

Design Guidelines for On-site Sewage Management for Single Households

APPENDIX C

User Manual for the Byron OSMS Design Computer Model

C1. Introduction

As an adjunct to Byron Council's On-site Sewage System (OSMS) Management Design Guidelines for Single Households, a computer model has been developed to assist in estimating appropriate size for effluent application fields based on expected loads, proposed treatment methods and the local site and soil characteristics. The Byron **OSMS Design Model** was originally developed for Lismore City Council by Greg Alderson & Associates and has been reworked for Byron Shire Council by Antony McCardell and David Bonner.

Byron Council recommends that the OSMS Design Model be used for the estimation of application field size. Alternatively, the State Government guidelines (E&HP, 1998) offer a more simplistic monthly water-balance model to determine appropriate size for effluent application fields if preferred, or any other design will be accepted if sufficient scientific justification is provided for the proposed system and application area. Whatever method is used to design the OSMS system and regardless of the model used to calculate the land application area size, the designer remains responsible for using their knowledge and experience to reject or modify any systems which will not adequately treat and disperse the effluent over the fifteen year design lifetime of the system.

C1.1 Model Availability & Features

A standard (3Mb) or Zipped (0.7Mb) version of the model can be downloaded from Byron Shire Council's website at www.byron.nsw.gov.au. The Design Model sits within a Microsoft Excel Workbook and comprises three linked spreadsheets; a simple data input worksheet, a data report worksheet and the model worksheet.

The first worksheet allows users to record relevant site parameters and run the model (including the print-out from the data report page), without needing to work through the more complex model spreadsheet. Experienced OSMS Designers can apply to Council for an "unlocked" version of the model on CD-Rom, which allows more direct manipulation of certain elements of the model. In all cases, designers can experiment with different treatment methods and land application options to achieve the desired results. However, deviation from standard parameters (e.g. volumes of household effluent generation, default nutrient reduction rates for particular technologies) must be declared by designers (with justification) when the design is considered for approval by Council.

The OSMS Design Model offers common tools and features such as list boxes, check boxes and buttons from which input values may be chosen. Some of these features are reproduced in this text and, in many cases, the text of the attached Design Guidelines. We recommend that the examples (provided in Section C3) be attempted by all users in order to become familiar with the operation of the model.

C2. Model Philosophy

The following sections of Appendix C provide a description of the model philosophy as well as details of model function, including data required for correct model operation. In designing an OSMS, it is important that the designer understands the approach used to estimate the sustainable application rates of treated effluent, and the nutrient loads contained in the effluent.

As discussed in Section 1.2 of the attached Design Guidelines, a "core objective" of the National Water Quality Management Strategy (1997), which all State and Local Government water management is required to follow, is "to enhance individual and community well-being and welfare by following a path of economic development that also safeguards the welfare of future generations". The Strategy (NWQMS, 1997) further requires that "the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised". In developing its On-Site Sewage Management Strategy, Byron Council is making a genuine effort to reflect the principles set out in the National Water Quality Management

Strategy within the OSMS Design Model, balancing environmental, public health and economic imperatives.

Council recognises that many waterways with Byron Shire are stressed by higher-than-natural nutrient levels and that there is a need to reduce current pollution loads from many sources, including on-site sewage, agricultural inputs and centralised sewerage outfalls. Council also recognises that safely treating and dispersing household effluent tends to be an expensive but vitally important process; the risks posed by each system in a catchment must be weighed against the economic costs of sewage treatment and dispersal of household sewage for that system, as well as cumulative pollution loads in that catchment. Although ensuring that good treatment and dispersal of on-site wastewaters is achieved, the proximity of individual sewage systems to waterways and to adjacent systems also plays a part in the cumulative risk posed by that OSMS. Systems close together and close to waterways pose more risks to the environment and public health because there is less opportunity for “polishing” of the effluent by natural processes on and in the soil.

BSC in their OSMS Design Guidelines (and model) provide incentives (i.e. a smaller requirement for land application areas) for improved treatment. Conversely, the guidelines (and model) responds to higher development density by increasing the land application area requirements. In effect, the guidelines and model reflect the reduced environmental risk on larger allotments, and it is therefore not as important to provide highly treated effluent on larger blocks. There may be other reasons why high quality treatment is required in a particular situation, e.g. public health risk, but this is beyond the scope of the model and unusual circumstance need to be assessed on a case-by-case basis.

BSC acknowledges that this notion deviates somewhat from the principle of maximum re-use espoused by the State Government guidelines (E&HP, 1998). However, BSC believes that the higher reliance on effluent polishing mechanisms in the soils surrounding the actual effluent dispersal area on suitable (i.e. well buffered) blocks is acceptable in view of the greatly reduced risks these applications pose to the environment.

The size of the Land Application Area allowed by the OSMS Design model should be seen as a “minimum” size for otherwise unconstrained sites, and designers are encouraged to expand the size of the land application area or improve the effluent quality if:

- a. site constraints will reduce the overall environmental or public health security of the OSMS
- b. they believe that the land application system will not be able to operate for a minimum design life of 15 years; and/or
- c. the owners prefer to follow a philosophy of total reuse and sustainability and the designer believes that the land application area is not sufficient to provide this.

A separate document is being prepared by Byron Shire Council to provide a detailed explanation of how the Design Model works. In the meantime, it is suggested that most users will find sufficient information in the following description and worked examples to understand how to apply the model to proposed applications.

C3. Model Function/ Description

The model calculates the minimum land application area required based on:

- Hydraulic loading.
- Total Phosphorous (TP) loading,
- Total Nitrogen (TN) loading,

The largest of these areas is selected as the minimum sustainable area in which the soil/ crop will continue to 'polish' and re-use water & nutrients in the effluent. The model considers the treatment/ disposal process in a series of 'compartments' or sub-models. This can be described as shown in Figure C1:

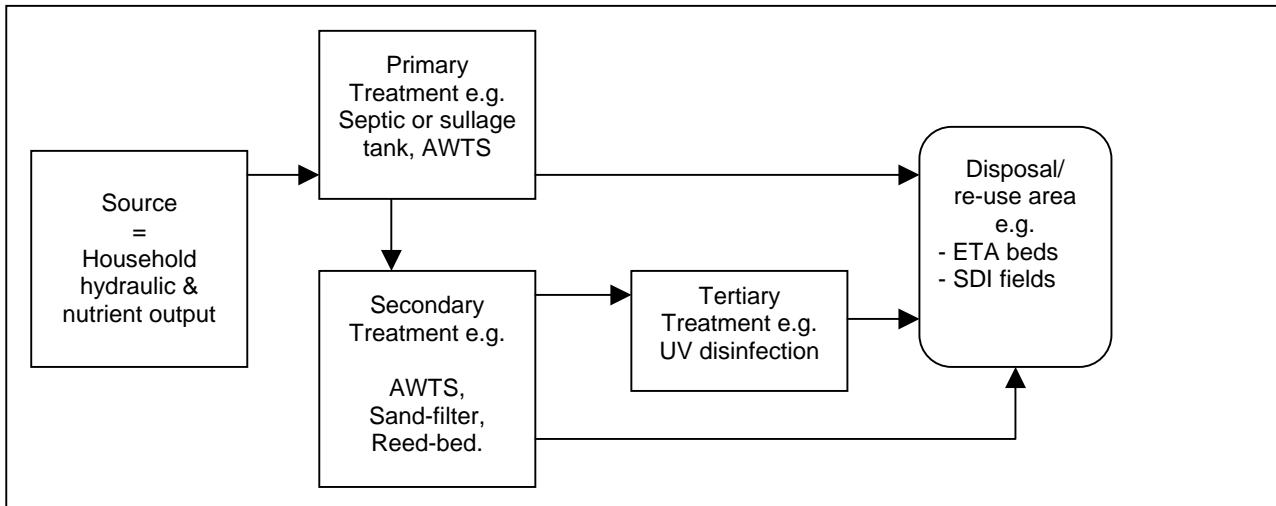


Figure C1: Schematic of typical On-site Sewage Management System components

C1.2 Hydraulic Calculation

The model performs a daily soil water moisture calculation to provide a baseline for the soil's capacity to absorb the next day's water input. The calculation is based on rainfall infiltration, hydraulic load from the household, crop evapotranspiration (from grass in this case), and deep percolation (drainage). Rainfall and Class A Pan Evaporation Data, for the 21yr period to 2003, was accessed from the Alstonville Agricultural Research Station, and is considered to be representative of rainfall patterns likely to occur in this region.

Soil texture and structure, both assessed in the field, determine the permeability of the soil. Predicted soil percolation values have been taken from AS/NZS 1547:2000 and applied in the model where soil type is identified and selected. The required land application area, for the hydraulic load, is the land area (in m²) which will accept the volume of applied effluent for 95% of the time (i.e. the 95th percentile for the 21yr data-base). Of the 5% of days that fall outside the soil capacity to accept this volume of water, effluent-contaminated runoff might theoretically occur. It is assumed however that, during these unusually high rainfall periods when some "daylighting" of effluent might occur, almost all of the runoff would consist of rain water and that actual contamination would be so low and diluted that the overall effects would be negligible.

C1.3 Phosphorus Calculation

The model calculates an annual total phosphorus budget based on TP input, soil adsorption potential, and crop uptake. Default values for TP input and crop phosphorus uptake is 0.6kg/person/yr and 20/kg/ha/yr respectively. The adsorptive capacity of the soil is considered to be finite, and is based on predicted soil adsorption capacity for soil type (default values for known soil types are listed in the model data-base). The soil adsorptive capacity is reduced by both depth (to rock or water-table) minus a default 0.5m water-table buffer. The design life of the land application area is restricted to 50yrs in the case of the phosphorus calculation. The model considers the treatment/ disposal process in a series of 'compartments' or sub-models, which can be described as:

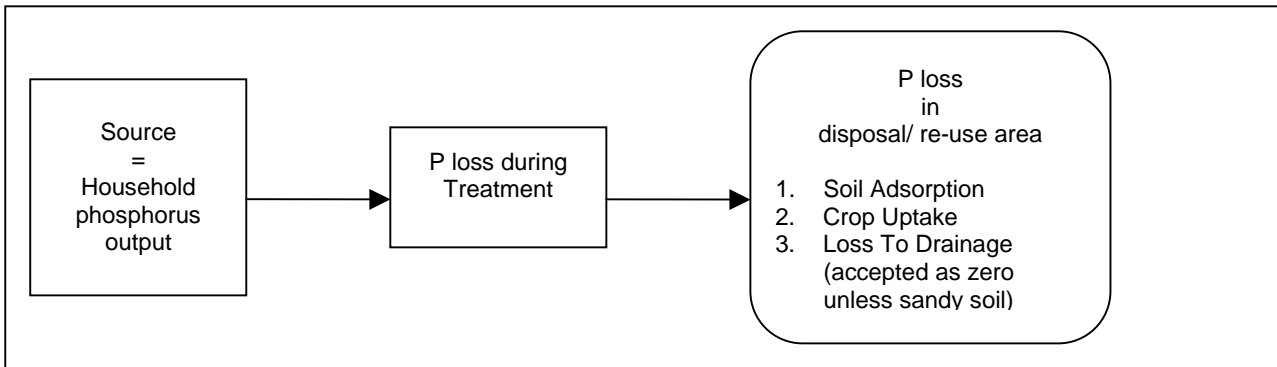


Figure C2: Phosphorus balance sub-model within OSMS Design Model

The equation for the phosphorus application area is:

$$\text{Area (m}^2\text{)} = (10,000 \times P_{\text{load}}) / [(P_{\text{sorp}} (W-B))/T + P_{\text{crop}}] \dots \text{Eqn. 1}$$

Where:

- Area - land application area required for soil/ plant P removal
- 10,000 - conversion factor from hectares to m²
- P_{load} - dwelling P output less any removal during treatment (kg/yr)
- P_{sorp} - soil P adsorption capacity (kg/ha/m depth)
- B - buffer to water-table (default 0.5m)
- T - time to max soil adsorption limit (default 50yrs)
- P_{crop} - annual crop P uptake capacity (kg/ha). Default in model is set at 10 kg/ha/year.

C1.4 Nitrogen Calculation

As with the phosphorus calculation the model calculates the land application area size for nitrogen based on an annual nitrogen budget for the site. Unlike the phosphorus cycle, the nitrogen cycle has an additional 'gas' phase that helps reduce the TN load to the terrestrial environment. Again the model considers the treatment/ disposal process in a series of 'compartments' or sub-models which can be described as:

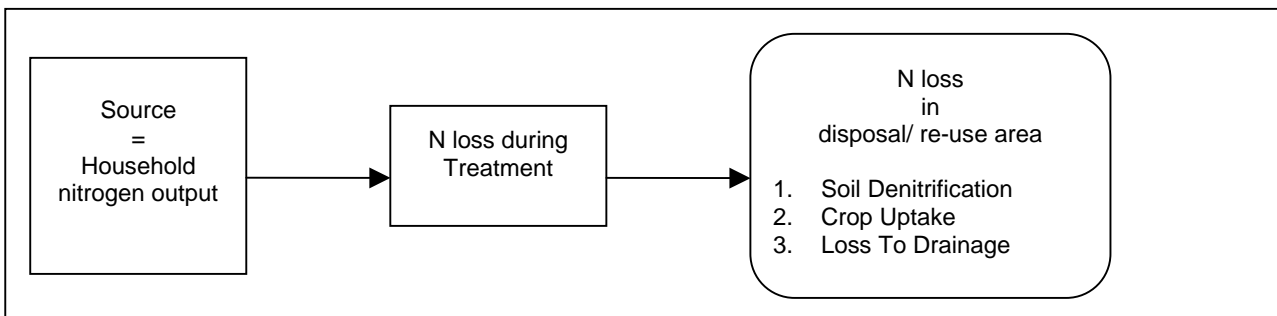


Figure C3: Nitrogen balance sub-model within OSMS Design Model

Model assumptions for the nitrogen calculations are:

1. 20% of the TN arriving at the land application area will rapidly cycle through to the gaseous N phase and vent to the atmosphere,
2. The default value for TN production is 4.2kg/person/yr,
3. Plant N uptake is 200 kg/yr (unless otherwise justified)

The basic model function for the nitrogen calculation is described by the equation:

$$\text{Area (m}^2\text{)} = ((N_{\text{load}} - N_{\text{denit}})/N_{\text{crop}}) \times 10,000 \dots \text{Eqn. 2}$$

Where:

Area	- land application area required for soil/ plant N removal
10,000	- conversion factor from Ha to m ²
N _{treat}	- dwelling N output minus any removal during treatment (kg/yr)
N _{denit}	- soil N denitrification capacity (default = 20% of TN after treatment)
N _{crop}	- annual crop N uptake capacity (kg/ha)

Byron Shire Council (BSC) has followed the example of Lismore Shire Council (LSC) and acknowledged that using the above equation produces large, and therefore costly, land application areas. To reduce the requirement for these large areas BSC accepts that domestic OSMSs in rural areas of low development density present much lower risks to the broader environment because of the additional assimilative (effluent polishing) capacity of the lands surrounding the land application area. Consequently, the equation has been re-arranged to reflect a relaxation of minimum disposal area sizes in low density, well-buffered developments, to include a nitrogen 'release to the environment factor'. This factor, currently set at a maximum of 10 kg TN/yr in the Byron OSMS Design Model, based conservatively on work done by Hornsby Shire Council (HSC, 1994), is calculated and applied according to block size.

The equation for the 'nitrogen release factor' is:

$$N_{\text{lim}} = N_{\text{max}} [1 - \exp(-kB)] \dots \text{Eqn. 3}$$

Where:

N _{lim}	- the allowable TN release/ export for the system (kg/yr),
N _{max}	- the maximum annual allowable TN release per household (currently 10kg/yr),
k	- curve to the line,
B	- block size

Equations 2 & 3 are re-arranged within the nitrogen sub-model to calculate land application thus;

$$\text{Area (m}^2\text{)} = (1 - N_{\text{lim}} / (N_{\text{treat}} - N_{\text{denit}})) \times ((N_{\text{treat}} - N_{\text{denit}}) / N_{\text{crop}}) \times 10,000 \dots \text{Eqn. 4}$$

Nitrogen Calculation & Creek Buffers

Reductions from the recommended minimum buffer distances to waterways restricts the nitrogen calculation by reducing the allowable nitrogen 'release to the environment'. The nitrogen sub-model does this as a simple linear reduction i.e. if the buffer distance between the proposed land application area is 50m (where the guidelines require 100m), then the effective block size is reduced by 50%. Essentially, the model increases land application areas by reappportioning the entered block size value.

C1.5 Conclusion

Land application areas must be able to accommodate all three processes in order to protect surface and ground water, human health and ecosystems. Designers should understand that neither guidelines nor computer models can replace professional knowledge and experience. In some cases the current draft OSMS model may suggest impractical options that may not be technically feasible (e.g. sub-surface irrigation may be of a computed size but irrigation will only work if the effluent is sufficiently filtered to not clog the emitters) or environmentally desirable. As

well as using the guidelines and model, designers are expected to use their skills and knowledge to reject or modify designs that will not work over the required minimum fifteen year design lifetime of the system.

C4. Using The Model – Case Study Examples

Once the workbook file has been downloaded from the web, the model is ready to use within a Microsoft Excel environment. The model opens to the default 'Data Input' worksheet, identified by the green worksheet tab at the bottom-left of the page. Users will see two further worksheets listed by colour tabs in the lower left corner of the screen.; the Council Report Page (red tab), and the Designer Model (blue tab). It is anticipated that most designers will find it easiest to use only the Data Input and Council Report pages.

One peculiarity of the Excel spreadsheet should be highlighted up-front; each input value must be entered by entering the value **and** hitting the Enter button on the keyboard, otherwise the Calculate function and list boxes will remain inoperable. Should a dialogue box appear offering to "debug" the model, users are advised to hit "No" or "Cancel" and proceeding on.

C5. Examples Using the Data Input Worksheet of Design Model

The Designer Input Sheet is an easy to use 14 step process that will compute the minimum land application area required for your on-site wastewater system. Before running the model, some preparation and data gathering is required. You will need to find out what type of soil exists in the proposed dispersal area, how deep the soil is and how the soil changes at depth. You will also need to measure the distance the proposed dispersal area is from permanent or intermittent waterways and any nearby springs or bores. In addition, you will need to consider what type of system will be selected as a treatment option, as well as which of the domestic water using facilities are to be connected to the treatment system. Property size and potential locations for wastewater treatment and land application areas also need to be measured so that the options can be considered in the model.

This simplified application of the model is designed to provide guidance in estimating minimum land application area sizing for commonly occurring site characteristics. The main benefit of the simplified model is that it allows the user to experiment with a range of water usage patterns in combination with various treatment and land application options to arrive at a site suitable sewage management system.

Example 1.

The following example applies the model to a situation which might typically be encountered in Byron Shire.

A family of five wish to build a four bedroom home on their north facing one hectare (10,000m²) property, located on rolling hills fifteen kilometres West of Byron Bay. The owners will capture rain-water as their preferred water supply but will supplement this with tanker deliveries. All domestic water using facilities are to be connected to the treatment system. Reduced water consumption has been assumed and the dwelling will be fitted with standard water saving devices. Recent soil sampling revealed a deep, well-structured clay loam and the water-table was not detected during site investigations despite a sampling bore depth of 3m. The surrounding area is mapped (Morand/DLWC, 1994) as deep, well-structured red krasnozems soils on basalt parent material. No permanent or intermittent waterways lie within 100m, and there are no licensed bores within 250m of the proposed dispersal area. Wastewater treatment is to be AWTS, and subsurface irrigation is to be installed to distribute the treated effluent to a small banana planting on the property.

Method

Starting at the top of the 'Designer Input Sheet' the above details are entered in the appropriate cell reference or selected from list boxes in a series of clearly identified steps (see Figures 1-4):

Step 1

Enter the 'number of bedrooms' (4) at cell ref. M3.

Step 2

Enter the 'property size' (10,000) at cell ref. M4.

Step 3

Do not change 'waterway buffer type' in select box because, in this instance, there is no nearby waterway.

Step 4

Leave 'enter within buffer distance' cell ref.M9, at default value (100m) – this value would only be changed if the distance from a nearby waterway is less than the default value. In this instance there is no nearby waterway.

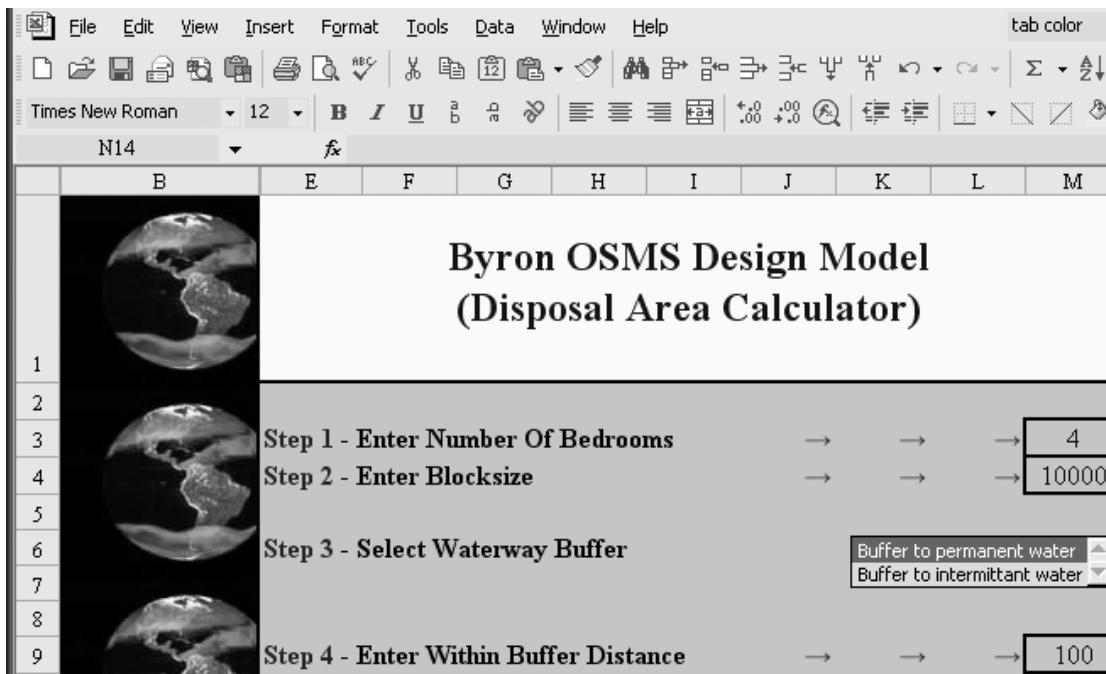


Figure 1: Steps 1-4 Designer Input Sheet

Step 5

Select 'water supply' from list box – 'roof water harvesting + std. water saving devices 115L/pp/day' (115L/pp/day is the predicted water use factor where rain water is harvested, water conservation devices are fitted and all facilities are connected to the treatment system).

Step 6

Select 'facilities/water usage' from list box – tick each of the facilities in the list box in this example.

Step 7

Select 'treatment method' from list box – 'AWTS'.

	B	E	F	G	H	I	J	K	L	M		
10		Step 5 - Select Water Supply		Reticulated supply (bore, spring, creek) 180L/p.d Reticulated + std. water saving devices 145L/p.d Roof water harvesting 140L/p.d Roof water harvesting + std. water sav. 115L/p.d								
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13				Step 6 - Select Facilities/Water Usage (select or deselect each checkbox)		→	→	<input checked="" type="checkbox"/> Toilet				
14		→	→			<input checked="" type="checkbox"/> Bathroom						
15				→	→	<input checked="" type="checkbox"/> Laundry						
16				→	→	<input checked="" type="checkbox"/> Kitchen						
17		Step 7 - Select Treatment Method		Septic (primary treatment only) AWTS Septic + single pass sandfilter (SPF) Septic + SPF, 25% septic return flow Septic + recirculating sandfilter Septic + reedbed								
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22		Step 8 - Select Soil Type ('Morand')		"Alluvial" Soils 1 (dp, mu, my, te) 10,000 kg/ha/m "Alluvial" Soils 2 (cr) 2,000 kg/ha/m Red Basaltic Soils (bg, ca, co, el, ew, mb, ro, wo) 10,000 kg/ha/m Duplex Soils (ba, bi, bu, mi, ni) 8,000 kg/ha/m Podzol Soils (ab, bo, br, eb, fh, ki, ku, og, po, ty, wy) 1,000 kg/ha/m								
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29				Step 10 - Select Soil Texture & Structure Below System		Gravels, Sands Ksat >3.0 Sandy loams - weakly structured Ksat >3.0m Sandy loams - massive Ksat 1.4 - 3.0m Loams - high/moderate structured Ksat 1.5 - 3.0m/c Loams - weakly structured or massive Ksat 0.5 - 1.5m/c Clay loams - high/mod structured Ksat 0.5 - 1.5m/c Clay loams - weakly structured Ksat 0.12 - 0.5m/c Clay loams - massive structured Ksat 0.06 - 0.12m/c Light clays - strongly structured Ksat 0.12 - 0.5m/c Light clays - moderately structured Ksat 0.06 - 0.12m/c Light clays - weak, structured or massive Ksat <0.06m Med. to heavy clays - strong, struct. Ksat 0.06-0.5m/c Med. to heavy clays - mod. structured Ksat <0.06m Med. to hvy clays - weak, struct. or massive Ksat <0.06m DISPERSIVE soil (Modified Emerson Aggregate test)						
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Figure 2: Steps 5-7 Designer Input Sheet

Step 8

Select 'soil type' from list box – 'red basaltic soils' ('Morand' soil map).

Step 9

Enter 'depth to water table' at cell ref. M35 – known to be greater than 3m in this case, therefore enter '3'.

Step 10

Select 'soil structure below system' from list box – 'clay loam, high/mod structure' (from soil test information).

	B	E	F	G	H	I	J	K	L	M		
26		Step 8 - Select Soil Type ('Morand')		"Alluvial" Soils 1 (dp, mu, my, te) 10,000 kg/ha/m "Alluvial" Soils 2 (cr) 2,000 kg/ha/m Red Basaltic Soils (bg, ca, co, el, ew, mb, ro, wo) 10,000 kg/ha/m Duplex Soils (ba, bi, bu, mi, ni) 8,000 kg/ha/m Podzol Soils (ab, bo, br, eb, fh, ki, ku, og, po, ty, wy) 1,000 kg/ha/m								
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Figure 3: Steps 8-10 Designer Input Sheet

Step 11

Select 'dispersal area slope/type' from list box – 'level bed with grass' (this refers to the irrigation design for the orchard area).

Step 12

Select 'soil texture in root zone' from list box – 'loam, clay loam, silt' (it is assumed that the surrounding surface soil will be used).

Step 13

Select 'land application type' from list box – 'SSI' (subsurface irrigation - of the banana planting).

Step 14

Click on the 'Calculate' button. This will transfer the information to the Design Model sheet and, within a few seconds a 'minimum land application area' (490 m²) will appear in the box below the calculate button.

Step 15

The print button at the bottom of the page allows the full list of parameters that have been entered into the model to be printed and submitted to Council as part of the on-site system design.

Step 11 - Select Disposal Area Slope/Type

Mounded bed
Level bed with grass

Step 12 - Select Soil Texture In Root Zone

Coarse Sand
Fine sand, Sandy loams
Loams, Clay loams, Silt
Clay (light, med, heavy)

Step 13 - Select Land Application Type

SSI
ETA

Step 14 - Select Calculate Button Below

Calculate

Minimum Land Application Area Required (m²)

490

Figure 4: Steps 11-15 Designer Input Sheet

The calculated minimum land application area of 490m² is based on the chosen input values. The main factors which affect the land application area size are: the number of people, source inputs (particularly from the toilet), size of the block, and treatment selected.

Significant reductions in land application area can be achieved by reducing source inputs (e.g. composting toilet), and by improving treatment especially where nitrogen is reduced (e.g. by adding a reed bed or re-circulating sand filter). By utilising all of the source input reductions listed above, the model will return a value of 192 m² as a minimum final land application area. Note though that in this eventuality your irrigation designer would need to consider whether to disperse the effluent using an ETA bed rather than SSI, as such a small SSI field might be likely to become over-saturated.

C6. Examples Using the Data Design Model Worksheet

Despite its more visually complex layout, the Design Model can be run in the same uncomplicated mode as the Designer Input Sheet. The easy to use 14-step process described above for the Designer Input Sheet is, with the exception of the sequential order of steps 1-4, replicated on the Design Model worksheet. The main difference between the two models is the increased level of interactivity in the Design Model, resulting from options to overwrite some of the model default values¹, and the option to consider varying sizes of reed-bed treatment available in the Design Model worksheet. As with the Designer Input Sheet, some preparation and data gathering is required prior to running the Design Model. Several extra output parameters are included in the Design Model and these include: The minimum land application area (and the ability to compare the areas required for phosphorus and nitrogen dispersal); Nitrogen Report; ETA trench configuration.

C1.6 Design Model Example

The following example applies the model to a second situation which might typically be encountered in Byron Shire.

A family of four are to build a three bedroom home plus a self-contained single bedroom 'studio' to be leased under permanent occupation. The two hectare (20,000m²) south-easterly facing property lies in a fertile valley several kilometres south-west of Mullumbimby. The property has a water bore which yields drinking quality water – supplementary water, if required, will be town-tanker deliveries. The main home, as well as the studio, will connect all domestic water using facilities to the treatment system. The property owners regard the plentiful bore water supply as sufficient to service both the main dwelling and studio at a rate to suit their needs without the installation of water conservation measures or appliances.

Soil sampling revealed a shallow (0.9m to weathered parent material), stony, red-brown, well structured clay loam on the upper slopes. Changes in the soil profile are gradual but reveal a strongly structured light clay ~0.45m below the surface. Sedges growing in down slope 'pockets' indicate intermittent water logging. The soil of the surrounding area is shallow and boulder strewn but well structured red and brown krasnozem on basalt parent material. The soil is classified by Morand (DLWC. 1994) as soil unit Rosebank (ro). A permanent creek runs along the south-easterly boundary, approximately 75m from a likely wastewater land application area. After discussing the situation with the client, the consultant's recommended wastewater treatment is to be septic + secondary-sized reed bed, followed by subsurface drip irrigation to distribute the final treated effluent.

Method

Starting at the top of the 'Design Model' worksheet [blue tab] the development details are entered in the appropriate cell reference or selected from list boxes in a series of clearly identified steps:

Preliminary Step

¹ Cells highlighted in blue or green may be altered by the user. Blue cells are reserved for data entry of parameters most likely to vary between designs. Cells highlighted in green are for data entry parameters unlikely to vary between applications, so-called default parameters. Cells which are not for data entry, but merely display calculation results, are left un-highlighted in black. Some cells contain red dots, these exact cells being reserved as data-entry boxes to overwrite the calculation result in the adjacent box. This allows users to perform limited customized calculations.

Select the 'Set Defaults' button to return all previously entered data to model default values.

Step 1

Select 'bedrooms' from the persons/bedrooms select box (in this instance we know how many bedrooms the development will have – 3 bedrooms in main home + 1 bedroom for studio).

Step 2

Enter the number of bedrooms '4' at cell ref. B5 for the main dwelling + studio (do not change default value at B6).

Step 3

Select 'buffer to permanent waterway' in select box because (in this instance there is a permanent stream nearby). Change buffer distance at cell ref.D6, to '75' (the default value is to be changed because at this stage of design, the distance of a possible land application area, from a nearby waterway, is less than the default value of 100m).

Step 4

Enter property size '20000' in cell ref. D5.

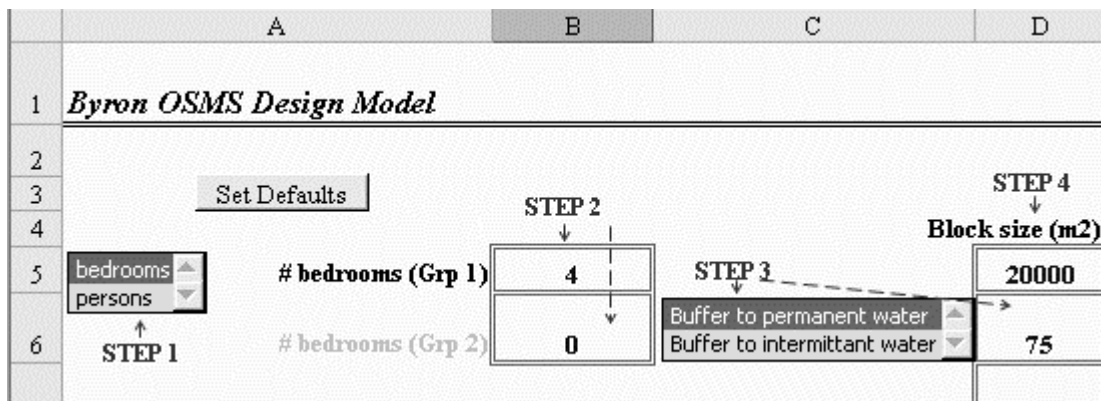


Figure 5: Steps 1-4 Design Model

Step 5

Select 'reticulated supply (bore, spring, creek, 180L/p.day)' from list (180L/pp/day is the predicted water use factor for this supply type where no water conservation devices are fitted and all facilities are connected to the treatment system).

Step 6

Select 'facilities/water usage' from list box – tick all four of the facilities in the list box for Group 1.

Step 7

Select 'treatment method' from list box – 'Septic + Reed bed'.

	E	F	G	H	I
2	STEP 5				
3	Daily effluent flow accord. water supply type				
4	Reticulated supply (bore, spring, creek) 180L/p.d Reticulated + std. water saving devices 145L/p.d Roof water harvesting 140L/p.d Roof water harvesting + std. water sav. 115L/p.d		Grp1	Grp 2	
5			<input checked="" type="checkbox"/> Toilet	<input type="checkbox"/> Toilet	
			<input checked="" type="checkbox"/> Bathroom	<input type="checkbox"/> Bathroom	
			<input checked="" type="checkbox"/> Laundry	<input type="checkbox"/> Laundry	
6			<input checked="" type="checkbox"/> Kitchen	<input type="checkbox"/> Kitchen	
7	% black to tot WW in a full system	32%	Wastewater stream		
8	% black to tot WW in a full system: TN	70%	STEP 7		
9	N loss in disposal bed (% reduction)	20%	Treatment system		
10			Septic (primary treatment only) AWTS Septic + single pass sandfilter (SPF) Septic + SPF, 25% septic return flow Septic + recirculating sandfilter Septic + reedbed		Current Inlet BOD conc. ~ 160 mg/L

Figure 6: Steps 5-7 Design Model

Step 8

Select 'soil type' from list box – 'red basaltic soils', based on field assessment and DLWC mapping by Morand, 1994, which classifies the soil as being typical of the Rosebank 'ro' landscape.

Step 9

Select 'Light Clay – strongly structured' from 'soil structure below system' list (from soil test information).

Step 10

Enter '0.9' for 'Water Table/Bedrock Depth' at cell ref. B14 (from soil test data).

Total Daily Flow (L/day) *	1080	(L/day)	180
TN production per year (kg/year)	25.20	N prod. per capita (kg/person/yr)	4.20
TN reduced by all N loss (kg/year) *	10.08	N loss in treatment system (% reduction)	50%
N Plant Uptake rate (kg/ha/year)	200		
Phosphorus in effluent (Ip) (kg/yr) *	3.60	P prod. per person per yr (kg/person/yr)	0.60
		Nitrogen Report	
P uptake by plants (Hp) (kg/ha/yr)	10	N plant uptake (kg/yr)	8.86
P soil sorption (Ps) (kg/ha/m depth)	10000	N load exceedence	0.00
Water Table/Bedrock Depth (m) STEP 10 →	0.90	N load percolated (kg/yr)	1.22
Buffer to Water Table (Bwt) (m)	0.5	N released (perc+exceed.) (kg/yr)	1.22
Time for accumulation of P(years)	50	Enviro.N limit (kg/yr)	7.77
Final area (m²)	443	Nitrogen area (m ²)	116
Phosphorus area (m²)	400	Hydraulic area (m ²)	443

Figure 7: Steps 8-10 Design Model

Step 11

Select 'level bed with grass' from '% effective rainfall' list box.

Step 12

Select 'loam, clay loam, silt' from 'soil texture in root zone' list box – (it is assumed that the surrounding surface soil will be used).

Step 13

Select 'SSI' from 'land application type' list box.

Step 14

Click on the 'Calculate' button. If input correctly, the model should return a required application area of 443 m².

Step 15

The print button at the bottom of the page allows the full list of parameters that have been entered into the model to be printed and submitted to Council as part of the on-site system design.

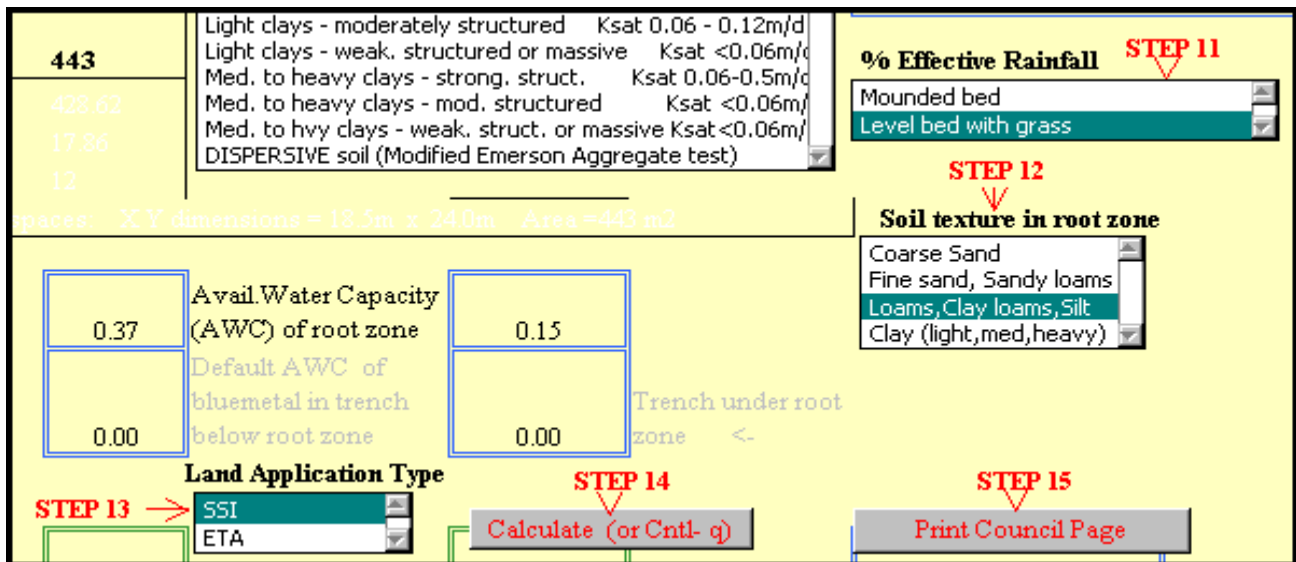


Figure 8: Steps 11-15 Design Model.

Unlike the previous example (using the Designer Input Sheet), the size of the land application area here is increased by the high water table which reduces the capacity of the soil to adsorb phosphorus. In this example there are fewer options to decrease the land application. Although a high level of treatment is being used in this case, it does little to remove phosphorus. The principal option in this case would be to remove the black water component by installing a composting toilet. This option would achieve a reduction from 443m² to 379m².

Note also that the implications of various reed-bed sizes on required application areas can be investigated in the Design Model worksheet by inserting suggested values in the macro box from H14 to I15.