Introduction to Irrigation Management

Evaluating your pressurised system

System 8

Drip (trickle) systems

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Aim

These worksheets outline the method and equipment needed to evaluate a drip irrigation system.

The appendix gives some additional design notes on drip systems.

Overview of drip systems

Irrigation using drippers is often considered the most efficient method in terms of both water use and labour, but, because it is more complex in design and management, a drip system must be designed, installed, managed and maintained correctly.

Drip irrigation technology has been developing in many parts of the world since the late 1950s. Vast improvements have been made, so that modern equipment is very efficient and has overcome many of the earlier problems encountered.

The range of industries includes permanent horticulture such as vines and orchards; row crops such as tomatoes, vegetables, sugar cane, cotton; pasture crops such as lucerne; and other industries such as nurseries and hydroponics.

Drippers are generally specified according to their flow rate, for example, 4 L/h. This flow rate is a nominal discharge rate at a specified pressure, generally 100 kPa.

Equipment needed

To measure pressure in a drip system, you need:

- an accurate pressure gauge with an appropriate scale so it works mid-range at your normal pressures (say 0 to 500 kPa). It should be fitted with T-adaptors for temporary installation at either end of laterals.

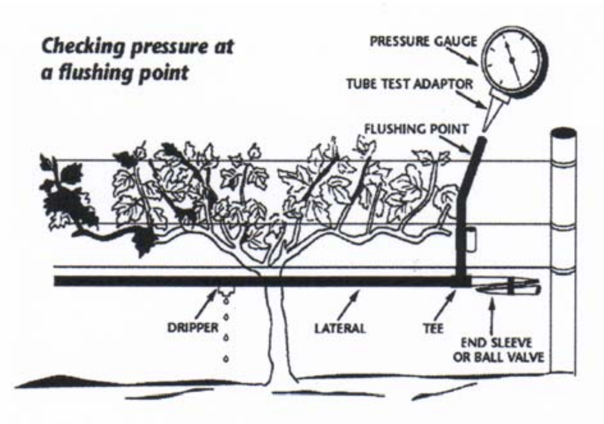


Figure 1. Checking pressure at a flushing point

- fittings such as reducing bushes and a Schrader valve (Figure 2)to attach to the lateral, or an adaptor to check pressure at the flushing points.

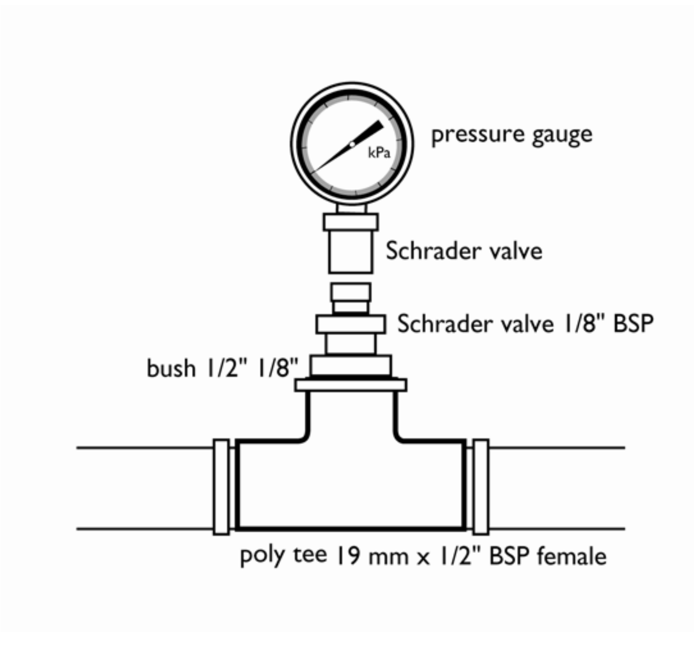


Figure 2. Schrader valve

To assess dripper output:

- a stopwatch or watch with an easily visible second hand
- a number of suitable containers (preferably buckets) to place under each dripper
- a measuring tape 5 to 8 metres long
- a soil auger or probe
- a measuring cylinder or jug with graduations in millilitres
- a calculator, a pen and data sheets
- masking tape (for some in-line systems)
- manufacturer's performance charts for the drippers being tested. (These should clearly show recommended outputs and operating pressures.)

Evaluation procedure

To evaluate the performance of a dripper system, buckets are placed beneath a selection of drippers and the volume of water collected in each over a certain time is recorded. The area wetted is also measured to obtain an average coverage area for the drippers used.

Follow the steps in the procedure below. When you have completed the measurements, move on to the calculation examples later in the worksheets.

Step 1. Record information for your system on the data sheet.

Step 2. Run the irrigation system long enough to allow a complete spread of water by the drippers.

Step 3. Check your system for malfunctions, blockages, leaks and damage. Record any faults in your maintenance report and schedule in your data sheet

Step 4. Choose four dripper laterals along an operating submain: one should be near the inlet, and two near the 'third' points (one-third and two-thirds), and the fourth near the outer end of the submain (see Figure 3 for an example).

Step 5. Choose four drippers along **each** of the four operating laterals (Figure 3): one should be near the inlet, two near the 'third' points (one-third and two-thirds), and the fourth near the outer end of the lateral. This will give you 16 drippers for the evaluation process.

Step 6. Identify (name) the laterals and drippers so that you do not get your buckets mixed up: for example, Lateral 1, 2, 3, 4, with the drippers identified as A, B, C, D starting from near the submain. Thus, the catch cans would be identified as 1A, 1B and so on until the last catch can, 4D.

Step 7. Make a plan of the test site showing the position of the selected drippers and the ID numbers (Figure 3).

Step 8. Determine whether the dripper's spread is overlapping or non-overlapping. Estimate the spread of water by digging down 15 to 30 cm to find the edge of the spread. Measure the wetted width and record in your calculation table: use Table 1 if your dripper spread is overlapping, or Table 2 if your dripper spread is non-overlapping.

Step 9. Measure the output of the drippers in turn by placing a bucket under each.

Write down the time that you place each bucket.

If you are testing in-line drippers, the water may run along the drip line and miss the bucket. To prevent this, wrap some masking tape loosely on both sides of the dripper to cause the water to fall in the can.

With subsurface drip systems, you will need to dig around the drip line to provide enough clearance underneath the dripper to place the bucket.

Step 10. Return to the selected emitters in the same order, remove the bucket, and write down the time it is removed.

Step 11. Measure and record the volume you collected in each bucket.

Step 12. Measure and record the water pressure at the inlet and downstream ends of each lateral tested.

Step 13. Check your pumping unit and record the operation of the pump in your pump record sheet.

When all of these steps have been completed for all sections of the system that are being evaluated, you can calculate the MAR and DU on the evaluation sheets.

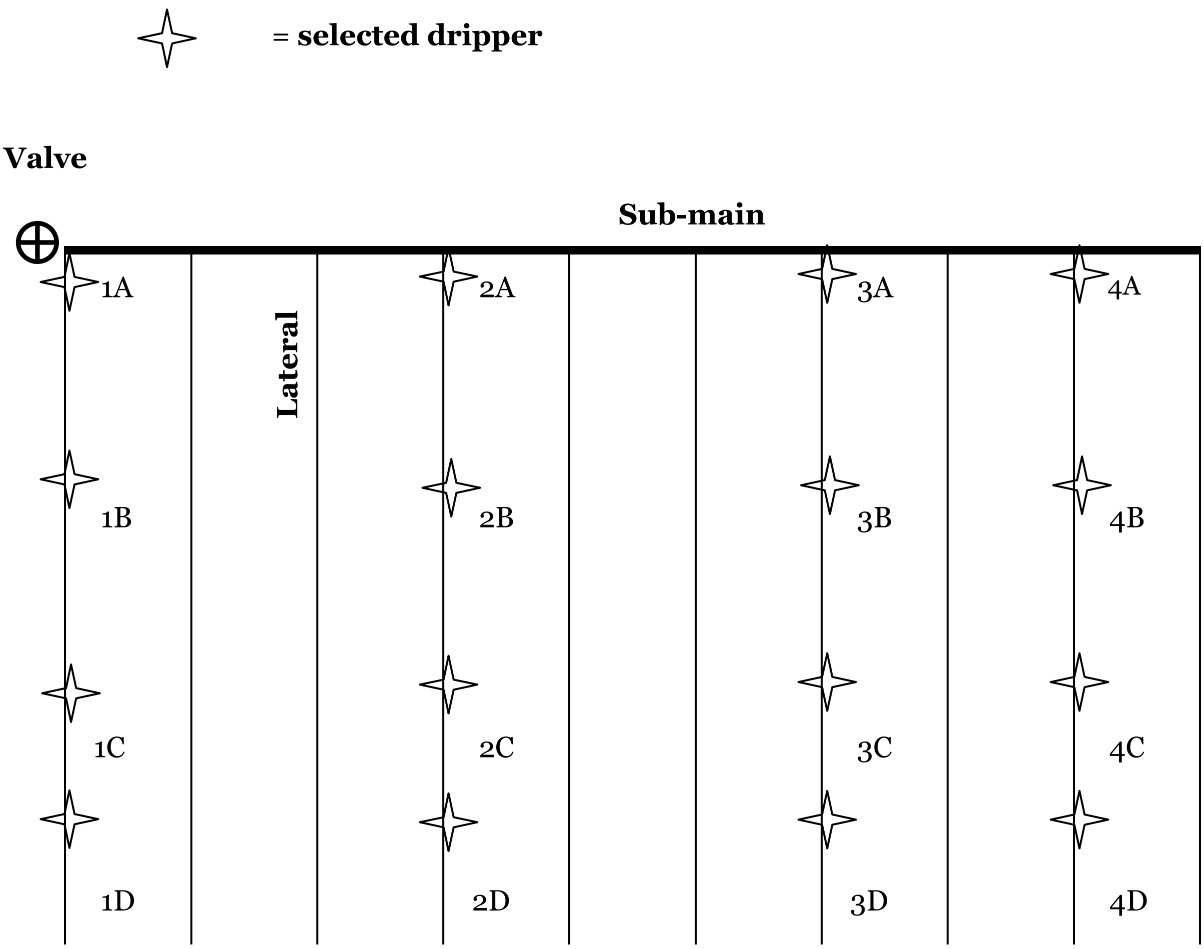
Data sheet (example)

Date: July 3 2003

Name:	T. Rickle
Crop	Grape
Location/block	Shiraz 2/3
Soil texture of block	Sandy loam
Effective root depth	300 **mm** (0.3 metres)
Rootzone RAW	25 **mm**
Maximum infiltration rate	30 **mm/h**
Designed flow rate	2.5 **L/h at** 100 **kPa**
Emitter make	Never Flood
Emitter model	2000/1
Emitter spacing along laterals	0.7 **metres**
Lateral spacing	3 **metres**
Row spacing	3 **metres**
Operating pressure	100 **kPa**
Irrigation frequency	6 **days**

Maintenance Record	Maintenance Schedule
Two blocked emitters	Unblock/ replace emitters 3 July 2003
Small leak at junction 5 South end	Replace seals at junction 5 7 July 2003

Figure 3: Layout of selected drippers



Pressure readings in laterals

		Lateral			
		1	2	3	4
Pressure (kPa)	Inlet end (near sub main)	120	115	100	95
	Down stream (far end)	105	100	90	90

Large variations in the pressure readings of the laterals may indicate problems, such as blockages or leaks.

How even is your pressure across the system ?

Wetted area measurements and calculations

For our calculation of MAR and DU%, we need to know the average wetted area of the emitter.

If your emitter wetted patterns overlap, then calculate your average wetted area using the following table.

Table 1: Overlapping wetted areas from emitters

Average wetted area of drippers = wetted width (metres) x dripper spacing (metres)

	A	**B**	**C**	**D**	**E**	**F**	Average wetted area
Lateral	Emitter A	Emitter B	Emitter C	Emitter D	Total wetted widths **A + B + C + D**	Average wetted widths **E ÷ 4**	**F × emitter spacing**
1	0.75	0.91	0.82	0.89	3.37	0.84	0.59
2	0.8	0.92	0.79	0.83	3.34	0.83	0.58
3	0.79	0.90	0.91	0.85	3.45	0.86	0.6
4	0.80	0.92	0.92	0.90	3.54	0.88	0.62
						Total	2.39 m² **G**

Average wetted area of all laterals = Total wetted area ÷ 4

Average wetted area	**G ÷ 4** **=** 2.39 **÷ 4** = 0.60 m^2	**H**

System 8: Drip (trickle) systems

If your emitter wetted patterns do not overlap, then calculate your average wetted area using the following table.

Table 2: Non overlapping wetted areas from emitters

Average wetted area of drippers	**= wetted diameter (m) x wetted diameter (m) × 0.786***						
	A	**B**	**C**	**D**	**E**	**F**	Average wetted area **F × F × 0.786**
	Emitter Position				Total wetted widths **A + B + C + D**	Average wetted width **E ÷ 4**	
Lateral	Emitter A	Emitter B	Emitter C	Emitter D			
1	0.75	0.91	0.82	0.89	3.37	0.84	0.55
2	0.8	0.92	0.79	0.83	3.34	0.83	0.54
3	0.79	0.90	0.91	0.85	3.45	0.86	0.58
4	0.80	0.92	0.92	0.90	3.54	0.88	0.59
						Total	2.26 m² **G**

Average wetted area of all laterals =	**Total wetted area ÷ 4**	
	G ÷ **4** = 2.26 ÷ **4**	
Average wetted area	= 0.56 m^2	**H**

* **0.786** is a convenient way of writing π **('pi')** ÷ **4** used in calculating the wetted area.

Dripper output record sheet (example data)

Lateral	Dripper	Time on	Time off	Elapsed time (mins) C – B	Volume collected (mL)	Dripper output (L/h) E ÷ D x 0.06 *
	A	B	C	D	E	F
1	1A	*11.13*	*11.29*	*16*	*570*	*2.1*
	1B	*11.17*	*11.32*	*15*	*540*	*2.2*
	1C	*11.20*	*11.36*	*16*	*610*	*2.3*
	1D	*11.24*	*11.39*	*15*	*490*	*2.0*
2	2A	*11.42*	*11.58*	*16*	*600*	*2.3*
	2B	*11.46*	*12.01*	*15*	*580*	*2.3*
	2C	*12.49*	*12.04*	*15*	*550*	*2.2*
	2D	*11.53*	*12.08*	*15*	*460*	*1.8*
3	3A	*12.12*	*12.27*	*15*	*530*	*2.1*
	3B	*12.15*	*12.29*	*15*	*490*	*2.0*
	3C	*12.18*	*12.34*	*16*	*580*	*2.2*
	3D	*12.22*	*12.37*	*15*	*540*	*2.3*
4	4A	*12.41*	*12.57*	*16*	*580*	*2.2*
	4B	*12.44*	*13.09*	*16*	*570*	*2.1*
	4C	*12.48*	*13.04*	*16*	*550*	*2.1*
	4D	*12.52*	*13.07*	*15*	*480*	*1.9*
Total buckets: 16					Total of outputs	34 **K**

Average output rate = total output ÷ number of buckets	
K ÷ total buckets 34 ÷ 16 = 2.13 L/h	**L**

To calculate the distribution uniformity later, draw a circle around the quarter of bucket figures (4 cans if your tested 16 drippers) in column [F] that have the lowest output.

* This factor changes minutes to hours, and mL to L. It is an easier way to do
(E × 60) ÷ (D × 1000)

Calculating MAR

- Complete all sections of the 'Dripper output record sheet'.
- Divide the average output rate **[L]** by the estimated wetted area of a dripper **[H]**

The wetting patterns of our example system overlap. Therefore, H has been calculated to be 0.6 m^2

MAR = average output ÷ wetted area	
MAR	**L ÷ H** 2.13 L/h ÷ 0.6 square metres = **3.6 mm/h**

In the example, 2.13 L/h is the **volume** put out in one hour.

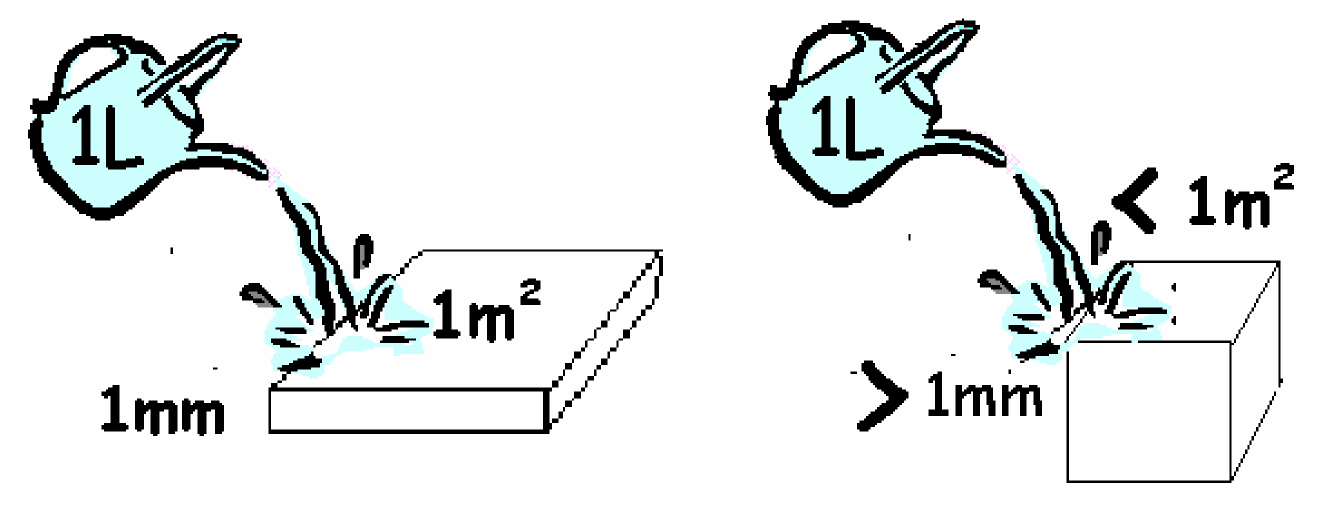
In metrics:

1 litre spread over 1 square metre is equal to a depth of 1 mm.

Thus,

2.13 litres spread over 1 square metre is equal to a depth of 2.13 mm.

If the area covered is LESS than one square metre, the depth will be greater for the same volume of water.



Calculating DU

- Calculate the number of one quarter (25%) of your catch cans.
- On the dripper output record sheet, circle one quarter of cans with the lowest output (in column **[F]**). These are your LQ cans.
- Add the amounts from your **LQ cans**.
- Use the following table to calculate the average of the LQ cans. Divide the total by the number of LQ cans.
- Divide the average LQ by the average output rate [**L**] and multiply by 100 to get the DU%.

Example data with full calculations

Number of catch cans	16 **cans**	**A**
One quarter of catch cans (Divide number of catch cans by 4. If this is not a whole number, round down.)	**A ÷ 4** 16 ÷ **4** = 4	**LQ cans**
On your catch can record sheet, highlight the lowest amounts for the appropriate number of LQ cans. *These are your lowest quarter catch cans (LQ cans).*		
Total of the selected LQ cans	1.8 + 1.7 + 1.8 + 1.9 = 7.2 **mm**	**B**
Average of LQ cans = total of LQ cans ÷ number of LQ cans		
Average of LQ cans	**B ÷ LQ cans** 7.2 **mm** ÷ 4 **cans** = 1.8 **mm**	**C**
DU = average of LQ cans ÷ average output rate		
Average output rate (L)	2.13	**L**
DU =	**C ÷ L** = 1.8 ÷ 2.13 = 0.845	**DU**
Convert DU into a percentage = DU x 100		
As a percentage the DU is	0.845 × 100 = 84.5%	

A DU of 85% is acceptable. If the DU is ***below*** this, then changes to the irrigation system may be required in order to improve the DU%.

A new system should have a DU% greater than 95%. It is a good idea to check the original specifications supplied with the irrigator to make sure the system is operating correctly.

How long to irrigate?

Using the **RAW**, **MAR** and **DU** you can now work out how long to operate your irrigation system to apply a certain amount of water.

Example

RAW	30 **mm**	**RAW**
MAR	3.6 **mm/h**	**MAR**
Irrigation time	**RAW ÷ MAR** = 30 mm ÷ 3.6 mm/h = 8.3 hours	

To estimate the extra time you would require to allow for differences in distribution uniformity, we simply divide our irrigation time by our distribution uniformity (DU%).

The example below demonstrates the additional time needed to compensate for an inefficient system.

Extra irrigation time required due to DU%

Irrigation time	8.3 **hours**
DU%	84.5 % (0.845)
DU % adjusted time	**Irrigation time ÷ DU** 8.3 ÷ 0.845 = 9.8 **hours**

Even with our DU% at 84.5%, we still require **an extra one-and-a-half hours** of irrigation to refill our RAW.

Pump unit record sheet

Name	Date:	Test Block:

Pump	
Make:	
Model:	
Age: years	
Impeller size: mm	
Pump speed (RPM):	
Has the impeller been turned down or replaced?	If yes, when?
Do you have a performance chart?	If no, see your dealer!

Transmission			
Type (please circle)	**Direct coupled**	**Belts and pulleys**	**Gear driven**
Pump pulley (PCD):			
Prime mover pulley (PCD)			
Type of belt (circle)	**V belt**	**Flat belt**	**Other**
Number of belts			
Distance between pulleys	metres		

Prime mover
Type:
Model:
Age: years
Prime mover speed (RPM)

Suction
Foot valve and strainer size: mm

Suction pipe diameter:	mm		
Suction pipe length:	metres		
Type of pipe:			
Static lift (water level to pump):	metres		

Pump unit operation				
Friction loss for suction pipe:	1		metre (generally)	**A**
Pressure at discharge:	....	kPa*	* *if not in kPa then convert*	**B**
Water meter reading (start):	....		*kilolitres or megalitres?*	**C**
Water meter reading (end):	....		*kilolitres or megalitres?*	**D**
Time at water meter reading (start):	....	*Use 24-hour clock*		**E**
Time at water meter reading (end):	....	*Use 24-hour clock*		**F**
Duration of pumping:	**Time at end reading – time at start reading** **F – E** **....... – ....** **= ....hours**			**G**

Maintenance
Previous service (date):
Details of service:
Next service (Date):

Select your type of meter and record your readings:

Power readings										
	Disc meter	**1**	**2**	**3**	**Electronic meter**	**1**	**2**	**3**	**Fuel**	
H	r/kWh				Reading at start				Level at start	
J	Multiplier on meter				Reading at end				Level at end	
N	Number of disc revolutions				Multiplier (stated on bill)				Temperature	
T	Time for N (seconds)				Time between reading (seconds)				Oil level (dip stick)	
$	Price/kWh				Price/kWh				Price/litre of fuel	

Step 1: Filter losses	
Filter pressure losses = pressure at filter inlet – pressure at filter outlet	
Filter location:	
Pressure at filter inlet:	**PI**
Pressure at filter outlet:	**PO**
Pressure differential	= PI – PO = ...– .... = ... kPa
Normal allowance is about 70 kPa (7 metres).	

Pump calculations

Pump flow rate		
Water pumped	D – C .... – .... Select unit of reading = ... KL or ML	**P**
Convert volume pumped into litres	If your meter reads in kilolitres P (KL) ÷ 1000 .... ÷ .... = ... litres If your meter reads in megalitres P (ML) ÷ 100000 .... ÷ .... = ... litres	**Q**
Flow rate of pump	Volume pumped (litres) ÷ duration of pumping (hours) ÷ 3600 Q ÷ G ÷ 3600 .... ÷ .... ÷................... = ... L/s	**R**

Final comments

If the DU% value was too low, the system should be upgraded. Before upgrading, you would need to decide whether you are going to under-water the dry patches or over-water the wet patches. Either decision can result in yield loss. It becomes a management decision based on the crop and possible effects of run-off or leaching.

Should the soil be at refill point prior to an irrigation and it was required to bring it to field capacity, the application required in the above example would be the RAW value for the particular soil and crop.

Irrigations swinging from refill point to field capacity are not generally applied with drip irrigation in view of the ability to apply small amounts of water fairly frequently.

With drip irrigation, soil is usually kept above refill point (unless plants are being intentionally stressed, as in regulated deficit irrigation, RDI) and they are usually not filled to field capacity. This allows greater ability for the soil to take advantage of any rain that may fall.

Data sheet (blank)

Date:

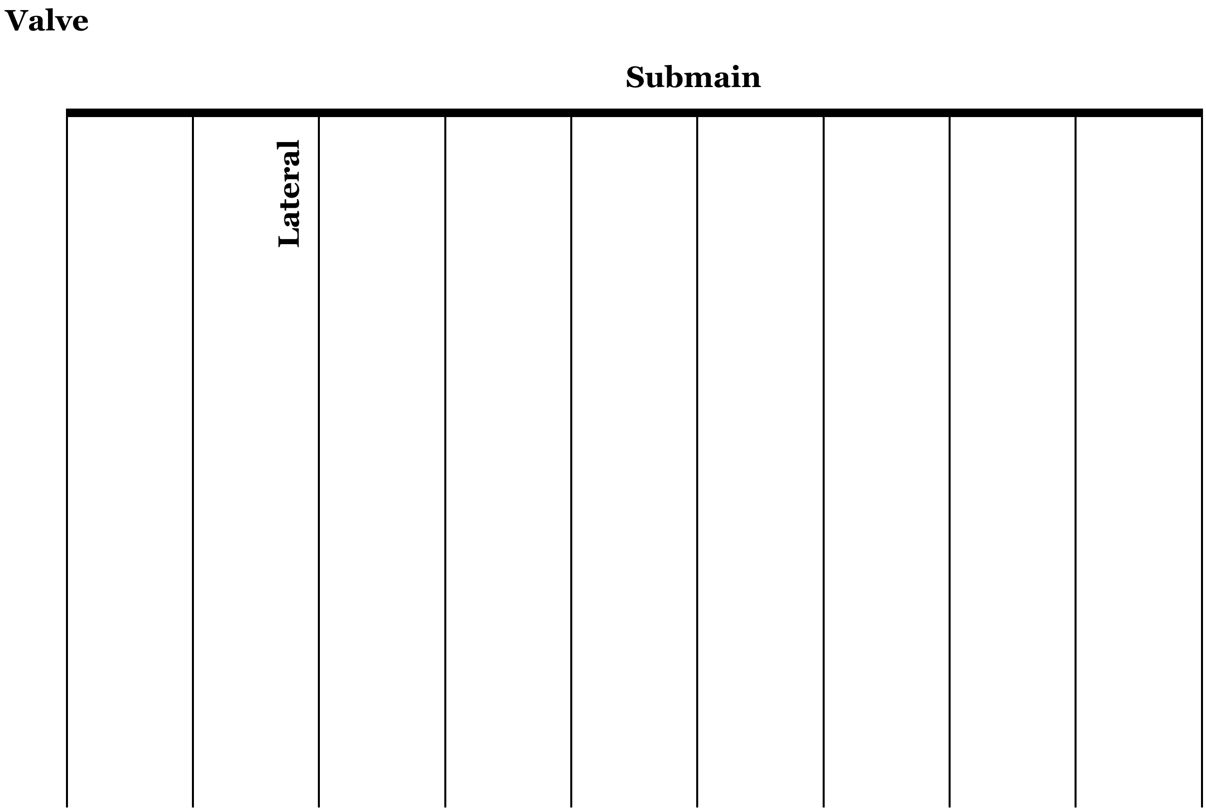
Name:	
Crop	
Location/block	
Soil texture of block	
Effective root depth	**mm**
Rootzone RAW	**mm**
Maximum infiltration rate	**mm/h**
Designed flow rate	**L/h at kPa**
Emitter make	
Emitter model	
Emitter spacing along laterals	**metres**
Lateral spacing	**metres**
Row spacing	**metres**
Operating pressure	**kPa**
Irrigation frequency	**days**

Maintenance Record	Maintenance Schedule

Layout of selected drippers

Mark and label them on the plan below.

 = **dripper location**



Pressure readings in laterals

		Lateral			
		1	2	3	4
Pressure (kPa)	**Inlet end (near sub main)**				
	Down stream (far end)				

Wetted area measurements and calculations

Table 1: Overlapping wetted areas from emitters

Average wetted area of drippers = wetted width (metres) x dripper spacing (metres)							
	A	**B**	**C**	**D**	**E**	**F**	Average wetted area
Lateral	Emitter A	Emitter B	Emitter C	Emitter D	Total wetted widths **A + B + C + D**	Average wetted widths **E ÷ 4**	**F × emitter spacing**
1							
2							
3							
4							
						Total	**G**

Average wetted area of all laterals = Total wetted area ÷ 4		
Average wetted area	**G ÷ 4** **= ÷ 4** =	**H**

Table 2: Non overlapping wetted areas from emitters

Average wetted area of drippers = wetted diameter (m) x wetted diameter (m) × 0.786*							
	A	**B**	**C**	**D**	**E**	**F**	Average wetted area **F × F × 0.786**
	Emitter Position				Total wetted widths **A + B + C + D**	Average wetted width **E ÷ 4**	
Lateral	Emitter A	Emitter B	Emitter C	Emitter D			
1							
2							
3							
4							
						Total	m² **G**

Average wetted area of all laterals = Total wetted area ÷ 4		
	G ÷ **4**	
	= ÷ **4**	
Average wetted area	=	**H**

Dripper output record sheet (example data)

Lateral	Dripper	Time on	Time off	Elapsed time (mins) C – B	Volume collected (mL)	Dripper output (L/h) E ÷ D x 0.06 *
	A	B	C	D	E	F
1	1					
	2					
	3					
	4					
2	1					
	2					
	3					
	4					
3	1					
	2					
	3					
	4					
4	1					
	2					
	3					
	4					
Total buckets: _-_-_-					Total of outputs	**K**
Average output rate = total output ÷ number of buckets						
				K ÷ total buckets ÷ = L/h		**L**

* This factor changes minutes to hours, and mL to L. It is an easier way to do
(E × 60) ÷ (D × 1000)

Calculating MAR

- Complete all sections of the 'Dripper output record sheet'.
- Divide the average output rate **[L]** by the estimated wetted area of a dripper **[H].**

MAR = average output ÷ wetted area	
MAR	**L ÷ H** ÷ =

In metrics:

1 litre spread over 1 square metre is equal to a depth of 1 mm.

Calculating DU

Number of catch cans	cans	**A**
One quarter of catch cans (Divide number of catch cans by 4. If this is not a whole number, round down.)	A ÷ 4 ÷ 4 =	**LQ cans**
On your catch can record sheet, highlight the lowest amounts for the appropriate number of LQ cans. *These are your lowest quarter catch cans (LQ cans).*		
Total of the selected LQ cans	= **mm**	**B**
Average of LQ cans = total of LQ cans ÷ number of LQ cans		
Average of LQ cans	**B ÷ LQ cans** **mm ÷ cans** = **mm**	**C**
DU = average of LQ cans ÷ average output rate		
Average output rate (L)		**L**
DU =	**C ÷ L** = ÷ =	**DU**
Convert DU into a percentage = DU x 100		
As a percentage the DU is	× 100 = %	

A DU of 85% is acceptable. If the DU is ***below*** this, then changes to the irrigation system may be required in order to improve the DU%.

A new system should have a DU% greater than 95%. It is a good idea to check the original specifications supplied with the irrigator to make sure the system is operating correctly.

How long to irrigate?

Using the **RAW**, **MAR** and **DU** you can now work out how long to operate your irrigation system to apply a certain amount of water.

Example

RAW	**mm**	**RAW**
MAR	**mm/h**	**MAR**
Irrigation time	**RAW ÷ MAR** = ÷ = **hours**	

To estimate the extra time you would require to allow for less than 100% distribution uniformity, we simply divide our irrigation time by our distribution uniformity (DU%).

The example below demonstrates the additional time needed to compensate for an inefficient system.

Extra irrigation time required due to DU%

Irrigation time	**hours**
DU%	
DU % adjusted time	**Irrigation time ÷ DU** ÷ = 9 **hours**

Appendix 1: Drip irrigation notes

Irrigation using drippers is often considered the most efficient method both in terms of water use and of labour, but because it is more complex in design and management, a drip system **must** be designed, installed, managed and maintained correctly.

To irrigators converting from other methods, it is often a new concept and requires a new approach to management.

Drip irrigation technology has been developing in many parts of the world since the late 1950s. Vast improvements have been made, so that modern equipment is very efficient and has overcome many of the earlier problems encountered.

Early attempts at dripper regulation were often crude, with poor results, whereas today flow rates and system control can be very precise.

Early dripper manufacture generally consisted of button drippers, some tapes, and drip tube (such as spaghetti tube) but has now developed into a range of products to suit particular soils, industries, crops, topography and many other requirements including permanent buried (subsurface) systems.

The range of industries includes permanent horticulture, such as vines and orchards; row crops, such as tomatoes, vegetables, sugar cane, cotton; pasture crops, such as lucerne; and other industries, such as nurseries and hydroponics.

Types of drippers

There are a range of dripper systems available, including:

- **button drippers**: these are installed by punching a hole in the dripline lateral and installing the dripper by a barb inserted in the hole.
- **tape**: these can either have two dripline walls or a seam that is designed to control flow and discharge water at set spacings.
- **in-line**: these have emitters inside the dripline at specified spacings and at a variety of emitter flow rates.

The thickness of the dripline can also be specified depending on whether the system is a permanent or seasonal installation or is to be buried.

Many drippers have what is termed a turbulent flow path. This flow path is generally a zigzag or labyrinth pattern that results in the water being turbulent and keeps any foreign matter in suspension, preventing it from settling and blocking the dripper.

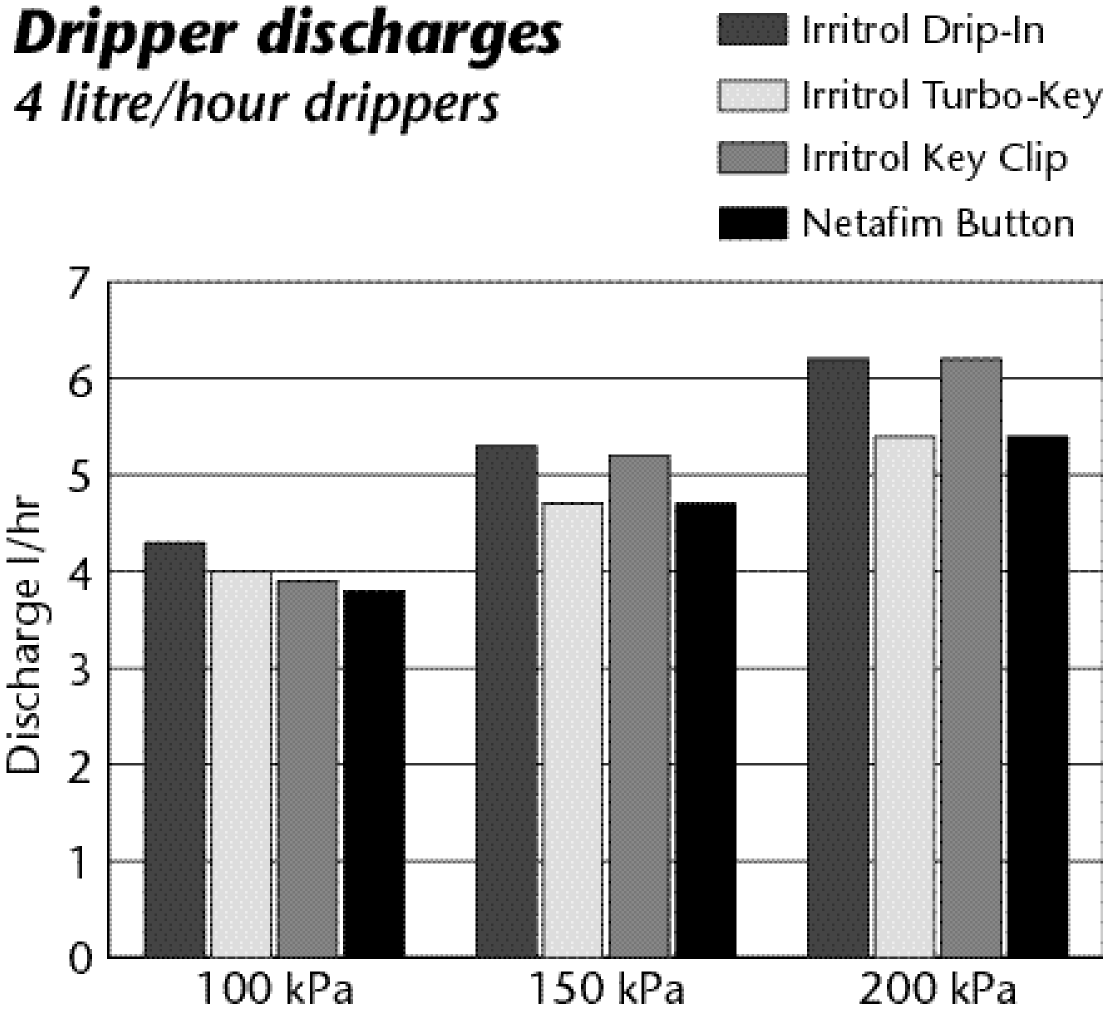
Some drippers are manufactured as self-compensating (that is, they can discharge a set flow rate over a wide pressure range). Others are non-draining, so that when a system shuts down, water does not drain to the lower areas, thus avoiding excess water discharge to these areas. This feature is particularly valuable in nursery installations.

Dripper flow versus pressure

Drippers are generally specified according to their flow rate, for example 4 L/h.

This flow rate is a nominal discharge rate at a specified pressure, generally 100 kPa, or about 10 metres head (10 metres pressure head is approximately 100 kPa). If the pressure varies from this nominated pressure, the flow rate will also vary (unless drippers are pressure-compensating).

Below is a chart showing the flow rate of some common drippers at three different pressures: 100 kPa, 150 kPa and 200 kPa. It can be seen that a 4-litre per hour dripper operating at 200 kPa can in fact be discharging about 6 litres per hour— a 50% increase in flow in the system. This higher flow will result in higher friction in the system and a change in the duty required of the pump, with a poor uniformity of water application.



Choosing a dripper system

Which dripper flow rate to choose?

The flow rate you choose will depend on the results of your **soil survey, the topography** and **the crop** you intend to grow.

In general, on light soils, or steep ground and/or crops with shallow roots and close spacing (such as vegetables), it is better to select a lower discharge dripper and have them at closer spacing. This will ensure small amounts of water can be applied regularly and supply sufficient water to the crop without causing deep drainage or run-off.

On heavier soils or flatter ground, and with crops such as vines or orchards, the drip discharge can be higher with wider spacing.

The final selection, however, will be a combination of factors and requires close consultation with your horticulturist and irrigation designer.

What else do I need to know about dripper selection?

There are two pieces of information the manufacturer or retailer should be able to provide which will indicate how evenly a brand-new dripper should perform, assuming design, filtration and so on are correct.

1. Coefficient of variation

The first is the **co-efficient of variation (cv).**

This figure is determined by testing many brand-new drippers to determine how much variability is caused by manufacturing variation.

The following table gives an indication of brand-new emitter manufacturer quality:

cv	classification
less than 0.03	excellent
0.03 - 0.07	average
0.07 - 0.10	marginal
more than 0.10	very poor

This figure will give an indication of the manufacturer's attention to quality control.

2. Emitter discharge exponent

The second piece of information that should be supplied by the manufacturer or retailer is the **emitter discharge exponent.**

The discharge exponent indicates the sensitivity of the emitter flow rates to pressure differences.

A dripper with a large exponent (such as 0.7) will have a greater sensitivity to pressure variation than one with a smaller exponent (such as 0.4).

Drip irrigation systems are designed to have a maximum pressure variation throughout the system of ± 10% and a flow variation of ± 5%, so you need to select a dripper with a discharge exponent which will result in this lower discharge variation. Generally a dripper exponent of 0.5 or less will achieve this.

For those who wish to know how to calculate the effect of pressure variation on flow variation the formula is:

$Q = K P^x$

Where Q= flow rate in L/h

K = a constant (supplied by manufacturer)

P = discharge pressure kPa

x = emitter discharge exponent

Design and filtration

For drip irrigation there are **two essentials** to be considered.

1. Design

The first essential is a good, professional design. The agronomic and hydraulic design of a drip irrigation is fairly complex and in order to achieve correct, uniform water application, a professional design is necessary. Drip irrigation requires precise irrigation management, and poor design does not allow the manager to achieve this. There are too many pitfalls for the unwary, inexperienced designer.

2. Filtration

The second essential is adequate filtration. If your filtration equipment is inadequate, you will have many problems, mainly blockages, and you will spend a lot of downtime in cleaning drippers or having to replace all the dripline.

The type, size and number of filters needed depend on the initial water quality, the system flow rate, and the final water quality required.

Even with a good filtration system, blockages can still occur and there are three basic factors which can cause these blockages:

1. **Physical** blockages: these can consist of inorganic particles such as sand, clays silts and tiny fragments of PVC or polythene from drilling or punching holes during installation or repair.
2. **Chemical** blockages: such as calcium, magnesium or iron deposits or poorly dissolved fertilisers in an injection system.
3. **Biological** blockages: such as microbial slimes, algae, snails eggs etc.

Pre-treatment may help in some situations, and this can include:

a) pre-screening to keep out twigs and leaves and so on. This is often achieved with the strainer on the pump footvalve.

b) settling basins for sands and silts. These are also useful for aerating waters high in iron to help remove the iron from the irrigation water.

c) sand separators, or hydrocyclones, can also be used as a pre-treatment for waters with a high sand load.

Filters

The main filtration system can consist of either a gravel or sand filter, or a disc or screen filter.

Gravel filters are generally considered as the most effective, but the level of filtration achieved may sometimes be more than required, depending on water quality. In some cases one of the other alternatives may be adequate and this should be discussed in detail with your designer.

For many irrigation systems with reasonable quality water, 120 mesh or 130 micron filtration is usually adequate.

You need enough filters to allow one filter to backflush while the system still supplies sufficient clean irrigation water.

This section has only just touched on filtration and is intended as an introduction only. Sound, professional advice should be obtained from your designer.

Fertigation and chemical injection

To gain full benefit from a drip irrigation system, a **fertigation system** is a worthwhile inclusion and, depending on water quality, may be essential.

Fertigation is the use of the irrigation system to supply fertiliser to the crop by injecting dissolved, soluble fertilisers into the irrigation water. Nitrogen and potassium are commonly applied through fertigation systems: some of the other fertilisers may not be suitable.

Check with your fertiliser supplier and also **check** fertiliser **compatibility** with the irrigation water and other fertilisers if mixing.

If the irrigation water is likely to contain algae or bacteria, for example from a dam, the ability to inject chlorine may be necessary.

If the irrigation water contains high levels of calcium, manganese or iron, the injection of acid may be required.

If these chemicals are to be injected, check with your equipment supplier that all equipment, pipes, fittings, and drippers are suitable. In most cases they are OK but check anyway.

Automatic controls

Again, to get maximum benefit from a drip irrigation system, it is worth considering the inclusion of automatic controls.

These controls can enable the automatic operation of various control valves and so provide the ability to irrigate different blocks separately depending on soils, crop variety, stage of growth, and so on, and to enable the automatic injection of fertilisers.

Even if you are not in a position to include this equipment in the initial installation, it may be worth considering having the necessary control wires or hydraulic tubing laid at the same time and in the same trench as pipelines. This will save a lot of trenching later. Discuss this option with your designer.

Subsurface drip irrigation

Subsurface drip irrigation has some additional requirements to be considered:

- In most cases, the dripline is buried at a depth to provide water to the rootzone of a maturing plant. This causes problems with seed **germination** for such crops as lucerne and for establishment of small transplants such as vegetables. In these cases some initial form of spray or furrow irrigation is needed for crop establishment.

- When irrigation ceases and the system shuts down, drainage continues in the laterals and submain. This can cause a **vacuum effect** in the laterals resulting in soil particles being sucked into the dripper orifice, causing blockages.

Air inlet vacuum relief valves must be installed at several locations to prevent this happening.

- **Root intrusion** and/or pinching can occur, particularly when surrounding soil is dry. Root inhibitors can be injected into the soil to minimise this effect but **ensure the chemical is registered for your crop** and that maximum residue limits (MRLs) will not be exceeded, particularly for export markets.

Some driplines developed for subsurface irrigation have a slow-release root-inhibiting chemical impregnated into the dripline.

- **Insect and rodent attack** can occur to the buried dripline. Again insecticides can be injected but again **check registration and MRLs**.

- **Application rates** are difficult to measure but water meters or flow meters can give you an indication of the amount being applied.

Ways to maintain system efficiency

Regular maintenance

To keep your irrigation systems performing efficiently and reliably a regular maintenance program is essential. This ensures your systems never reach the stage where their performance is costing you money rather than making you money.

To regularly maintain your irrigation systems:

- Replace any drippers that have blockages if they cannot be adequately cleaned.
- Repair any leaks in your pipelines and laterals.
- Regularly backflush filters. If water quality is poor this may be required every few hours. If this is the case, consider automatic backflushing or increasing the number of filters.
- Regularly check filters to ensure they are not becoming blocked. Check the pressure before and after the filter. If the pressure differential is gradually increasing, there are problems such as aggregation of gravel in gravel filters by high calcium loads.

Flushing

Even the most efficient irrigation filter cannot remove all suspended material, such as clay colloids, so a regular flushing program must be initiated.

In any new installation the system should be flushed completely before the drippers are installed to prevent blockages at the first use and also flushed again immediately after drippers have been installed to flush out any polythene fragments or any other potential blockage material.

Before the initial seasonal use of drip irrigation and at several times throughout the season, **particularly after any pipeline repair work,** a complete flushing of the system is recommended. Flush again 2-4 weeks after the initial flush. The cleanliness of the water flushed will give an indication of you future timings. A final flushing should also be carried out at the conclusion of the irrigation season.

Procedure

1. The mainline should be flushed with submains and laterals closed for at least 2 minutes or until clean water is flowing.
2. The submains are next with the water being discharged from the end of the submain until clean water is discharging.
3. The laterals should be then flushed plot by plot for at least 2 minutes and until clean water is discharging.