massive or weak	0.6	1.670
Very fine sand	N/A	0.6	1.670
Loamy very fine sand	N/A	0.6	1.670
Sandy loam	Moderate to strong	0.9	1.111
Sandy loam	Weak, weak platy	0.6	1.670
Sandy loam	Massive	0.5	2.000
Loam	Moderate to strong	0.8	1.250
Loam	Weak, weak platy	0.6	1.670
Loam	Massive	0.5	2.000
Silt loam	Moderate to strong	0.8	1.250
Silt loam	Weak, weak platy	0.3	3.333
Silt loam	Massive	0.2	5.000
Sandy clay loam	Moderate to strong	0.6	1.670
Sandy clay loam	Weak, weak platy	0.3	3.333
Sandy clay loam	Massive	0.0	0.000
Clay loam	Moderate to strong	0.6	1.670
Clay loam	Weak, weak platy	0.3	3.333
Clay loam	Massive	0.0	0.000
Silty clay loam	Moderate to strong	0.6	1.670
Silty clay loam	Weak, weak platy	0.3	3.333
Silty clay loam	Massive	0.0	0.000
Sandy clay	Moderate to strong	0.3	3.333
Sandy clay	Massive to weak	0.0	0.000
Clay	Moderate to strong	0.3	3.333
Clay	Massive to weak	0.0	0.000
Silty clay	Moderate to strong	0.3	3.333
Silty clay	Massive to weak	0.0	0.000

Table Source: Wisconsin Private Sewage Disposal Code

DRIP EMITTER TUBING DEPTH AND SPACING

Subsurface effluent drip disposal systems generally have drip tubing placed on two foot centers with two foot emitter spacing. This design allows each emitter to dose a four square foot area. In sandy and loamy soils with a cover crop of grass, emitter tubing is best placed at depths of six to ten inches below the surface of the soil. In heavy clay soils or very coarse sands where lateral movement of water is restricted, closer line spacing or twelve inch emitter spacing may be used. Using closer spacing of drip tubing or closer spacing of emitters should not reduce the size of the disposal field. Drip emitter tubing with alternate spacing requirements is available by special order. Contact Norweco for details.



DRIP TUBING DEPTH AND SPACING RECOMMENDATIONS

SOIL LAYERS AND TYPES

Placing emitter tubing in the top soil is an advantage of drip disposal systems, as this soil is the most biologically active and the most permeable. The top soil also dries the fastest after a rainfall event and will maintain the highest water absorption rate. The quality and uniformity of the soil structure is important to the proper operation of an effluent drip disposal system. If the soil contains variations in structure, rocks or construction debris, it will be difficult to obtain the proper distribution of effluent. In many cases, particularly if the soil is severely compacted, soil properties must be improved by ripping and disking.

ADDING FILL TO THE DISPOSAL AREA

Some disposal sites require additional soil be brought in to increase separation distances between emitter tubing, a restrictive layer or a high water table. Restrictive layers stop or greatly reduce the rate of downward water movement. As a result, ponding of effluent may occur during part of the year. In soils with high water tables, treatment is minimized due to a lack of oxygen.

Placing drip tubing in selected fill material above the natural soil provides an aerated zone for treatment. Dispersal still occurs in the natural soil and the design of the disposal system must be based on the hydraulic conductivity of the natural soil to prevent overload.

Any time fill material is to be used, the area to receive the fill should have all vegetation removed. This prevents an organic layer from forming and restricting downward water movement after the fill material is placed.

The fill material should be applied in shallow layers with the first four to six inches incorporated into the natural soil to prevent an abrupt textural interface. Continue this process until all fill has been incorporated.

The fill area should be left crowned to shed surface water and may need diversion ditches or other drainage devices to prevent surface water from infiltrating. The entire fill area should have a vegetative cover to prevent erosion. If possible, allow the fill to settle at least seven to ten days before installing the drip emitter tubing. Fill should not be used on sites with a slope of greater than 20%.

HIGH POINTS, SIPHONING AND SLOPES

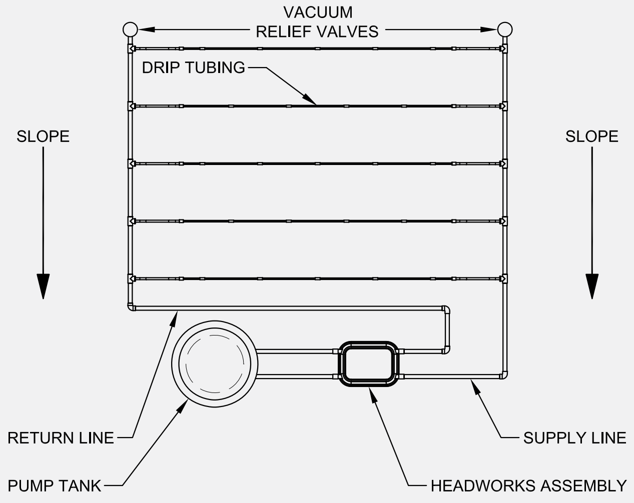
A potential problem with effluent drip tubing is siphoning soil into the emitters when the pump is switched off. To eliminate emitter siphoning:

1. Emitter tubing should be installed level. On sloped terrain, install tubing horizontally across the contour of the site.
2. At least one air/vacuum relief valve should be installed at the highest point in each supply or return line.
3. Avoid installing emitter tubing along rolling hills where there are high and low points along the same line. If this cannot be avoided, connect all the high points together and install an air/vacuum relief valve on the connecting manifold.
4. Emitter tubing should be connected to a common return line with a flush valve.

EXCESSIVE ELEVATION DIFFERENCES

Norweco pressure compensating drip emitter tubing can tolerate height variations provided the pressure remains within 10 to 45 PSI.

On a sloped site, installing short manifolds with fewer lines and longer drip tubing runs is recommended. A maximum of 1,500 feet of drip tubing within each zone can be used as a rule of thumb. Do not exceed five lines in a single zone with a slope greater than 10%. Install drip tubing with narrow spacing at the top of a slope and with wider spacing towards the bottom. In the case of compound slopes, consult a professional designer or engineer prior to finalizing the layout of the disposal field.



SINGLE ZONE DRIP DISPOSAL SYSTEM

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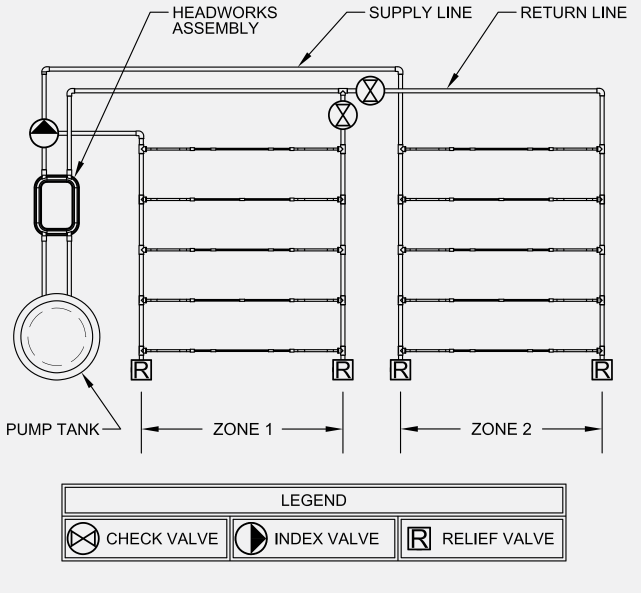
MULTIPLE ZONES

Subsurface drip disposal systems can be divided into multiple zones with a zone indexing valve when the following conditions apply:

1. Dividing the drip disposal field into smaller zones eliminates the need to upsize the pump, valves, filters, supply lines and return lines.
2. If the drip disposal field is located in multiple areas on the property.
3. The optimum ranges necessary for the disc filter to operate efficiently can be achieved by dividing the disposal field into several smaller zones.
4. On steep slopes, the disposal field can be divided to distribute the effluent more uniformly when the pump turns off.
5. Accommodating varying soil structures or vegetative cover on a single site.

Note: For fields with multiple zones, a single headworks assembly can be used by placing a zone valve downstream of the headworks box. All zones would require a check valve in the return line. A minimum operating pressure of 25 PSI must be maintained when using a zone valve.



MULTIPLE ZONE DRIP DISPOSAL SYSTEM

REUSE FOR IRRIGATION

A good vegetative cover is necessary to prevent erosion and utilize effluent applied to the root zone of the soil. Sites should be planted or seeded immediately after installation. Grasses are particularly suitable for this application. Most lawn grasses will consume 0.25" to 0.35" of water per day during the peak growing season. This calculates to be about 0.16 to 0.22 gallons/ft^2/day.

By over seeding lawns with winter ryegrass, the effluent can be reused for irrigation through most of the year. For vegetation consuming 0.16 to 0.22 gallons/ft^2/day by evapotranspiration, a wastewater flow of 500 gallons per day would supply the water needs of a landscaped area of 2,300 to 3,200 sq. ft. without having to add fresh water. For areas larger than this, plants will suffer water stress during the hot months unless additional fresh water is applied.

EFFLUENT APPLICATION FORMULA

When the effluent is to be reused for irrigation, the application rate must be calculated to insure the maximum consumption demand of the vegetation is satisfied. To determine the rate of application for various drip disposal system designs, use the following formula:

Effluent application rate (inches per hour) = 231 x (emitter flow rate in gph) ÷ [(Emitter spacing in inches) x (drip line spacing in inches)]

Example: Drip line with 1.0 gph flow rate emitters spaced 24" apart and drip tubing spaced 24" apart.

Effluent application rate = (231 x 1.0) ÷ (24 x 24) = 0.40 inches of effluent per hour

INSTALLATION GUIDELINES

Subsurface drip disposal systems require emitter tubing, PVC supply line, PVC return line, air/vacuum relief valves and a headworks assembly that includes an enclosure, lid, disc filter, three pressure monitoring valves and a flush valve. See Appendix A for a diagram of a typical single zone drip disposal system and components.

Handle effluent drip disposal system components with care. Store the drip tubing out of direct sunlight in a cool, shaded place. When installing emitter tubing in very hot and sunny areas, the life span of the subsurface drip disposal system will be increased if the tubing is buried an extra two or three inches below the soil surface.

1. All subsurface effluent drip disposal system construction shall be completed in compliance with state regulations and local codes.
2. No utility lines, cable wire, drain tile, etc. shall be located within the drip disposal system.
3. For safety, stake off the entire drip disposal system area prior to construction and keep out unauthorized persons until installation has been completed.

4. Drip emitter tubing must not be installed when the ground is wet or frozen.

5. Divert all downspouts and surface water away from the drip disposal system or into a curtain drain.

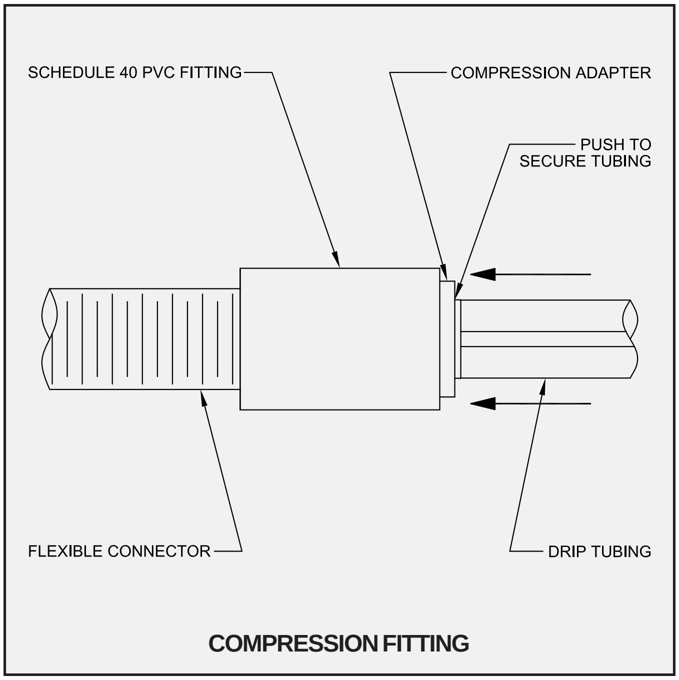
6. Excavation for the treatment plant and dosing tank, backfilling and grading should be completed before installation of the subsurface drip disposal system.

7. All components and equipment required for the installation of the drip disposal system should be onsite before opening trenches.

8. Pre-assemble as many components as practical above ground. Compression adapters should be glued to the flexible connectors and the connectors glued to PVC tees. Norweco manifold sections can be assembled and used to mark the beginning and end of emitter lines.

9. For particularly tough soil conditions, moisten the soil the day before opening the supply and return line trenches or installing drip emitter tubing. **Note:** It is much easier to install a subsurface drip disposal system in moist soil. The soil should be moist, but must allow the proper operation of the installation equipment and not cause smearing in the trenches. The soil surface should be dry enough to allow the installation equipment to maintain traction.

10. Mark the four corners of the drip disposal field. The top two corners should be at the same elevation and the bottom two corners should be at a lower elevation. In freezing conditions, the lowest emitter line must be higher than the invert of the supply and return lines at the dosing tank.



COMPRESSION FITTING

11. Install a watertight dosing tank, with a watertight riser, at the lowest elevation of the entire system.

12. Determine the proper size for the supply and return manifolds. See Appendix B, Line (M).

13. Install the supply manifold from the dosing tank, up hill through one lower and one upper corner stake of the disposal field. Refer to state regulations and local codes for depth of burial.

14. Paint a line between the two remaining corner stakes to indicate the location of the return manifold.

15. Leaving 12" of drip emitter tubing in the supply line trench, install the emitter tubing from the trench to the painted line at the depth specified. Upon reaching the painted line, pull 12" of tubing above ground and cut. Tape both ends of the tubing to prevent debris from entering. Continue this process until all of the emitter tubing has been installed. Drip emitter tubing must be spaced according to specification (two feet on center is standard). Emitter tubing depth of burial must be consistent throughout the field. Take care not to get dirt into the tubing.

16. Connect the drip tubing to the supply header. Do not glue emitter tubing. Compression fittings are used to connect emitter tubing.

17. When installing compression fittings:

    a. Hold the fitting in one hand and the emitter tubing with the other hand.
    b. Push the emitter tubing into the compression fitting as far as possible.

18. Install the pre-assembled headworks assembly between the field and the pump tank. **Note:** Determine the proper orientation of the supply and return lines prior to installation. The headworks assembly should be insulated in freezing conditions.

19. Dig the return header trench along the line painted on the ground and back to the dosing tank. The return line must be sloped back to the dosing tank.

20. Install the return manifold and connect all of the emitter tubing. Care must be taken to prevent kinking of the emitter tubing.

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21. Install air/vacuum relief valves at the highest points in the disposal field. Use pipe dope or Teflon tape and hand tighten.

22. Connect the field supply and return lines to the headworks assembly. Connect the headworks assembly supply line to the dosing pump. Install the headworks assembly return line into the dosing tank.

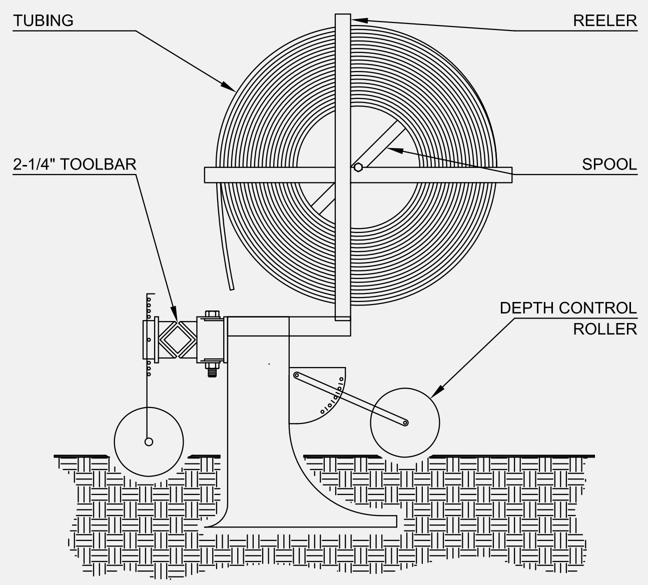
23. Install the floats in the dosing tank and connect them to the Singulair Drip Integrated System Control Center. The pump timer in the control center should be set to deliver no more than the system design daily flow. Do not set the timer to match the treatment capacity of the system.

24. Open the flush valve and turn on the pump to flush all lines. Check the pressure in the headworks assembly upstream of the flush valve. Adjust the flush valve until the design operating pressure (25 PSI standard) is maintained. Do not exceed 45 PSI. Check all connections for leaks.

25. Turn the pump off. Check the filter for construction debris and clean as necessary.

26. Replace the covers on all valve enclosures and the headworks assembly. Set the Integrated System Controls to automatic operation. Close and latch the control center cover.

27. Provide owner with final as-built diagrams and system design parameters at start-up. See Appendix D.



TUBING INJECTOR TOOL

TABLE III. DRIP EMITTER TUBING INSTALLATION METHODS

METHOD	ADVANTAGES	DISADVANTAGES
Hand Trenching	• Handles severe slopes and confined areas	• Slow • Labor intensive • Disrupts landscaping • Backfill required
Oscillating or vibrating plow. Use the type that inserts the drip tubing directly in place, not one that pulls the drip tubing through the soil.	• Fast in small to medium installations • Minimal ground disturbance • No need to backfill the trench	• Depth has to be monitored closely • Cannot be used on slopes greater than 20% • Requires practice to operate properly • Tends to stretch tubing. Shorter runs are required
Trenching Machine	• Faster than hand trenching • May use 1" blade for most installations • Uniform depth	• Slow • Disrupts surface of existing turf • Backfill required
Tractor with drip line insertion tool (see diagram above)	• Fast • Minimal damage to landscaping • Minimal ground disturbance • Does not stretch tubing • Adaptable to any tractor	• The installation tool is designed specifically for this purpose and cannot be used for other applications.
Tractor mounted 3-point hitch insertion implement	• Fastest. Up to four plow attachments with reels • A packer roller dumps soil on top of the tubing	• Suitable for large installations only

Note: Disturbing the soil may effect the pore structure and create hydraulic conductivity problems. Consult a soil scientist or professional engineer before choosing the installation technique.

WINTERIZATION

Norweco effluent drip disposal systems are not prone to frost damage because air/vacuum relief valves are included in the disposal system. The emitter tubing itself is made of polyethylene and is not susceptible to freezing. The tubing drains through the emitters, the supply line and the return line when the pump turns off. The following precautions should be followed if freezing conditions are anticipated:

1. Manifolds, supply lines and return lines must be sloped back to the dosing tank. These lines need to drain rapidly to prevent freezing. Under extreme cold conditions, return and supply manifolds must be insulated or buried below frost line.

2. Make sure the dosing pump has no check valve.

3. Insulate equipment enclosures, including those that contain headworks assembly, zone indexing valves and air/vacuum relief valves. Closed cell insulation, such as Perlite in a plastic bag is recommended.

4. In extreme cold conditions, use heat tape or a small heater in the headworks assembly.

5. The top of the air/vacuum relief valves must be no higher than soil surface.

6. If using a zone indexing valve to split the drip field into multiple zones, be sure it is capable of self-draining.

7. Drip tubing will drain through the emitters. If the grass cover over the drip field is not adequately established, add hay or straw over the disposal system for insulation.

8. Mark the valve boxes with metal pins so they can be found in the winter when covered in snow.

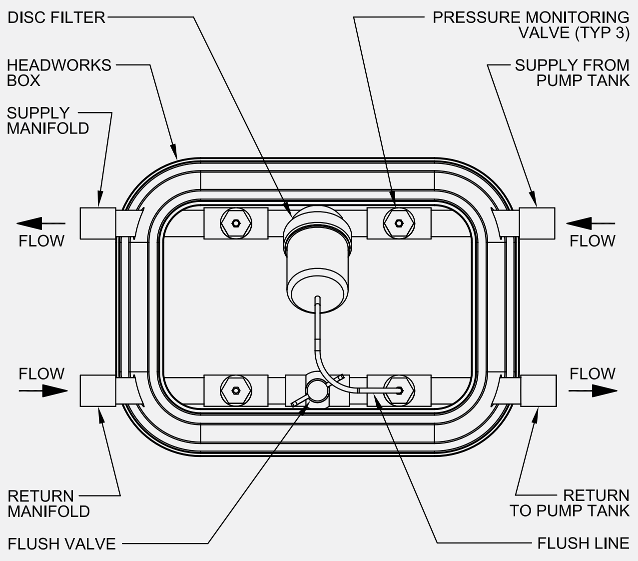
9. Fields dosed with small quantities of effluent are more likely to freeze than those dosed with design quantities. In multiple zone systems, only use a proportional number of zones if winter use is less than summer.

SYSTEM MAINTENANCE

The best way to assure years of trouble-free service from subsurface drip disposal systems is to continuously monitor the system and to perform maintenance functions regularly. Inspection and routine maintenance should be performed every six months.

ROUTINE AND PREVENTIVE MAINTENANCE

1. Remove the disc filter and clean. If bacteria buildup is a problem, soak the filter in a mixture containing 50% bleach and 50% water.



HEADWORKS ASSEMBLY

2. Open the flush valve and flush the field for three to five minutes by manually activating the pump. Close the flush valve.

3. With the pump operating, check the pressure in the drip field by using a pressure gauge on the Schrader valve located upstream of the flush valve. The pressure should be the same as shown in the installation records. Open the flush valve slightly until the design pressure is reached. This will allow the field to drain after each dose to prevent freezing.

4. Remove the lid on each of the air/vacuum relief valve enclosures and check for proper valve operation. If water is seen leaking from the top of the air/vacuum relief valve, turn the pump off. Remove the cap of the air/vacuum relief valve and remove any debris. Be careful not to come in contact with the effluent.

5. **Important: Reset the control center for automatic pump operation.**

6. Visually check and document in the service record the condition of the disposal system, including any excessive or abnormal wetness.

7. Singulair treatment plants and effluent dosing tanks are to be inspected routinely and maintained when necessary in accordance with service instructions.

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SYMPTOM	POSSIBLE CAUSE	REMEDY
High water alarm activates periodically (1-2 times/week). During other times, the water level in the pump tank is at a normal operating level.	Peak water usage (frequently laundry day) is causing a temporary high water condition.	Set timer to activate the pump more frequently by reducing the off cycle time. Be sure not to exceed the total design flow. Provide a larger pump tank to accommodate the peak flow periods.
High water alarm activates during or after periods of heavy rainfall.	Infiltration of ground or surface water into system.	Identify sources of infiltration, such as tank seams, pipe connections, risers, etc. Repair as required.
High water alarm activates intermittently, including times when it is not raining or when laundry is not being done.	A plumbing fixture may be leaking sporadically, but not continuously. Check water meter readings for 1 to 2 weeks to determine if water usage is unusually high. Determine if water usage is within design range.	Identify and repair fixture.
High water alarm activates continuously on a new installation. Inspection of the filter indicates it is plugged with a gray colored growth. Water usage is normal.	Slow start-up of treatment plant resulting in the presence of solids in the effluent sufficient to cause a biological growth on the filter. This is typical of an underloaded treatment plant receiving a high percentage of gray water.	Remove and clean filter cartridge in a bleach solution. Add a gallon of household bleach to pump tank to oxidize organics.
High water alarm begins to activate continuously after a long period of normal operation. Inspection of the filter indicates it is plugged with a heavy accumulation of solids.	A buildup of solids has occurred in the pump tank.	Replace the filter cartridge with a clean cartridge. Check the pump tank and remove solids if necessary. Check the operation of the treatment plant to insure it is operating properly.
Water surfaces continuously at one or more isolated spots.	Damaged drip tubing or a loose connection is leaking. If water is located at the base of a slope, it may be caused by improper design or installation.	Dig up drip emitter tubing. Activate pump and locate leak. Repair as required. Consult a design professional. Install check valves and air/vacuum relief valves in the supply and return manifolds to redistribute water in the system after pump is turned off. This is not advised for freezing climates where manifold drainage is required.

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SYMPTOM	POSSIBLE CAUSE	REMEDY
A portion of the drip field closest to the supply manifold is saturated while the rest of the field is dry.	Insufficient drip field operating pressure. A pressure check upstream of the flush valve indicates less than 10 PSI.	Check filter and pump intake for plugging. Clean as required. Check for leaks in connections. Check air/vacuum relief valves to insure they are closing properly. Repair as necessary.
	The duration of each dose is of insufficient length to allow the drip field to become pressurized before the pump shuts off (or runs for only a brief time before turning off).	Increase the pump run time or decrease the frequency of doses. Determine how long the system takes to fully pressurize and add this time to each pump run cycle.
	Pump is worn or improperly sized. Pressure at supply manifold is less than 15 PSI.	Verify pressure requirements of system and provide a new or larger pump. Alternatively, divide the drip field into two or more zones.
Effluent surfaces in drip field during dosing periods. Installation is recent and the soil is a moderate to heavy clay.	Smearing of the soil may have occurred during installation of drip tubing. The “cut” resulting from the installation allows an easy path for effluent to surface.	Reduce the pump run time or increase the frequency of doses. Seed the area to develop an effective root zone. In most cases, the soil will compact naturally around the drip tubing and the surfacing will ultimately cease.
Entire area of drip field appears to be totally saturated with water. Situation occurs during dry season when there is little rainfall.	Amount of effluent being discharged to drip disposal field exceeds design. Excess water may be a result of infiltration, plumbing leaks or excessive water usage.	Check water meter to determine if water usage is in excess of design. Check for leaks or infiltration. Repair leaks as required. Reduce water usage by installing water saving fixtures.
	Area of drip disposal field was inadequately sized.	If water usage cannot be reduced, enlarge drip field.

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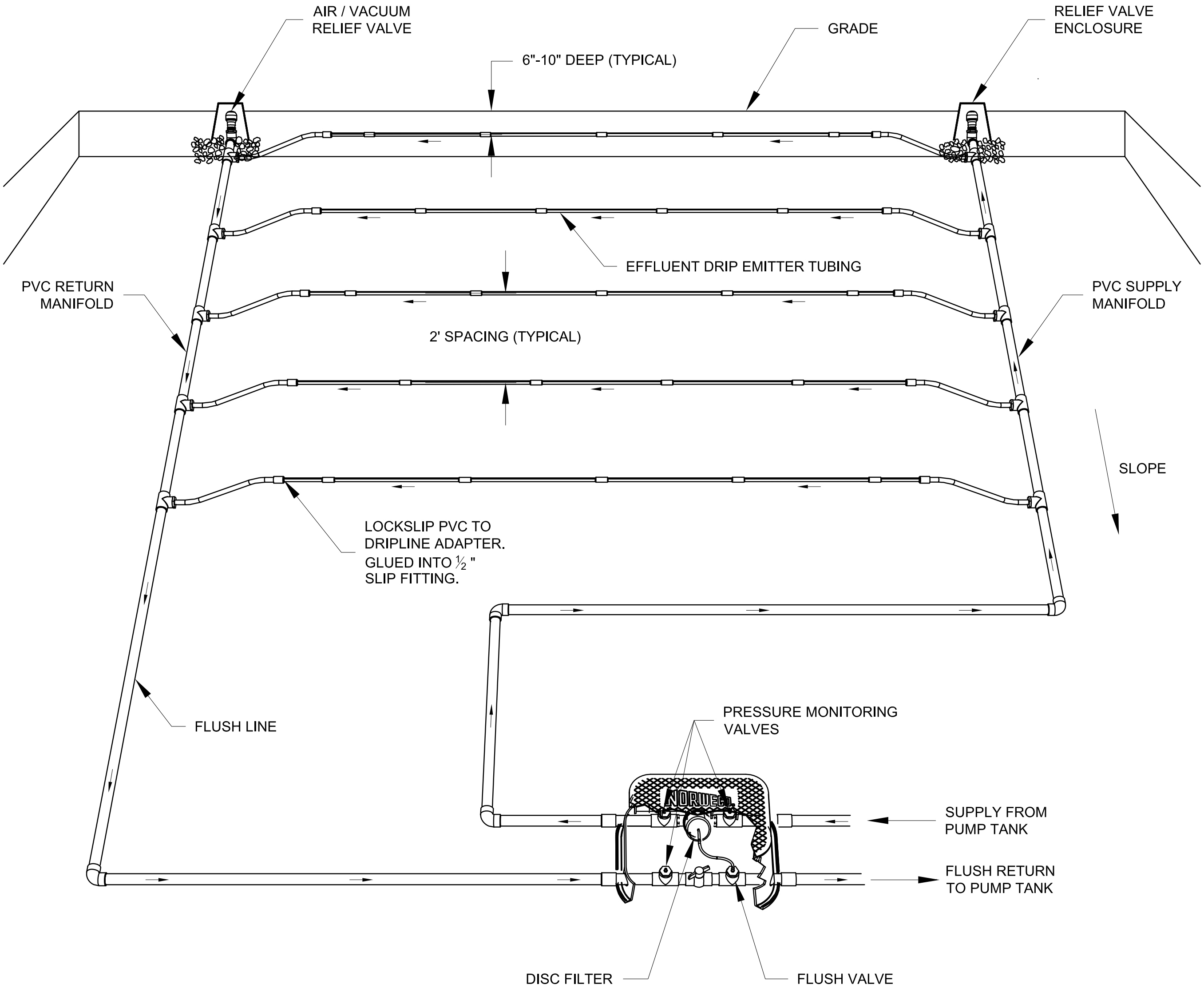
The following appendices contain worksheets, calculations, industry references and an as-built data sheet. This information is supplied for use by the drip disposal system design professional in determining the detailed specifications for each site application. Calculations and design parameters contained herein are general recommendations only. State regulations and local codes must be used where applicable.

To minimize total system cost, consideration should be given to the use of standard Norweco effluent drip disposal equipment as indicated herein. Non-standard equipment is available from Norweco by special order if desired. Immediately following the installation and start-up of the Norweco subsurface drip disposal system, the as-built data sheet should be completed. The as-built data sheet should remain on file with the drip disposal system owner to provide a historical reference for maintaining the system. This reference should also be consulted before any additional construction such as fencing, lighting, landscaping, etc. takes place on or near the disposal site.

APPENDIX A



TYPICAL SINGLE ZONE SUBSURFACE DRIP DISPOSAL SYSTEM

APPENDIX B
DISPOSAL FIELD DESIGN FOR SINGLE ZONE SYSTEM

To calculate the area required for your drip disposal system, you must know:

1. Design daily flow in gallons per day (Line A below).
2. The hydraulic loading rate in gallons per square foot per day (Line B below).

Make a sketch of the disposal area with contour lines

WORKSHEET	FORMULA
A) Quantity of effluent to be dispersed per day __________Gallons Per Day	
B) Hydraulic loading rate __________Loading Rate (Gallons/Square Foot/Day)	Based on soil analysis and Tables I and II. Refer to state regulations and local codes.
C) Determine the total area required __________Square Feet	(A) ÷ (B)
D) Determine the spacing between drip lines __________Inches	Standard spacing is 24 inches
E) Determine the spacing between drip emitters __________Inches	Standard spacing is 24 inches
F) Calculate the total linear feet of drip tubing required __________Linear Feet	[(C) ÷ 2] for 24 inch tubing spacing (standard) [(C) ÷ 1] for 12 inch tubing spacing [(C) ÷ 0.5] for 6 inch tubing spacing
G) Calculate the number of emitters required __________Emitters	[(F) ÷ 2] for 24 inch emitter spacing (standard) [(F) ÷ 1] for 12 inch emitter spacing [(F) ÷ 0.5] for 6 inch emitter spacing
H) Determine drip field pressure __________PSI	Standard pressure is 25 PSI
I) Determine the total number of laterals __________Laterals	Based on field layout and site conditions

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APPENDIX B CONTINUED

<table>
<tr><th>WORKSHEET</th><th>FORMULA</th></tr>
<tr>
<td>J) Determine the length of each lateral

__________Feet</td>
<td>Based on field layout and site conditions
(I) x (J) must be greater than or equal to (F)

The maximum length of each lateral should not exceed the values shown in the table below.

Maximum Length Run vs Pressure
Allows a minimum of 10 PSI at the end of the line
Recommended operating pressure is 10 to 45 PSI

<table>
<tr><th>Pressure</th><th>Head</th><th>Maximum Length</th></tr>
<tr><td>10 PSI</td><td>23.10 Feet</td><td></td></tr>
<tr><td>15 PSI</td><td>34.65 Feet</td><td>211 Feet</td></tr>
<tr><td>20 PSI</td><td>46.20 Feet</td><td>265 Feet</td></tr>
<tr><td>25 PSI*</td><td>57.75 Feet</td><td>315 Feet</td></tr>
<tr><td>30 PSI</td><td>69.30 Feet</td><td>335 Feet</td></tr>
<tr><td>35 PSI</td><td>80.85 Feet</td><td>379 Feet</td></tr>
<tr><td>40 PSI</td><td>92.40 Feet</td><td>385 Feet</td></tr>
<tr><td>45 PSI</td><td>103.95 Feet</td><td>429 Feet</td></tr>
</table>
*Standard operating pressure</td>
</tr>
<tr><td colspan="2">K) Sketch a layout of the drip tubing in the disposal field</td></tr>
</table>

APPENDIX B CONTINUED

WORKSHEET	FORMULA
L) Determine the dosing rate __________GPH __________GPM	Number of emitters multiplied by the emitter flow rate GPH = (G) x emitter flow rate (1.02 is standard) GPM = (L1) ÷ 60
M) Determine drip tubing flushing rate __________GPM	Consult drip tubing manufacturer's guideline. For standard Norweco drip tubing at a 2 feet/second flushing velocity, use (I) x 1.48
N) Minimum pump capacity __________GPM	[(L) + (M)] x 1.05 Includes a 5% safety factor
O) Return line flow rate __________GPM	(N) - (L)
P) Static head __________Feet	Elevation change from pump to drip field
Q) Supply line friction head loss 1) Equivalent length of fittings __________Feet 2) Distance from pump to field __________Feet 3) Total equivalent length of pipe __________Feet 4) Supply line size __________Inches 5) Pressure drop in 100 feet of supply line __________PSI 6) Total supply line friction head loss __________Feet	Estimate loss through fittings - usually inconsequential for small systems Add (Q1) + (Q2) Based on minimum pump capacity (N) and Appendix C. Optimum velocity is between 2 to 5 feet per second Based on minimum pump capacity (N), supply line size (Q4) and Appendix C (Q3) ÷100 x (Q5) x 2.31

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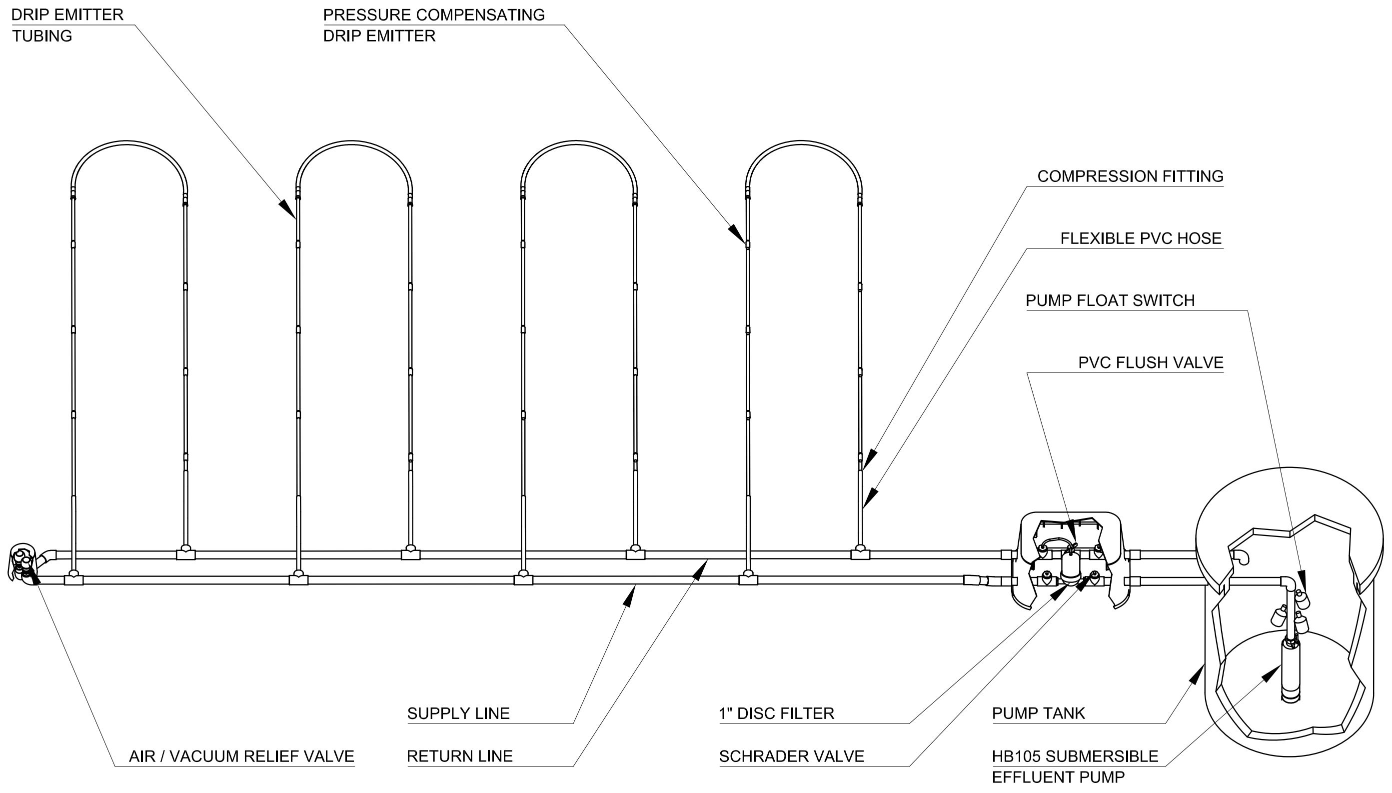
APPENDIX B CONTINUED

<table>
<tr><th>WORKSHEET</th><th>FORMULA</th></tr>
<tr><td>R) Determine filter head loss
__________Feet</td><td>Use flow rate (N) and table below for standard Norweco 1" filter. For other filters, consult filter manufacturer.
<table>
<tr><th>Flow Rate (GPM)</th><th>Head Loss (Feet)</th></tr>
<tr><td>5</td><td>0.44</td></tr>
<tr><td>10</td><td>1.78</td></tr>
<tr><td>15</td><td>3.98</td></tr>
<tr><td>20</td><td>6.36</td></tr>
<tr><td>25</td><td>9.96</td></tr>
</table></td></tr>
<tr><td>S) Drip line friction head loss
__________Feet</td><td>Based on lateral length (J) and table below when using Norweco drip tubing. For other drip tubing, consult tubing manufacturer.
<table>
<tr><th>Lateral Length (Feet)</th><th>Head Loss (Feet)</th></tr>
<tr><td>50</td><td>0.23</td></tr>
<tr><td>100</td><td>1.29</td></tr>
<tr><td>150</td><td>4.13</td></tr>
<tr><td>200</td><td>9.49</td></tr>
<tr><td>250</td><td>18.18</td></tr>
</table></td></tr>
<tr><td>T) Return line friction head loss</td><td></td></tr>
<tr><td>1) Estimate length of fittings
__________Feet</td><td>Estimate loss through fittings - usually inconsequential for small systems</td></tr>
<tr><td>2) Distance from field to pump
__________Feet</td><td></td></tr>
<tr><td>3) Total equivalent length of pipe
__________Feet</td><td>Add (T1) + (T2)</td></tr>
<tr><td>4) Return line size
__________Inches</td><td>Based on return line flow rate (O) and Appendix C. Optimum velocity is between 2 to 5 feet per second</td></tr>
<tr><td>5) Pressure drop in 100 feet of return line
__________PSI</td><td>Based on return line flow rate (O), return line size (T4) and Appendix C</td></tr>
<tr><td>6) Total return line friction head loss
__________Feet</td><td>(T3) ÷ 100 x (T5) x 2.31</td></tr>
</table>

SUBSURFACE DRIP DISPOSAL SYSTEM GUIDE (Page 16 of 18)

APPENDIX B CONTINUED

WORKSHEET	FORMULA
U) Determine feet of head required at drip field __________Feet	(H) x 2.31
V) Minimum total dynamic head __________Feet	Add (P) + (Q6) + (R) + (S) + (T6) + (U)
W) Choose the pump __________Model Number __________Manufacturer	Based on total dynamic head from line (V) above and flow from line (N). Standard pump is Norweco Model HB105



TYPICAL SINGLE TRENCH INSTALLATION SUBSURFACE DRIP DISPOSAL SYSTEM

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APPENDIX C
SCHEDULE 40 PVC PIPE FRICTION LOSS IN POUNDS PER SQUARE INCH (PSI) PER 100 FEET OF PIPE

	1/2"		3/4"		1"		1 1/4"		1 1/2"	
Flow GPM	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI
1	1.05	0.43	0.60	0.11	0.37	0.03				
2	2.11	1.55	1.2	0.39	0.74	0.12	0.43	0.03		
3	3.17	3.27	1.8	0.83	1.11	0.26	0.64	0.07	0.47	0.03
4	4.22	5.57	2.41	1.42	1.48	0.44	0.86	0.11	0.63	0.05
5	5.28	8.42	3.01	2.15	1.86	0.66	1.07	0.17	0.79	0.08
6	6.33	11.81	3.61	3.01	2.23	0.93	1.29	0.24	0.95	0.11
8	8.44	20.10	4.81	5.12	2.97	1.58	1.72	0.42	1.26	0.20
10	10.55	30.37	6.02	7.73	3.71	2.39	2.15	0.63	1.58	0.30
15			9.02	16.37	5.57	5.06	3.22	1.33	2.36	0.63
20					7.42	8.61	4.29	2.27	3.15	1.07
25					9.28	13.01	5.36	3.42	3.94	1.63
30					11.14	18.22	6.43	4.80	4.73	2.27
35							7.51	6.38	5.52	3.01
40							8.58	8.17	6.30	3.88
45							9.65	10.16	7.09	4.80
50							10.72	12.35	7.88	5.83
60									9.46	8.17
70									11.03	10.87

	2" Pipe		2 1/2" Pipe		3" Pipe		4" Pipe		6" Pipe	
Flow GPM	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI	Velocity FPS	Pressure Drop PSI
6	0.57	0.03								
8	0.76	0.06	0.54	0.02						
10	0.96	0.09	0.67	0.04						
15	1.43	0.19	1.01	0.08	0.65	0.03				
20	1.91	0.32	1.34	0.13	0.87	0.05				
25	2.39	0.48	1.67	0.20	1.08	0.07				
30	2.87	0.67	2.01	0.28	1.30	0.10				
35	3.35	0.89	2.35	0.38	1.52	0.13	0.88	0.03		
40	3.82	1.14	2.64	0.48	1.73	0.17	1.01	0.04		
45	4.30	1.42	3.01	0.60	1.95	0.21	1.13	0.05		
50	4.78	1.73	3.35	0.73	2.17	0.25	1.26	0.07		
60	5.74	2.42	4.02	1.02	2.60	0.35	1.51	0.09		
70	6.69	3.22	4.69	1.36	3.04	0.47	1.76	0.12		
80	7.65	4.13	5.36	1.74	3.47	0.60	2.02	0.16		
90	8.60	5.13	6.03	2.16	3.91	0.75	2.27	0.20		
100	9.56	6.23	6.70	2.63	4.34	0.91	2.52	0.24	1.11	0.03
125	11.95	9.42	8.38	3.97	5.42	1.38	3.15	0.37	1.39	0.05
150			10.05	5.56	6.51	1.93	3.78	0.51	1.67	0.07
175					7.59	2.57	4.41	0.68	1.94	0.09
200					8.68	3.40	5.04	0.90	2.22	0.12

Optimum velocity is 2 to 5 feet per second
ASTM D 1785, D2672, D1784 Cell Class 12454-A

APPENDIX D

RECOMMENDED AS-BUILT DATA SHEET

1. Site Name:______________________________

2. Site Street Address Including State:______________________________

3. Drip Field Designed by:______________________________

4. Drip Field Installed by:______________________________

5. Date of Installation: ____________________ 6. Daily Design Flow:____________________GPD

7. Soil Percolation Rate:____________________

8. Singulair System Model Number: ____________________

Aerator Serial Number: ____________________

Control Panel Serial Number: ____________________

9. Number of zones in drip field:_______________

If more than one zone, describe zone valve (size, manufacturer, part number, type):____________________

10. Amount of drip tubing installed in each zone:

Zone 1:_______Feet Zone 2:_______Feet Zone 3:_______Feet Zone 4:_______Feet

11. Total emitter flow rate per zone:

Zone 1:_______GPM Zone 2:_______GPM Zone 3:_______GPM Zone 4:_______GPM

12. Drip tubing installation depth:__________Inches

13. Pump manufacturer: ______________________________
Model number: ______________________________
Number of pumps: ______________________________

14. Pressure in each zone:

Zone 1:_______PSI Location pressure measured:______________________________
Zone 2:_______PSI Location pressure measured:______________________________
Zone 3:_______PSI Location pressure measured:______________________________
Zone 4:_______PSI Location pressure measured:______________________________

15. Size (diameter) of supply manifold:_______Inches Depth of supply manifold:____________________ Inches

16. Size (diameter) of return manifold:_______Inches Depth of return manifold:____________________Inches

18. Size of field flush valve:_______Inches

If more than 1 zone, do the zones share a flush valve? ____________________

19. Was any fill material supplied in the drip field? __________

Describe fill: ____________________

20. Provide owner with as-built drawings, including, but not limited to, direction of drip tubing, location of air/vacuum relief valves, headworks assembly, Singulair Bio-Kinetic wastewater treatment system and dosing tank.

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