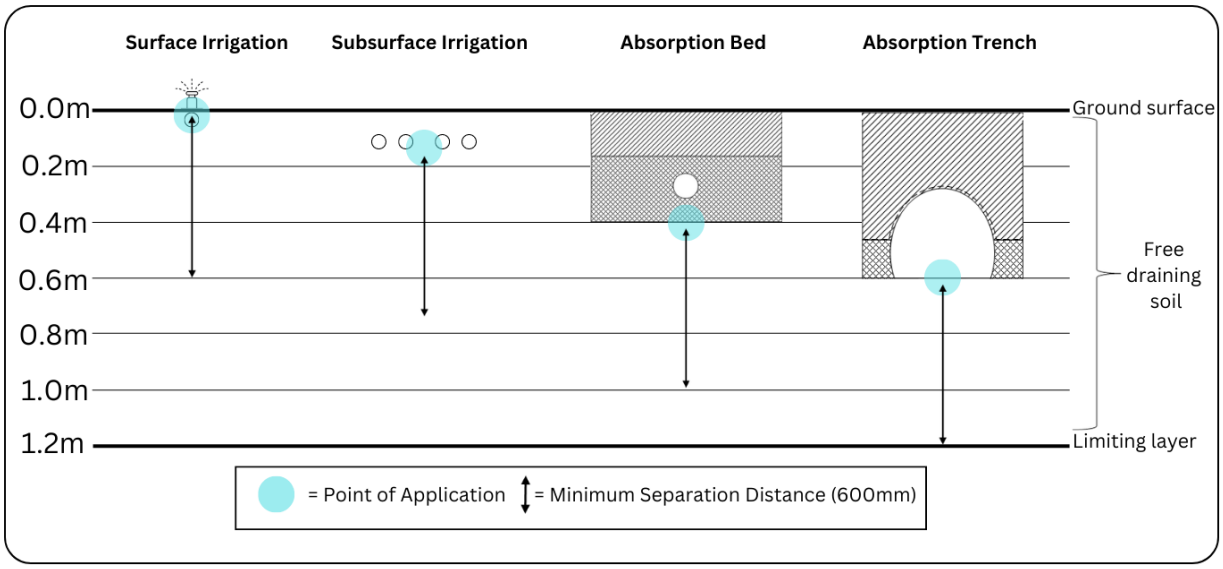
SITE ASSESSMENT AND DESIGN EXERCISE

Prior to commencing, it is important that we understand the relevance of the soil information gathered in the field, and how to interpret that information and successfully apply the methodology outlined in GOWM and EDRS (EPA VIC 2024) and VLCAF (MAV 2014) to determine:

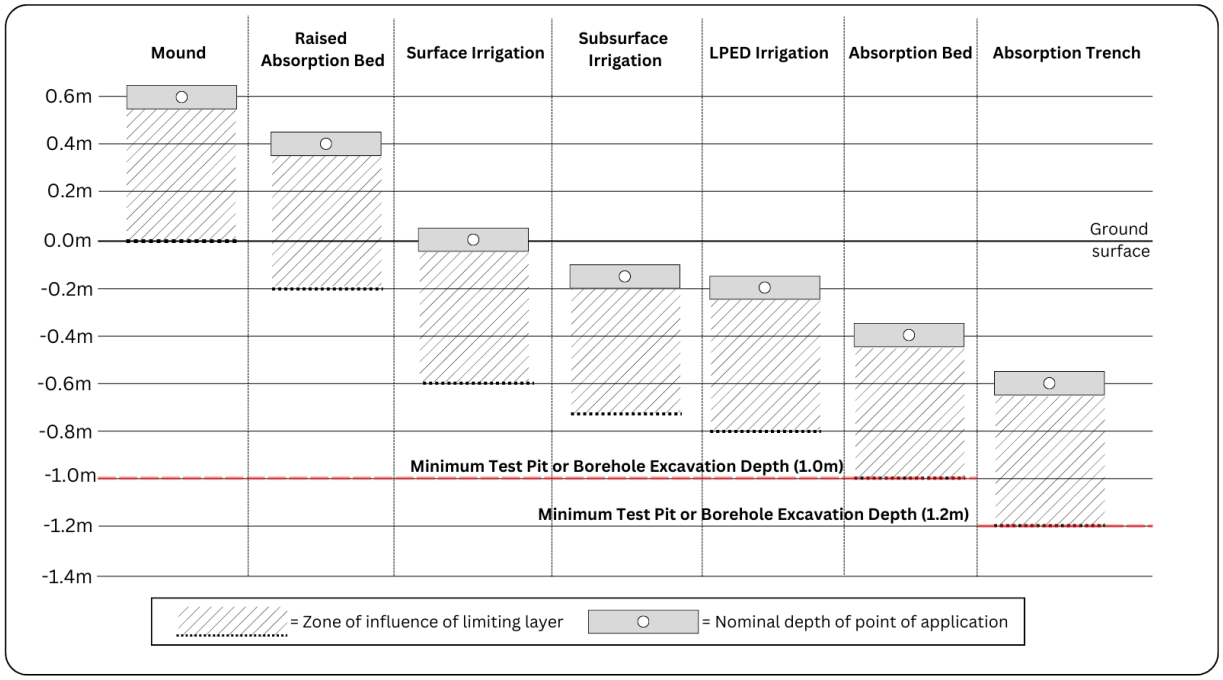
1. The most-limiting horizon (or constraint) within the 'zone of influence' for the chosen effluent application system, and
2. The appropriate soil loading rate (SLR) for the observed characteristics of the limiting horizon.

To achieve this, we must understand two (2) important concepts.

Point of Application (POA) – The point at which treated effluent is applied to the soil. This is the level of the emitters in an irrigation system or the base of a bed or trench system.



Separation distance – The 'vertical' separation between the point of application and a limiting horizon. The separation distance between the point of application and the limiting horizon (or constraint) should be a minimum of 0.6 metre.



For this exercise we will work in small groups to complete a site assessment and design exercise for an on-site wastewater system.

Step One – Interpreting the Soil Log

(i) A 'typical' soil borehole log is provided below, along with a photograph of the excavated core. As seen, the core has been drilled to a depth of 1.2m and three (3) soil 'horizons' are identified.

On the log, draw the point of application and show the minimum separation distance for the following effluent application systems: (a) absorption trench; (b) ETA bed; (c) Wisconsin sand mound and (d) irrigation system.

Note how different application systems intercept with the observed soil horizons and how selection of an appropriate 'limiting constraint' is guided by the POA.

Soil Bore Log

Client:	Mr & Mrs Dirt	**Test Pit No:**	**BH2**
Site:	Somewhere up the back	Excavated/logged by:	
Date:	Yesterday	Excavation type:	Shovel, auger & crowbar
Notes:	- refer to site plan for position of test pit		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Photo Log	Identify the POA and required separation distance for each of the following LAA types				Depth (m)
										Trench	ETA/Bed	Sand Mound	Irrigation	
														0.6
														0.5
														0.4
														0.3
														0.2
														0.1
0.1		A1	SL	Moderate	Dark brown	No	2 - 10% 2-6mm	SM						-0.1
0.2														-0.2
0.3		A2	SCL	Moderate	Dark greyish brown	No	2 - 10% 2-6mm	SM						-0.3
0.4														-0.4
0.5														-0.5
0.6							2 - 10%	D						-0.6
0.7		B	LC	Strong	Strong brown	Red and Orange (moderate)	6-20mm	D						-0.7
0.8														-0.8
0.9														-0.9
1.0														-1.0
1.1														-1.1
1.2						Minor gley								-1.2
1.3														-1.3

Step Two – Preliminary LAA Sizing

AS/NZS 1547:2012 supports a simple sizing methodology for effluent land application systems based on an **'areal loading'** rate calculation.

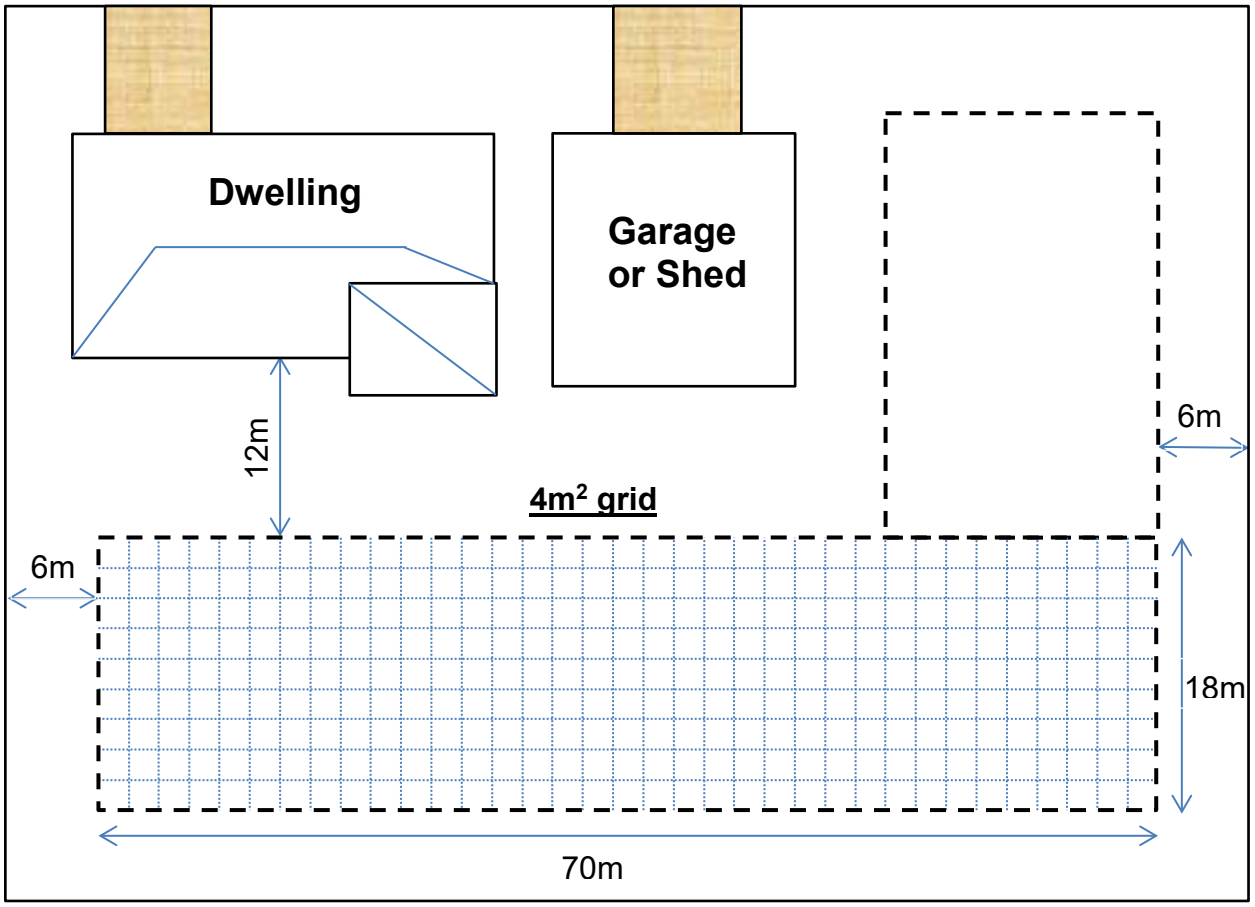
A (m^2) **= Q** (L) **/ soil loading rate** (DLR, DIR, BLR) (mm/day)

Assume that you are designing an OWM system for a new dwelling to be constructed on the Site, with reticulated water supply, and a design hydraulic load of **600L/day**.

(ii) To examine the relative land area requirements for a range of LAA systems, use Tables 4.8 and 4.9 from GOWM (EPA 2014) (see following pages) to determine the applicable (soil) loading rate and minimum system area required for each of the following LAA types, based on the 'limiting' soil condition from the soil log provided in Step 1.

LAA System Type	Loading Rate (mm/day)	Minimum Size (m^2)
Absorption Trench/bed		
ETA bed		
Mound		
Irrigation area		

(iii) On the example Site Plan (below), sketch out how each LAA configuration might be arranged for this example Site.



Step Three - Fieldwork

Use the **Soil Survey Sheet** and **Appendix 2** (following pages) to record details of **your** site and soil assessment.

Auger a hole and lay the soil out carefully to represent the observed soil profile. Excavate a soil pit adjacent to the auger hole and note how much additional detail in the soil profile can be obtained by digging a soil pit.

Use the skills you have learned earlier to assess the soil texture by hand and feel for each horizon (layer) you can distinguish in the soil profile. Compile this information and the results of the other soils investigations listed on the table (Soil Survey Sheet).

(iv) What is the **'texture and structure'** of the most-limiting soil horizon or constraint in the identified effluent land application area (LAA)?

Remember: Minimum vertical separation to limiting condition is 0.5m (AS/NZS 1547:2012)

(v) Would it be possible to mitigate the limiting condition identified? If so, how might you do that?

Step Four – Design Conditions

Assume that you are designing an OWM system for a **three-bedroom** dwelling with detached **one-bedroom** studio on the Site you have just investigated. Reticulated (town) water supply and standard water fixtures will be provided.

(vi) What is the **'design occupancy'** for the buildings and on what basis have you made this determination?

(vii) If the dwelling is to be occupied by **four** people, and the studio can potentially be occupied by **two** people, what is the **'design hydraulic load'**?

TABLE H1

TYPICAL DOMESTIC WASTEWATER DESIGN FLOW ALLOWANCES – AUSTRALIA

Source	Typical wastewater design flows (L/person/day)	
Residential premises	On-site roof water tank supply	Reticulated water supply
	120	150
Source: Australian Bureau of Statistics. Water Account 2004/2005. Chapter 7 Figure 7.3		

Table 4-3: Example calculations for household wastewater generation

Water supply	Household fixtures	Number of bedrooms	Number of people[8]	Design flow rate (L/person/day)	Daily wastewater volume (L/day)[9]
Reticulated	Standard water fixtures	4	5	180	900
Reticulated	Standard water fixtures	2	3	180	540
Reticulated	Water-reduction fixtures	4	5	150	750
Reticulated	Water-reduction fixtures	2	3	150	450
Onsite roof water tank	Standard water fixtures	4	5	150	750

(Source: GOWM EPA VIC 2024)

Table 4-4: Minimum daily wastewater flow rates and organic loading rates – community/commercial premises[10]

Source	Design hydraulic flow rates for all water supplies (L/person/day)	Organic material loading design rates (g BOD/person/day)
Motels/hotels/guesthouse		
Bar trade per customer	7	8
Bar meals per diner	10	10
Per resident guest and staff with in-house laundry	150	80
Per resident guest and staff with outsourced laundry	100	80
Restaurants (per potential diner)[11]		
Premises <50 seats	40	50
Premises >50 seats	30	40
Tearooms, cafés (light refreshments and prepared food (e.g. cakes, etc.) per seat	10	10
Conference facilities per seat	25	30
Function centre per seat	30	35
Take-away food shop per customer	10	40
Public areas (with toilet, but no showers and no café)[12]		
Public toilets	6	3
Theatres, art galleries, museums	3	2
Meeting halls with kitchenette	10	5
Premises with showers and toilets		
Golf clubs, gyms, pools etc. (per person)	50	10
Hospitals – per bed	350	150
Shops/shopping centres		
Per employee	15	10
Public access	5	3
School – childcare		
Per day pupil and staff	20	20
Resident staff and boarders	150	80
Factories, offices, day training centres,		

[10] Based on EPA Publication 500: Code of Practice for Small Wastewater Treatment Plants.
[11] Number of seats multiplied by the number of seatings, i.e., may include multiple seatings for breakfast, morning and afternoon teas, lunch and dinner.
[12] For premises such as public areas, factories or offices with showers and toilets, use the flow rates for 'Premises with showers and toilets' in the calculations.

(Source: GOWM EPA VIC 2024)

Step Five – Final Design Solution

(viii) Discuss amongst your group and decide upon the **'most suitable'** OSSM system for the Site layout (below) and the soil conditions you have assessed today.

Treatment System: (Primary / Secondary), Why? _____

LAA System type: _____

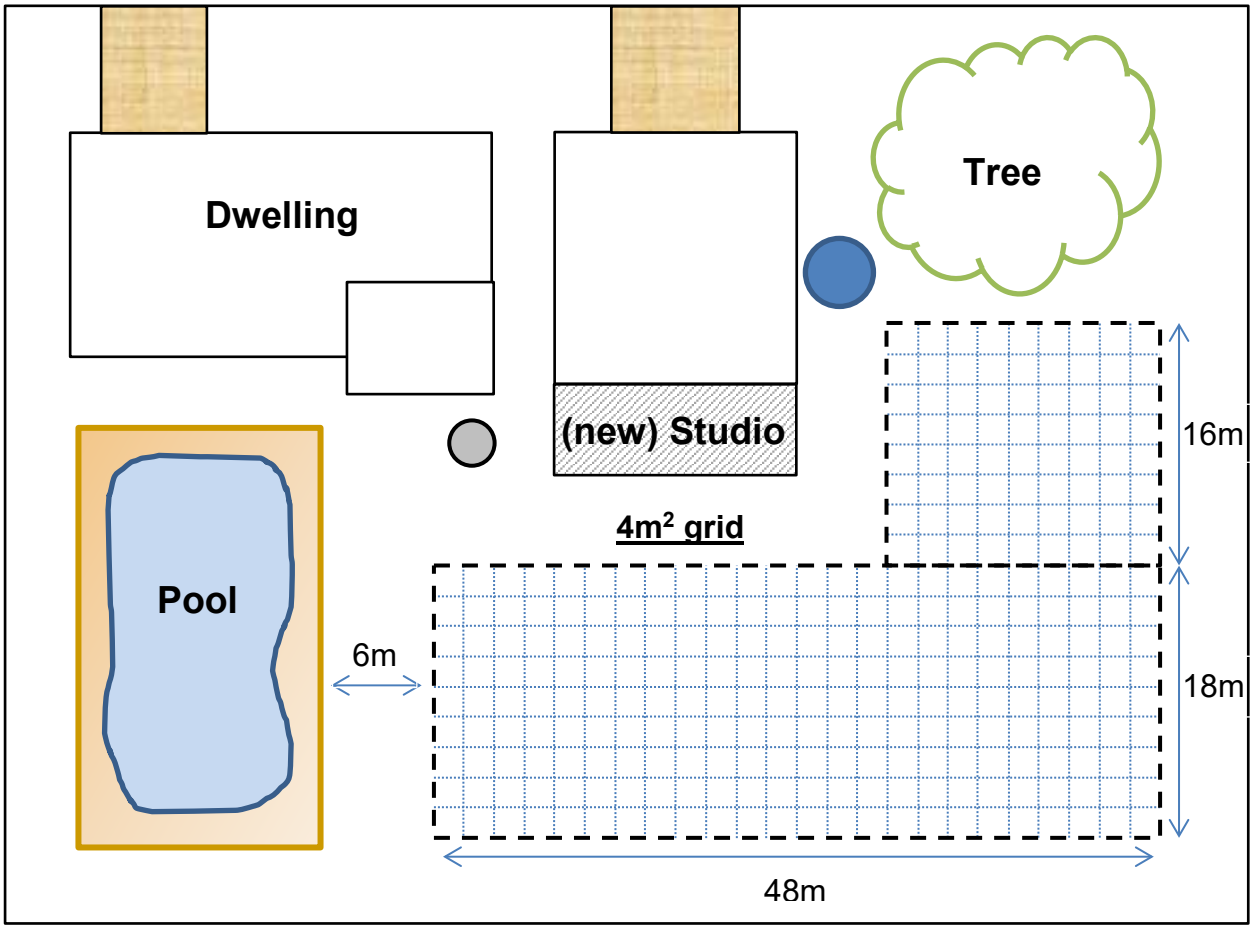
Applicable (Design) Soil Loading Rate: (mm/day) _____

Mitigation proposed: (What/Why?) _____

_____

(ix) Prepare a case to justify your system selection and determine the appropriate sizing and arrangement for your system on the following development Site.

LAA required (m^2): _____



Each group will have an opportunity to present their design and will be expected to explain / rationalise how they have reached their conclusions.

Table 4-8: Soil categories and design loading/irrigation rates (reproduced from AS1547:2012 with permission by Standards Australia)

Soil texture	Soil structure	Soil category	Indicative soil permeability Ksat (m/d)	Design irrigation rates (DIR)/design loading rates (DLR) (mm/day)						
				Absorption trenches/ beds			ETA trenches/ beds	Subsurface and surface irrigation	LPED irrigation	Mounds (basal area)
				Table L1, AS/NZS 1547:2012			Table L1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table N1, AS/NZS 1547:2012
				Primary treated effluent		Secondary treated effluent				
				Conservative rate	Maximum rate					
Gravels and sands	Structureless (massive)	1	>3.0	See Note 1 of Table L1, AS/NZS 1547:2012 for DLR values			See Note 4 of Table L1, AS.NZS1547 :2012	5 (See Note 1 of Table M1, AS/NZS 1547:2012)	See Note 3 of Table M1, AS/NZS154:201 2)	32
Sandy loams	Weakly structured	2a	>3.0					5 (See Note 1 Table M1, AS/NZS 1547:2012)	4	24
	Massive	2b	1.4–3.0	15	25	50			4	24
Loams	Highly/moderately structured	3a	1.5–3.0	15	25	50		4	3.5	24
	Weakly structured or massive	3b	0.5–1.5	10	15	30		4	3.5	16
Clay loams	Highly/moderately structured	4a	0.5–1.5	10	15	30	12	3.5	3	16
	Weakly structured	4b	0.12–0.5	6	10	20	8	3.5	3	8
	Massive	4c	0.06–0.12	4	5	10	5	3.5	3	5 (See Note

Soil texture	Soil structure	Soil category	Indicative soil permeability Ksat (m/d)	Design irrigation rates (DIR)/design loading rates (DLR) (mm/day)						
				Absorption trenches/ beds			ETA trenches/ beds	Subsurface and surface irrigation	LPED irrigation	Mounds (basal area)
				Table L1, AS/NZS 1547:2012			Table L1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table N1, AS/NZS 1547:2012
				Primary treated effluent		Secondary treated effluent				
				Conservative rate	Maximum rate					
										of Table N1 AS/NZS 1547:2012)
Light clays	Strongly structured	5a	0.12–0.5	5	8	12	8	3	2.5	8
	Moderately structured	5b	0.06–0.12		5	10	5	3 (See Note 1 of Table M1, AS/NZS1547:2012)	(See Note 4 of Table M1, AS/NZS1547:20 12)	5 (See Note of Table N1 AS/NZS 1547:2012)
	Weakly structured or massive	5c	<0.06			8	(See Note 2, 3 5 of Table L1 AS/NZS 1547:2012)			
Medium to heavy clays	Strongly structured	6a	0.06–0.5	(See Notes 2 and 3 of Table L1 AS/NZS1547:2012)				2 (See Note 2 of Table M1, AS/NZS1547:2012)	(See Note 3 of Table M1, AS/NZS1547:20 12)	
	Moderately structured	6b	<0.06							
	Weakly structured or massive	6c	<0.06							

(Source: GOWM EPA VIC 2024)

Table 4-9: Soil categories and design loading/irrigation rates recommended for Victoria

Soil texture	Soil structure	Soil category	Design irrigation rates (DIR)/design loading rates (DLR) (mm/day)				
			Absorption trenches/ beds	ETA trenches/ beds	Subsurface and surface irrigation	LPED irrigation	Mounds (basal area)
			Table L1, AS/NZS 1547:2012	Table L1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table M1, AS/NZS 1547:2012	Table N1, AS/NZS 1547:2012
Gravels and sands	Structureless (massive)	1	Recommended to use values from "conservative rate" column of Table 4-8 See also Note 1, 2 and 3 of Table 4-9	ETA/ETS systems are not normally used on soil categories 1 and 2a.	Refer to values and notes in Table 4-8 See also Note 4 of Table 4-9	LPED irrigation is not suitable on soil categories 1 and 2a	Refer to values and notes in Table 4-8
Sandy loams	Weakly structured	2a					
	Massive	2b		15		Refer to values and notes in Table 4-8	
Loams	Highly/moderately structured	3a		Refer to values and notes in Table 4-8			
	Weakly structured or massive	3b					
Clay loams	Highly/moderately structured	4a					
	Weakly structured	4b					
	Massive	4c					
Light clays	Strongly structured	5a					
	Moderately structured	5b					
	Weakly structured or massive	5c					
Medium to heavy clays	Strongly structured	6a				LPED irrigation is not suitable on soil category 6	
	Moderately structured	6b					
	Weakly structured or massive	6c					

Notes to Table 4-9:

1. There is elevated risk associated with primary treated effluent being dispersed to trenches and beds in soil categories 1 and 2a. This is due to the high infiltration rate of these soils, which leads to uneven distribution along the base of the trench. These soils have low nutrient retention capacities, often allowing accession of nutrients to groundwater.
2. Use of absorption trenches/beds in category 1 and 2a soils require design by a suitably qualified and experienced person. Where groundwater quality is at risk, secondary treatment is required and consideration should also be given to disinfection, nutrient removal, soil modification or distribution over a large application area.
3. Use of absorption trenches/beds in category 5b, 5c and 6 soils requires special design and distribution techniques or soil modification procedures. In most situations the design will need to rely on more processes than just absorption by the soil.
4. The design irrigation rate for subsurface or surface irrigation may be increased in sandy soils (categories 1 and 2) where secondary treatment is installed with disinfection and nutrient reduction.

(Source: GOWM EPA VIC 2024)

TABLE L1

RECOMMENDED DESIGN LOADING RATES FOR TRENCHES AND BEDS

Soil category	Soil texture	Structure	Indicative permeability (K_{sat})(m/d)	Design loading rate (DLR) (mm/d)			
				Trenches and beds			ETA/ETS beds and trenches
				Primary treated effluent		Secondary treated effluent	
				Conservative rate	Maximum rate		
1	Gravels and sands	Structureless (massive)	> 3.0	20 (see Note 1)	35 (see Note 1)	50 (see Note 1)	(see Note 4)
2	Sandy loams	Weakly structured	> 3.0	20 (see Note 1)	30 (see Note 1)	50 (see Note 1)	
		Massive	1.4 – 3.0	15	25	50	
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50	
		Weakly structured or massive	0.5 – 1.5	10	15	30	
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	15	30	12
		Weakly structured	0.12 – 0.5	6	10	20	8
		Massive	0.06 – 0.12	4	5	10	5
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	8
		Moderately structured	0.06 – 0.12	(see Notes 2 & 3)	5	10	5 (see Notes 2, 3, & 5)
		Weakly structured or massive	< 0.06			8	
6	Medium to heavy clays	Strongly structured	0.06 – 0.5				
		Moderately structured	< 0.06				
		Weakly structured or massive	< 0.06				

NOTES:

1 The treatment capacity of the soil and not the hydraulic capacity of the soil or the growth of the clogging layer govern the effluent loading rate in Category 1 and weakly structured Category 2 soils. Land application systems in these soils require design by a suitably qualified and experienced person, and distribution techniques to help achieve even distribution of effluent over the full design surface (see L6.2 and Figure L4 for recommended discharge method by discharge control trench). These soils have low nutrient retention capacities, often allowing accession of nutrients to groundwater.

2 To enable use of such soils for on-site wastewater land application systems, special design requirements and distribution techniques or soil modification procedures will be necessary. For any system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In most situations, the design will need to rely on more processes than just absorption by the soil.

3 If K_{sat} < 0.06 m/d, a full water balance for the land application can be used to calculate trench/bed size (see Appendix Q).

4 ETA/ETS systems are not normally used on soil Categories 1 to 3.

5 For Category 6 soils ETA/ETS systems are suitable only for use with secondary treated effluent.

(Source: AS/NZS 1547:2012 Standards Australia)

TABLE M1

RECOMMENDED DESIGN IRRIGATION RATE (DIR) FOR IRRIGATION SYSTEMS

Soil Category (see Note 1)	Soil texture	Structure	Indicative permeability (K_{sat}) (m/d)	Design irrigation rate (DIR) (mm/day)		
				Drip irrigation	Spray irrigation	LPED irrigation
1	Gravels and sands	Structureless (massive)	> 3.0	5 (see Note 2)	5	(see Note 3)
2	Sandy loams	Weakly structured	> 3.0			4
		massive	1.4 – 3.0			
3	Loams	High/ moderate structured	1.5 – 3.0	4 (see Note 1)	4	3.5
		Weakly structured or massive	0.5 – 1.5			
4	Clay loams	High/ moderate structured	0.5 – 1.5	3.5 (see Note 1)	3.5	3
		Weakly structured	0.12 – 0.5			
		Massive	0.06 – 0.12			
5	Light clays	Strongly structured	0.12 – 0.5	3 (see Note 1)	3	2.5 (see Note 4)
		Moderately structured	0.06 – 0.12			
		Weakly structured or massive	< 0.06			
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	2 (see Note 2)	2	(see Note 3)
		Moderately structured	< 0.06			
		Weakly structured or massive	< 0.06			

NOTES:

1 For Category 3 to 5 soils (loams to light clays), the drip irrigation system needs to be installed in an adequate depth of topsoil (in the order of 150 – 250 mm of *in situ* or imported good quality topsoil) to slow the soakage and assist with nutrient reduction.

2 For Category 1, 2, and 6 soils, the drip irrigation system has a depth of 100 – 150 mm in good quality topsoil (see CM1 and M3.1).

3 LPED irrigation is not advised for Category 1 or Category 6 soils – drip irrigation of secondary effluent is the preferred irrigation method.

4 LPED irrigation for Category 5 soils needs a minimum depth of 250 mm of good quality topsoil (see M5 and CM7.1).

(Source: AS/NZS 1547:2012 Standards Australia)

TABLE N1

RECOMMENDED MOUND DESIGN LOADING RATES

Soil Category	Soil texture	Structure	Indicative permeability (K_{sat})(m/d)	Design loading rate (DLR) (mm/d)
1	Gravels and sands	Structureless (massive)	> 3.0	32
2	Sandy loams	Weakly structured	> 3.0	24
		Massive	1.4 – 3.0	24
3	Loams	High/ moderate structured	1.5 – 3.0	24
		Weakly structured or massive	0.5 – 1.5	16
4	Clay loams	High/ moderate structured	0.5 – 1.5	16
		Weakly structured	0.12 – 0.5	8
		Massive	0.06 – 0.12	5 (see Note)
5	Light clays	Strongly structured	0.12 – 0.5	8
		Moderately structured	0.06 – 0.12	5 (see Note)
		Weakly structured or massive	< 0.06	
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	
		Moderately structured	< 0.06	
		Weakly structured or massive	< 0.06	

NOTE: To enable use of such soils for on-site wastewater land application, special design requirements and distribution techniques or soil modification procedures will be necessary. For any system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In most situations, the design will need to rely on more processes than just absorption by the soil.

(Source: AS/NZS 1547:2012 Standards Australia)

SOIL SURVEY SHEET

Landscape (description) Site No.....

Geology		Surface drainage	
Vegetation		Internal drainage	
Aspect		Groundwater	
Slope (%)			

Buffer distances (all distances in metres, upslope or downslope)

Sketch house on the lot	Surface water storage	Groundwater bore or well
	Other buildings	Swimming pool
	Property boundary - upslope	Property boundary - down slope

Profile Description (section numbers refer to Chapter 7 notes)

	Soil horizon 6.2.1	depth (mm) from - - - to	boundary type 6.2.3	field texture 6.2.4	structure -shape, grade, size 6.2.5	pH (units) Exercise 3	EC (dS/m) Exercise 2	dominant colour - moist 6.2.6	mottles 6.2.7	dispersion Exercise 1	coarse fragments 6.2.15
top											
second											
third											

Recorder ..... Date .....

APPENDIX 2
MODEL SITE REPORT

1 SITE EVALUATORS	
Company	Name(s)
Address	
ph:	fax:
Date of assessment: / /	Signature of evaluator: / /

2 SITE INFORMATION	
Address/locality of site	Council area
Owner/developer:	ph:
Address:	
Size/shape/layout Site plans attached Photograph attached	 yes/no
Intended water supply	rainwater reticulated water supply bore/groundwater
Expected wastewater quantity (litres/day)	
Local experience (information attached regarding on-site sewage management systems installed in the locality)	yes/no

If any site or soil features have not been assessed, note why.

3 SITE ASSESSMENT	
Climate	
Are low temperatures expected (particularly below 15°C)?	yes/no
Where appropriate:	
Rainfall water balance attached	yes/no
Land application area calculation attached	yes/no
Wet weather storage area calculation attached	yes/no
Flood potential	
Land application area above 1 in 20 year flood level	yes/no
Land application area above 1 in 100 year flood level	yes/no
Electrical components above 1 in 100 year flood level	yes/no
Exposure	
Slope	
Landform	
Run-on and seepage	
Erosion potential	
Site drainage	
Fill	
Groundwater	
Horizontal distance to groundwater well used for domestic water supply (m)	
Relevant groundwater vulnerability map referred to?	yes/no/not available
Level of protection (I – VI)	
Bores in the area and their purpose:	
Buffer distances from wastewater	
Management system to:	
Permanent waters (m)	
Other waters (m)	
Other sensitive environments (m)	
Boundary of premises (m)	
Swimming pools (m)	
Buildings (m)	
Is there sufficient land area available for:	
Application system (including buffer distances)	yes/no
Reserve application system (including buffer distances)	yes/no
Surface rocks	

4 SOIL ASSESSMENT
Depth to bedrock or hardpan (m)
Depth to high soil watertable (m)
Hydraulic loading rate (where applicable) Soil structure: Soil texture: Permeability category: Other measures of soil permeability: Hydraulic loading recommended for soil absorption system (mm/day): Reasons for the hydraulic loading recommendation:
Coarse fragments (%)
Bulk density (and texture) (g/cm^3)
pH
Electrical conductivity (dS/m)
Exchangeable sodium percentage
Cation exchange capacity ($cmol^+/kg$)
Phosphorus sorption index
Geology & soil landscape survey Presence of discontinuities Presence of fractured subsoil Soil and Landscape map reference:
Dispersiveness

5 SYSTEM SELECTION	
Consideration of connection to a centralised sewerage system	
Approximate distance to nearest feasible connection point:	
Potential for future connection to centralised sewerage	high/med/low
Potential for future connection to reticulated water	high/med low/already connected
Type of land application system considered best suited to site: Why?	
Type of treatment system considered best suited to site and application system: Why?	

6. GENERAL COMMENTS
Are there any specific environmental constraints?
Are there any specific health constraints?
Any other comments?