On-site Wastewater Management Training Course

Evapotranspiration Systems and Sizing by Water Balance

Terminology

Evapotranspiration Systems referred to as:

- Evapotranspiration Absorption Systems ETA – Australia (unlined)
- Evapotranspiration Seepage Systems ETS – New Zealand (unlined)
- Or simply Evapotranspiration Systems ET, if lined

Purpose

ETA/S Systems designed to:

- Maximise evapotranspiration
- Reduce absorption (drainage) in unlined systems
- Avoid absorption in lined systems
- Provide alternative to conventional trenches/beds in areas of low permeability soils (<0.5-1.5 m/d) e.g. clay loams, light, medium and heavy clays

AS/NZS 1547:2012 and NSW Guidelines

- Table L1 (AS/NZS 1547:2012) and table 6-4 (NSW Guidelines) give recommended DLRs of between 12 mm/d (CL) and 5 mm/d (LC/MC) based on soil texture
- Secondary treated effluent is required in Category 6 soils
- Not necessary for annual evaporation to exceed annual precipitation
- Can use plant transpiration and void space storage to manage hydraulic load throughout seasons

AS/NZS 1547:2012 and NSW Guidelines

- DLRs are conservative values
- Any variation to be justified by full water balance for 12-month cycle (Appendix Q)
- No higher DLRs for Secondary treated effluent (may be better to use conventional trench or bed)
- Plant with grasses and shrubs which tolerate wet conditions and have high evapotranspiration capacity
- Construction outlined in Appendix L (AS/NZS 1547:2012) and Section A4.5.1 (NSW Guidelines)

Water Balance Design

- Background outlined in Appendix Q in AS/NZS 1547:2012
- Main factors:
  - Effluent largely disposed of through deep infiltration, interflow and evapotranspiration
  - Evapotranspiration is significant, but may not dominate water balance
  - Some deep infiltration is required to prevent salt build up
  - Not suited to shallow water tables unless using a lined system

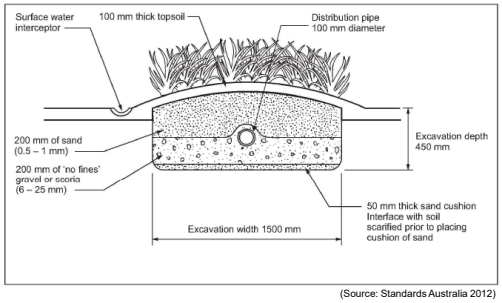
Important Components in ET Bed Design

- Crop Factors (Cf), Evaporation (E) and Evapotranspiration (ET) – explained further in water balance example later
- Capillary Water – movement of water laterally and upwards under surface tension
- Field Capacity (FC) – upper limit of available water storage in soil / medium
- Void Ratio (*n*) – proportion of bed available for water/air storage

ETA Bed Design Considerations

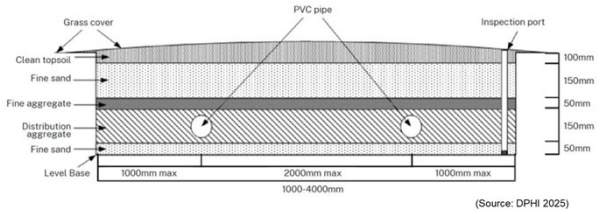
- Generally constructed subsurface, with mounded upper surface to reduce rainfall ingress
- Suited to slopes <10%
- Consider Linear Loading Rate; Section 6.4 NSW Guidelines
- Prefer good exposure to sun and wind
- Maximum bed length 20m if gravity fed
- Prefer pressure dosing to ensure even distribution
- May require downslope Nutrient Uptake Area (NUA) see Section 6.3.4 NSW Guidelines. Size with nutrient balance.

AS/NZS 1547:2012 ETA Bed Design Detail



(Source: Standards Australia 2012)

'Typical' ETA Bed Arrangement



(Source: DPHI 2025)

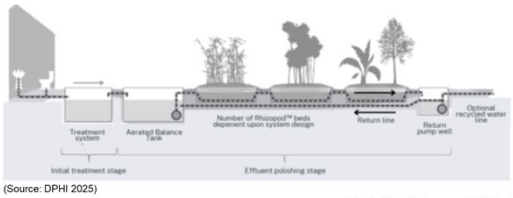
- Can be raised bed, but beware of potential for seepage of stored effluent

ETA Bed

Raised ETA Bed

Recirculating Evapotranspiration Channel System (Rhizopod®)

- With sufficient pods, can be configured as a no-release system
- Size using a water balance and to determine the number and frequency of pumpouts required



(Source: DPHI 2025)

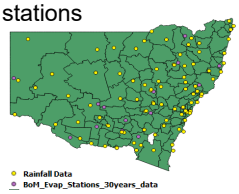
Consideration of Climatic Data

- Pan evaporation (E)
  - From nearest climatically similar meteorological station
- Rainfall (R)
  - From nearest climatically similar meteorological station
- www.bom.gov.au
- Or use SILO data:
- https://www.longpaddock.qld.gov.au/silo/

'Class A' Evaporation Pan

Total historical station coverage nationwide:

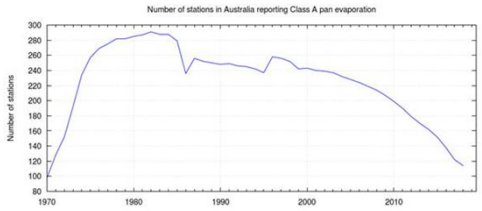
- 17,875 rainfall stations
- Only 601 evaporation stations



(Source: BoM)

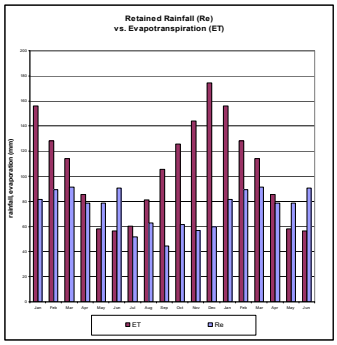
'Class A' Evaporation Pan

- Diminishing number of evaporation stations
- Move to SILO data (5km x 5km intersections)



(Source: BoM)

Inputs (Re) vs. Outputs (ET)



- ET dominates the WB, but not completely
- Excess rainfall can be managed for periods of the year provided that there is storage available in the system

The Use of Water Balances

- See Section 6.3.3 and A6.3 of NSW Guidelines
- Will work through an example of an unlined ETA bed
- Have provided a water balance template for both beds and irrigation areas
- Once you have practiced the skills required in doing water balances longhand they lend themselves to setting up spreadsheets to speed calculation

Water Balance Exercise

- Calculate the minimum basal area (m^2) of an evapotranspiration-absorption area for a three bedroom / five person dwelling with tank water supply
- BoM rainfall and pan evaporation data / crop factor

Site name: RICHMOND - UWS HAWKESBURY **Site number:** 067021

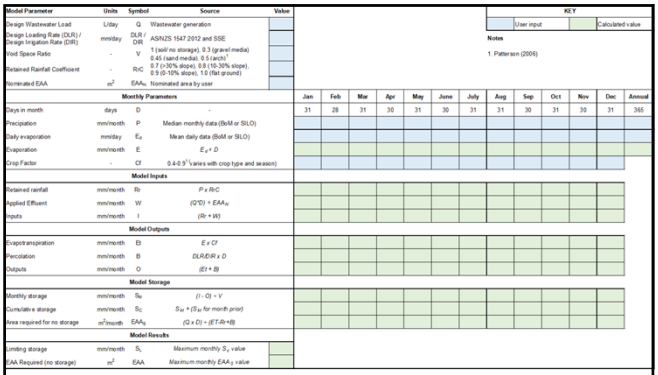
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Decile 5 (median) rainfall (mm)	74.3	75.8	66.5	50.4	30.9	38.6	27.6	24	32.8	43.2	66.2	55.6
Mean daily evaporation (mm)	5.9	4.9	4	3	2.1	1.7	1.9	2.7	3.8	4.6	5.2	5.7
Crop factor	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8

Water Balance Exercise

- Three test pits excavated on the proposed effluent application area indicate that the soils are 475 mm weakly structured clay loam, overlying moderately structured light clay to a depth of 2,000 mm. Use the recommended design loading rate derived from Table L1 of AS/NZS 1547:2012 (see the Field Workshop and Design Exercise section of these Course Notes)
- The site has a 5% gradient

Water Balance Exercise

- Calculate the required evapotranspiration-absorption basal area using the worksheet provided following the PowerPoint slides
- The evapotranspiration-absorption area is to be constructed of imported aggregate, is to have a maximum depth of 400 mm with a minimum of 50 mm freeboard (i.e. maximum depth of stored effluent is 350 mm)
- Conventional beds may have between 300 mm and 600 mm of aggregate, ETA beds have 400 mm of aggregate and sand



- Figure A6-1 NSW Guidelines

Basal Area vs Storage Depth

- The water balance spreadsheet will calculate the required basal area for zero storage
- If the basal area is reduced, the depth of effluent stored in the bed will increase
- By adjusting the “Nominated area by User”, the implications of reducing the basal area can be determined
- The depth of stored effluent must not exceed the bed depth (in this case, 400 mm) less any required freeboard (50 mm)

References

- Patterson RA, (2006). Evapotranspiration Bed Designs for Inland Areas. Septic Safe Technical Sheet Reference 05/15. NSW Department of Local Government, July 2006

WATER BALANCE ANALYSIS WORKSHOP SESSION

Calculation of evapotranspiration-absorption area basal area by the water balance method.

Using the following information and your Course Notes, calculate the minimum basal area of an evapotranspiration-absorption area for a three bedroom / five person dwelling with tank water supply.

Bureau of Meteorology rainfall and pan evaporation data for the nearest station and appropriate crop factor data is provided below.

Site name: RICHMOND - UWS HAWKESBURY					**Site number:** 067021							
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Three test pits excavated on the proposed effluent application area indicate that the soils are 475 mm weakly structured clay loam overlying moderately structured light clay to a depth of 2,000 mm. Use the recommended design loading rate derived from Table L1 of AS/NZS 1547:2012 (see the Field Workshop and Design Exercise section of these Course Notes).

Calculate the evapotranspiration-absorption area using the worksheet provided on the following page.

The evapotranspiration-absorption area is to be constructed of imported aggregate and is to have a maximum depth of 400 mm with a minimum of 50 mm freeboard (i.e. maximum depth of stored effluent is 350 mm).

Model Parameter	Units	Symbol	Source	Value
Design Wastewater Load	L/day	Q	Wastewater generation	
Design Loading Rate (DLR) / Design Irrigation Rate (DIR)	mm/day	DLR / DIR	AS/NZS 1547:2012 and SSE	
Void Space Ratio	-	V	1 (soil/ no storage), 0.3 (gravel media) 0.45 (sand media), 0.5 (arch)[1]	
Retained Rainfall Coefficient	-	RrC	0.7 (>30% slope), 0.8 (10-30% slope), 0.9 (0-10% slope), 1.0 (flat ground)	
Nominated EAA	m^2	EAA_N	Nominated area by user	

KEY			
	User input		Calculated value

Notes

1. Patterson (2006)

Monthly Parameters	Units	Symbol		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Days in month	days	D	-	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipiation	mm/month	P	Median monthly data (BoM or SILO)													
Daily evaporation	mm/day	E_d	Mean daily data (BoM or SILO)													
Evaporation	mm/month	E	E_d x D													
Crop Factor	-	Cf	0.4-0.9[1] (varies with crop type and season)													
Model Inputs																
Retained rainfall	mm/month	Rr	P x RrC													
Applied Effluent	mm/month	W	(Q*D) ÷ EAA_N													
Inputs	mm/month	I	(Rr + W)													
Model Outputs																
Evapotranspiration	mm/month	Et	E x Cf													
Percolation	mm/month	B	DLR/DIR x D													
Outputs	mm/month	O	(Et + B)													
Model Storage																
Monthly storage	mm/month	S_M	(I - O) ÷ V													
Cumulative storage	mm/month	S_C	S_M + (S_M for month prior)													
Area required for no storage	m^2/month	EAA_S	(Q x D) ÷ (ET-Rr+B)													

Model Results	Units	Symbol		Value
Limiting storage	mm/month	S_L	Maximum monthly S_c value	
EAA Required (no storage)	m^2	EAA	Maximum monthly EAA_S value	