Irrigation Efficiency and System Evaluation Notes

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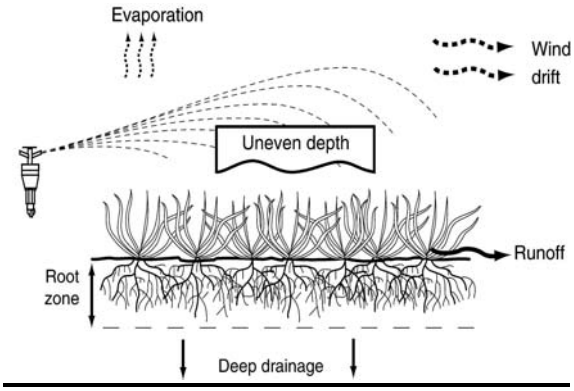
Some reasons for non uniformity

1. Sprinklers and sprays spaced too far apart
2. Poor sprinkler precipitation distribution profile
3. Unfavourable environmental operating conditions - wind
4. Incorrect operating pressure
5. Incorrect nozzle size
6. Poor pipe and valve sizing - excessive pressure and flow variation in system
7. Sprinkler head or equipment not functioning effectively.



Identifying irrigation losses

Examples of losses or inefficiencies

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WATER VOLUME CALCULATION

EG: Water used by landscape

Depends on the water use characteristics of the plant and the amount of evaporation.

ET = Crop Coefficient (KL) x Evaporation (ETo)

ET – evapotranspiration rate (mm)

Crop Coefficient – Water use characteristic of plant

Evaporation – Amount of evaporation in period, day, week, year

Example

Lawn area of 100 m^2, is ryegrass and the evaporation (ETo) for the week is 40 mm. Crop Coefficient (Kc) from reference Table (Resource Manual) is EG. 0.6

ETL = 0.6 x 40 = 24 mm

Volume of water = Area (m^2) x Depth (mm) = Litres

= 24 x 100 = 2,400 Litres

MANAGING SOIL WATER - SCHEDULING

The key properties of a soil that impact on irrigation are:

(1) Water holding capacity of the soil

(2) Water infiltration rate

(3) Stability of soil e.g. erosion, breakdown

There are a number of terms to describe the various water properties of soils.

The **Available Water Holding Capacity (AWHC)** of a soil refers to the amount of water that is stored and available to the plant.

The maximum amount of water that can be held by the soil and not drain away following saturation is the **Field Capacity (FC)** in the soil. The lower limit is the amount of water that cannot be removed by the plant. It is limited by the capacity of the plant to extract

the water and strength of the forces with which the water is held by the soil. This is the **Permanent Wilting Point (PWP).**
The rate at which water enters the soil, **Infiltration Rate (IR),** is another important property of a soil. Open soils, such as sands, with high infiltration rates readily absorb rainfall whereas in the finer soils, much water can be lost due to runoff as the precipitation rate often greatly exceeds the infiltration rate.

Table . Guide to soil water properties

Soil Type	Available Water (AWH) mm/m	Infiltration Rate (IR) mm/h
Sand	60	> 20
Fine Sand	90	15-20
Sandy Loam	110	10-18
Loam	170	10-15
Silt Loam	170	8-12
Clay Loam	165	5-10
Clay	140	1-5

Irrigation Scheduling

Scheduling means applying the right amount (depth) of water to the plant root zone at the right time.

Therefore need to know depth to apply and when to apply, that is, at a time that the soil is depleted but the plant is not excessively stressed.

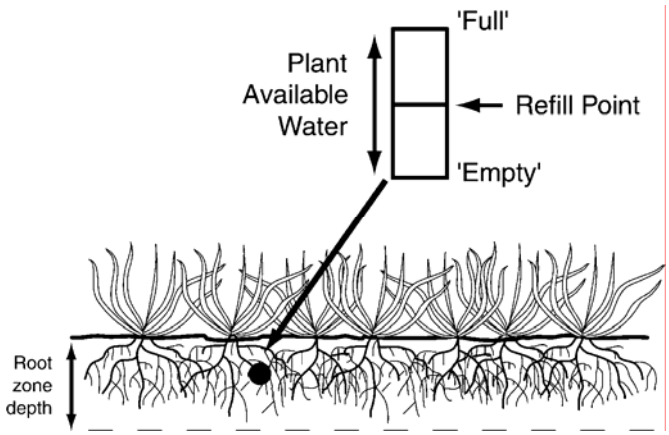

Fig: Water capacity of soil and the Refill Point

Notes:

Soil "Full" at Field Capacity

Soil "Empty" at Wilting Point

Water potentially available for irrigation, the amount of water between Field Capacity and Wilting Point.

However, can't remove all water, as there would be plant/crop damage.

BIG Irrigation management decision, When do you Refill the root zone?

Several techniques available, including:

(1) Allow for a percentage of depletion. It is called Management Allowable Depletion (MAD). Typically for turf 50%.

(2) Use tension with which the water is held in the soil. Refer to Resource Manual.

Water stored in soil (Referred to as Plant Available Water (PAW)

The depth of water that can be stored in the soil and be available to the plants is the foundation of good irrigation. It is determined in the following way:

Water Stored

= Root zone depth (RZD) (mm) x Available Water Holding Capacity (AWHC) mm/h

Example

Kikuyu grass growing in sandy loam soil
Root zone depth (RZD): 200 mm
Available water holding capacity (AW): 110 mm per 1000 mm

Water Stored = 200 mm x (110 /1000) = 22 mm

Exercise

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Calculating Irrigation Depth

The delivery of water to the plant root zone by the irrigation system is not 100% efficient. Water can be lost due to runoff, drainage below the root zone, poor uniformity, wind drift and evaporation. The irrigation "application efficiency" takes these into account.

Irrigation Depth

The irrigation system needs to apply a depth of water to both (a) refill the soil storage and (b) allow for the inefficiency of the irrigation method.

$$\text{Irrigation depth (mm)} = \frac{\text{Percentage Allowable Depletion (\%) x PAW}}{\text{Application efficiency (\%)}}$$

Note: Efficiency is expressed as a decimal ie. 75% = 0.75.

Example - Irrigation depth:

Turf:	kikuyu in sandy loam	
Irrigation:	Pop-up sprinklers	
P A W:	22 mm	
Percentage allowable depletion:	50%	
Allowable depletion depth:	11 mm	
Application efficiency:	75%	
Irrigation depth:	14.7 = 15 mm	$(= \frac{0.5 \times 22}{0.75})$

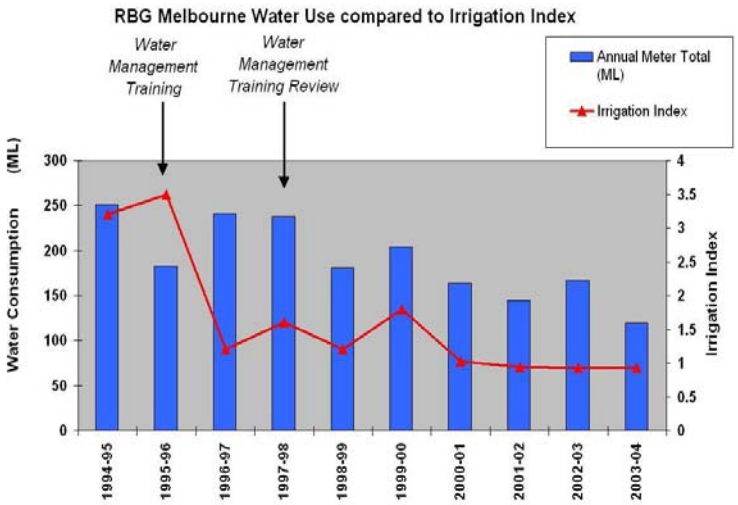
In this situation the irrigation system will need to apply 15 mm to ensure that 11 mm is delivered to the turf root zone.

REPORTING WATER CONSUMPTION PERFORMANCE

Whilst the number of megalitres used to maintain turf and landscape assets is a valuable number, it does have significant limitations as a Benchmarking indicator.
It is now common to report annual total consumption values and these are useful particularly when trends over a number of years can be demonstrated. Reporting of savings is now very popular.

The Irrigation Index (Ii) can be defined in the following way:

$$\text{Irrigation Index (Ii)} = \frac{\text{Water Applied to Site}}{\text{Estimated Water Required}}$$



Water consumption report for Royal Botanic Gardens - Melbourne

RECOMMENDATIONS FROM AN IRRIGATION SYSTEM EVALUATION

Identification of potential improvements including correction of existing deficiencies and areas of further investigation.

Examples of areas of possible further investigation might include:

a. Upgrade of water supply – flow and pressure

b. Use of alternative sprinkler nozzles

c. Pressure regulation to be implemented

d. Installation of soil moisture sensors or rain shut off devices

e. Installation of dedicated irrigation water consumption meters

f. Maintenance program implemented

g. Potential improvement due to soil amendment (wetting agents), dethatching, coring etc (If qualified to offer this advice?)