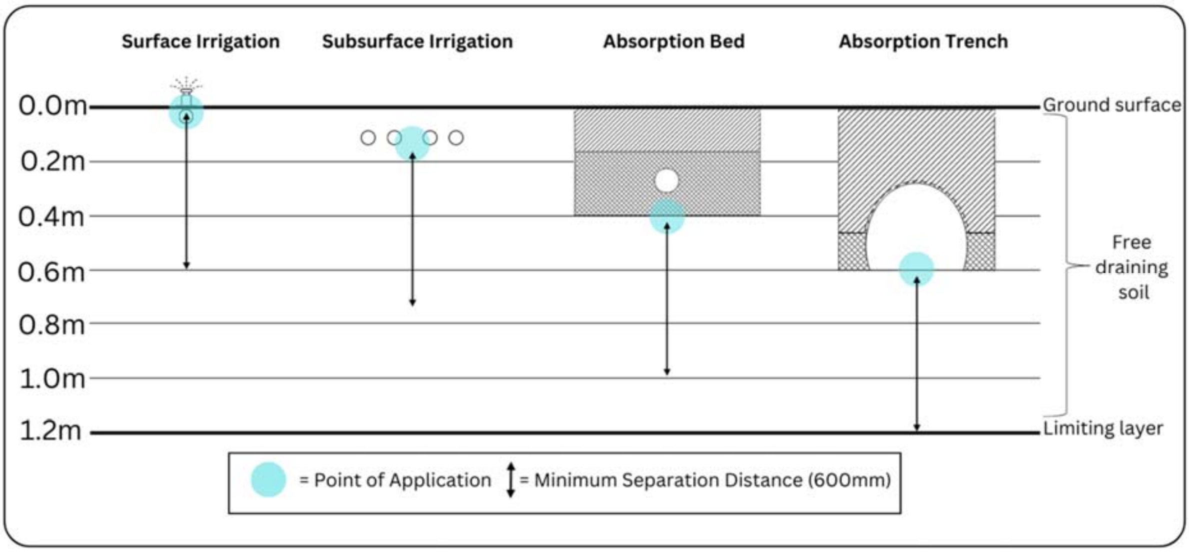
SITE ASSESSMENT AND DESIGN EXERCISE

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 EPA 891.4 (VIC CoP, 2016) to determine:

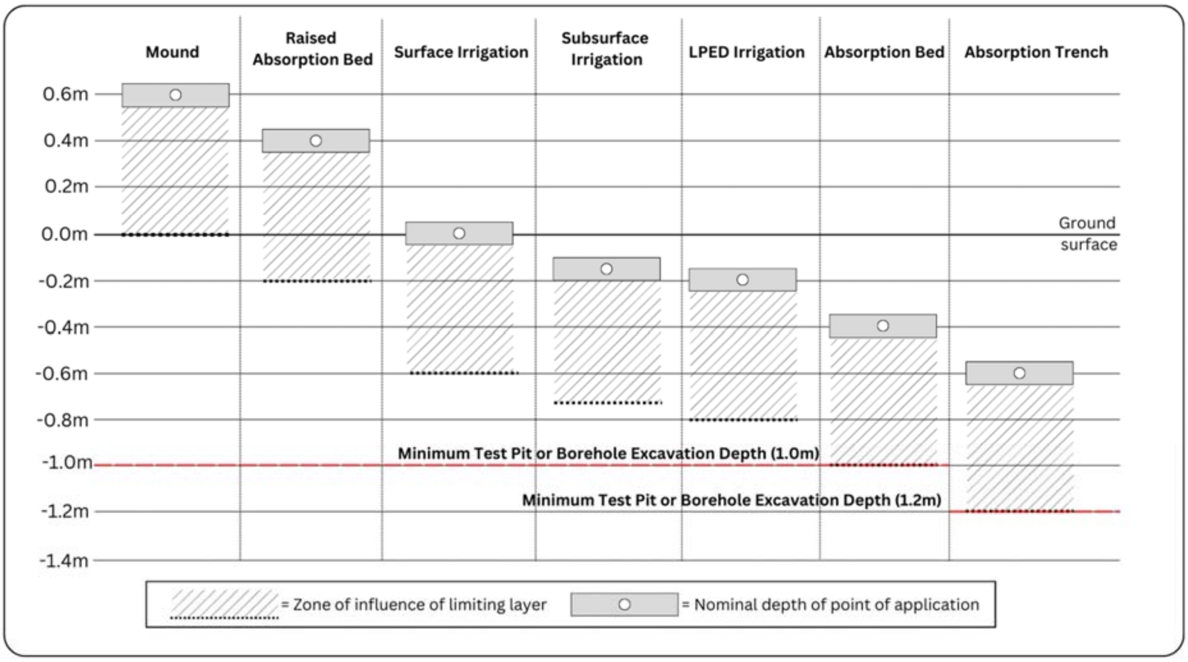
1. The most-limiting horizon (or constraint) within the 'zone of influence' for the chosen effluent application system, and
2. The appropriate soil loading rate (SLR) for the observed characteristics of the limiting horizon.

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.

<u>Step One – Interpreting the Soil Log</u>

(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 <u>point of application</u> and show the minimum <u>separation distance</u> 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%	SM						-0.1
0.2							2-6mm							-0.2
0.3		A2	SCL	Moderate	Dark greyish brown	No	2 - 10%	SM						-0.3
0.4							2-6mm							-0.4
0.5														-0.5
0.6							2 - 10%	D						-0.6
0.7														-0.7
0.8		B	LC	Strong	Strong brown	Red and Orange (moderate)	6-20mm	D						-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.

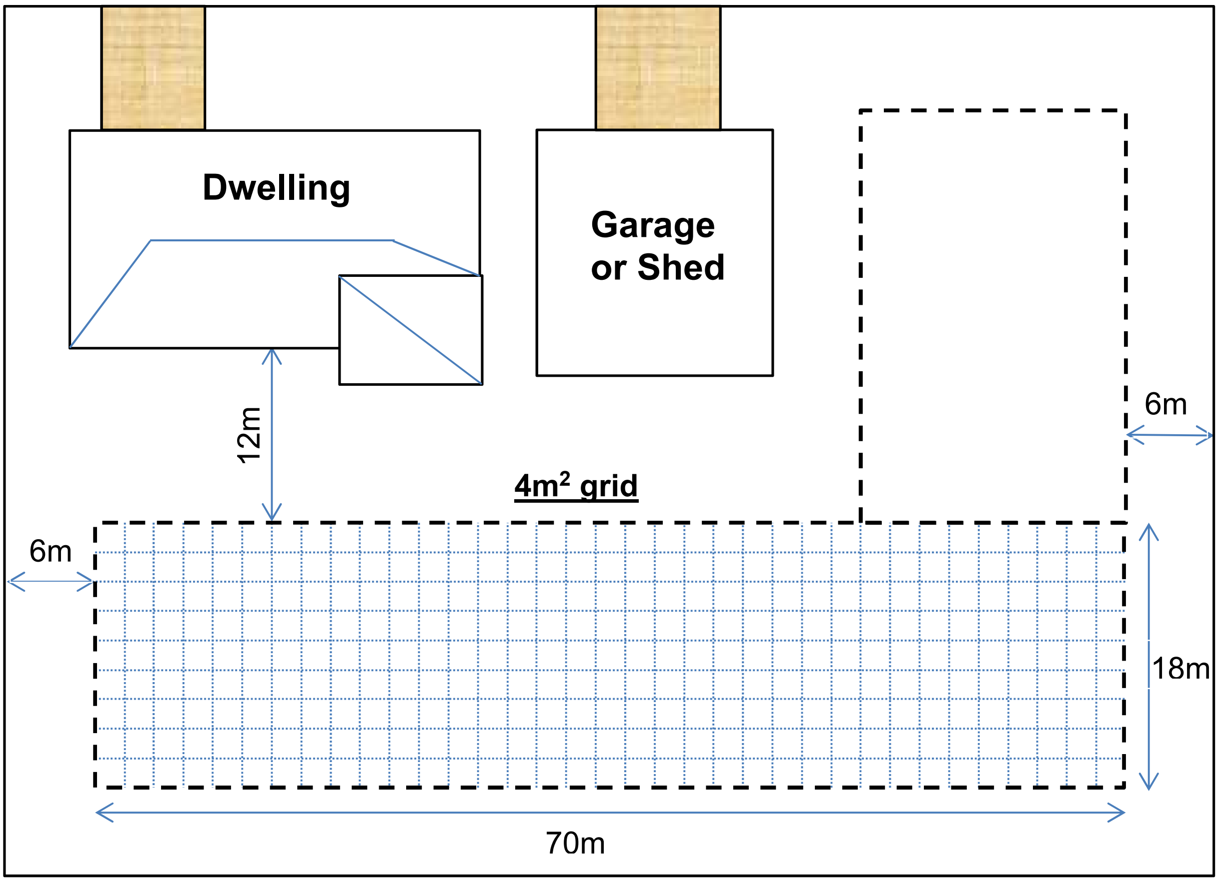
A (m^2) **= Q** (L) **/ soil loading rate** (DLR, DIR, BLR) (mm/day)

Assume that you are designing an OSSM 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 Table 9 from EPA 891.4 (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.



<u>Step Three - Fieldwork</u>

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?

____

<u>Step Four – Design Conditions</u>

Assume that you are designing an OSSM 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 <u>occupied by **four** people</u>, and the studio can potentially be occupied by <u>**two** people</u>, 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: Minimum daily wastewater flow rates and organic loading rates [1, 10]

Source	Design hydraulic flow rates for all water supplies [2, 4, 5] (L/person.day)	Organic material loading design rates (g BOD/person.day) [7]
Households with extra wastewater producing facilities [6]	220	60
Households with standard water fixtures	180	60
Households with full water-reduction fixtures [3]	150	60
Motels/hotels/guesthouse		
- per bar attendant	1000	120
- bar meals per diner	10	10
- per resident guest and staff with in-house laundry	150	80
- per resident guest and staff with out-sourced laundry	100	80
Restaurants (per potential diner) [9]		
- premises <50 seats	40	50
- premises >50 seats	30	40
- tearooms, cafés 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) [8]		
- public toilets	6	3
- theatres, art galleries, museum	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 - child care	20	20
- per day pupil and staff	20	20
- resident staff and boarders	150	80
Factories, offices, day training centres, medical centres	20	15
Camping grounds		
- fully serviced	150	60
- recreation areas with showers and toilets	100	40

1. Based on EPA Code of Practice for Small Wastewater Treatment Plants, Publication 500 (1997).
2. When calculating the flow rate for an existing commercial premise, use this table or metered water usage data from the premise's actual or pro-rata indoor use.
3. WELS-rated water-reduction fixtures and fittings - minimum 4 Stars for dual-flush toilets, shower-flow restrictors, aerator taps, flow/pressure control valves and minimum 3 Stars for all appliances (e.g. water-conserving automatic clothes washing machines).
4. These flow rates take into consideration the likelihood of a reliable water supply being currently provided to a premises or in the future (e.g. from groundwater, surface water or reticulated water supply, or a tankered water supply).
5. Where Council is satisfied a household or premises is unlikely to be provided with a reliable water supply (e.g. a rural farming property where groundwater or surface water is unavailable or used only for stock) the design flow rates for Onsite Roof Water Tank Supply listed in the most current version of AS/NZS 1547 may be used.
6. Extra water producing fixtures include, but are not limited to, spa baths.
7. Based on Crites & Tchobanoglous (1998) and EPA Publication 500 (1997).
8. For premises such as public areas, factories or offices that have showers and toilets, use the flow rates for 'Premises with showers and toilets' in the calculations.
9. Number of seats multiplied by the number of seatings i.e., may include multiple seatings for breakfast, morning and afternoon teas, lunch and/or dinner.
10. The organic loading rate must be considered as well as the hydraulic flow rate when selecting the most suitable treatment system.

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: ____

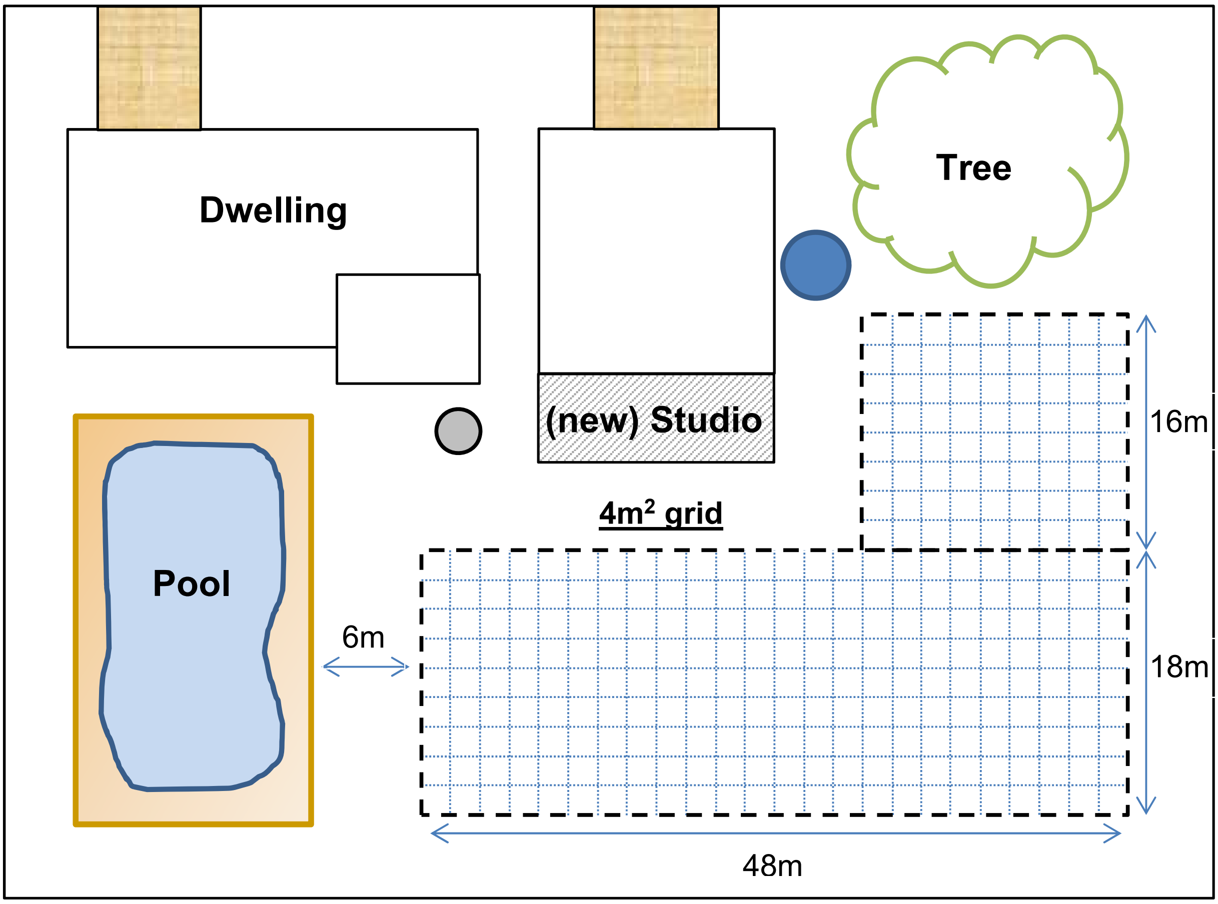
Applicable (Design) Soil Loading Rate: (mm/day) _____________________________________

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 9: Soil Categories and Recommended Maximum Design Loading/Irrigation Rates (DLR/DIR) for Land Application Systems [1,2,5]

Soil texture	Soil structure	Soil category	Indicative permeability (Ksat) (m/d)	Design Loading Rates and Design Irrigation Rates (DLR / DIR) (mm/day)					
				Absorption trenches/beds and Wick Trench & Bed Systems 6 for primary effluent (see Table L1 in AS/NZS 1547:2012)	(ETA) Evapo-transpiration absorption beds and trenches (see Table L1 in AS/NZS 1547: 2012)	Secondary treated effluent applied to Wick Trench & Bed System [4]	Sub-surface and surface irrigation (see Table M1 in AS/NZS 1547: 2012)	LPED (see Table M1 in AS/NZS 1547: 2012)	Mounds (basal area) (see Table N1 in AS/NZS 1547: 2012)
Gravels and sands	Structureless (massive)	1	>3.0	NA [3]	NA [3]	25	5 [6] (see Note 2 in Table M1)	NA [3]	24
Sandy loams	Weakly structured	2a	>3.0						24
	Massive	2b	1.4 - 3.0	15	15	30		4	24
Loams	High / moderate structured	3a	1.5 - 3.0	15	15	30	4 (see Note 1 in Table M1)	3.5	24
	Weakly structured or massive	3b	0.5 - 1.5	10	10	30			16
Clay loams	High / moderate structured	4a	0.5 - 1.5	10	12	30	3.5 (see Note 1 in Table M1)	3	16
	Weakly structured	4b	0.12 - 0.5	6	8	20			8
	Massive	4c	0.06 - 0.12	4	5	10			5 (see Note to Table N1)
Light clays	Strongly structured	5a	0.12 - 0.5	5	8	12	3 (see Note 1 in Table M1)	2.5 (see Note 4 in Table M1)	8
	Moderately structured	5b	0.06 - 0.12	(see Notes 2 and 3 in Table L1)	5 (see Notes 2, 3 & 5 in Table L1)	10			5 (see Note to Table N1)
	Weakly structured or massive	5c	<0.06			8			
Medium to heavy clays	Strongly structured	6a	0.06 - 0.5			5 (see Notes 2 and 3 in Table L1)	2 (see Note 2 in Table M1)	NA	
	Moderately structured	6b	<0.06						
	Weakly structured or massive	6c	<0.06						

1. Adapted from Australian Standard AS/NZS 1547: 2012 - On-site domestic wastewater management.
2. The DIR and DLR are recommended maximum application rates for treated effluent. A water balance may indicate that a reduced application rate is required for a specific site.
3. The exception is where the soil does not have a high perched or high seasonal (winter) watertable (see AS/NZS 1547).
4. See Appendix E for design, installation and maintenance details.
5. Lower application rates may be required for reduced soil permeability in sodic and dispersive soils, soils with a perched or seasonally high watertable or soils with a limiting layer.
6. The application rate may be increased in sandy soils with a high watertable where an advanced secondary treatment system with disinfection replaces a primary treatment system on an existing lot that is too small to accommodate the maximum DIR for category 1 to 2b soils.

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 massive	> 3.0			4
			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 Land application area calculation attached Wet weather storage area calculation attached	 yes/no yes/no yes/no
Flood potential Land application area above 1 in 20 year flood level Land application area above 1 in 100 year flood level Electrical components above 1 in 100 year flood level	 yes/no yes/no 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? Level of protection (I – VI) Bores in the area and their purpose:	 yes/no/not available
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) Reserve application system (including buffer distances)	 yes/no 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?

Calculation of evapotranspiration-absorption area size by water balance method

Size of area for each month

(1) Month	(2) Pan evaporation E mm	(3) Evapo transpiration ET $ET = 0.75E$ mm	(4) Rainfall R mm	(5) Retained rainfall R_r $R_r = 0.75R$ mm	(6) DLR per month mm	(7) Disposal rate per month (3)-(5)+(6) mm	(8) Effluent applied per month L	(9) Size of area (8)/(7) m^2
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
							First trial area = average monthly area =	m^2

Depth of stored effluent (first trial)

(1) Month	(2) First trial area m^2	(3) Application rate (8)/(2) mm	(4) Disposal rate per month (7) mm	(5) (3) - (4) mm	(6) Increase in depth of stored effluent (5)/n mm	Depth of effluent for month (X - 1) mm	(7) Increase in depth of effluent + (6) mm	Computed depth of effluent month (X) mm
Dec		-	-	-	-	0		
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								

n = effective void space factor. For imported durable aggregate, n = 0.3