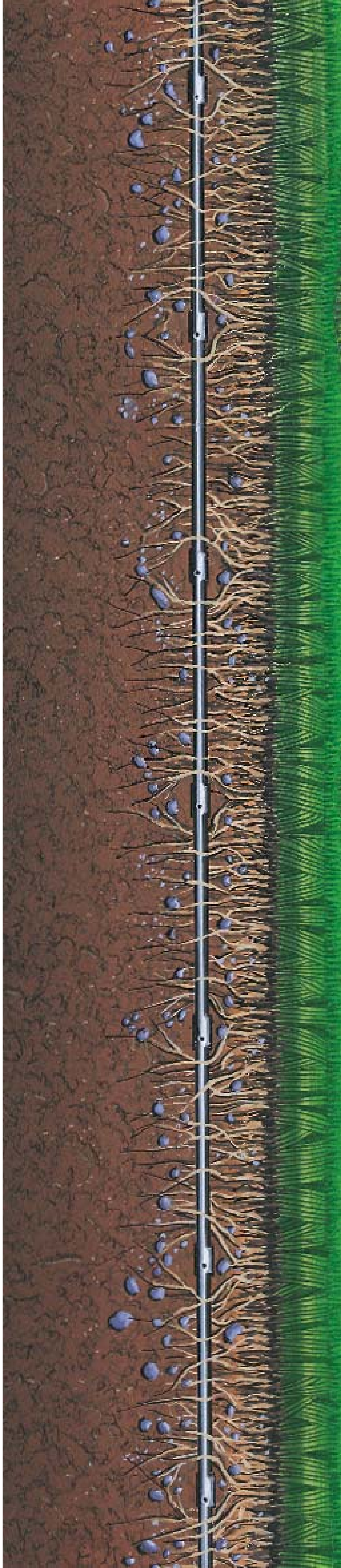
Subsurface Irrigation Manual



Irritrol®

Contents

Introduction

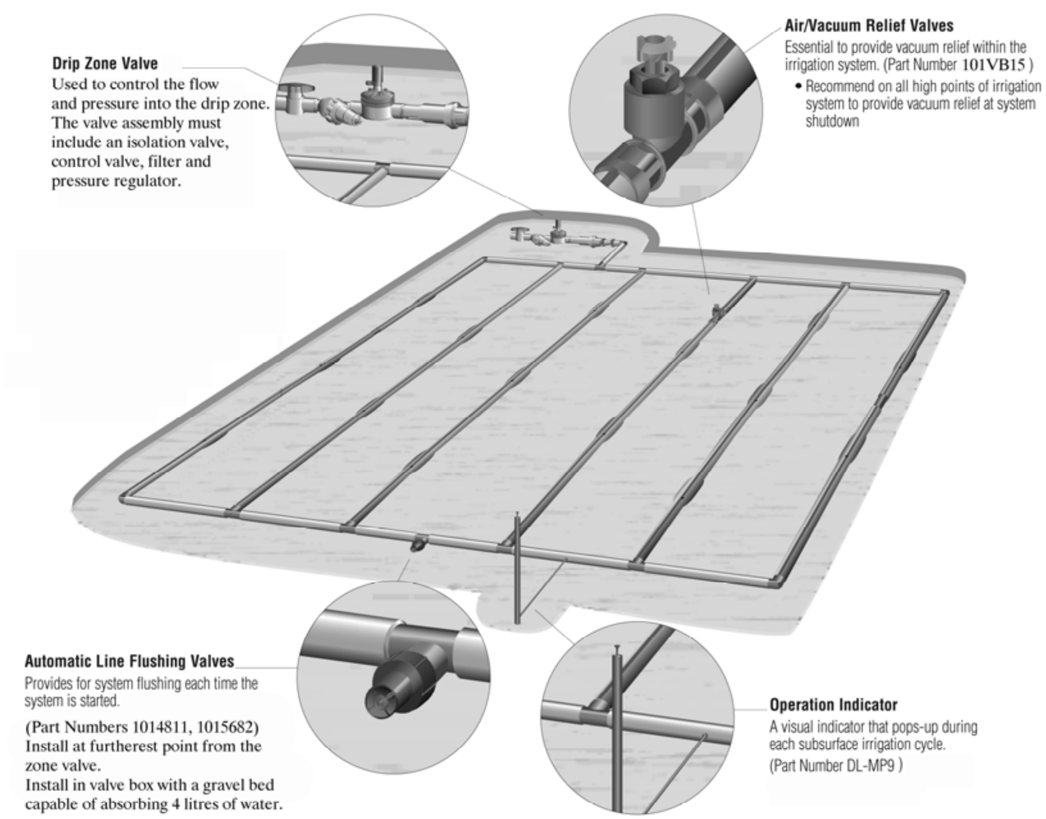
Toro provides more than just irrigation products — we provide turf solutions. For more thirty-five years, we've supplied a full line of quality irrigation equipment to fit any turf need. Customers have grown to trust Toro because we translate new technology into productive irrigation products for every turf requirement.

And now, Toro brings subsurface drip irrigation to the residential and commercial turf markets. Toro Drip-In with Rootguard® is the most technologically advanced subsurface irrigation system available. Through revolutionary ROOTGUARD® technology, Drip-In with Rootguard® prevents roots clogging emitters while delivering optimal water application directly to the root zone. Drip-In with Rootguard® is perfect for odd-shaped designs, median strips, public recreation areas and residential property — any place where sprinklers don't fit the application.

Complex design challenges. The simple subsurface solution.

Toro Drip-In with Rootguard®.

Typical Subsurface Drip Irrigation System



This manual has been written with the assumption that users already possess a fundamental understanding of basic irrigation design.

Terminology

Application Rate — the rate at which a subsurface grid applies water to a specific zone, over a given period of time, measured in milli-metres per hour.

Backflow Prevention Device — the device, required by law, on an irrigation system that prevents water from re-entering the potable water lines once it flows into the irrigation pipes.

Blackwater — wastewater from toilet and latrine flushing and sinks used for food preparation or disposal of chemical or chemical-biological ingredients.

BOD— the abbreviation for "Biochemical Oxygen Demand;" a measure or the amount of oxygen required to neutralize organic wastes.

Controller — the device that sends timing commands to remote control valves for actuation.

Design Operating Pressure — the pressure a designer uses to determine spacing distances and flow for drip-lines. The design operating pressure is determined by subtracting estimated friction losses from the static water pressure.

Dynamic Pressure — the pressure reading in a pipeline system with water flowing.

Effluent Water — any substance, particularly a liquid, that enters the environment from a point source. Generally refers to wastewater from a sewage treatment or industrial plant.

Emitter — a device used to control the rate at which water is applied to a specific area. Emitters are usually injection molded out of chemical-resistant plastics and come in both inline and online configurations. The Drip-In with Rootguard® product line is manufactured with factory installed, inline emitters.

Evapo-transpiration — the combined rate at which water evaporates into the atmosphere and/or is consumed by plants.

Flow — the movement of water through the irrigation piping system.

Flush Cap — a device used to automatically flush sediment and debris from drip-lines within a grid. Flushing occurs at the beginning of each irrigation cycle and ends as soon as the system operation pressure reaches 6 kPa.

Flush Manifold — the end line or pipe in a subsurface grid that connects to all the drip-lines. A flush valve and/or cap is installed in the manifold to flush debris and sediment from the grid during each irrigation cycle.

mps — the abbreviation for "metres per second;" refers to the velocity of water in pipes.

Friction Loss — the loss of pressure (force) as water flows through the piping system.

LPH — the abbreviation for "litres per hour;" unit of measure for water flow.

LPM — the abbreviation for "litres per minute;" unit of measure for water flow.

Greywater —wastewater from washing machines, showers, bathtubs and sinks that are not used for disposal of chemical or chemical-biological ingredients.

I.D. — the abbreviation for "inside diameter."

Lateral — the pipe in an irrigation system located downstream from the remote control valve. Lateral pipes carry water directly into a zone.

Main Line — the pipe in an irrigation system that delivers water from the backflow prevention device to the remote control valves. This is usually the largest pipe on the irrigation system, generally under constant pressure and located upstream from the remote control valves.

Manifold — a group of control valves located together in the same area.

O.D. — the abbreviation for "outside diameter."

kPa — the abbreviation for "kilopascals;" unit of measure for water pressure.

PVC Pipe — Poly Vinyl Chloride pipe; the most common pipe used in irrigation systems.

P.O.C. — abbreviation for "point of connection." This is the location on the irrigation system where a tap is made for connection of a backflow prevention device or water meter.

Potable Water — water used for drinking purposes.

Reclaimed Water — domestic wastewater that has been treated to a quality suitable for a beneficial use and is under the direct control of a treatment plant.

Remote Control Valve — the component in the irrigation system that regulates the on/off of water from the main line to the drip-lines; activated by the controller.

Service Line — the pipe supplying water from the city water main to the water meter.

Spacing — the distance between the emitters or the drip-lines.

Static Water Pressure — the pressure that exists in a piping system when there is no flow; measured in kilopascals (kPa).

Subsurface Grid — a group of parallel, inline drip-lines that are connected to supply manifolds and flush manifolds.

Supply Manifold — the pipe connected to the remote control valves that supplies water to the drip-lines within a subsurface grid.

Surge — the build-up of water pressure in a piping system due to certain characteristics of the pipe, valves and flow.

TDS — the abbreviation for “total dissolved solids.” The sum of all inorganic and organic particulate material within a given amount of water. TDS is an indicator test used for wastewater analysis and is also a measure of the mineral content of bottled water and groundwater.

TSS — the abbreviation for “total suspended solids.” The sum of all non-dissolved inorganic and organic material within a given amount of water. The other component of Total Solids (TS) in water are Total Dissolved Solids, so generally TSS + TDS = TS.

Velocity — the speed at which water flows through the piping system; measured in metres per second (mps).

Wastewater — water containing waste including greywater, blackwater or water contaminated by waste contact, including process-generated and contaminated rainfall runoff.

Water Main — the city water pipe located in the street.

Water Pressure — the force of water that exists in a piping system; measured in kilopascals (kPa).

Working Pressure — the remaining pressure in the irrigation system when all friction losses are subtracted from the static pressure.

Zone — a subsurface grid or area of drip-line that is controlled by the same remote control valve.

Subsurface Irrigation Design

Design Parameters

DRIP-IN WITH ROOTGUARD drip-line is designed for use in subsurface applications using the grid concept, with supply and flush manifolds at each end to create a closed-loop system. The result generally of the grid design is a completely subsurface-wetted area that is ideal for plant growth and root development. Complete wetting depends on the soil type, emitter and drip-line spacing.
DRIP-IN WITH ROOTGUARD subsurface drip-line can also be installed on both sides of tree and shrub rows when the grid installation is not justified.

Product Selection

DRIP-IN WITH ROOTGUARD drip-line is available in one pressure-compensating model with a nominal emitter flow rate of 2.0 LPH and with emitter spacing choice of 30cm or 40cm intervals. Product choice (emitter spacing) is dependent on site conditions and soil types. The choice of dripper spacing, drip-line lateral spacing and depth is dependent on the types of soil and plants used.

Water Availability and Quality

The allowable water flow (always use a de-ration, say 75% of available flow) and pressure are the determining factors for the maximum allowable zone flow. This is determined by the capacity at the point of connection and supply restrictions beyond the point of connection.
Available flow and pressure can be obtained from the following sources:

- physical pressure and volume tests (most reliable)
- your local water supply office
- engineered calculations based on the size of the point of connection, meter and static pressure

Always make these determinations during the time of day at which the water pressure is at its lowest point.
Water quality determines the type of filter used and any necessary treatment that may be required.

Water quality varies significantly according to the source which can be classified generally as:

- potable water
- irrigation district water
- greywater or industrial recycled water
- effluent water
- recycled water
- well water

Potable water, the most common type of water used in landscape applications, has relatively little debris and chemical contamination.
Therefore, it only needs to be filtered with a screen or disk filter. With other water sources, it is advisable to obtain a water analysis prior to designing and installing the system. Some of the important parameters are:

- total dissolved solids (TDS)
- iron content
- calcium, magnesium, sulfates, bicarbonates and hardness
- chemical compounds present, BOD and TSS (greywater, industrial treated water and recycled water)
- the types and amount of sediment present (irrigation district water and well water)

Soil Types and Preparation

For design purposes, soil classifications of clay (heavy), loam (medium) and sand (light) are used in conjunction with plant types to determine the emitter and lateral spacing necessary to provide a uniform subsurface soil moisture regime for the plant material.
As with all types of landscape irrigation systems, properly prepared soil is necessary to provide a homogenous bed for proper plant establishment, plant growth and uniform water distribution. Heavily compacted and layered soils should be ripped and tilled at a uniform 200 to 300mm depth to improve the consistency and tilth of the soil.
Soil and water analyses are recommended when the soil texture, soil pH and water quality are in doubt. This is necessary in order to recommend soil amendments and water treatment when required. If possible, pre-irrigate the installation site when the soil is too dry to till and trench.

Plant Material Classification and Planting Layouts

Emitter and lateral spacings are determined by soil and plant material classifications. For design purposes, two general plant classifications are used:

1. trees, shrubs and ground cover, and
2. turf.

Turf plantings have a much more intense and compact root structure, thus requiring a closer emitter and lateral spacing to efficiently irrigate these areas.

Planting layouts determine the size and type of subsurface irrigation system necessary to provide uniform moisture distribution. Individual or isolated planting areas separated by large expanses of unplanted areas or hardscapes require individual grids that provide moisture within the foliage canopy of the landscaped area.

Narrow, linear tree and shrub plantings require narrow, linear subsurface grids consisting of two to four laterals. More intense plantings that provide a complete foliage canopy at maturity require a grid design that applies uniform moisture levels within the foliage canopy (turf, groundcover, and dense shrub and tree plantings).
Use the Spacing Guidelines Table (Table 1.2) to determine the proper emitter and lateral spacing.

Emitter and Drip-line Selection

13mm Drip-In with Rootguard offers the following types of drip-line products:

Code	Tube Diameter	Flow Rate (Lph)	Emitter Spacing (cm)	Pressure Compensating	Roll Length (m)
DGC1320030-200	13mm	2.0	30	Yes	200
DGC1320040-200	13mm	2.0	40	Yes	200

Table 1.1

13mmDrip-In with Rootguard emitters are pressure compensating.

Toro recommends that pressure-compensating drip-line be used when long runs, steep slopes and rolling terrain are factors in your design.
(In flat areas, use non-pressure-compensating drip-line (see the Toro Ag range) in applications where the source pressure is less than 150 kPa pressure.)

On steep slopes, design the system so that the drip-line lateral follows the contours of the slope. If forced to run the drip-line perpendicular to the contours of the slope, pressure-compensating drip-line will help to maintain even flows along the drip-line.

Rolling terrain is the most difficult situation for subsurface drip, due to the risk of soil ingestion. If the difference in height from trough to peak exceeds 2 metres, pressure-compensating drip-line should be used. Vacuum relief valves must be placed at the top of each rise.

Drip-In with Rootguard is great for small, tight areas because of its flexibility. It can also be used to loop around trees and bushes.

Spacing Guidelines for Grid Systems Only

Turf			
Soil Type	Line Spacing	Dripper Spacing	Burial Depth
Medium Sand	30cm	30cm	100mm
Loam	30cm	30cm	100mm
Clay Loam	40cm	40cm	100mm
Clay	30cm	40cm	100mm
Annuals, Ground Cover			
Soil Type	Line Spacing	Dripper Spacing	Burial Depth
Medium Sand	30cm	30cm	100mm
Loam	30 to 40cm	40cm	100mm
Clay Loam	40cm	40cm	100mm
Clay	30cm	40cm	100mm
Large Bushes, Shrubs, Beds			
Soil Type	Line Spacing	Dripper Spacing	Burial Depth
Medium Sand	Vary to suit planting density	30cm	150mm
Loam	Vary to suit planting density	30cm	150mm
Clay Loam	Vary to suit planting density	40cm	150mm
Clay	Vary to suit planting density	40cm	150mm

Table 1.2

Drip-line Placement From Edges

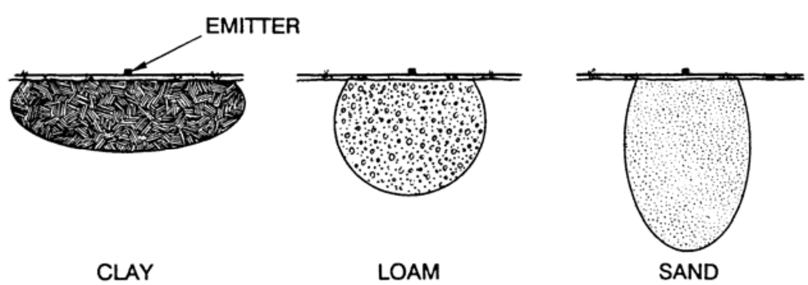
Consideration of drip-line location is necessary when laying out zone edges. Hardscape materials act as heat collectors and cause landscape edges to dry out before the centre of the landscape, making it essential to compensate by placing the first drip-lines no more than 50 to 100 millimetres from the landscape edge. In uncontained landscape areas, start the first drip-line 50 to 100 millimetres outside of the planted area. In turf applications, add a drip-line over the supply and flush manifolds to ensure that these edges have adequate moisture coverage.

Burial Depth

Plant type, soil type and gardening/cultivation practices play a big part in determining the correct burial depth.

Plant Type
The aim of the irrigation system is to apply water efficiently to the root zone. Therefore the depth of burial is determined by the root zone depth. Some water from the emitter will travel upwards (by capillary action), some sideways, but the majority will travel downwards (under gravity). Drip tube installed below the root zone will waste the majority of water it applies. Drip tube installed too close to the surface runs the risk of water "breaking" through to the surface. This will cause un-even evaporation losses (in-efficient watering) and can promote weed growth.
Ideally the drip tube should be installed roughly one-third of the way down in the root zone.

Soil Type
The pore space and particle size play a major role in the movement of water through the soil. Sandy soils have typically elongated and narrow wetted patterns around each emitter. Movement downwards is significantly greater than upwards or sideways.
Clay soils typically have "squatter" wetted areas around each emitter, with shallower but broader patterns than sands.



The objective of selecting the correct combination of spacing and depth is to ensure that the sideways movement of the wetted pattern from one lateral reaches the next, without water "breaking" through to the ground surface or water being pushed below the root zone.
Laterals that are spaced too far apart run the risk of "striping", ie. rows of green and yellow turf.

Gardening/Cultivation Practices

The closer the drip tube is to the surface, the greater the risk of mechanical damage to the drip tube.
Where the plant and soil combination will allow, bury the drip tube lower than where gardening implements can damage it.

If this is not suitable, gardening/cultivation practices will need to be modified to avoid damage to the system.

Wind

As with all total-coverage irrigation systems, attention must be given to windward turf edges in high-wind areas to prevent browning. Place the first drip-line no more than 50 to 100 millimetres from the edge of hardscaped areas or 50 to 100 millimetres outside the turf edge in uncontained landscape areas. Add an extra drip-line 150millimetres from the first line between the first and second lateral lines on the windward lateral edge.

Slopes

Drip-lines should be located parallel to the contour of slopes whenever possible. Since subsurface runoff can occur on areas with a slope of greater than 3%, consideration must be given to drip-line density from the top to the bottom of the slope. The drip-line on the top two-thirds of the slope should be placed at the recommended spacings for the soil type and plant material in use. On the lower one-third, the drip-lines should be spaced 25% wider. The last drip-line can be eliminated on slopes exceeding 5%. For areas exceeding 3 metres in elevation change, zone the lower one-third of the slope separately from the upper two-thirds to help control drainage.

Elevation Differences

When working with rolling landscapes with elevation differences of 1.5 metres or more within a zone, it is best to use pressure-compensating drip-line to equalize pressure differentials created by the elevation differences.

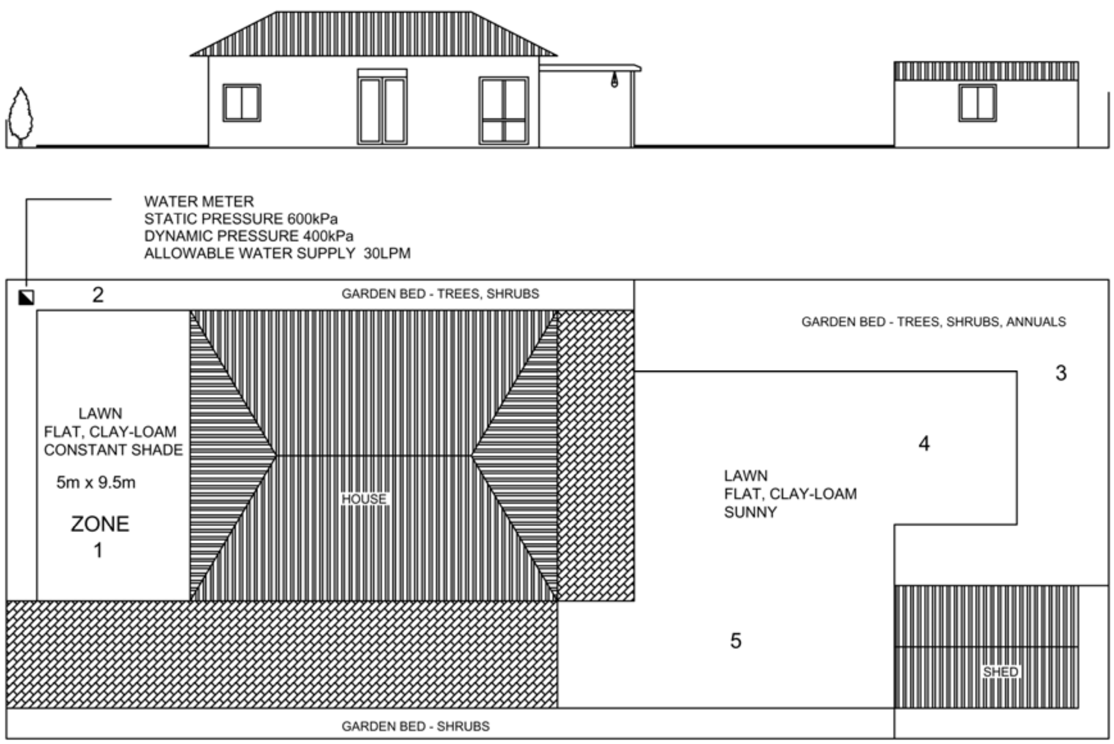
Subsurface irrigation zones must have a vacuum relief valve at the highest point in order to eliminate the vacuum created by low-line drainage, which causes soil ingestion. This is especially crucial when the drip-line laterals are placed perpendicular to the contour of the slope as in street medians. All drip-line laterals within the elevated area must be connected with an air relief lateral (see details 8,9,10, pg.31, 32).

In-line spring-check or swing-check valves should be used on slopes where low-line drainage could cause wet areas in the lowest areas of an irrigation zone.

Typical Design Procedures

Designing a System

Try designing your own subsurface system using the diagram shown below and the tables and information provided in the remainder of this section.
When you have finished the design worksheet, check your answers on page 19 at the end of this section.
Design a typical subsurface system for zone 1, where the width is 5 metres and the length is 9.5 metres.



Design Worksheet

Use this worksheet to determine the type and quantity of product required for the system.

DW1 Allowable Water Supply ____LPM

DW2 Dynamic Pressure ____kPa

ZONES *						
	1	2	3	4	5	6
DW3 Soil Texture						
DW4 Plant Type						
DW5 Slope %						
DW6 Emitter Spacing						
DW7 Max. Drip-line Lateral Spacing						
DW8 Nominal Flow Rate						
DW9 Drip-line Product						
DW10 Max. Run Length						
DW11 Inlet Lateral Pressure (kPa)						
DW12 Actual Flow Rate						
DW13 Exact Lateral Spacing						
DW14 Zone Flow (LPM)						

Table 2.1

* The number of zones may vary depending on the specific needs of each installation.

Typical Design Steps

Step 1:
Obtain or draw a scaled plan of the area to be irrigated.

Step 2:
Locate the point of connection on the scaled plan.

- Determine the water meter size and/or allowable volume of the water source: ______________________________LPM (DW1)
- Verify the dynamic water pressure: ______________________kPa (DW2)

Later in the design process it will be necessary to select a pressure regulating device to establish/control the pressure in the system. The dynamic water pressure must be higher than the pressure required to operate the system. The system operating pressure is the sum of the following items:-

1. Inlet pressure to drip-line
2. Pressure loss in supply manifold
3. Filter Pressure Loss
4. Control Valve Pressure Loss
5. Elevation Pressure Loss/Gain
6. Mainline Friction Pressure Loss
7. Fittings Pressure Loss
8. Backflow Preventer Pressure Loss

Step 3:
Note the site and environmental parameters.

- Soil texture (clay, loam or sand): __________________________(DW3)
- Plant material(s) (trees, shrubs, ground cover or turf): __________ (DW4)
- Direction and degree of slope: _________________________% (DW5)

Step 4:
Lay out the laterals.

- Using the Spacing Guidelines Table 2.2 below, determine the maximum recommended spacing between drippers and spacing between drip-lines based on plant material and soil types.

SPACING GUIDELINES				
	Emitter Spacing	Row Spacing	Nominal Emitter Flow	Burial Depth
Medium Sand				
• Trees/ Shrubs/ Groundcover	30cm	30cm	2LPH	100mm
• Turf	30cm	30cm	2 LPH	100mm
Loam				
• Trees/ Shrubs/ Groundcover	40cm	30cm	2LPH	100mm
• Turf	30cm	30cm	2 LPH	100mm
Clay Loam				
• Trees/ Shrubs/ Groundcover	40cm	40cm	2LPH	100mm
• Turf	40cm	40cm	2 LPH	100mm
Clay				
• Trees/ Shrubs/ Groundcover	40cm	30cm	2LPH	100mm
• Turf	40cm	30cm	2 LPH	100mm

Table 2.2

Emitter spacing: ____cm (DW6)
Maximum drip-line lateral spacing: ________________________________cm (DW7)

- Using the Spacing Guidelines Table, determine the nominal emitter flow rate.

Nominal emitter flow rate: ___________________________________LPH (DW8)*

- Use Table 2.3 below to determine the type of drip-line product necessary to fit the irrigation needs of the site.

Drip-line product: ____(DW9)

Drip-line Product	Tubing Diameter	Flow Rate	Pressure Compensating	Emitter Spacing
DGC1320030-200	13mm	2.0 LPH	Yes	0.3m
DGC1320040-200	13mm	2.0 LPH	Yes	0.4m

Table 2.3

Do not use pressure-compensating drip-line in applications with less than 150kPa pressure. (Note: Toro Ag has a range of larger diameter and non-compensating Rootguard drip tubes)

Table 2.4 shows the maximum recommended run length for various lateral inlet pressures.

Based on the maximum run length of lateral required for the project, determine the required inlet pressure.
Maximum length of run: ____metres (DW10)

Inlet pressure for lateral: _______________________________________kPa (DW11)

Maximum Recommended Run Length @ 0% Slope			
	Nominal Flow (LPH)	Input Pressure (kPa)	Length (m)
13mm, PC, 0.3m	2.0	150	50
		200	65
		250	75
13mm, PC, 0.4m	2.0	150	65
		200	85
		250	100

Table 2.4

Note: Run lengths are based on a minimum operating pressure of 100 kPa at the end of the lateral, on flat ground.

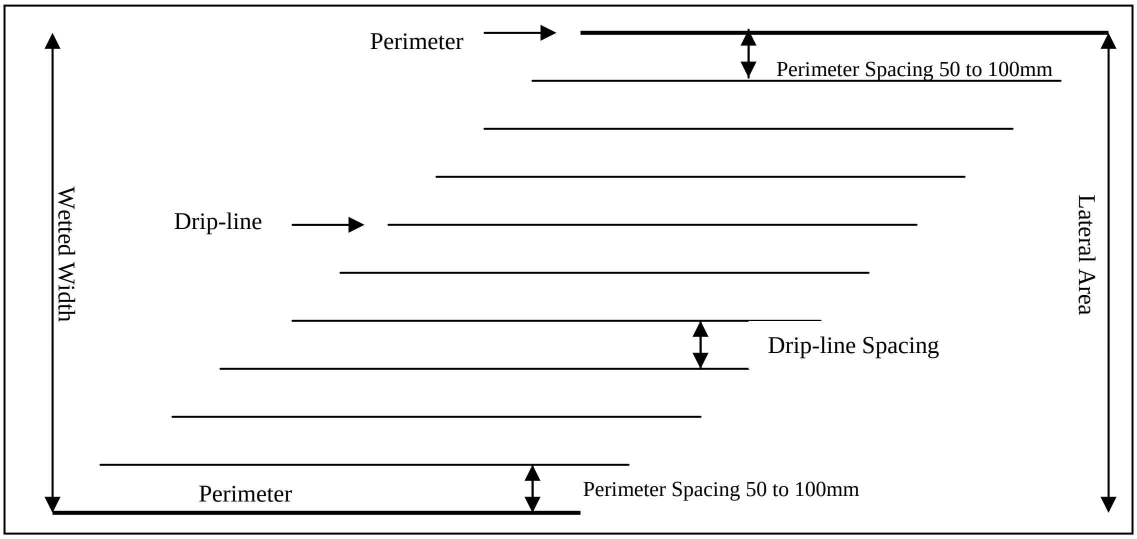
* Actual flow is a function of pressure. Use the Flow vs. Pressure Table (Table 2.5) to determine actual flow per emitter: ______________________________LPH (DW12)

Emitter Flow (in LPH) vs. Pressure						
	Nominal Flow (LPH)	Actual Flow @100kPa	Actual Flow @150kPa	Actual Flow @200kPa	Actual Flow @250kPa	Actual Flow @300kPa
13mm PC	2.0	2.13	2.09	2.03	2.01	2.03

Table 2.5

Step 4:
Lay out the laterals: (cont.)

- Calculate the exact lateral spacing based on the dimensions of the area to be irrigated with subsurface drip.



A. Measure, in metres(to the nearest cm), the subsurface drip area at its widest width.
Width: ____metres

B. The first and last lateral perimeter spacings can be no further than 50 to 100 milli-metres from the confining hardscape or 50 to 100 milli-metres outside of unconfined landscapes. For this example we will use 100mm. spacing.

C. Subtract the sum of the perimeter spacings from the width to determine the lateral area to be covered by subsurface drip-lines.

Width (in metres) – perimeter spacings (in metres) = Lateral area: ________metres

D. Divide the lateral area (as determined in Step C above) by the recommended lateral spacing (DW7) to obtain the total number of spaces between laterals. Round off to the nearest whole number to determine the exact number of spaces necessary to cover the subsurface drip area.

$$\frac{\text{Lateral area}}{\text{Drip-line lateral spacing}} = \_\_\_\_\_\_\_\_ \text{ spaces}$$

Exact Lateral spacing (ie distances between drip-lines) _____________(DW13)

E. Add 1 to the number of spaces between drip-lines (from Step D above) to determine the total number of drip-lines across the widest part of the zone.

1 + Number of spaces between drip-lines = Total lengths of drip-line: ________

Step 5:
For applications exceeding a 3% slope, place the laterals parallel to the slope contour. Increase the calculated lateral spacing by 25% on the lower one-third of the slope to avoid excessive drainage.
For areas exceeding 3 metres in elevation change, zone the lower one-third of the slope separately from the upper two-thirds to help control drainage.

Step 6:
Determine the total estimated drip-line metreage required for each zone. There will always be some waste with each installation. Therefore, you should plan for additional metreage by applying an appropriate factor for each drip-line metreage calculation (10%-25% should suffice).

A. Total drip-line metreage required: __________ = length of runs x number of laterals

B. Total drip-line metreage required x 1.10 (10%) = __________ total estimated drip-line metreage required
(round off to nearest whole number)

Step 7:
Calculate the total estimated litres per minute (LPM) per zone by using one of the two following methods. Be sure to use the total estimated drip-line per zone (see Step 6-A above).

EITHER

- Determine the total number of drip emitters in each zone, then calculate the flow per zone based on the total flow rate of all drippers.

Step A:

Number of drippers (within the zone) = $\dfrac{\text{Drip-line metreage required (6A above)}}{\text{emitter spacing (cm) (see DW6)}}$

Step B:

Flow per zone in GPM = $\dfrac{\text{Total number of drippers x dripper flow rate (LPH)}}{\text{60 (minutes)}}$

OR

- Calculate zone flow by multiplying the total metreage of drip-line in hundreds (metreage/100) by the flow per 100 metres obtained from the following table 2.7.

Flow rate per 100 Linear Metres				
	Nominal Flow Rate LPH	Emitter Spacing (cm)	Flow per 100m. LPH	Flow per 100m. LPM
13mm PC,	2.0	40	500	8.33

2.0LPH @ 40cm				
13mm PC, 2LPH @ 30cm	2.0	30	667	11.11

Table 2.7

Zone flow: ____LPM (DW14)

Step 8:
Locate and size both the supply and flush manifolds in each zone. Both manifolds should be sized to accommodate the entire flow of the zone in LPM. Always make the flushing manifold the same size as the supply manifold.

Total Zone Flow	Supply Manifold Size *
Up to 25 LPM	19mm LDPE
Up to 40 LPM	25mm LDPE

- Manifold size recommendation based on maximum drip line spacing of 1 metre.

Pressure Loss in 19mm LDPE Supply Manifold (Max^{m} flow – 25 Lpm)

		Lateral Off-take Spacing							
Lateral Length (m)	No. of Laterals	0.3m		0.4m		0.5m		1.0m	
		Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)
5	46	13.5	10	18	15	22.5	20	45	30
10	23	6.6	10	8.8	10	11	10	22	20
25	9	2.4	10	3.2	10	4	10	6	10
50	5	1.2	10	1.6	10	2	10	4	10

Pressure Loss in 25mm LDPE Supply Manifold (Max^{m} flow – 40 Lpm)

		Lateral Off-take Spacing							
Lateral Length (m)	No. of Laterals	0.3m		0.4m		0.5m		1.0m	
		Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)	Manifold Length (m)	Head Loss (kPa)
5	73	21.6	40	28.8	40	36	20	72	30
10	36	10.5	20	14	20	17.5	20	35	20
25	14	3.9	10	5.2	10	6.5	10	13	20
50	7	1.8	10	2.4	10	3	10	6	20

Step 9:
Determine the number and location of the flush caps for each zone. One flush cap is required for each 30 litres per minute of zone flow. Place the flush caps at the hydraulic centre of the flush manifold(s) (see detail 2, p. 26).

Step 10:
Calculate the total number of air/vacuum relief valves from the following table 2.8.

15mm Air Vacuum Relief Valve		
	2.0 LPH @ 40cm	2.0 LPH @ 30cm
13mm PC	360 m	270 m

Table 2.8

One air vacuum relief valve is required per total length indicated in the chart above. For example, two air vacuum relief valves are needed for 430 metres of pressure-compensating drip-line with 2.0LPH flow and 40cm emitter spacing.

Place air vacuum relief valve(s) at the highest point(s) of each zone. Using an air vacuum relief lateral, connect the air vacuum relief valve to all drip-line laterals within the elevated area (see details 8,9 and 10, p. 31-32). If the supply and flush manifolds are at the same depth as the drip-line, and are at the highest point in the zone, they can be used as the air relief lateral.

Step 11:
Size pressure regulators based on the total zone flow. If using an Omni-reg or EZ Reg ensure that the solenoid valve size is selected so that the zone flow falls within the recommended flow range of the valve. Do not over-size the valve for the zone flow. Best practice (where pressure permits) is to select a valve where the flow falls mid way within the recommended flow range of the valve.
If using spring loaded type pressure regulators, consult the manufacturer's catalogue for the appropriate size.
The pressure setting is the sum of the following:-

1. Inlet Pressure required for drip-line (see Table 2.5) (DW11)
2. Pressure Loss in supply manifold.
3. Filter Pressure Loss
4. Elevation Pressure Loss/Gain

Step 12:
Size the zone filter according to the total zone flow (see DW14) using the Filter Sizing Table 2.10 below. To eliminate the chance of debris contamination in the event of a main or sub-main break, use one filter per zone close to the drip-line.
The minimum particle filtering requirement is 120 mesh.

Filters						
Code	Size (mm)	Flow Range (LPM)	Maximum Pressure (kPa)	Pressure Loss (kPa) @ Max. Flow	Mesh Size	Micron equivalent
1011120	20	0-80	1000	50	150	100
1011122	25	0-115	1000	50	150	100
1011124	32	0-200	1000	50	150	100
1011126	40	0-250	1000	50	150	100

Table 2.10

Answers for ZONE 1, Table 2.1, Page 13			
DW1	30	DW8	2 Lph
DW2	400	DW9	DGC1320040-200
DW3	Clay-Loam	DW10	9.4 metres
DW4	Turf	DW11	150 kPa
DW5	0	DW12	2.09 Lph
DW6	40cm	DW13	0.392 metres
DW7	40cm	DW14	20.48 Lpm

Irrigation Scheduling

Irrigation scheduling with subsurface drip uses the same methods of calculation as above-ground irrigation. The subsurface grid system is designed to wet the irrigated area completely by methods similar to those used in above-ground irrigation, supplying water in inches per hour. For efficient water application, it is necessary to apply water rates equal to or less than the rate at which the plants use water (evapo-transpiration rate; ET). The ET rate is expressed in milli-metres per unit of time, thus our application rates are expressed in milli-metres per hour. (*For regional ET data, refer to the http://www.bom.gov.au/climate/averages/ website page and select the nearest weather station to the site*.)

The following formula is used to determine application rates for subsurface drip irrigation.

$$\text{Application rate (millimetres per hour)} = \frac{\text{Emitter flow (LPH)}}{\text{Dripper spacing x Drip-line spacing (in metres)}}$$

For example:

Drip-line row spacing = 30cm, emitter spacing = 30cm

Emitter flow rate = 2.0 LPH

$$\text{Precipitation Rate} = \frac{2.0\ \text{LPH}}{0.3\text{m x } 0.3\text{m}} = 22.2 \text{ mm per hour}$$

Or, use the Water Application Rate Table below to determine application rates.

Water Application Rate – Millimetres per hour				
Line Spacing	25cm	30cm	35cm	40cm
13mm, PC 2.0 LPH @ 40cm	20	16.7	14.3	12.5
13mm, PC, 2.0 LPH @ 30cm	26.7	22.2	19	16.7

Zone Run Time Scheduling Worksheet

To determine zone run times, obtain the following information:

- monthly evapo-transpiration value for the location
- irrigation application rate

(*For regional ET data, refer to http://www.bom.gov.au/climate/averages/.*)

The following formulae can be used to determine run times.

$$\text{Run time per week (hours)} = \frac{\text{Weekly evapo-transpiration rate (mm)}}{\text{Application rate (mm/hr)}}$$

$$\text{Run time per day} = \frac{\text{Run time per week}}{\text{Days per week}}$$

Month:						
Zones						
Day	1	2	3	4	5	6
Sunday						
Monday						
Tuesday						
Wednesday						
Thursday						
Friday						
Saturday						

Table 3.2

** The number of zones may vary depending on the specific needs of each installation.*

Installation Procedures

Storage and Handling

It is a characteristic of Trifluralin® that the decay rate increases with increasing temperature. It is therefore a requirement that Rootguard® tube is stored in a dry, well ventilated place out of direct sunlight. It is recommended that Rootguard® tube be installed as close as possible to the time of manufacture. Do not store for more than six months from the date of manufacture.

Each drip emitter in Rootguard® tube is impregnated with Trifluralin®. The amount contained in each emitter is below harmful levels to humans. As with any irrigation installation it is recommended that installers wash their hands with soap and water after handling. Do not drink from the tube and do not ingest the tube or emitter. Keep out of reach of children.

Installation Guidelines

1. The typical recommended pipe depth for drip-line is 100mm below finished grade.
2. For turf areas where aeration is part of normal maintenance operations, tubing must be buried below the reach of aeration equipment.
3. Use standard 13mm barbed fittings with ratchet clamps or Cobra clamps for all drip-line connections to ensure the integrity of the connection.
4. It is imperative that Drip-In with Rootguard drip-line is installed at a uniform depth and width according to specifications.

Drip-line can be installed using one of the following methods:

INSERTION METHOD	**ADVANTAGES**	**DISADVANTAGES**
Hand trenching or backfilling	– Handles severe slopes and confined areas – Uniform depth	– Slow – Labor intensive – Disrupts existing turf and ground
Oscillating or vibrating plough (cable or pipe pulling type)	– Fast in small-to-medium installations – Minimal ground disturbance – No need to backfill the trench	– Depth must be monitored closely – Cannot use on steeper slopes (20%) – Requires practice to set and operate adequately – Tends to “stretch” pipe
Trenching machine	– Faster than hand trenching – May use 1" blade for most installations – Uniform depth	– Slower, requires labor – Disrupts surface of existing turf – Backfill required
Tractor-mounted 3-point hitch insertion implement	– Fastest method, up to four plough attachments with reels – Packer roller compacts soil over pipe	– Only suitable for areas large enough to manoeuvre a small tractor

5. When possible, pressure test the system before covering trenches or, when ploughing, pre-test for leaks prior to planting.

Planting Guidelines

1. Pre-irrigate to ensure that the soil is hydrated to field capacity before planting begins. This is especially important when planting sod or hydro-seeding.

2. When planting container plants with pot sizes wider than the drip-line lateral spacing, there are two options:

- Plant the oversized plants prior to installing the drip-line laterals and plant the smaller plants after installing the drip-line laterals.

OR

- Plant all plants after installing the drip-line, taking care to pre-cut and tape the open ends of the drip-line when planting the oversized plants. Re-connect the severed drip-line after planting.

3. As with all types of irrigation, it is critical that the root balls are not allowed to dry out during the plant-establishment period. Initial post-planting irrigation is critical, so it is necessary to over-irrigate to ensure water transfer between the landscape soil medium and container plant root balls.

4. When planting sod or hydro-seeded grasses, establishment can be accomplished without supplemental overhead watering by:

- ensuring the soil is hydrated to field capacity prior to planting.
- thoroughly rolling the sod to ensure optimum contact between the sod and the soil medium. Use multiple-start run times (up to 10 times per day) until the sod has knit into the soil. Take care not to let the sod dry out during this period.
- using multiple start times as described above to establish seeded or hydro-seeded grasses.

Installation Steps

- Assemble and install filter, remote control valve and pressure regulating valve assembly(ies) according to detail numbers 1, p. 25.

- Assemble and install supply manifold(s). Tape or plug all open connections to prevent debris contamination.

- Refer to the Material Safety Data Sheet for handling recommendations of Drip-In with Rootguard.

- Assemble and install flushing manifold(s). Tape or plug all open connections to prevent debris contamination.

- Install drip-line laterals. Tape or plug all open ends while installing the drip-line to prevent debris contamination.

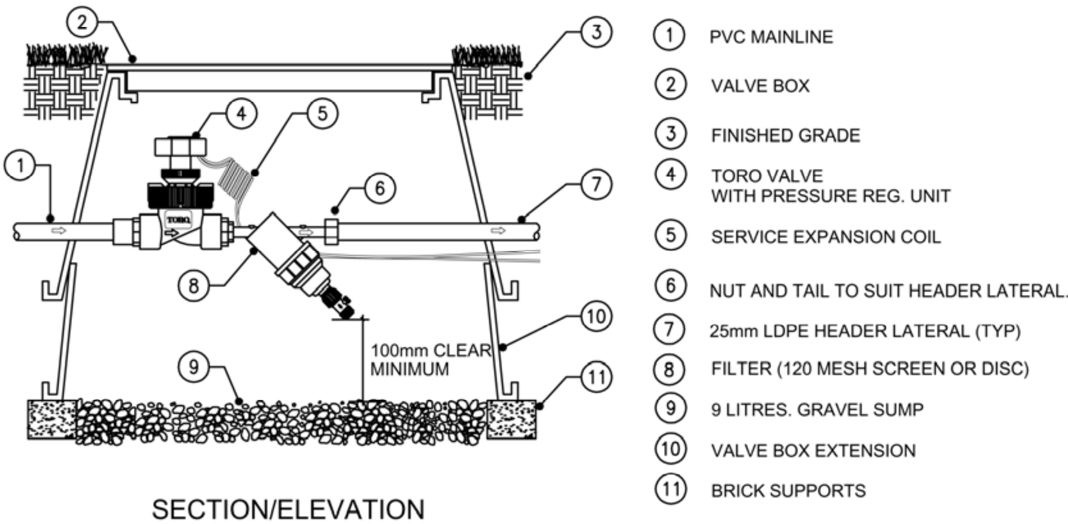
- Install air vacuum relief valve(s) at the highest point(s) of the zone(s) according to detail numbers 8,9and 10, p. 31,32.

- Thoroughly flush supply manifold(s) and connect drip-line laterals while flushing.

- Thoroughly flush drip-line laterals and connect to flushing manifold(s) or interconnecting laterals while flushing.

- Thoroughly flush flushing manifold(s) and install line flushing valves according to detail number 2, p. 26. Thorough flushing of each installation segment is necessary to ensure that no debris contamination occurs.

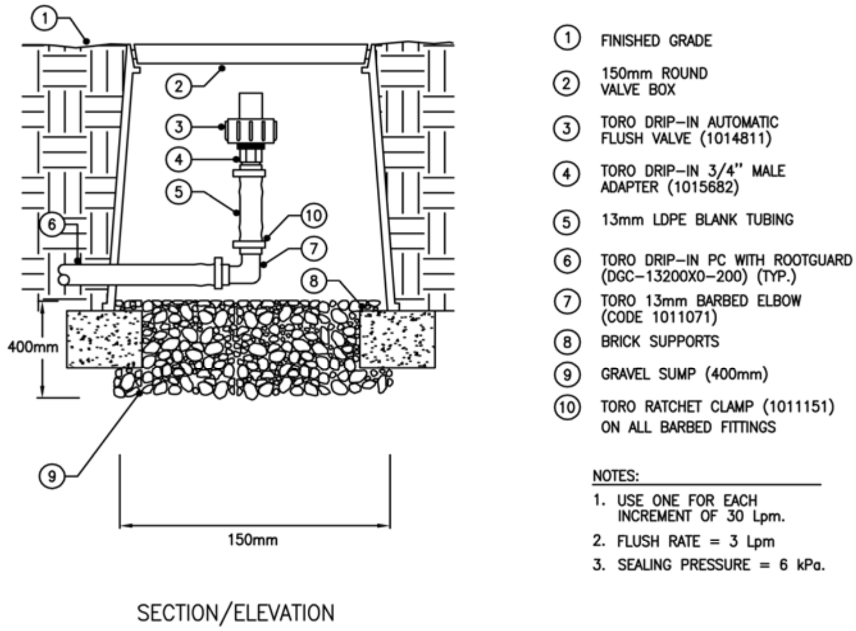
Installation Assembly Details



REMOTE CONTROL VALVE & FILTER
TORO DRIP-IN PC WITH ROOTGUARD

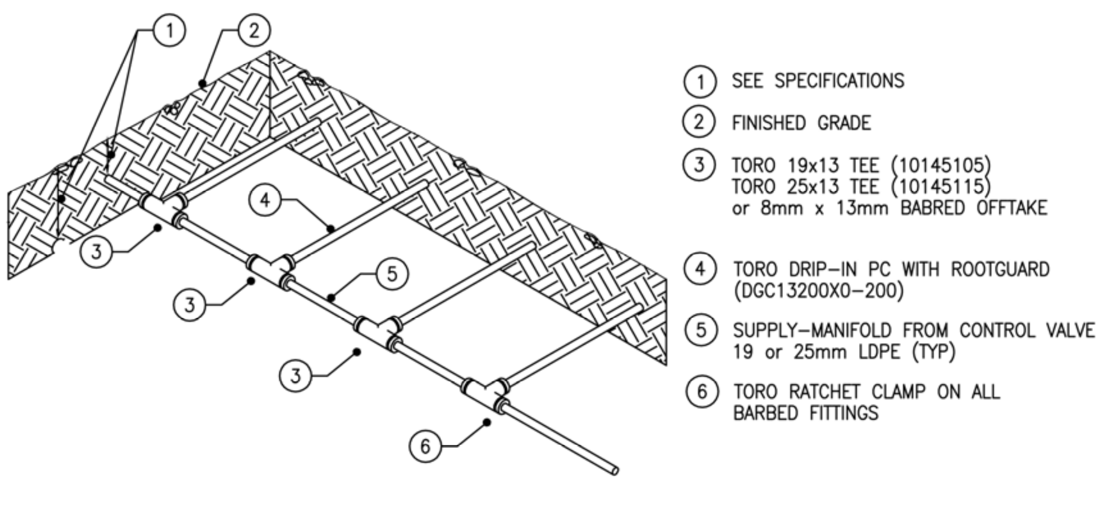
NOT TO SCALE

Detail 1.



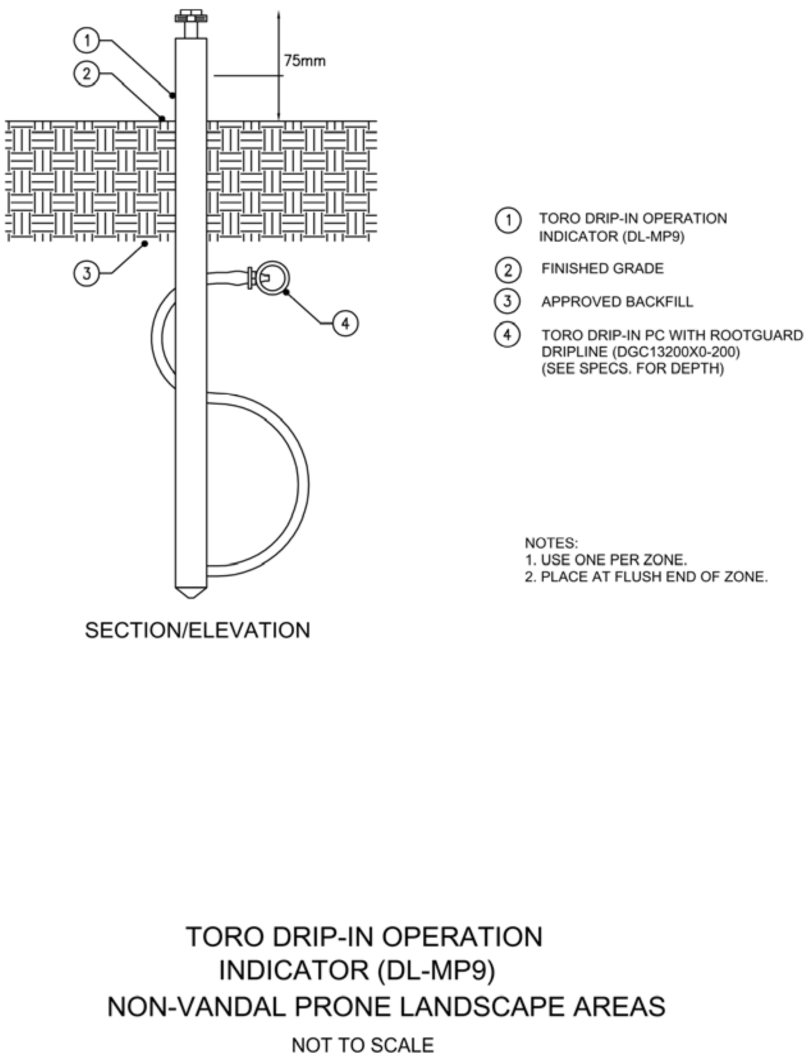
AUTOMATIC FLUSH VALVE
TORO DRIP–IN PC WITH ROOTGUARD

Detail 2.



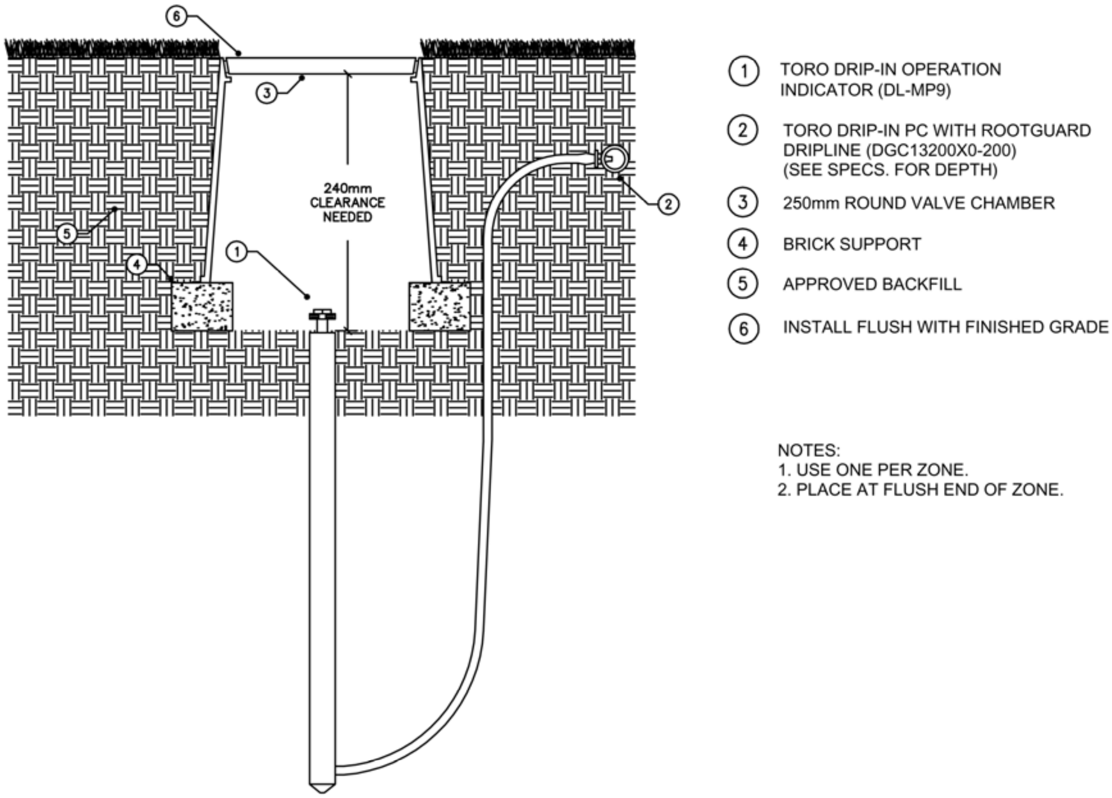
END FEED SUPPLY MANIFOLD
TORO DRIP–IN PC WITH ROOTGUARD

Detail 3.



1
2
75mm
3
4
1 TORO DRIP-IN OPERATION INDICATOR (DL-MP9)
2 FINISHED GRADE
3 APPROVED BACKFILL
4 TORO DRIP-IN PC WITH ROOTGUARD DRIPLINE (DGC13200X0-200) (SEE SPECS. FOR DEPTH)
NOTES:
1. USE ONE PER ZONE.
2. PLACE AT FLUSH END OF ZONE.
SECTION/ELEVATION
TORO DRIP-IN OPERATION
INDICATOR (DL-MP9)
NON-VANDAL PRONE LANDSCAPE AREAS
NOT TO SCALE

Detail 4.

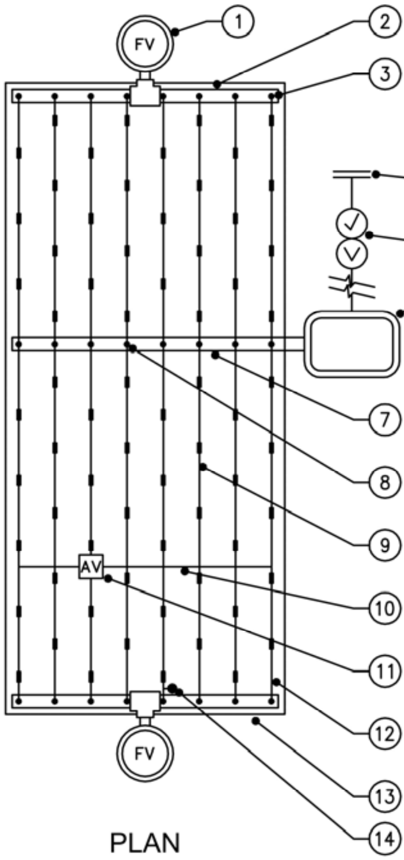


SECTION/ELEVATION

TORO DRIP-IN OPERATION
INDICATOR (DL-MP9)
TURF AND VANDAL PRONE AREAS

NOT TO SCALE

Detail 5.

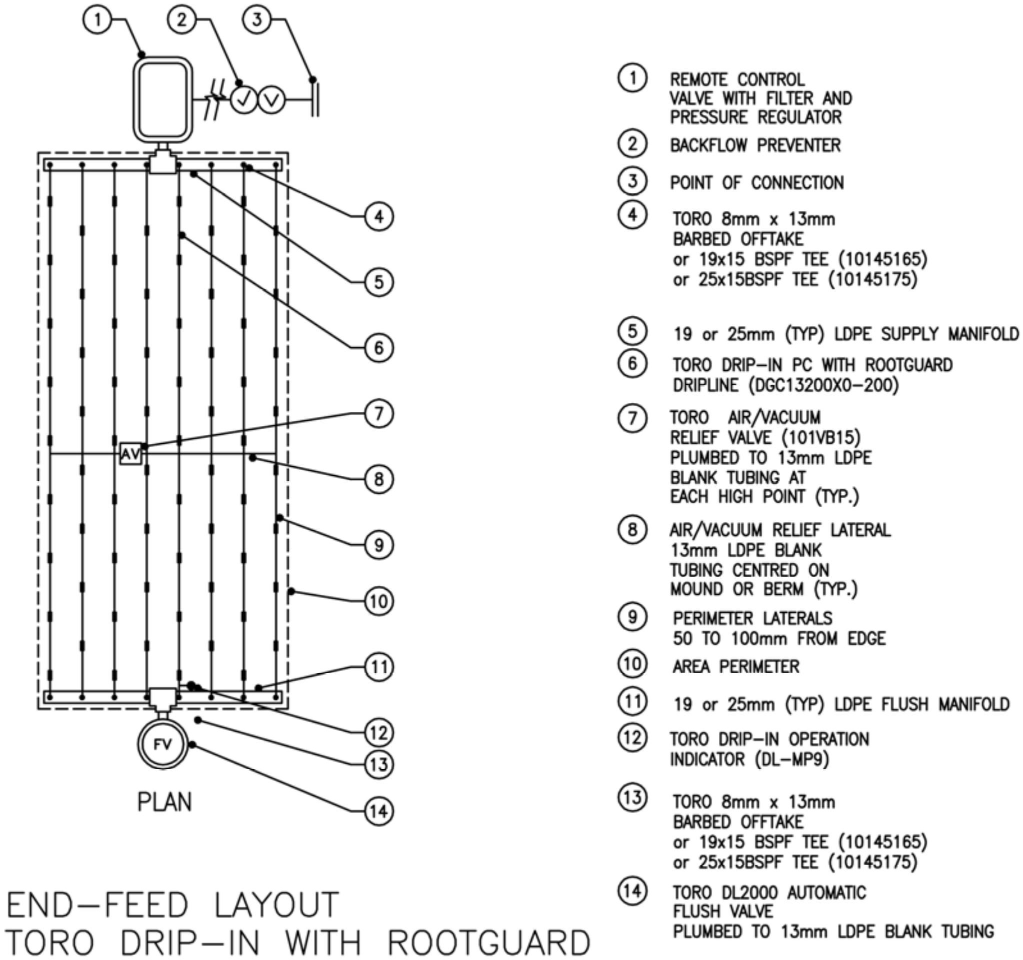


1. TORO DRIP-IN WITH ROOTGUARD AUTOMATIC FLUSH VALVE (1014811 and 1015682) PLUMBED TO 13mm LDPE TUBING (TYP.)
2. 19 or 25mm LDPE (TYP.) FLUSH MANIFOLD
3. TORO 13mm END STOP PLUG (1011098) ELBOW CONNECTION (TYP.)
4. POINT OF CONNECTION
5. BACKFLOW PREVENTER
6. REMOTE CONTROL VALVE WITH FILTER AND PRESSURE REGULATOR
7. 19 or 25mm (TYP.) LDPE SUPPLY MANIFOLD
8. MANIFOLD-TO-LATERAL CONNECTION
   FEMALE THREADED x BARBED TEE 19x15
   CODE 10145165
   FEMALE THREADED x BARBED TEE 25x15
   CODE 10145175
9. TORO DRIP-IN WITH ROOTGUARD DRIPLINE LATERAL (DGC13200x0-200)
10. AIR/VACUUM RELIEF LATERAL 13mm LDPE BLANK TUBING CENTERED ON MOUND OR BERM
11. TORO AIR/VACUUM RELIEF VALVE (101VB15) PLUMBED TO 13mm LDPE BLANK TUBING AT EACH HIGH POINT
12. PERIMETER LATERALS 50 TO 100mm FROM EDGE
13. AREA PERIMETER
14. TORO DRIP-IN OPERATION INDICATOR (DL-MP9)

TYPICAL CENTRE FEED LAYOUT
TORO DRIP-IN PC WITH ROOTGUARD

NOT TO SCALE

Detail 6.


1
2
3
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11
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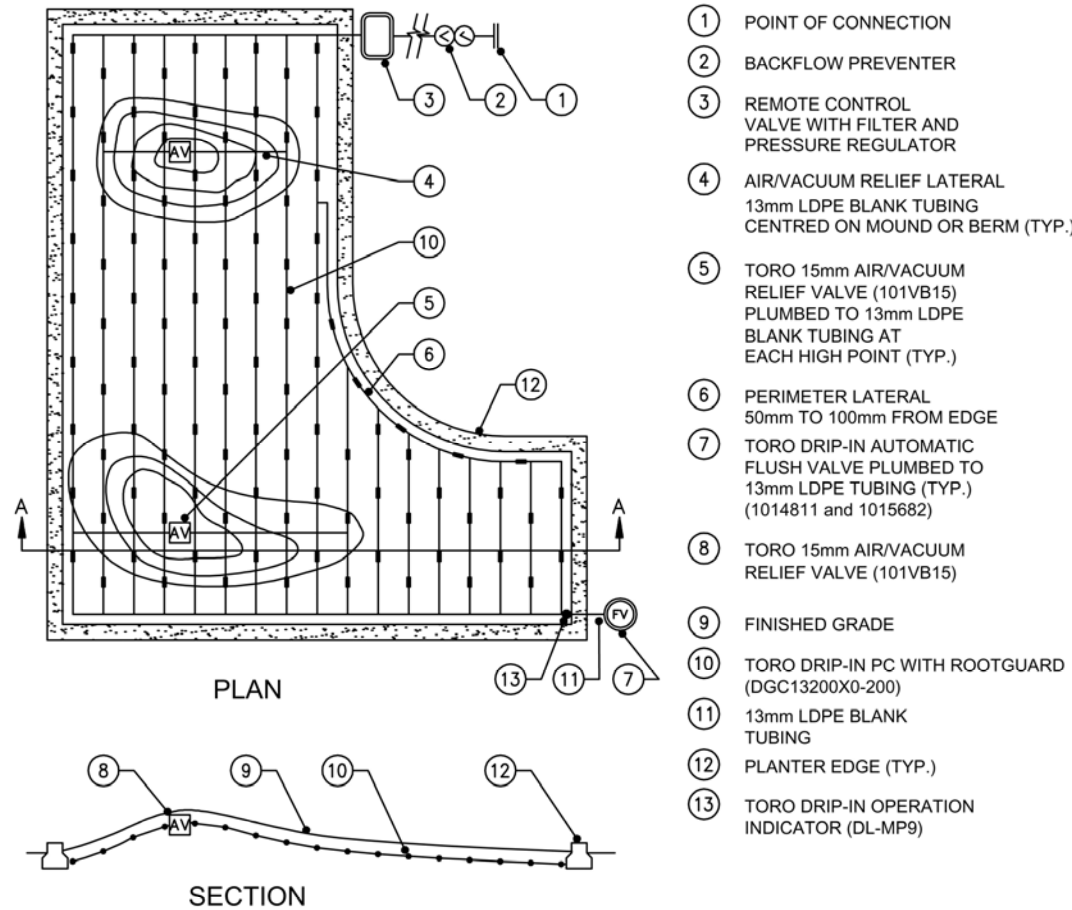
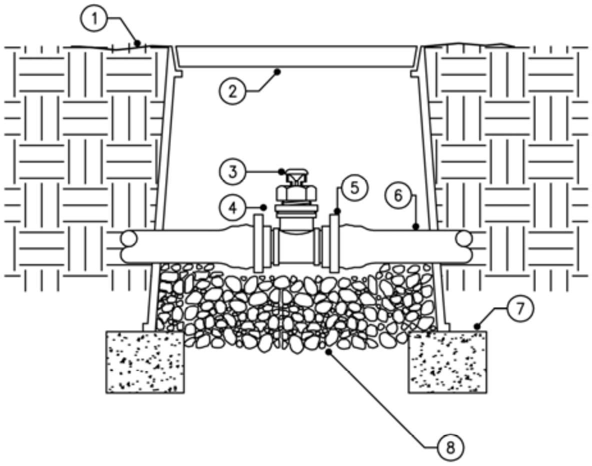
13
14
AV
FV
PLAN
END–FEED LAYOUT
TORO DRIP–IN WITH ROOTGUARD
1 REMOTE CONTROL VALVE WITH FILTER AND PRESSURE REGULATOR
2 BACKFLOW PREVENTER
3 POINT OF CONNECTION
4 TORO 8mm x 13mm BARBED OFFTAKE or 19x15 BSPF TEE (10145165) or 25x15BSPF TEE (10145175)
5 19 or 25mm (TYP) LDPE SUPPLY MANIFOLD
6 TORO DRIP–IN PC WITH ROOTGUARD DRIPLINE (DGC13200X0–200)
7 TORO AIR/VACUUM RELIEF VALVE (101VB15) PLUMBED TO 13mm LDPE BLANK TUBING AT EACH HIGH POINT (TYP.)
8 AIR/VACUUM RELIEF LATERAL 13mm LDPE BLANK TUBING CENTRED ON MOUND OR BERM (TYP.)
9 PERIMETER LATERALS 50 TO 100mm FROM EDGE
10 AREA PERIMETER
11 19 or 25mm (TYP) LDPE FLUSH MANIFOLD
12 TORO DRIP–IN OPERATION INDICATOR (DL–MP9)
13 TORO 8mm x 13mm BARBED OFFTAKE or 19x15 BSPF TEE (10145165) or 25x15BSPF TEE (10145175)
14 TORO DL2000 AUTOMATIC FLUSH VALVE PLUMBED TO 13mm LDPE BLANK TUBING

Detail 7.



MOUND LAYOUT
TORO DRIP-IN PC WITH ROOTGUARD
NOT TO SCALE

Detail 8.



SECTION/ELEVATION

1. FINISHED GRADE
2. 150mm ROUND VALVE BOX
3. TORO 15mm AIR/VACUUM RELIEF VALVE (101VB15)
4. FEMALE THREADED x BARBED TEE 13x15 CODE 10145155
   FEMALE THREADED x BARBED TEE 19x15 CODE 10145165
   FEMALE THREADED x BARBED TEE 25x15 CODE 10145175
5. TORO RATCHET CLAMP ON ALL BARBED FITTINGS
6. TORO DRIP-IN PC WITH ROOTGUARD OR 19,25mm LDPE HEADER TUBING.
7. BRICK SUPPORTS
8. GRAVEL SUMP (150mm DEEP)

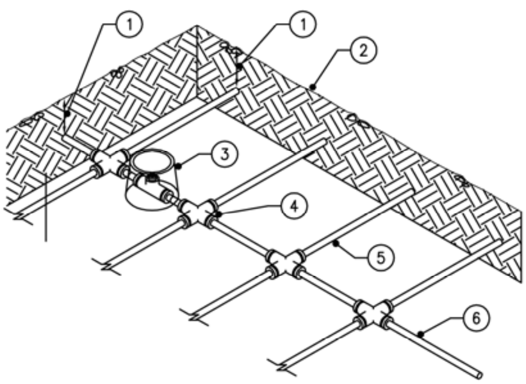
NOTES:

1. AIR/VACUUM RELIEF VALVE CANNOT BE CONNECTED LOWER THAN DRIPLINE LATERALS.
2. USE ONE FOR EACH INCREMENT OF 30 Lpm.

15mm AIR/VACUUM RELIEF VALVE TORO DRIP-IN PC WITH ROOTGUARD

NOT TO SCALE

Detail 9



1. SEE SPECIFICATIONS
2. FINISHED GRADE
3. TORO DRIP-IN PC WITH ROOTGUARD AIR/VACUUM RELIEF VALVE (101VB15) IN VALVE BOX AT HIGHEST POINT PLUMBED TO TUBING
4. 13mm BARBED CROSS (1011059) WITH CLAMPS (1011151) ON ALL BARBS.
5. TORO DRIP-IN PC WITH ROOTGUARD DRIPLINE (TYP.) (DGC13200x0-200)
6. 13mm BLANK LDPE TUBING (TYP.)

ISOMETRIC

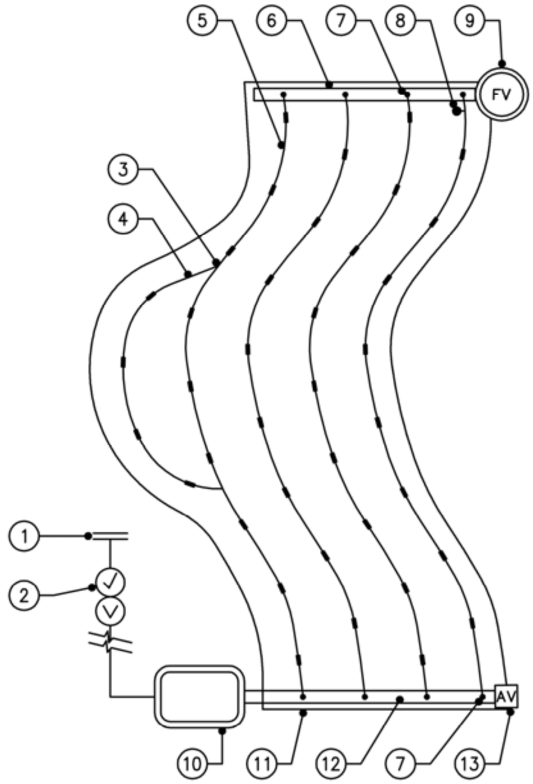
NOTES:

1. INSTALL AN AIR VACUUM RELIEF VALVE AT EACH LOCAL HIGH POINT WITHIN A ZONE.
2. IF GRADE IS CONSIDERED FLAT INSTALL ONE AIR VACUUM RELIEF VALVE FOR EVERY 30 Lpm OF ZONE FLOW.

Detail 10

AIR VACUUM RELIEF LATERAL TORO DRIP-IN PC WITH ROOTGUARD

NOT TO SCALE



PLAN

1. POINT OF CONNECTION
2. BACKFLOW PREVENTER
3. BARBED TEE 13mm x 13mm (1011011)
4. PERIMETER LATERALS 50 TO 100m FROM EDGE
5. TORO DRIP-IN PC WITH ROOTGUARD DRIPLINE (DGC13200x0-200)
6. 19 OR 25mm LDPE (TYP) FLUSH MANIFOLD
7. MANIFOLD-TO-LATERAL CONNECTION
   FEMALE THREADED x BARBED TEE 19x15
   CODE 10145165
   FEMALE THREADED x BARBED TEE 25x15
   CODE 10145175
8. TORO DRIP-IN OPERATION INDICATOR (DL-MP9)
9. TORO DRIP-IN PC WITH ROOTGUARD AUTOMATIC FLUSH VALVE (1014811 and 1015682) PLUMBED TO TUBING
10. REMOTE CONTROL VALVE WITH FILTER AND PRESSURE REGULATOR
11. AREA PERIMETER
12. 19 or 25mm LDPE (TYP) SUPPLY MANIFOLD
13. TORO DRIP-IN PC WITH ROOTGUARD AIR VACUUM RELIEF VALVE (101VB15) PLUMBED TO TUBING

NOTE:

WHEN "TEEING" OFF A ROOTGUARD LATERAL ENSURE THE TOTAL LENGTH OF ALL INTERCONNECTED DRIP LINE SHALL NOT EXCEED THE MAXIMUM RUN LENGTH. SEE TORO SUBSURFACE IRRIGATION DESIGN GUIDE.

TYPICAL ODD CURVES LAYOUT
TORO DRIP-IN PC WITH ROOTGUARD

NOT TO SCALE

Detail 11.

System Inspection

Physical inspections are necessary in the following circumstances:

- At the beginning of each irrigation season
- After any landscape planting operation or renovation
- After any maintenance function requiring digging at or below the Drip-In with Rootguard drip-line depth

Physically inspect system components (remote control valves, filters, automatic flush caps and flush-end pressure checks) on a routine basis as determined by historical experience.
Base zone-flow readings, supply manifold pressures and flush-end pressure readings should be recorded with all system components operating at their optimum capacity. Baseline readings after installation should be determined during the final system inspection upon initial start-up.
However, they can be determined at any time as long as all system components are operating properly. Record this data on the System Data Record below as a permanent reference record.

System Data Record		
Station Number: ______ Drip-line Model Number: ____________________ Emitter Spacing: _______ cm Emitter Flow:_______ LPH Drip-line Spacing: ________ cm Initial Supply Manifold Pressure: __________ kPa Initial Flush Valve Pressure: _________ kPa Application Rate: ________ millimetres per hour Evapotranspiration Rate (millimetres per week):		
Jan.	May	Sept.
Feb.	Jun.	Oct.
Mar.	Jul.	Nov.
Apr.	Aug.	Dec.

Routine Preventative Maintenance

Routine Inspections Checklist

- Turn on each zone for five to 10 minutes and walk the area, looking for excessively wet areas that might indicate leaks.
- Inspect automatic flush caps and air/vacuum relief valves for proper operation.
- Check pressures at the supply manifold and flush ends of each zone, and compare them with the base information on the System Data Record. For proper flushing, the flush-end pressure should be at least 70 kPa.
- Check the operational flow of each zone and compare it with the design flows or the flows on the System Data Record. High flows could indicate leaks or malfunctioning automatic flush caps. Flows lower than expected could indicate clogged drippers, drippers with excessive salt build-up, kinked drip-line or a clogged filter. Low flows might also indicate that the capacity of the installed remote control valves, filters or pressure regulators are too low, thus restricting the flow to the zone.

Component Maintenance Checklists

Remote Control Valves

- Upon initial inspection, check to see if the valve is properly sized for the zone flow. Refer to the manufacturer's specification. Oversized valves may not close properly and undersized valves will restrict flow and cause excessive pressure loss.
- Follow the manufacturer's recommended procedures for repair and general maintenance.

  Inspect for proper operation when opening or closing. A weeping valve can cause excessively wet areas at low points in the zone.

Filters

- Filters must be inspected and cleaned periodically. The frequency of inspection is dependent on the water source. Municipal potable water may require less frequent cleaning than irrigation district water, pond water or well water. The frequency is determined by historical experience as new systems are operated.
- Commercial installations should include pressure gauges, or facilities to connect pressure gauges, immediately upstream and downstream of each filter. Filters should be cleaned when the pressure drop across the filter is 30 kPa or greater, or when the downstream pressure falls below the designed working pressure of the system.
- Filters without pressure gauges should be inspected monthly until the necessary frequency is determined.

- Filters should always be inspected when any system break occurs ahead of the filter.
- If filters are plugging too frequently, a larger filter (two times the highest zone flow) may need to be installed upstream of the zone filters to pre-filter the water supply.

Pressure Regulators

- Annually check the pressure output just downstream of the regulators to ensure that the valve is operating at designed pressures.

Drip-line

- Inspect drip-lines at the air vent and/or flush cap locations for salt build-up after the first year of operation. If necessary, inject commercially available cleansing solutions through the system at the recommended rates and continue with annual treatment. Consult with local fertilizer distributors for recommended materials and rates.
- Prior to digging in planted areas, turn on the system long enough to create wet areas on the surface to locate the subsurface drip-lines.
- After cultivation or maintenance activities, turn on the system for five to 10 minutes to inspect for leaks that might have been caused by these operations.

Flush Caps

- Automatic flush caps operate by automatically flushing a small amount of water each time the system is activated. Observe the flush operation annually to ensure that flushing is occurring properly.
- The system must be flushed thoroughly after repairs or alterations are made to the irrigation components. Automatic flush caps do not allow enough water to pass through excessive debris and, therefore, must be removed in order to effect a manual flush.
- Manual flush caps should be flushed three times each irrigation season for a period of 30 to 60 seconds or until the flush water is visibly clean. More frequent flushing may be required under extremely dirty water conditions. Flushing is also necessary any time the system is repaired.

Troubleshooting Checklists

Excessively Wet Soil Areas

- Determine if the wet area is caused by damaged drip-line. Carefully dig up the area and expose the drip-line. Make a clean cut when cutting through the damaged area. If the system is a subsurface grid system, water will flow from both sides of the cut, automatically flushing any debris that may have worked its way into the drip-line. While the water is running, flush both sides of the cut and repair it with the appropriate coupling.
- If the wet area is at the low side of a slope or mound and a leak is not found, the wet area is probably caused by subsurface runoff. To remedy the problem, expose the lowest line in the area. Cut the line and plug it off at both the inlet and flush manifolds.
- Localized wet areas are sometimes caused by differences in soil depth or uneven drip-line depths. If uneven drip-line depth is the problem, the line must be excavated and re-installed at a uniform depth. If it is caused by shallow soil conditions, it will be necessary to correct the shallow condition or wrap some of the dripper outlets in the area with electrical tape to cut off flow.
- Localized wet areas also can be caused by leaky fittings. If this is the case, the fittings are either the incorrect size or not properly secured.
- Area-wide wet areas are probably due to improper scheduling. Set the controller to apply water at rates that correspond to local evapotranspiration data. Use the Application Rate Table and the Scheduling Form provided in this manual.

Excessively Dry Soils

- Check system flows and pressures to determine if the system is operating at designed pressures. If excessively low pressures are detected, follow the standard procedures for determining the cause of a pressure drop (i.e., a clogged filter).
- Localized dry soil conditions are sometimes caused by kinked or pinched drip-line, or upstream leaks. Dig up the dry area and correct the situation.
- Massive dry areas can be caused by improper scheduling. Set the controller to provide the application rate that corresponds to the local evapotranspiration data. Use the Application Rate Table and Scheduling Form provided in this manual.