ON-SITE DISPOSAL OF TREATED WASTEWATER WITH WASTEFLOW® SUBSURFACE DRIP IRRIGATION

Gary Horton
Triangle Filtration & Irrigation. Mordialloc, Victoria

Abstract

On-site wastewater disposal has led to the development of Geoflow Wasteflow® sub-surface drip irrigation pipe and system.

An on-site treated wastewater subsurface drip irrigation system combines the benefits of high irrigation efficiency, least possible health risk, and controlled percolation into the aquifer.

Keywords

drip irrigation, subsurface irrigation, wasteflow

1 Introduction

On-Site effluent disposal using subsurface drip irrigation has similar design and hydraulic characteristics to traditional irrigation systems, but they are not truly identical.

The principal objective with effluent disposal is to dispose of the treated wastewater in a given area as efficiently as possible with uniform distribution throughout the year without raising health concerns.

The critical factor for subsurface drip to succeed with biologically active water is a well-designed, reliable installation and management control. The basis of any design is knowing how much water the treatment system will produce, and how much water can be applied per square metre on a daily basis. This means testing each site for absorption rates.

The key **advantages** of subsurface drip irrigation when used in conjunction with effluent are-:

- Less problems associated with penetration into the soil, run off or pooling;
- Distribution uniformity of wastewater over the disposal area;
- Safe for playing fields, residential landscaping, parks, edible agricultural crops, applications where spraying is considered unacceptable;
- Plants and vegetation can make better use of the nutrients present in the effluent;
- Less treated water is directly discharged into water bodies reducing environmental pollution;
- Can be used in difficult circumstances such as steep slopes or prevailing wind conditions;
- Increases consumption of nitrates by the plant material;
- Economical, invisible and vandal proof installation;
- Non intrusive, allows for use of space while in operation; and
- Durable system with few moving parts, and can be fully automated.

2 Factors in Designing a Sub-Surface Drip Irrigation System

When designing a subsurface drip irrigation scheme using reclaimed wastewater a number of factors need to be considered.

- Health hazard
- Pollution of the aquifer
- Suitability of the reclaimed water for the vegetation
- Salt management
- Heavy metal concentration in the soil
- Effect on soil permeability
- Plugging of the system due to bacteria growth and root intrusion
- Reliability and system life
- The economic cost

Health hazards will vary from insignificant to crucial, depending on the quality of the source of reclaimed wastewater, the vegetation and the soil.

Subsurface drip irrigation systems have been installed using secondary and tertiary treated municipal wastewater, commercially packaged sewage treatment plants and domestic treatment plants (AWTS) with effluent and grey water.

3 System Components

A typical Wasteflow® wastewater sub-surface irrigation system will comprise of the following components.

3.1 Wasteflow®

Wasteflow® is 16 mm O.D. extruded polyethylene piping with an in line drip emitter every 60cm. The drip emitters are turbulent flow "in line" with large flow paths to prevent clogging. Historically the difficulties with sub-surface irrigation has been root intrusion and slime build up on the inside of the pipes The patented process developed by Geoflow whereby minute amounts of the non toxic herbicide Trifluralin is compounded into the emitters at the moulding process. This creates a barrier when irrigating and directs root growth away from the emitters.

To eliminate the slime build up, Wasteflow® is coated on the inside with a bactericide Ultra Fresh DM-30 lining to inhibit bacterial growth on the walls of the tube, and in the emitters, eliminating the need to scour the drip-line with velocities exceeding turbulent flow. It does not migrate through plastic nor does it leach into the water.

Wasteflow® drip-line is supported with a ten-year warranty against manufacturing defects and root intrusion

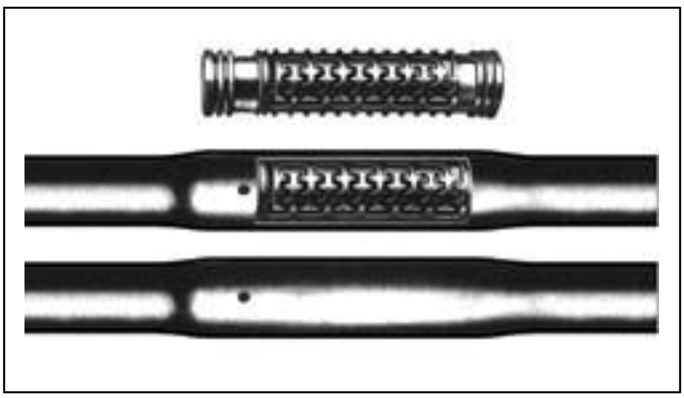


Figure 1. Wasteflow® Cut-away Showing Emitter System Inside Pipe

The Wasteflow® Classic non-pressure compensating has 4.3 L/h turbulent flow emitters where as the pressure compensating Wasteflow® used specifically for hilly and undulating terrains has 2.4 L/h emitters. In both products the emitters are spaced at 60 cm intervals.

3.2 Vacuum Breakers

With sub-surface irrigation systems, vacuum breakers must be installed at the **highest** point in each block to prevent the system from sucking dirt back into the dripline, due to back siphoning or back pressure when the system is turned off.

3.3 Pressure Regulating Valves

In normal operating conditions the pressure at the drip lines needs to be between 100 to 175 kPa for classic Wasteflow® and between 50 to 400 kPa for pressure compensating extra Wasteflow® to ensure even distribution across the field.

3.4 Filters

Effective filtration for each system is essential. A100 micron (150 mesh) primary filter is required at the control head of the subsurface drip irrigation system. This will ensure removal of any particles that may enter the water between the treatment plant and the irrigation system

3.5 Chemical Injectors

This allows chlorine acids and alkalis to be safely applied through the system. This is required for any system with a BOD> 20mg/l, and optional for BOD< 20mg/l. If a chemical injector is not used with effluent BOD< 20mg/l then a chlorinator is required.

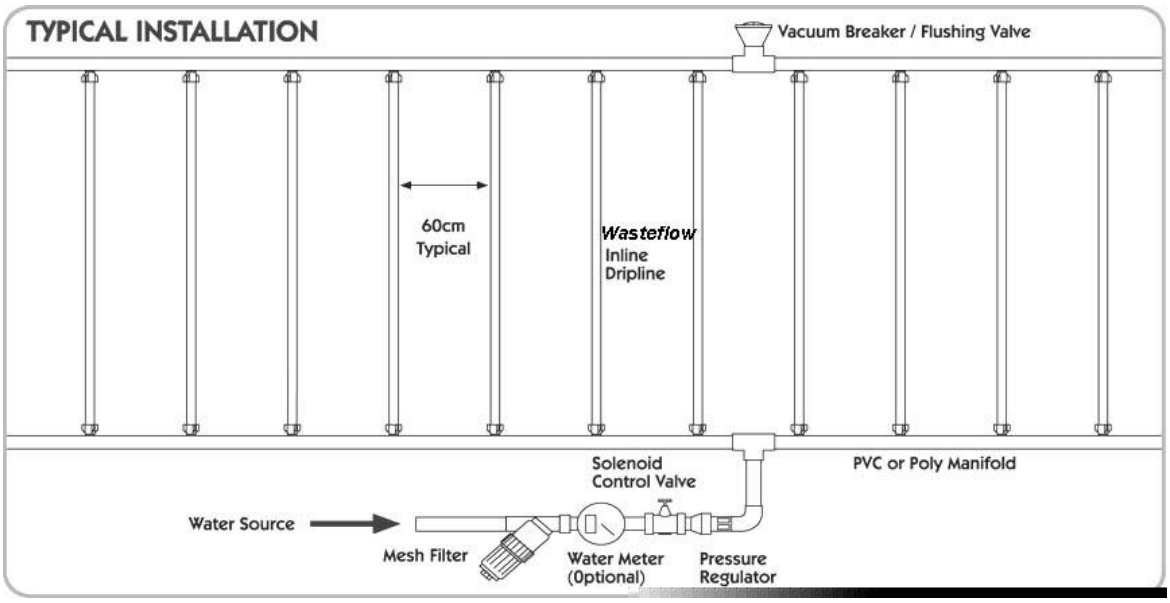
3.6 Controllers

Larger systems can incorporate irrigation controllers connected to solenoid valves. Control for domestic systems can range from a hydraulically controlled rotor valve through to ball valves.

3.7 Main and Sub-Main Manifold Lines

The delivery mainline from the pump to the Wasteflow® manifold can be in either rigid PVC or polyethylene piping. Sizing of these pipelines is determined by the system flow and by hydraulic calculation. In smaller domestic systems with flows under 1500 L/h the Wasteflow® pipe can be used as the manifold to simplify the installation.

Figure 2. Typical Installation of Drip Line



3.8 Flushing Manifold

At the end of each section of irrigation connect a flushing valve to support periodical maintenance. After system installation open flush valves under full line pressure to ensure all lines are clean then close the valve. In the interest of health and safety connect a pipeline to the flush valve which will return all flow back into the treatment plant.

3.9 Pumps

To ensure that the disposal area has a uniform distribution of $\pm$ 5% you require a drip line pressure of between 100 to 175 kPa for non pressure compensating Wasteflow® and 50 to 400 kPa pressure compensating.

4 Design Parameters

4.1 Select the Area

In selecting the disposal area carefully consider soil types, terrain, vegetation and the local and state regulations.

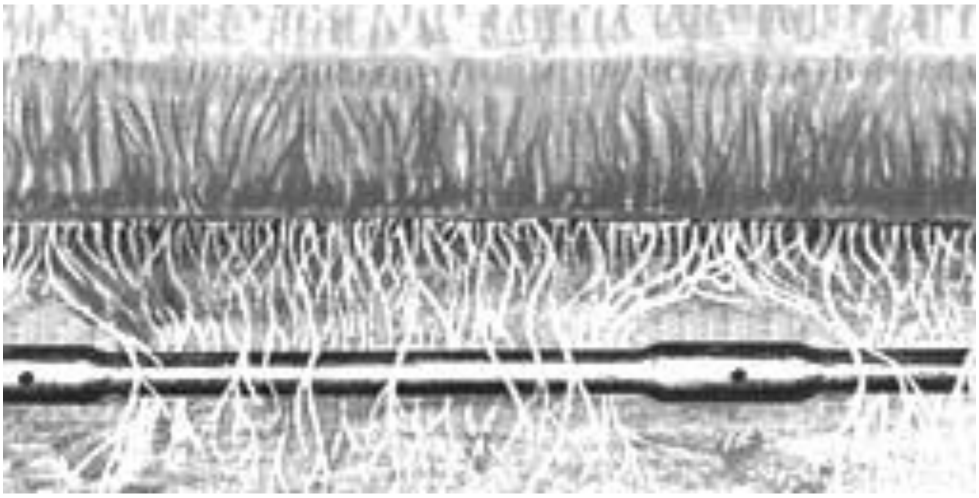


Figure 3. Drip Line Within Root Zone of Vegetation

4.2 Soil Application Design

Note: This paragraph is extracted from *Subsurface Trickle Irrigation Systems for On-Site Wastewater Disposal and Reuse* by B.L. Carlile and A. Sanjines.

The instantaneous water application rate of the system must not exceed the water absorption capacity of the soil. Determination of the instantaneous water absorption capacity of the soil is difficult, since the value varies with the water content of the soil. As the soil approaches saturation, the absorption rate reduces to an equilibrium rate called the "saturated hydraulic conductivity". Wastewater application rates should be less than 10 percent of this saturated equilibrium.

Even though the trickle irrigation system maximises the soil absorption rate through the low application rate, keeping the soil below saturation, there may be times when the soil is at or near saturation from rainfall events. The design must account for these periods and assume the worst case conditions of soil saturation.

By designing for a safety factor of 10 or 12, based on the saturated hydraulic conductivity, the system will be under-loaded most of the time but should function without surface failure during extreme wet periods.

Using a safety factor of 12, a suitable design criteria would be to load the system at based on estimated hydraulic conductivity but apply water for only 2 h/day out of the available 24 hours. By applying waste water for a total of 2 h/day, particularly if applied in "pulses", or short doses several times per day near the soil surface where the soil dries the quickest the soil absorption rate should not be reduced.

Table 1: Minimum Surface Area Guidelines to Dispose of 1000 L/day.

Soil Type	Soil absorption rates			
	Est. Soil Perc. Rate Min/25mm	**Hydraulic Conductivity mm/h**	**Design Loading Rate mm/m^2 per day**	**Total area required m^2/1000 L/day**
Coarse-Sand	<5	>50	81	13
Fine Sand	5-10	38-50	65	16
Sandy Loam	10-20	25-38	53	19
Loam	20-30	19-25	37	27
Clay Loam	30-45	12.5-19	24	42
Silt-Clay Loam	45-60	7.6-12.5	16	63
Clay non-swell	60-90	5-7.6	8	125
Clay-swell	90-120	2-5.5	4	250
Poor Clay	>120	<2.5	3	334

- The above chart is provided as a guide only. Always refer to your local authorities that may have different guidelines.
- Surface area of disposal field calculation:
- Design flow divided by loading rate = total area (m^2) of disposal field.

Example of a Disposal Field Calculation

To calculate the disposal area required you must know the following-:

1. The volume of water per day (LPD) to be disposed of
2. The long-term design hydraulic loading rate – mm/m^2 /day

Product: Wasteflow® Classic 16mm x 4.5 L/h x 600mm emitter spacing.
System Flow: 2000 L/day
Hydraulic Loading: 5 mm/m2 / day

a) Area Required $= \dfrac{2000\ \text{LPD}}{5\ \text{Hyd Loading}} = 400\ \text{m}^2$

b) Wasteflow® required with laterals 1metre spacing

$$\text{Flow} = \frac{400\ \text{m}^2}{1\ \text{m spacing}} = 400\ \text{lineal metres}$$

c) Capacity of system flow rate with 4.3 L/h emitters @ 600 mm emitter spacing

$$\text{Capacity} = \frac{400\ \text{L/metres} * 4.3\ \text{L/h}}{0.6\ \text{m emitter spacing}} = 2866\ \text{L/h}$$

d) Running time = 0.69 hours per day

The above flow rate in some instances may not be practical to supply to one area. The total area can be designed so that the total flow is distributed over a number of smaller fields to make up the required area.

4.3 Soil Layers and Types

The shallow installation depth is an advantage of the subsurface drip irrigation field, since the topsoil or surface soil is generally the most biologically active and permeable soil for accepting water. The topsoil also dries the fastest after a rainfall event and will maintain the highest water absorption rate.

The quality and homogeneity of the soil may present a problem. If the soil was not properly prepared and there are pieces of construction debris, rocks and non-uniform soils, it will be very difficult to obtain uniform water spread. In all cases, but particularly if the soil is compacted, soil properties can be greatly improved by ripping and disking, sifting the coarser material and laying it down first.

4.4 High points, Siphoning

A potential problem with buried subsurface drip irrigation lines is syphoning dirt into the emitters when the pump is switched off. For this reason:

- Drip lines should have a fairly constant slope and always run drip lines along the contour;
- Install a minimum of one vacuum breaker at the highest point in each zone;
- Drip lines should be connected at the end to a common manifold with a flush valve / vacuum breaker; and
- Avoid installing lines along rolling hills where you have high and low points along the same line. If this is the case, connect all the high points together and install a vacuum breaker on the line.

4.5 Slopes

When designing on a slope the drip lines are installed to follow the contour. If the slope over a disposal block is more than 2 m, then pressure-compensating Wasteflow® must be used.

4.6 Excessive Level Differences

Level differences between drip lines belonging to the same valve should not exceed 3m. If it does, each would require its own pressure regulation valve, with vacuum breakers installed at the end of each line.

4.7 Positioning of Vacuum Breakers / Flush valves

Ensure that these valves are installed at a point high enough to prevent the system from draining through these valves when the water pressure is switched off.

5 System Installation

Handle your Wasteflow® drip line and components with care, as it is temperature sensitive.

To assure a long life, store the drip line under shade in a cool place prior to installation. Avoid hot temperature extremes.

1. Excavation, filling and grading should have been completed before installation of the subsurface drip system
2. For ease of installation before opening trenches pre-assemble as much as practical
3. Install head works first: pump, valves, filters, pressure-reducing valves, chemical injection equipment etc. Then install the mainline, buried to between 300 – 450 mm.
4. Open trenches for sub-mains, manifold and flush lines buried to 200 – 250mm.
5. Install Wasteflow ® to a depth of 150– 200mm. Wasteflow® can be installed by hand trenching or with a vibrating plough.
6. Cover all open ends including drip-line ends to avoid getting debris into the system.

7. Leave enough tail at the beginning and end of each drip-line for connection to manifolds.
8. Do not bend Wasteflow® tubing below a 0.6 m radius as pipe work may kink.
9. Backfill the trenches early in the morning when temperatures are low as polyethylene elongate in high temperatures.
10. Connect drip lines to sub-main and flush manifolds. Open flush valves.
11. Run the system before completing backfilling of trenches and check connections for leaks.

6 System Maintenance

To assure a trouble-free system monitor the system and perform regular maintenance functions. For large systems, or systems with a BOD >20mg/l automation of maintenance is essential. For systems with a BOD < 20mg/l, quarterly inspection and maintenance is adequate.

1. Filters require cleaning when the pressure differential between the inlet and outlet reaches 50kpa. If the filter clogs frequently, a larger filter may be required.
2. Flush the system under pressure. The velocity in the pipes should be as high as possible to remove any deposits or scale.
3. Clean and check that all valves are working.
4. Clean flush valves and vacuum release valves.
5. Inject a commercially available cleaning solution with fresh water through the system.

Chlorine and either phosphoric or sulfuric acid at a low concentration are suitable. This should be done automatically in the event of the flow rate dropping more than 5% below specified flow rate.

7 Conclusion

The installation of a Wasteflow® subsurface drip irrigation system is a sound economical investment taking into account the important ecological advantages obtained, combined with potable water savings, safe wastewater disposal and significant reduction of pollution.

Subsurface drip irrigation systems are practical, economical and complement wastewater recycling programs and wastewater disposal systems.

Water savings combined with a substantial reduction in pollution of the aquifer and a low perceived health risk, makes subsurface drip irrigation the best solution for may conditions.

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