Polydrain Design Sheet

Drainage

Proper drainage is a vital part of any landscape design and construction. A well designed drainage system is vital to the establishment and continued development of plants and the soil in which they grow.

There are essentially two types of drainage - surface and subsurface. Surface drainage is needed for the removal and redirection of water which does not penetrate the soil and consequently ponds or flows over its surface. Without correct surface drainage, it is considerably more difficult to establish successful subsurface drainage.

When water is applied to soil, the top layer is temporarily saturated. As water continues to move downward, the soil becomes moist, with a film of water around each particle, separated by air-filled pores. Once all the soil particles reach this state, the soil is regarded as being at 'Field Capacity'. The rate at which the water moves through the soil is known as the infiltration rate, and this varies depending on the soil type (Table 1).

Soil Type	Infiltration Rate (mm/hr)	Total Water Storage in Top 1m at field capacity (litres/m²)
Deep Sand	100 – 200	90 of which 70 is available to plants
Sand Loam	30 – 100	230 of which 140 is available to plants
Clay Loam	5 – 30	300 of which 140 is available to plants
Clay	1 – 5	500 of which 200 is available to plants

Table 1: Infiltration and Storage in Soils
(comparative approximations)

Once the total water storage capacity of the soil is reached, the excess water must be removed. If it is allowed to sit, the soil will be saturated by a high water table, all pore spaces will be filled with water and plant roots will be starved of air. Even temporary saturation can be a major hindrance to the successful growth of plants, especially turf.

There are a number of different factors and influences which need to be addressed when determining the drainage requirements for a particular area. This guide is intended to increase your understanding of how subsurface drainage works and what is required in any given situation.

When is sub-surface drainage needed?

Saturated soils can be a cause of major problems where the inherent weight impacts on structures such as retaining walls, planting beds, concrete slabs and rooftop gardens. Seepage of excess water can also result in moisture entry into ground level dwellings and the staining of external walls from 'rising damp'. This excess water needs to be taken away. There are a number of easily identifiable signs which indicate that subsurface drainage is required:-

- Salt crusts on the soil surface due to alkali formation
- Stunted plants or trees
- Soil colour change from brown to grey
- Yellowing of leaves
- Standing water or springy spots
- Tight soil lacking in structure

For plant roots to develop properly, there needs to be sufficient depth of soil above the water table. This can be checked by digging holes approximately 30-40cm deep in the area affected. If free water is found, subsurface drainage is required if the plants are to thrive.

Where is Polydrain installed?

There are two elements of design which will dictate the performance of the drainage system - depth and spacing of the Polydrain. Once again, soil type will influence this. Uniformly structured soils with low infiltration rates will generally require closer spacing of Polydrain laterals with less depth. Soils with higher rates will need pipes placed lower to allow for deeper lateral movement of water (Table 2).

Soil Type	Spacing	Depth (m)
Deep Sand	30 – 60	1.6 – 1.8
Sand Loam	20 – 30	1.4 – 1.6
Clay Loam	15 – 20	1.2 – 1.4
Clay	10 – 15	0.8 – 1.2

Table 2: Polydrain Guidelines for Agriculture
Installations in Uniformly Structured Soils

If desired, pipes can be placed shallower if spacings are decreased proportionately ie. half the depth = half the spacing.

The cost of digging more trenches at shallower levels will need to be weighed up against the cost of fewer deeper trenches.

In many areas the soil will be layered, such as with a top layer of sandy loam on a clay foundation. In these instances it will be necessary to design the drainage to remove the excess water from the top layer, so that it does not sit before infiltrating through the clay. In these instances, the Polydrain should be installed slightly below the clay layer.

This is the situation in many urban landscapes, where the soil structure typically consists of a relatively thin layer of sandy loam or clay loam topsoil over a clay bed, or other impervious layer. The installation requirements can be generally broken down into gardens and turf (Table 3).

Soil Type	Spacing (m)	Depth (m)
Turf (Clay Loam – Sandy Loam)	3 – 5	0.2 – 0.3
Garden (Clay Loam – Sandy Loam)	10 – 15	0.8 – 1.2

Table 3: Polydrain Guidelines for Urban Installations

What size Polydrain is required?

Various factors will need to be known in order to determine the required Polydrain size. These are:

- The available slope for the drainage pipe
- The infiltration rate of the soil
- The area that needs to be drained
- The highest precipitation rate expected

PPI Polydrain is available for various load bearing applications designated by classification (Table 4).

SN4 (Class 200)	intended for surface land drainage
SN8 (Class 400)	intended for road or civil engineering works not subjected to heavy vehicular traffic.
SN20 (Class 1000)	for road or civil engineering works subject to heavy vehicular traffic.

Table 4: Pipe Strength Classification

The flow rates of each will be affected by the slope they are installed at. Smaller pipes require greater grades in order to ensure effective self cleaning. The recommended range of gradients for Polydrain is between 1 to 3% but can be as low as those listed in Table 5.

Pipe Size (mm)	Minimum Grade
50	0.5%
65	0.4%
80	0.3%
100	0.25%
160	0.15%

Table 5. Recommended Gradients

In an installation with gradients less than those recommended, PPI Polydrain fitted with Filter Sock must be used to prevent the entry of small particles into the pipe. Filter Sock should also be used in soils with a very high sand content.

Installing Polydrain with suitable drainage material above it will remove any excess water that is moving down under the influence of gravity. The trench for the Polydrain should have a regular fall without any high and low spots in it. Gravel should surround the pipe to increase permeability and to filter out coarser particles from the pipe (Figure 1).

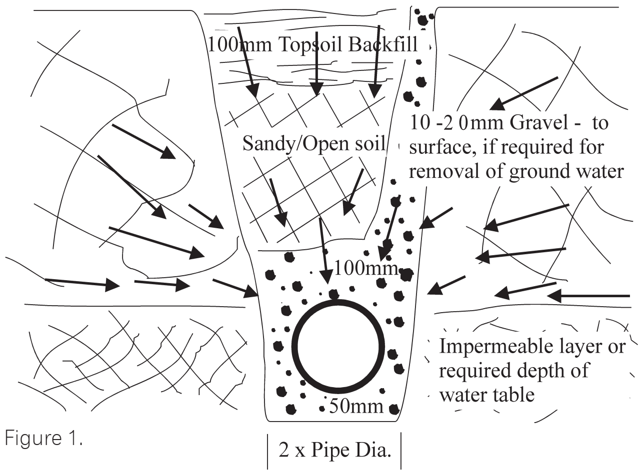


Figure 1.

How much water needs to be drained?

In order to establish how much water needs to be carried away by the Polydrain, it is necessary to determine the rate at which water can pass through the soil in the area affected. This can be done quite easily by obtaining a length of pipe approximately 300mm long and pressing it approximately 100mm vertically into the soil. If the soil is too compacted, saturate the area first and continue the test once the ground has dried.

After inserting the pipe, completely fill the pipe with water, and after one hour has elapsed, measure the change in water level to obtain the infiltration rate of the soil in mm/hr. We can then use this rate to determine our soil type.

Calculating the area and multiplying it by the amount of water expected to fall on it in one hour will give us the volume of water which needs to be removed over time. Some of this water will infiltrate the soil, the rest will need to be diverted by surface drainage to either open drains or Polydrain in gravel covered trenches (Figure 1). Once we know our expected flow, we can calculate the necessary pipe size needed to carry this water away using the PPI Polydrain Flow Capacity chart included with this guide.

How is the drainage system designed?

Example: We have a turf area that measures 10m x 10m that requires drainage. The highest expected rainfall in the area is 75mm/hour (rainfall statistics of a particular area can be obtained from the Bureau of Meteorology).

After some exploratory digging, we find we have topsoil to a depth of approximately 200mm, on top of a clay subsoil. We will assume that after testing we obtained an infiltration rate of 20mm/hour. Therefore 20mm/75mm x 100% = 27%.

Using Table 1 we can conclude that we have a clay-loam topsoil. This means that 20mm, or 27% of the rain falling in one hour, will be absorbed into the soil, and once field capacity is reached it will need to be drained. The remaining 55mm will need to be removed by diverting the water runoff (surface drainage).

From these figures we can calculate the required pipe size:

Volume of water in one hour

= Area x Precipitation Rate

= 10m x 10m x 0.075m/hour

= 7.5 m_/hour

= 7500 litres/hour ÷ 3600

= 2.1 litres/second

As mentioned above, 27% of this water will infiltrate into the soil. Therefore, we need to design our subsurface drainage to extract 0.57 litres/second. Installing our drainage at the clay layer 200mm down, our Polydrain laterals should be spaced at approximately 3m apart (Table 3). A suggested layout would look like Figure 2.

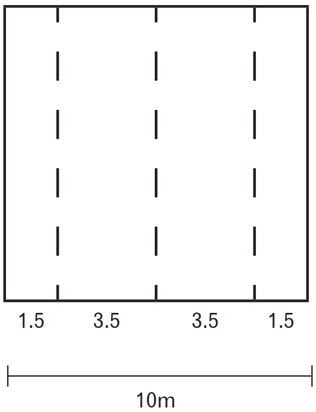


Figure 2.

We have three lengths of Polydrain running the length of the area. This means that each pipe will need to carry approximately 0.19 litres/second (0.57 ÷ 3). Using the PPI Polydrain Flow Capacity Chart we find 0.19 litres/second on the bottom axis and follow the line vertical up to the 50mm pipe line. Tracing a line from this intersection across to the vertical axis (pipe slope) we can see that a slope of at least 0.15% or 15mm over a 10m pipe run, is required to carry this quantity of water through each 50mm pipe line.

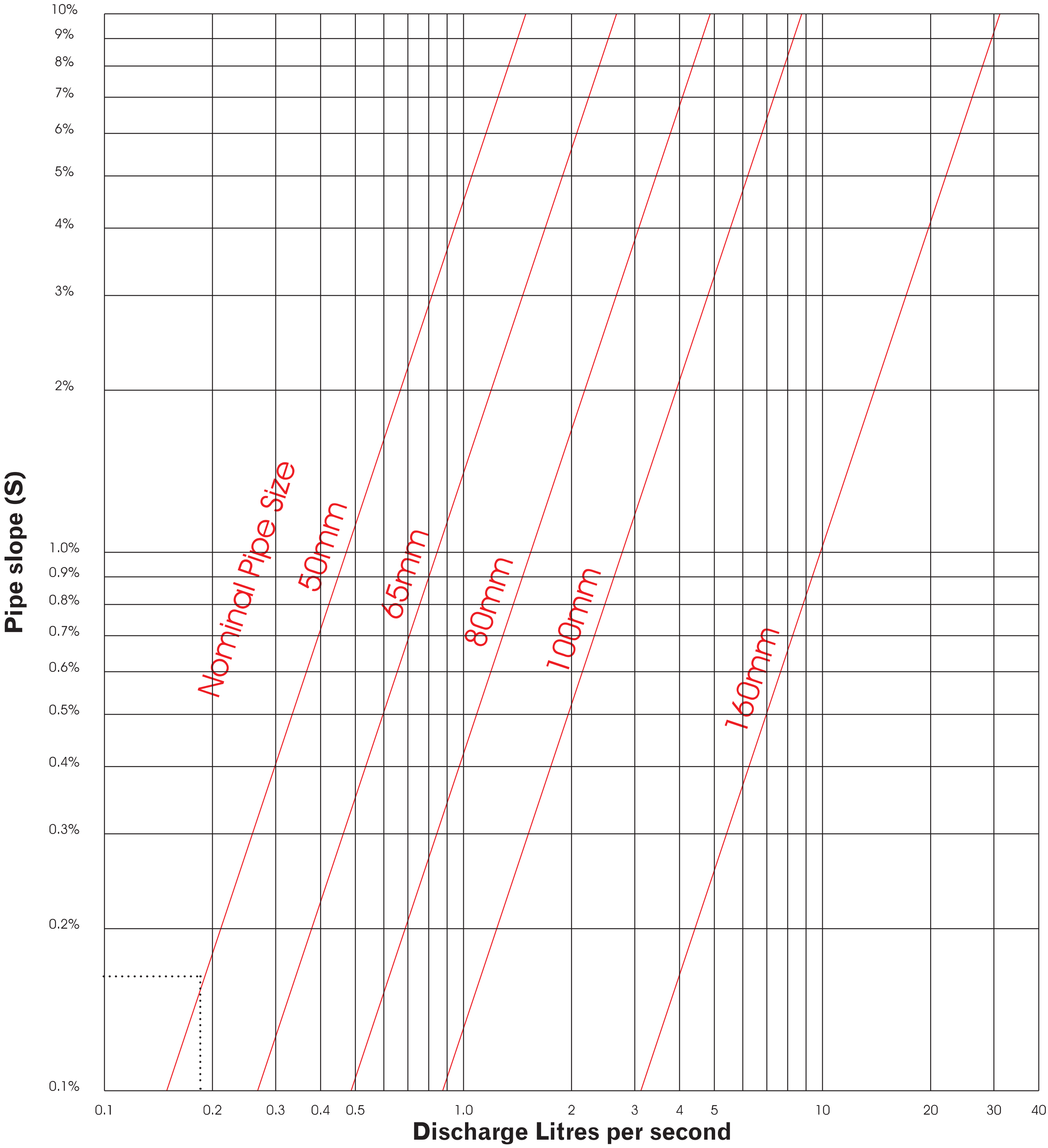
If this slope was not attainable we would need to use 65mm pipe at a 0.1% gradient, which is the recommended minimum.

If all the water from both surface and subsurface drainage were to be diverted to a single Polydrain, we would then use the chart to determine the required pipe size to carry this volume of water.

Where should the water be diverted to?

There are a number of options available for the removal of this water. For example, it can be diverted to an existing stormwater drain, water catchment area or a gravel pit. Local councils will advise on the regulations that exist in your particular area.

PPI Polydrain Flow Capacity



$V = \frac{1}{n} x\ R^{0.67}\ x\ S^{0.5}$ A roughness coefficient of n = 0.015 was used.

MANNING FORMULA:

This chart was developed using the Manning Formula as quoted in AS2200 - 1978 “Design Charts for Water Supply and Sewerage”.

NOTE:
All care has been taken to develop this chart and to check its accuracy. However, PPI cannot be held responsible for any design failures resulting from the use of the chart as design involves inputs and decisions which are outside our control. Water Authorities, Departments of Primary Industries or Agriculture and Private Consultants provide excellent design services. The reader is encouraged to make use of their services.

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