Byron Shire Council

Design Guidelines for On-site Sewage Management for Single Households

Protecting the Environment and Health of Byron Shire

1 December 2004

Foreword – On-site sewage management in Byron Shire

Management of human wastes is an important issue affecting the water quality of Byron Shire, especially in the more densely inhabited catchment areas. Stricter environmental and public health requirements imposed by State and Federal government authorities, as well as rising community expectations within the shire, dictate the need to reassess and, where necessary, improve the on-site management of household wastes.

In March 1998 changes were announced to the sewage management regulations. A working group of government agencies, (including the NSW Department of Local Government, the NSW Environment Protection Authority, the NSW Department of Health, the NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning) developed a set of guidelines (EHP, 1998) which requires that all major environmental and health issues are considered in on-site sewage management in NSW. Under these new regulations and guidelines, councils and landowners must ensure that:

- surface and ground water resources are protected;
- degradation of land and vegetation systems is prevented;
- public health risks are prevented;
- natural resources are reused (effluent irrigation, compost) and Ecologically Sustainable Development is promoted; and
- activities that are dependent on waterways are not adversely impacted (e.g. swimming, tourism and oyster growing).

Councils also have specific responsibility under local government legislation to:

- maintain a register of approvals granted for on-site sewage management systems; and
- prepare annual updates of State of the Environment reports for their areas showing details of polluted areas and on-site sewage management policies, performance of on-site sewage management systems and the cumulative impacts of those systems on catchments within the council's area.

Every council is now required to prepare an on-site sewage management strategy suitable for its local area. Byron Shire Council's *On-Site Sewage Management Strategy* was adopted in 2001 and is available from the Council. Council has also produced a booklet for landowners giving a plain English overview of responsibilities and options. The *Home Owners Guide to On-Site Sewage Management* is also available from the Council for a small fee or without charge from Council's website www.byron.nsw.gov.au.

Front cover photo – Sleepy Ck, Bangalow, photo by Cal MacKinnon, Lush Photographics

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See also: **Byron Shire Council OSMS Design Model** [#487846]

1. INTRODUCTION

In situations where it is not feasible to connect to a reticulated centralised sewage treatment system (e.g. in unsewered rural areas), wastewater generated from households must be managed on-site. In other cases, even those who are connected to sewerage may wish to utilise at least some of their household wastewaters on-site. An on-site sewage management system (OSMS) generally consists of three main components: the wastewater source (household); treatment device/s; and final reuse or disposal of treated effluent via land application. This document offers guidance for applicants, owners and developers to plan the selection, design, installation, operation and maintenance of on-site sewage management systems (OSMSs) for single households in Byron Shire. In particular, it provides guidance for the appropriate selection and design of treatment system/s and the application of effluent into the land.

The NSW Environment and Health Protection Guidelines (E&HP Guidelines, 1998) referred to in the Foreword provide the statutory requirements and guidance for design of on-site sewage management systems for single households in NSW. Australian Standard AS/NZ1547 (2000) also provides important additional technical information on the subject. These **Design Guidelines for On-Site Sewage Management for Single Households (2004)** (hereon referred to as the Design Guidelines) provide local interpretations of these state and federal guidelines for Byron Shire, but do not replace or diminish their importance. System designers must be familiar with all of the above guidelines if they intend to submit an OSMS design to Byron Shire Council.

1.1. Scope and Applicability

These Design Guidelines are intended to provide guidance for those designing and installing on-site sewage management facilities for single domestic dwellings in Byron Shire. They provide information on:

- preparing an on-site sewage management report;
- the design of OSMSs in sewered and unsewered areas;
- Byron Shire Council's on-site sewage management objectives and guiding principles; and
- a glossary of technical terms used in the industry.

These Design Guidelines do not specifically apply to systems servicing more than a single household or dwelling. Package treatment plants and systems designed to cater for more than one household will be covered by separate guidelines, and until these are available will be dealt with on a case-by-case basis. Further, these Design Guidelines do not provide specific information on:

- designs for subdivision of land;
- off-site sewage management systems;
- specific advice for OSMS in urban areas;
- multiple-dwelling (combined or package) sewage management systems
- agricultural, commercial and industrial developments; or
- patented sewage treatment systems.

Nevertheless, these Design Guidelines may provide useful information when assessing the above and related issues.

The Design Guidelines rely heavily on both the NSW Environment and Health Protection Guidelines (1998) and Australian Standard AS/NZS (2000), and designers are expected to understand and follow these two documents closely. Where conflicts or ambiguities arise between the two external documents and these Design Guidelines, the advice in the Design Guidelines shall prevail.

For further advice on providing for appropriate OSMS on subdivisions, designers are required to refer to the Byron Shire Rural Settlement Strategy (BSC, 1998) – if ambiguities arise between these two documents, the Settlement Strategy takes precedence over these Design Guidelines.
There are particular difficulties involved in developing on-site wastewater solutions in urban areas, and these are recognised in Council's Policy 5.59 – On-site Sewage Management Systems in Urban Areas. If a home-owner wishes to treat or utilise sewage in an urban area, these Design Guidelines should be followed in conjunction with the the above-named Policy. If ambiguities or conflicts arise between the two documents regarding an application in an urban area, the advice set out in the Policy shall take precedence.

Council has not yet developed design guidelines for larger on-site sewage management systems, e.g. for cluster dwellings, commercial, agricultural or industrial applications, etc. Until this document is prepared, these applications will need to be designed by specialists in the field in consultation with Council officers.

Finally, Byron Shire Council also offers a plain English version of on-site sewage management options called *The Home owners guide to on-site sewage management.* This is a greatly simplified version of the Design Guidelines and, if any ambiguities arise between the two documents, the advice in these Design Guidelines shall prevail.

1.2. Guiding Principles

Byron Shire Council's On-site Sewage Management Strategy aims to protect our local waterways and their capacity to assimilate and transform wastes without altering the quality of their ecosystems. The Strategy also advocates the reuse of nutrients and hydraulic loads from sewage, preferably to achieve some beneficial outcome such as the diversion of high quality potable water resources from garden watering duties. In order to achieve the aims of the Strategy, these Design Guidelines provide guidance and information to ensure sites are adequately assessed and on-site sewage systems are designed and installed in a manner that does not threaten public health or the downstream environment. The Design Guidelines adopt the precautionary principle in attempting to ensure that the long-term environmental impacts of OSMSs are minimised through the implementation of current "best practice" sewage management approaches.

The following principles underpin Council's Design Guidelines for On-site Sewage Management for Single Households:

- Selection of a treatment system and land application area begins with consideration of the health and sensitivity of the down-stream catchment and the cumulative impact to which the subject OSMS is contributing.

- Low-tech gravity-fed systems are encouraged as these tend to be cheaper and more sustainable, provided that effluent can be reliably and evenly distributed over a sufficiently broad area to enable adequate evapo-transpiration.

- Maximise the opportunity for nutrient and water re-use by vegetation uptake. Re-use by evapotranspiration is the preferred method of managing post-treatment nutrients.

- Prevent off-site movement of effluent via surface runoff, lateral subsurface seepage or percolation into ground water.

- Minimise the risk to householders and the public of contact with pathogenic microorganisms.

- Distribute effluent evenly throughout the effluent application area.

- Minimise the quantity of natural resources utilised in construction, including energy.

- Ensure that on-site sewage management systems are to be designed and installed by a suitably qualified and experienced person with demonstrated expertise in on-site sewage management issues.

Experience shows that there is no standard solution for all sites. Each site and each owner have specific requirements that must be addressed. The following step-by-step guide will assist designers and owners in selecting and designing the most suitable options for their specific sites.

1.3. NSW Health Accreditation of OSMS Facilities

Under the provisions of Division 6 (Clauses 42 and 43) Local Government (Approvals) Regulation 1999, a local council must not approve of the installation of certain sewage management facilities unless they have been accredited by the NSW Department of Health. Details of which sewage management facilities are affected by this legislative requirement and the process for gaining accreditation are provided, along with other relevant information, on NSW Health's website at http://www.health.nsw.gov.au/public-health/ehb/general/wastewater/wastewater.html.

1.4. More information

There exists in the literature a wealth of information regarding on-site sewage management. Those seeking further detail than is provided within this document are referred to the following (for example);

- *Environment and Health Protection Guidelines: On-site Sewage Management for Single Households*, 1998 available from the NSW Department of Local Government. This document can be downloaded from www.dlg.nsw.gov.au
- Australian Standard AS/NZS 1547, 2000*. On-site domestic wastewater management.* Available from Standards Australia, PO Box 1055 Strathfield NSW 2135 or www.standardsaustralia.gov.au.
- NSW Department of Local Government at www.dlg.nsw.gov.au (an overview of the Department's on-site sewage management programs to improve health and environment). A very useful document provided by DLG is the *On-site Sewage Risk Assessment System*, which is available on-line from www.dlg.nsw.gov.au/dlg/dlghome/dlg_osras.asp.
- NSW Department of Health at www.health.nsw.gov.au/public-health/ehb/general/. Information on the accreditation of sewage management facilities by NSW Health is available on www.health.nsw.gov.au/public-health/ehb/general/wastewater/wastewater.html.
- Byron Shire Council website at http://www.byron.nsw.gov.au/health_and_compliance
- Byron Shire Council's *On-Site Sewage Management Strategy, 2001*, available from Council website cited above
- Byron Shire Council's *Home owners guide to on-site sewage management, 2001.* A simplified or 'plain English' version of the design guidelines, available from Council website cited above
- BSC's *Byron Rural Settlement Strategy, 1998*.

2. STEPS REQUIRED FOR PREPARING AN OSMS DESIGN

An OSMS generally consists of three main parts: the wastewater source, treatment components, and a land application area for the final reuse or disposal of the treated effluent. These components are represented graphically in Figure 1.

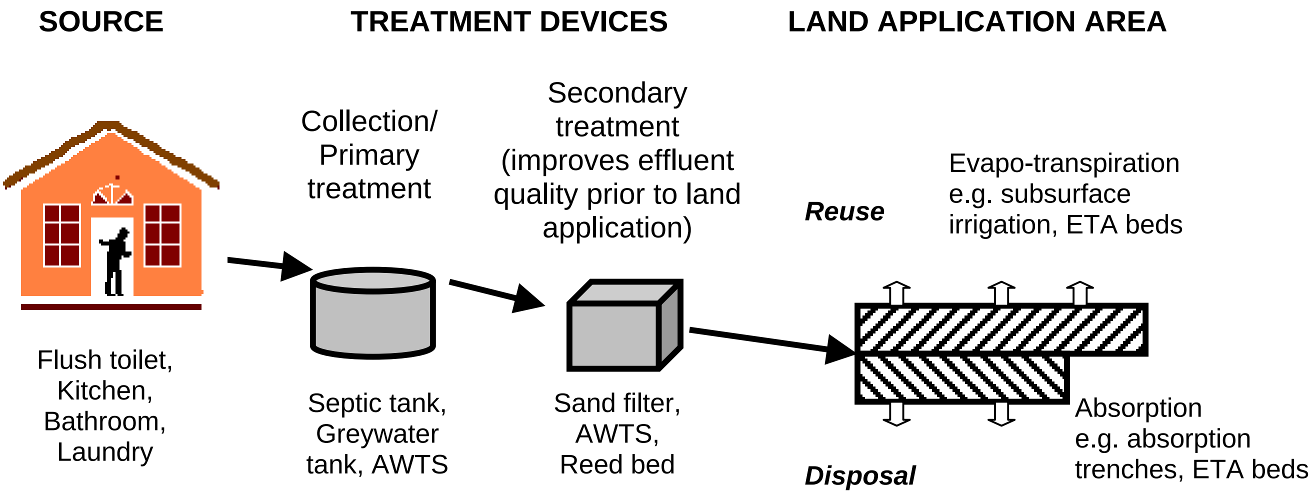


Figure 1: Major Components of On-Site Sewage Management Systems (OSMSs)

The process of designing an OSMS involves gathering, interpreting and reporting information relevant to each part of the treatment train. Thus, designing a suitable OSMS requires a good understanding of the soils and other physical variables of the site (e.g. slope, aspect and shape of the land), the wastewater generating activities of the household, and an extensive knowledge of the available treatment and land application options.

2.1. Recommended Design Steps

A number of steps are involved in successfully designing an OSMS in Byron Shire, as summarised in Table 1. Generally, once preliminary information has been gathered via desktop search, a detailed site and soil assessment is carried out to identify any potential constraints and limitations of the site for managing effluent. Once the site limitations are known, suitable treatment and land application options can be identified that will address any constraints appropriately.

Table 1 should be used as a checklist when preparing an OSMS design report for submission to Council. References to the relevant sections of the Design Guidelines are provided in Table 1 where appropriate. A computer-based model (using MS Excel) has also been developed by Byron Shire Council to assist in the design and sizing of effluent treatment and land application systems (refer Appendix C).

Note that the requirements that must be met by installers of OSMS (once an OSMS design has received Council approval) are provided in Section 10 (page 31).

Table 1: Steps required in preparation of an OSMS design report for submission to Byron Shire Council

Step	Task	Relevant section of *Design Guidelines* to refer to;
1	Undertake desktop research	Section 3.0 (page 5)
2	Identify wastewater sources and water utilising devices, and estimate hydraulic loads	Section 4.0 (page 6); Appendix C; OSMS Design Model.
3	Conduct detailed site and soil assessment to identify potential limitations of the site and soil for accepting effluent	Section 5.0 (page 8); Appendix B and H.
4	Identify suitable treatment and land application options and consult with client to determine preferred options	Section 4.5, Appendices A & B.
5	Design treatment system	Appendices A and C; OSMS Design Model.
6	Determine the most suitable method of land application system and calculate the size of the land application area.	Appendices B and C; OSMS Design Model.
7	Measure and peg out proposed land application area. Compile a diagram showing layout of proposed land application area	Section 8 (page 27)
8	Compile the above information in a detailed design report, including preparation of OSMS Management Plan for homeowners	Section 8 (page 27), Appendix G.
9	Submit 2 copies of the report to Council for approval	Section 8 (page 27)
*****	Once design has been approved, requirements for installation by licensed plumber are set out in Installers Requirements	Section 10 (page 32)

3. DESKTOP RESEARCH

Desktop research must be undertaken to determine the approval status of any existing systems, Deposited Plan (DP) and Lot numbers (or BSC Parcel Numbers when known), flooding depths and frequency, risk of disturbing acid sulphate soils, geology and soils of the area (see Table 4) using, for example, *Soil Landscapes of the Lismore-Ballina 1:100,000 Sheet* by Morand (1994) and other references as necessary.

All designers are urged to come to the Byron Shire Council counter in Mullumbimby to get a copy of a selective GIS image of the subject property (ask for “OSM Layer”, small fee applies). This will show the approximate buffer distances to waterways, proximity to registered water bores and cattle tick dip sites, and slopes greater than 10 %. Approximate flood-levels are usually available but unfortunately Council’s mapping is not accurate enough to confidently predict flood levels in some areas and local information may need to be sought.

4. ESTIMATING WASTEWATER GENERATION

4.1. Predicted Hydraulic Flow

For existing dwellings fitted with a water meter, an accurate estimate of household sewage volumes can be obtained by monitoring the meter readings over a number of weeks when little or no outside watering is occurring, or examining water usage reported on previous water bills during wet periods. For new houses or where no meter readings are available, effluent generation rates should be based on the potential maximum number of people that may inhabit the dwelling at any one time. In Byron Shire, this is calculated on the basis of the number of bedrooms multiplied by 1.5 persons per bedroom, unless there is information to suggest that more people will be or are living there, in which case the higher number should be used.

Installing water efficient fittings and appliances in the household to minimise wastewater generation rates can achieve significant reductions in the size and cost of treatment and land application components of OSMS. Installing composting toilets rather than flushing toilets can achieve the greatest single reduction.

In consultation with the home-owner, the OSMS designer is required to refer to AS1547 (2000) to determine appropriate wastewater generation rates, based on what the household water source will be (e.g. tank water or reticulated supply) and whether water-saving devices are installed. Note that Council will need to confirm that any water-saving devices claimed in the design are installed when it inspects the OSMS (refer Section 10). The daily volume of household effluent that the OSMS will need to cater for is then estimated by multiplying the number of persons expected to reside there (see above) with the expected effluent generation rate from AS1547 (2000). These calculations are performed within a subroutine of the Byron OSMS Design Model (refer Appendix C).

4.2. Nutrients and Pathogens

Besides the volume of water, there are two other components of domestic sewage which need to be closely considered by the OSMS designer; nutrients (e.g. carbon, nitrogen and phosphorus) and pathogens.

4.2.1 Nutrients in Sewage

The often high levels of nutrients found in sewage can be either a potential source of pollution if they are allowed to reach surface or groundwaters, or a resource in sustaining the growth of lawns and gardens. As indicated in the Guiding Principles (Section 2.1), the challenge for the OSMS designer is to reduce the nutrient levels and spread those that remain in the effluent in such a way that they will virtually all be taken up by plants in the land application area and virtually no excess nutrients will reach the groundwaters or neighbouring surface waters.

It is expected that compliance with these Design Guidelines, in conjunction with the associated OSMS Design Model or an equivalent, will enable home-owners to be confident that they will not be causing pollution by allowing excess nutrients to leave their property boundaries or enter waterways. In most cases, this is achieved by matching the likely loads with plant uptake rates and sizing the land application area (LAA) to ensure complete reuse within that LAA. On larger blocks where the cumulative risks of OSMS are lower, Council's OSMS Design Model permits a proportional reduction of the LAA, with the expectation that the buffering capacity of the vegetated lands surround the LAA will assist in assimilating any excess nutrients (refer Appendix C).

4.2.2 Pathogens in Sewage

Pathogens are micro-organisms that can cause diseases, including bacteria, protozoa, viruses and helminths. Pathogens are found in varying concentrations in all domestic sewage, but are found in particularly high concentrations when one of more of the residents are infected with a disease.

Similarly, if pathogens are transmitted they might have no effect on a healthy adult but can be much more of a risk for small children or immunity-suppressed receptors. Another related point to note is that OSMSs servicing those who are taking strong medication, e.g. antibiotics and chemotherapy drugs, are liable to be affected and maybe disabled by these medications.

Some types of pathogens, e.g. viruses and helminths, are able to survive outside the body for months (refer for example to DLG, 2001 – OSRAS Handbook Appendix F). Although soil often performs as a very good filter for pathogens, there always remains some risk that pathogens can be transmitted from carelessly treated or inappropriately applied land application systems.

Based on available published information, Byron Council expects that adherence to these Design Guidelines will ensure that risks posed to home-owners and neighbours are kept to acceptably low levels. However, where designers have cause to reduce the recommended buffer distances (refer Section 5.1.6) or where above-ground application of effluent is proposed (refer Section 7), designers are required to provide additional written consideration to the risks of pathogenic transport and potential infection by householders, neighbours or downstream water users.

5. SITE AND SOIL ASSESSMENT

Correct and accurate site assessment is critical to developing appropriate and sustainable sewage management systems. The main aims of the site and soil assessment are to identify any constraints that may potentially limit the ability of the site to adequately deal with effluent and to determine the amount of suitable land available for land application of the treated effluent. The information gained from the site and soil assessment will ultimately be used to determine the type, size and location of the land application system, and the level of treatment required to overcome any constraints.

Different situations require different levels of assessment, especially where there are limitations to be surmounted. It is stressed that site and soils assessment are specialised disciplines and it is not possible to include in these Design Guidelines all the relevant and necessary information that professional assessors are required to understand (refer Section 1.3 for further information).

The following sections explain in detail the various parameters required for a site and soil assessment. If constraints are found during the site and soil investigations, designers should examine options for ameliorating these constraints (refer Table 6).

5.1. Site Evaluation Procedures

Most of the following information is drawn from the Australian Standard (AS/NZS1547, 2000). The information below will help you evaluate your site's capacity to manage on-site sewage (Table 9).

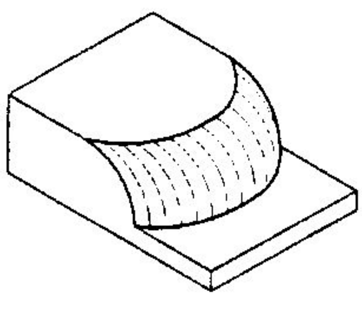
5.1.1 **Slope Angle** (Refer also AS/NZS1547, 2000)

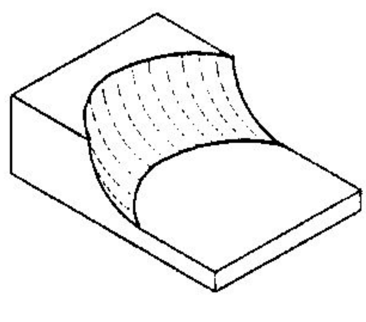
The slope of the site, especially the proposed application area(s), should be determined in the field through the use of such instruments as an inclinometer over at least 20 m distance or through a formal survey of the site.

Slopes greater than 15% (8.5 degrees) are regarded as severely limiting the installation and operation of land application systems (refer Table 6).

5.1.2 Slope shape

The shape of the slope may either assist or hinder drainage as shown in the following diagrams





Best water-shedding shape (convex) Worst water-shedding shape (concave)

(Source AS/NZS1547, 2000)

Concave-shaped slopes are much more likely to have problems with effluent dispersal than convex-shaped slopes because of the way groundwater is concentrated in them. Additional cut-off drains and diversion bunds may be used to ameliorate poor drainage conditions. The reader is referred to the Australian Standard (AS1547, 2000) for more detailed diagrams of the various types of slope shape and their implications for OSMS.

It is strongly recommended that the site be surveyed to aid landform and slope assessment. A minimum distance of 20 meters will be required to measure and determine the degree of slope, and variations in slope around relevant parts of the property should be marked on the plan.

5.1.3 Aspect

Use a compass to ascertain the dominant direction that the proposed irrigation area faces. North and northeast-facing slopes are preferred due to greater exposure to sunlight, hence higher evapo-transpiration rates. Refer to AS/NZS1547 (2000) for further advice.

5.1.4 Exposure

High exposure to sunlight and prevailing winds greatly aids the uptake of water vapour through transpiration and evaporation processes. It is worth noting that meteorological stations are invariably located in positions fully exposed to sun and wind. The daily water balance model recommended in these Design Guidelines (Appendix C and OSMS Design Model), which are based on Alstonville climate records, would not be representative of a damp shaded area. Any such areas should be marked on the site plan and avoided in the selection of the land application area. Refer to AS/NZS1547 (2000) for further advice.

5.1.5 Boulders/Floaters/Rock Outcrops

Boulders/floaters or rock outcrops may reduce the effectiveness of effluent “polishing” mechanisms in the soil. Rocks make installation more difficult and may also restrict infiltration and allow sewage to short-circuit the dispersal field and more rapidly enter waterways. (Refer also AS/NZS1547, 2000)

Proposed application areas should be traversed on foot and the presence of any boulders/floaters or rock outcrops should be recorded in the site plan. Note: The definition of a boulder is a rock whose middle dimension is at least 600mm (see Glossary).

Shallow bedrock is a significant constraint because it greatly limits the natural assimilation capacities which might otherwise be provided by clay soils, and may provide a much faster and much more poorly filtered conduit to groundwater resources. Where investigations indicate that the C-horizon (weathered bedrock) lies within 1.5m of the soil surface, the depth to bedrock should be entered into LAA calculations (e.g. in cell B14 in Byron OSMS Design Model) and amelioration measures should be considered to compensate for the constraint (refer Table 6).

5.1.6 Buffer Distances

Accurate distances to certain critical features must be recorded as described below. Appropriate setback distances are determined by the E&HP Guidelines (1998) or the Beavers and Gardner method, described in their published paper (Beavers and Gardner, 1993). It is likely that there will be difficulties in obtaining the necessary parameters (i.e. accurate estimations of soil permeability) to use the Beavers and Gardner method however, in which case the default setback distances set out below should be used.

Byron Council accepts that the following buffer distances cannot always be met. Where it is necessary, or for some reason highly desirable, to reduce the one or more of the buffer requirements, greater attention shall be paid to improving quality of the effluent or expanding the size of the land application area (Refer Table 6). Where it is proposed to place the treatment system or land application area within the following buffer distances, the designer must provide a written evaluation of the potential risks for the transfer of pathogens from the OSMS to residents or neighbours (refer Section 4.2.2) and proposed amelioration measures to be taken to reduce health and environmental risks in the reduced buffers:

1. minimum buffer distance of one hundred (100) metres from the nearest edge of permanent watercourses including rivers, creeks, wetlands, dams or lakes.

2. minimum buffer of forty (40) metres from the centre-line of ephemeral water courses (e.g. intermittent waterways, drainage channels and dry gullies).
3. minimum buffer of 250 metres to downstream or cross-gradient domestic groundwater well, and at least 50 m from upstream groundwater well.
4. minimum buffer distances between the treatment and/or land application area (LAA) **other than ETA beds** and a building or property boundary are as follows:
   (i) for sites with slopes less than 10% (5.7 degrees):
      a) three (3) meters when the building or boundary is up-gradient of the LAA; and
      b) six (6) meters when the building or boundary is down-gradient from the LAA; and
      c) 1.5 meters between adjoining subsurface application systems (e.g. ETA beds); and
      d) six (6) meters from a swimming pool, driveway, building or property boundary;
5. minimum buffer distances between the treatment and/or land application area (LAA) **for ETA beds** should be double those listed above (e.g. 6 m if building or property boundary is up-gradient of the LAA, and 12 m if it is down-gradient from the LAA)

6. effluent dispersal fields/distribution networks (i.e. pipes, gravel, etc.) should be located a minimum of 1200 millimeters above the top of the natural ground water table. This depth may need to be increased to account for highly permeable soils, low-quality effluent and/or potential sensitive environmental impacts;

6. areas of high water table (i.e. less than 1.2 m below ground surface), groundwater recharge, highly permeable soils and/or containing rock outcrops, shallow bedrock, acid sulfate, sodic or saline soils are considered major limitations to onsite effluent dispersal.

7. treatment and application systems should be kept at least 100 m from Cattle Tick Dip Sites or other known contaminated sites, unless detailed soil sampling confirms that there are no contaminated soils in the treatment or application areas.

5.1.7 Run-on and Upslope Seepage

Any known run-on or upslope seepage which might affect the application areas must be recorded on the site plan (refer AS/NZS1547, 2000). The presence of flood debris and silt deposits may assist in identifying run-on flowpaths. If stormwater cannot be reliably controlled by the construction of a catch drain, a diversionary swale or an interception trench above the dispersal field, then an alternative location must be chosen.

5.1.8 Flooding Potential

The flooding potential of the site must be determined, especially for low-lying areas and flood plains. All land application areas should be above the 1 in 20 year flood height, and treatment systems should be above the 1 in 100 year flood level. Council or the NSW Department of Public Works may be able to supply flood height records in some areas.

5.1.9 Site Drainage

The frequency and duration of seasonal shallow waterlogging should be noted. Signs of poor drainage include hard packed soils, vegetation growth characteristic of damp sites, and pooling of water. It is not recommended that land application areas be installed within sites with poor drainage. The location of channeled (concentrated) runoff on site, as well as any runoff likely to move onto neighboring properties, should be noted on the site plan (refer also AS/NZS1547, 2000) and avoided in the siting of the Land Application Area.

5.1.10 Vegetation Indicating Waterlogging

While wetland species such as bulrushes etc are obvious signs of frequent waterlogging, other less obvious species such as sedges and buffalo grass can, in this region, indicate seasonal waterlogging. The presence of these or other moisture-loving species should be noted in the site plan.

5.1.11 Surface Condition

Note cracks, hardness, previous compaction patterns, dampness and the location of seepage areas (refer also AS/NZS1547, 2000).

5.1.12 Fill

The location, depth and type of any fill should be noted on the site plan, as shown in AS/NZS1547 (2000). Clean fill consisting of soil, which has settled and is on a stable site, may be used for effluent application. However other types of fill with coarse fragments and located on steep sites, are unsuitable for land application of effluent.

5.1.13 Erosion/Mass Movement

The location and details of existing mass movement and erosion, such as gullies, slips and rills should be recorded on the site plan (refer AS/NZS1547, 2000). To protect against future erosion, adequate drainage controls must be undertaken to ensure that effluent is not concentrated within one location, and upslope runoff is diverted around the land application area.

Particular attention should be paid to ensuring that on-site systems in steep areas will not lead to slumping on slopes. If in doubt, seek suitably qualified advice.

5.2. Soil Evaluation

The relevant soil properties of each proposed land application area should be investigated and assessed in accordance with AS1547 and these Design Guidelines by a suitably skilled and qualified, independent practitioner. The assessment must contain an accurate estimation of the soil and sub-soil characteristics. The three key tests to be performed are

- the manual bolus or ribbon test to determine soil *texture*
- the visual test to determine soil *structure*
- the modified Emerson Aggregate test to determine soil *dispersiveness*

Soil evaluation needs to be focused on the proposed land application area as recommended in AS1547 (2000). At least two soil profiles should be examined in each land application area, either by boring or trenching. If significant differences are found in the first two profiles, more sampling should be undertaken in order to establish the approximate boundaries of the various soil types.

Soil profiles should be examined to a depth of at least 1.2 m, or deeper if changes in soil colour or texture are still being noted at the base of the hole. Unless there are less permeable layers found during the profiling, samples from around 0.4 m depth and around 1.0 m should be collected for detailed textural assessment, either by an independent geotechnical laboratory or by a skilled practitioner. A single sample from around 0.8 m depth in the centre of the proposed land application area may be acceptable in deep krasnozems, sands or particularly evenly graded soils.

Soil texture and structure determine the soil's ability to accept effluent, which in turn determines the appropriate effluent loading rate. For example, highly dispersive soils are problematic due to the damaging effect that excessive sodium can have in destroying the soil structure, leading to a decrease in soil permeability, and very low effluent loading rates are therefore recommended for highly dispersive soils (refer Section 8). Designers should also be aware that, even though they are not classified as highly dispersive, krasnozem and many other volcanic-derived soils in this area are prone to exhibiting reduced permeability after prolonged contact with highly sodic sewage effluents (Patterson, 1998).

An indication of the broad soil category of a site can be obtained from *Soil Landscapes of the Lismore-Ballina* or *Tweed 1:100,000 Sheet* Morand (1994). However, soil parameter values within any one soil type can be highly variable. As part of the initial desk top study the soil unit from this text should be ascertained in order to identify *likely* site and soil limitations as well as indicate likely phosphorous sorption rates. Table 2 will assist in this process.

Table 2: **Soil Landscapes in Byron Shire (showing likely limitations for effluent dispersal, and phosphorous sorption.** Sources: Morand (1994), P-sorption analyses by EAL, Southern Cross University 1998.

Soil Unit (Morand, 1994)	**Code** (Morand 1994)	**Broad Soil Type**	**Likely limitations** Asterisk (*) indicates comments from Morand (1994)	**P-sorption kg/ha/m** (Morand, 1994)
Bagotville	**Ba**	Sandy Duplex	Flood prone footslopes*.	8,000
Bangalow	**Bg**	Red Basaltic	Steep, shallow*. May need benching and/or SDI on slopes.	10,000
Billinudgel	**Bi**	Yellow and red podzols	Acidic, hardsetting soils, mod. CEC	10,000
Black Rock	**Br**	Sandy podzol	Waterlogging, high watertables, low CEC*.	1,000
Coolamon	**Co**	Red Basaltic / Dark Basaltic	Steep, shallow, stony soils, mass movement*.	10,000
Disputed Plain	**Dp**	Alluvial (highly reactive)	Waterlogged, impermeable soils, high watertables*.	10,000
Eltham	**el**	Red Basaltic	Locally waterlogged, flood hazard, proximity to streams. *	10,000
Ewingsdale	**ew**	Red Basaltic	High permeability, but mass movement hazard near drainage lines, waterlogging on lower slopes.*	10,000
Mount Burrel	**mb**	Red Basaltic / Dark Basaltic	Steep slopes, mass movement*. May need benching and/or SDI on slopes.	10,000
Minyon	**mi**	Sandy / Clayey Duplex	Steep slopes, rockiness, seasonal waterlogging and shallow soils (all localised)*	8,000
Mullumbimby	**mu**	Alluvial clays	Flood hazard, seasonal waterlogging, high watertables. May need mounds.	10,000
Myocum		Alluvial clays	Flood hazard, seasonal waterlogging, high watertables. May need mounds.	10,000
North Casino	**nc**	Alluvial (highly reactive)	Shrink-swell soils, localised waterlogging and high watertables*.	10,000
Nightcap	**ni**	Varied: includes Red Basaltic, Clayey Duplex	Steep slopes, mass movement, rockiness*	8,000
Nimbin Rocks	**Nr**	Steep thin volcanic soils	Severe limitations for development on cliff-footslopes. Not suitable for OSMS.	---
Rosebank	**Ro**	Red Basaltic	Steep slopes, mass movement*. May need benching and/or SDI on slopes.	10,000
Terania	**te**	Alluvial (varied, not highly reactive, and doesn't easily fit Great Soil Group or profile categories)	Close to watercourse, flooding, stream-bank erosion, slumping*.	10,000
Tuckean	**tu**	Humic Gley	Unsuitable for effluent dispersal.	
Tyagarah	**ty**	Alluvial /Sandy Podzolic	Waterlogging, high watertables, low CEC*.	1,000
Wollongbar	**wo**	Red Basaltic	High permeability*.	10,000

5.2.1 Soil Texture Classification

Soil texture may be measured by the behavior of a small amount of soil, incrementally moistened and kneaded into a small ball (bolus), then manipulated between the thumb and forefinger to form a ribbon. The soil is then categorised from the behavior of the moistened bolus and the length the squeezed ribbon achieves before shearing or failing

There are six broad texture categories which are used to classify the likely permeability of soil, as set out in Table 3. Each texture group and any change in texture group within the soil profile should be recorded. The following table is provided to assist in determining the soil texture category.

Table 3: **Soil Texture Grades.** Source: Northcote (1979) and AS/NZS1547(2000).

Soil Category (Texture Group)	Grade of Soil Texture	Behavior of moist bolus	Indicative ribbon length before failure (mm)
1 - Gravels & sands	Sand	nil to very slight coherence, won't mould, single grains adhere to fingers	Less than 5
	Loamy sand	slight coherence	≤ ~6.35
	Clayey sand	slight coherence, sticky when wet, many sand grains stick to fingers, discolours fingers with clay stain	6.35-13
2 - Sandy loams	Sandy loam	bolus just coherent, v.sandy to touch, dominant sand grains readily visible	13-25
	Fine sandy loam	bolus coherent; fine sand can be felt and heard when manipulated (clearly seen under hand lens)	13-25
	Light sandy clay loam	strongly coherent bolus, sandy touch, med. size sand grains easily visible	20-25
3 - Loams	Loam	bolus coherent, spongy, smooth (not sandy / silky) feel when manipulated	~ 25
	Loam, fine sandy	bolus coherent and slightly spongy, fine sand can be felt and heard when manipulated	~ 25
	Silt loam	coherent bolus; very smooth to silky when manipulated	~ 25
	Sandy clay loam	strongly coherent bolus, sandy touch, med. size sand grains in finer matrix	25-38
4 - Clay loams	Clay loam	coherent plastic bolus, smooth	38-50
	Silty clay loam	coherent smooth bolus, plastic and silky to touch	38-50
	Fine sandy clay loam	coherent bolus, fine sand can be felt and heard when manipulated	38-50
5 - Light clays	Sandy clay	plastic bolus; fine to med. sands seen, felt or heard in clayey matrix	50-75
	Silty clay	plastic bolus; smooth and silky to manipulate	50-75
	Light clay	plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger	50-75
	Light medium clay	plastic bolus; smooth to touch; slightly greater resistance to shearing between thumb and forefinger.	~ 75
6 - Medium to heavy clays	Medium clay	plastic bolus; like plasticine & can be moulded into rods without fracture; some resistance to ribboning shear.	≥ 75
	Heavy clay	Smooth plastic bolus; like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning shear.	≥ 75

5.2.2 Soil Structure

The soil structure is to be determined from visual assessment of the site and from borehole testing, through the examination of exposed soil surfaces. Table 4 summarises the common soil structures.

Table 4: Soil structure according to degree of pedality. Source (AS/NZS1547, 2000)

Degree of Pedality	Appearance
Massive	Coherent, with any partings both vertically and horizontally spaced at greater than 100 mm. Pieces do not break along planes of weakness but break according to stress loads
Single grained	Loose incohesive, structureless e.g. sands
Weak	Peds indistinct and barely observable on pit face. When disturbed approximately 30% consist of peds smaller than 100mm
Moderate	Peds well formed and evident.. but not distinct in undisturbed soil. When disturbed 30% - 60% consists of peds smaller than 100mm
Strong	Peds quite distinct in undisturbed soil. When disturbed >60% consists of peds smaller than 100mm

5.2.3 Soil Permeability Determination

Accurate soil permeability assessment is encouraged but is often quite problematic. A preferred method for field evaluation using a constant-head permeameter is provided in Appendix 4.1 F of AS/NZS1547 (2000). Alternatively, AS 1547 (2000) provides indicative permeabilities based on textural and structural soil characteristics (refer Appendix 4.2 of AS1547 cited above).

5.2.4 Colour Description

The colour of a soil is often a good indicator of state of saturation of the soil, in turn reflecting the oxygen availability in the soil. For example, red or brown colours generally indicate well aerated soils lying above the standing water table, while grey or white soils are often found in saturated or periodically saturated soils.

A detailed colour description of the soil profile should therefore be conducted during the soil assessment. The soils should be described in the moist condition by the following colours: black, white, grey, red, brown, orange, yellow, green or blue. The classification can be modified as required by the words pale, dark or mottled. Transitional colours may be described as a combination of these colours (e.g. red-brown).

When a soil horizon has a predominant colour with mottles of another colour, it is described in the form: (predominant colour) mottled (secondary colour), e.g. grey mottled red-brown. Where two colours are present in roughly equal proportions, the colour description is described in the form: mottled (first colour) and (second colour), e.g. mottled brown and red-brown.

5.2.5 Assessment of Coarse Fragments

Coarse fragments include hard rock material and nodules or segregations. These may be separated from the fine earth component of a soil sample by using a 2 mm sieve. This is a difficult process when a soil is moist and heavy, in which case a field estimate using abundance charts is acceptable. A visual estimate of abundance should be recorded, along with the size range of rock fragments and their corresponding amounts, using Table 5a and 5b.

Table 5. Abundance (a) and Size (b) of Coarse fragments Source: (AS/NZS1547, 2000)

Class	% of coarse fragments
Very few	<2
Few	2-10
Common	10-20
Many	20-50
Abundant	50-90
Profuse	>90

Type of rock	Size of coarse fragments mm
Fine gravel	2-6
Medium gravel	6-20
Coarse gravel	20-60
Cobbles	60-200
Stones	200-600
Boulders	>600

Where coarse fragments occupy more than 20% of soil volume *and* larger pores correspondingly accompany these coarse fragments, the flow of water is not expected to be impeded. Where coarse fragments occupy more than 20% of the soil volume but large pores accompanying the larger fragments are not present, the water flow is expected to be impeded and the Soil Category should be increased by one class e.g. a Clay Loam should be classed as a Light Clay for permeability estimation purposes.

Where there are more than 20% cobbles, stones and boulders, this can impede surface preparation and excavation and contribute to trench collapse.

5.2.6 Field pH

The pH of a soil can alter the availability of nutrient elements for plant uptake and can cause metal toxicities if pH is too low or too high. Acid soils tend to be leached of major plant nutrients e.g. calcium, magnesium, nitrogen and possibly molybdenum, while phosphorus may not be present in plant-available form. Alkaline soils are often deficient in iron, manganese, copper or zinc (Morand, 1994). A field pH test, using a calibrated field instrument or colour-test-strips, should be undertaken to determine the acidity/alkalinity of the soils. Soil pH of between 6.5 to 8 is ideal for plant uptake of phosphorous, potassium and nitrogen.

5.2.7 Dispersive Class (Modified Emerson Aggregate test)

The Modified Emerson Aggregate test provides a simple field assessment of a soil's aggregate stability. It is carried out using effluent or a prepared solution with similar qualities as the effluent to be applied to the soil being tested (for septic tank effluent this is equivalent to a solution with Sodium Absorption Ratio (SAR) of 5 and EC around 1000 μS/cm) (Patterson, 1998).

The test involves placing about three 5mm diameter undisturbed soil aggregates from the soil profile into a beaker of the above solution, and leaving undisturbed for 24 hours. The behavior of the aggregates is then recorded from the following:

Class 1: Material disperses completely.
Class 2: Aggregates disperse (clouds solution appreciably)
Class 3: Aggregates slake - smaller aggregates/particles fall off the original aggregate
Class 4: No change to aggregate, therefore non-dispersive.

If any of the replicates are in Classes 3 or 4 then the soil shall be considered *dispersive* and the Soil Category should be considered Grade 6, as though for a Texture Grade of Medium to Heavy Clays (refer Table 3 above and AS/NZS1547, 2000 for further information). In such cases, gypsum will need to be worked into the land application area at a predetermined rate in order to prevent soil structure degradation. Further ameliorative measures, such as the expansion of the land application area or provision of a larger reserve field, is also likely to be required to compensate for the likely long-term reduction in permeability in the land application area.

5.3. Site Constraints and Possible Solutions

The information in preceding sections should be used to make an assessment of the proposed land application area(s), and to identify any constraints for treatment or dispersal of effluent. Should any site or soil limitations be found, applicants or their consultants must clearly report them in the assessment report, highlighting all limitations and detailing the appropriate mitigation measures intended to be taken to address these limitations. Tables 6 and 7 show some common site and soil constraints, and the measures which might be employed to overcome them or ameliorate their effects.

Table 6: Limiting Site Conditions for Land Application Areas and Suggested Solutions

Site Feature	Examples of limiting conditions	Suggested solutions to limitations
Slope For steeper ground use narrow ETA beds or SSI	Slopes >15%	Enhanced treatment, sub-surface irrigation over larger area. Irrigation with wider spaced SDI emitters along contour for very steep or highly constrained sites.
Landform	Convergent (drainage-concentrating) land shape	Stormwater diversion bunds above concentrating areas, larger application area.
Exposure Good aspect and exposure to sun enhances evapotranspiration rates	Land application area faces SW or SE quadrants, and/or trees sheltering from sun-wind	Shade plants trimmed often, expand land application area or improve effluent.
Distance to Water Body and man-made features Potential for polluting downstream waters or neighbouring properties	<100m to permanent surface water OR <250m to domestic groundwater wells OR <40m to other waters (e.g. farm dams, intermittent waterways, dry gullies and drainage channels) OR <6m if up-gradient and <3m if down-gradient of property boundaries, swimming pools, driveways and buildings (In the case of ETA beds: <12m if up-gradient and <6m if down-gradient of property boundaries, but 6m/3m as above for pools etc)	Enhanced treatment of effluent, expand land application area, ensure that drainage is diverted around land application area.
Run-off/seepage from upstream lands	Run-on periodically saturates Land Application Area.	Swales, diversion drains, subsurface drainage.
Flooding Potential	Land application area below 1 in 20 year flood contour OR Treatment system below 1 in 100 year flood contour	Pump and electrical components must be out of 1:100 year flood zone, consider SDI with wet-weather storage or raised application area (e.g. mounds).
Site Drainage	Signs of surface dampness	If due to shading, trim trees or find alternative area. If due to stormwater, adjust surface drainage
Vegetation indicating waterlogging	Presence of sedges etc that indicate waterlogged soil	Swales or diversion drains to control drainage, improve treatment, expand application area or use raised mounds.
Surface Condition	Bare ground or cracking	Add or amend surface soils, improve treatment.
Fill	Land application area contains fill	Attempt to find alternative area, or replace fill with stable, compacted mixture of sand and clay soil. Ensure geotechnical stability will not be compromised by effluent
Erosion/Mass Movement	Rills, slips	Promote vegetation growth, improve drainage, get geotechnical advice.

The following table provides a summary of common soil problems which may be encountered in Byron Shire, with an indication of when the soil characteristic may limit on-site effluent dispersal, and possible amelioration measures for constrained land application areas.

Table 7: Soil limitations and suggested solutions

Soil Feature	Examples of limiting conditions	Suggested solutions to limitations
Dispersive or swelling Soils using modified Emerson Aggregate test	Soils in proposed land application area found to be dispersive (i.e. Class 3 or 4 in Table 4.1.1 of AS1547:2000), sodic or prone to shrink-swell characteristics.	Add gypsum or otherwise amend soil. Improve or increase second-stage treatment, and/or increase application areas.
Coarse Fragments(Coarse fragments, rocks, boulders impede absorption)	Rock fragments occupy >20% of soil volume	Increase size of land application area proportionally.
Field pH pH extremes inhibit plant growth	pH < 5.5 or >8	Improve or increase second-stage treatment. Conditioning with lime may assist if pH<5.5

6. CHOOSING A TREATMENT SYSTEM

This section provides information to assist in selecting the most suitable treatment system that will satisfy the needs of the given homeowner and adequately deal with any site constraints (such as close proximity to waterway or small block size). For each treatment system, general information is given regarding its function and form, and important information relevant to the operation and maintenance of each system is provided.

More detailed information for use in the design and sizing of each treatment system is provided in Appendix A. Designers are also strongly encouraged to do further reading and research (e.g. Crites & Tchobanoglous,1998; Metcalf & Eddy, 2002) to ensure that they understand all relevant aspects of all treatment systems under consideration. Applications based on innovative designs or emerging technologies are encouraged, provided sufficient technical justification can be provided to support their stated performance expectations.

Designers and prospective owners should be aware that each system will require some monitoring and maintenance, specified by Byron Shire Council in the Approval to Operate for that sewage management system (refer Appendix G). Highly mechanised systems such as aerated wastewater treatment systems and sub-surface irrigation fields generally have quarterly maintenance requirements, whilst most other systems need to be checked and maintained by a suitably skilled service-provider at least once a year. Designers and prospective owners should ensure that they are aware of the monitoring and maintenance requirements and consider their costs when choosing the system.

6.1. SOURCE CONTROL

6.1.1 Water-Saving Devices

The size and cost of treatment and land application systems are directly related to the volume of effluent that must be dealt with. Thus, activities or devices that minimise the generation of effluent at the source can often bring about a significant reduction in the cost and size of the OSMS. Careful consideration should therefore be given to the water consuming appliances used in the household (e.g. washing machines, flush toilets, shower heads, leaking plumbing).

Installing water efficient fittings and appliances in the household to minimise wastewater generation rates can achieve significant reductions in the size and cost of treatment and land application components of OSMS. Installing composting toilets rather than flushing toilets can achieve the greatest single reduction.

The designer is then required to refer to AS1547 (2000) to determine appropriate wastewater generation rates, based on what the household water source will be (e.g. tank water or reticulated supply) and whether water-saving devices are installed. Note that Council will need to confirm that any water-saving devices claimed in the design are installed when it inspects the OSMS (refer Section 10). The daily volume of household effluent that the OSMS will need to cater for is then estimated by multiplying the number of persons expected to reside there (see above) with the expected effluent generation rate from AS1547 (2000). These calculations are performed within a subroutine of the Byron OSMS Design Model (refer Appendix C).

6.1.2 Waterless Compost Toilets

Compost toilets significantly reduce the amount of treatment required for sewage by eliminating faeces and urine from the wastewater stream at the source. By eliminating the need for toilet flushing, they also reduce household water usage by as much as 30%. Consequently, the size and complexity of the treatment component of the OSMS can be significantly reduced, as only greywater is generated by the household. Nevertheless, it should be noted that compost toilets still generate a small amount of leachate that will need to be directed to the greywater management system or a small trench.

Details regarding the design and functioning of composting toilets are provided in Appendix A5. Operation and Maintenance advice is provided in Appendix G. All compost toilet installations shall be strictly in accordance with the requirements of the Local Government Act 1993.

6.2. Primary Treatment

Primary treatment refers to the physical removal of solids and organic matter through settling and sedimentation. Collection tanks (i.e. septic and greywater tanks) for raw effluent provide significant primary treatment through settlement and anaerobic digestion of organic solids by microbes. Primary treatment results in an effluent that is lower in suspended solids and biochemical oxygen demand (organic matter), but does not significantly reduce nutrient levels. The level of primary treatment depends on the residence time of the sewage in the tank, which in turn depends on the size of the tank, the volume occupied by scum and sludge layers and the volume of water used in the house.

6.2.1 Septic Tanks

The septic tank operates as a small anaerobic digester. Septic tank effluent is much lower in settled solids than the raw influent, but is still concentrated in nutrients and biochemical oxygen demand and generally requires some level of secondary treatment before it is suitable for land application (refer Section 6.3). Additional information regarding the function, sizing and management of septic tanks is provided in Appendix A. Operation and maintenance advice is provided in Appendix G.

6.2.2 Greywater Treatment

"Greywater" (or sullage) is the term used for all household wastewater excluding toilet wastes, for example the wastewater generated in a house with only composting toilets. Greywater generally contains lower nutrients but can still contain significant levels of pathogens, e.g. from showering and nappy washing. NSW Health requires that greywater be disposed of below ground level unless it has been adequately disinfected.

Greywater must be collected in an in-ground sullage tank (sized in accordance with NSW Health requirements, refer Appendix A), where primary treatment can occur, before being dispersed into the soil. Where the site is unconstrained, it can be piped directly from the sullage tanks into a suitably sized sub-surface land application system (refer Appendices B and C), but it should be understood that this is likely to reduce the operational life of the land application system. Byron Council therefore recommends that effluent from the sullage tank be further filtered and/or treated before land application (e.g. in a reed-bed or sandfilter).

The size of the application area required to safely disperse of greywater depends on effluent volumes and household inputs, and may be calculated using Byron Shire Council's OSMS Design Model (refer Appendix C). The minimum allowable size for a greywater dispersal bed must be calculated based on the nutrient uptake and hydraulic capacity of the land application system, but in no cases shall it be smaller than 10 m^2 per person in the household. This minimum figure is based on hydraulic dispersion capabilities of most soils, and would only be considered appropriate for at least partial-secondary treated greywater (refer Section 6.3).

6.2.3 Effluent Filters

An effluent filter is a coarse screen filter that fits into the outlet of a primary treatment tank. Effluent filters reduce Total Suspended Solids (TSS) carry over and thereby extend the operational life of land application components. Effluent filters are required to be fitted on the outlets of both septic and greywater tanks. Homeowners shall be made aware of the frequency and mode of cleaning before a particular filter is selected (refer Appendix G).

6.3. Secondary & Partial-Secondary Treatment

For the purposes of these Design Guidelines, the term "secondary treatment" applies to systems which produce effluents containing less than:

- 20mg/L BOD
- 30mg/L Total Suspended Solids
- 30 mg/L Nitrogen
- 10 mg/L Phosphorus

(Source: Dept Natural Resources, Interim Code of Practice for On-site Sewerage Facilities, 1999)

It is noted that the above performance standard is from Queensland, and that the equivalent design standard in NSW does not provide criteria for nutrients, but the above criteria is nonetheless offered in these Design Guidelines for additional guidance.

Council acknowledges that there are smaller treatment system options (e.g. smaller scale reed-beds), which will significantly improve the quality of effluent, but wouldn't necessarily reach the "secondary" performance standards listed above. For the purpose of these Design Guidelines, these options are termed "partial-secondary" treatment systems (refer Glossary for definitions). **The minimum standard of treatment generally accepted for blackwater-inclusive OSMSs in Byron Shire is to a partial-secondary standard which achieves a 20% reduction in total nitrogen.**

The choice of a treatment system to achieve secondary or partial-secondary effluent quality at any given property will involve balancing the strengths and weaknesses of the available treatment options, summarised in Table 8 and discussed in more detail in Appendix A. Constrained land application areas, e.g. within stated buffer distances (Section 5.1.1) or on poor soils or steep slopes, will generally require higher levels of treatment or larger land application areas to ensure that pollution of waterways is avoided.

By reducing the concentration of nutrients and suspended materials, the level of effluent treatment has a proportional impact on the size of the land application area required (as calculated by the OSMS Design Model, see Appendix C). Homeowners and system designers have the option to choose better quality (e.g. secondary) treatment and small land application areas, or lesser quality (partial-secondary) treatment combined with larger application areas, provided that the partial-secondary treatment option achieves at least a 20% reduction in total nitrogen for blackwater-inclusive systems.

Table 8. Strengths and weaknesses of secondary treatment systems. Source: Davison (2003)

Performance criterion	AWTS	Single pass sand filter	Recirculating sand filter	Reed bed (horizontal flow wetland)
Power required?	Yes	Pump needed on flat ground	Yes	No
Fall of site	Any	1m fall if no pump	Any	Flat to moderate slope
Surface area	Small	~ $4m^2$ /person	<$3m^2$ /person	$4\text{-}6m^2$ /person
Maintenance	High – quarterly contactor required	Owner can do checks, annual contractor to service	Owner can do checks, annual contractor to service	Owner can do checks, annual contractor to service
Construction cost	High	High	High	Moderate
Nitrification	Good	Good	Good	Poor to moderate
Nitrogen removal	Low	Low	Good	Moderate to good
Intermittent dosing needed?	No	Yes	Yes	No
Tolerance to peak loads	Low	Low	Moderate	Very good
Tolerance to low loads (holidays)	Low	OK	OK	OK
Visual impact	Low unless above ground	Can be hidden	Can be hidden	Moderate, can be landscaped
Awareness? Does the device invite user participation & hence awareness/ commitment?	No	No	No	Yes

6.3.1 Aerated Wastewater Treatment Systems (AWTS)

Aerated wastewater treatment systems (AWTS) have become popular in recent years, and a range of proprietary systems is available on the market. AWTS's are small-scale package treatment plants that are conceptually similar to large-scale sewage treatment facilities. They typically produce an effluent which, with sufficient filtering, can be distributed straight into a subsurface dispersal system (i.e. partial secondary effluent quality with 20% nitrogen reduction).

AWTS's depend on steady-state microbiological conditions, reliable electrical supply and regular maintenance of mechanical and electronic components to sustain reliable treatment. Failure or a sustained interruption in any part of the system, e.g. as a result of power interruptions or when a tourist dwelling is unoccupied during the off-season, can lead to a definite health and environmental risk until sufficient microorganisms are once again restored to adequately treat the effluent. Furthermore, AWTS's require regular (quarterly) maintenance to ensure that adequate disinfection (via chlorination) is maintained if this is required by their NSW Health Accreditation. This is why Byron Shire Council will usually only approve sub-surface irrigation as the land application method connected to an AWTS.

The sometimes high up-front and quarterly monitoring and maintenance costs associated with AWTS must also be considered when choosing an AWTS. Maintenance requirements for AWTSs are detailed in Appendix G.

6.3.2 Sand Filters

Sand filters (or derivations using other media) are an alternative type of secondary treatment device popular in the Europe and North America. Sand filters are generally of two types: single-pass and recirculating. Sand filters work best when the effluent is spread in even, pulsed doses over the top of the sand-bed. This can be achieved under gravity using a dosing siphon if sufficient static head (fall) is available, or more commonly by electric pump. Adequate primary treatment and good filtering must be maintained to prevent too much carry over of suspended solids and consequent clogging of the upper layers of sand media.

A disadvantage of some single pass sand-filters is their poor nitrogen-removing performance (though good nitrifying capacity). This can be remedied either by deepening the filter to ensure an anaerobic zone or by recirculating a proportion of the highly nitrified sand-filter effluent back over the sand filter or into the carbon-rich septic tank for rapid denitrification (USEPA, 2003). Recirculating sand filters usually provide better N-removing capability and better overall treatment performance than single-pass sand filters. However they are more expensive and complicated to construct, and require additional pump power.

More detail on the design and performance of sand filters is provided in Appendix A. Operation and maintenance requirements for sand filters are provided in Appendix G.

6.3.3 Subsurface Flow Reed Beds (Constructed Wetlands)

Constructed wetlands, or reed-beds, comprise a constructed impermeable basin in which water or effluent is kept slightly below the surface of a gravel substrate which supports the growth of wetland plants (usually reeds but can also be shrubs or trees). The effluent is biologically treated as it moves slowly through the root zone of the wetland plants.

Reed-beds are an increasingly popular type of secondary treatment device due to their aesthetic appeal, their reliable treatment performance capacities once the reeds are fully established, and their somewhat lower construction costs and maintenance requirements compared to other options. They are also passive devices not necessarily reliant upon power or pumps, and therefore economical to operate in the long term.

Details of reed-bed design requirements are provided in Appendix A. Sizing options for secondary and partial-secondary quality effluents is incorporated into the OSMS Design Model. Operation and maintenance requirements for sand filters are provided in Appendix G

6.4. Tertiary Treatment

In domestic on-site sewage management, tertiary treatment is generally taken to mean disinfection of secondary-treated effluent, but it may also include additional secondary treatment, filtration, and/or nutrient removal.

6.4.1 Disinfection

There are a number of options for effective long-term disinfection for on-site systems. Chlorination is commonly used with AWTS's. Some systems use bromine, UV light or ozone to disinfect. For surface spray or dripper-under-mulch irrigation systems, the effluent *must* be disinfected after partial-secondary treatment. Subsurface irrigation requires partial-secondary or secondary treatment, but does not require disinfection. NSW Health regulations require that disinfection of AWTS effluent occurs in most cases, even for sub-surface applications.

6.5. Other Considerations

6.5.1 Maximisation of Effluent Take-up by Plants

Land application areas calculated by the OSMS Design Model or similar means should be considered minimum requirements only. Council encourages all applications to maximise re-use of effluent into the filtering matter of plants, and any alternative applications that achieve a higher re-use than is required to comply with these design Design Guidelines are encouraged. Those wishing to distribute effluent in a manner that best serves their garden, and still complies with Council and State guidelines, are welcome to submit plans for consideration by Council that will better meet this objective.

6.5.2 Phosphorus Removal

Land application areas located on sandy soils may need suitable soils to be imported into the land application area to aid in phosphorus removal. Filters specifically designed to remove phosphorus may be incorporated into secondary treatment devices (e.g. through the use of media with a high phosphorus-sorption capacity). The media in such systems will need to be replaced once it becomes saturated with phosphorus.

6.5.3 Wet-Weather Storage

The NSW guidelines (E&HPG, 1998) highlight the desirability of not irrigating effluent during wet-weather, as this may lead to occasional surcharging and contamination of run-off waters with effluent. Byron Shire Council agrees with this sentiment but believes that, for single domestic applications, the expense, difficulty and increased risks to householders of contacting the effluent often outweigh the potential health and environmental risks of effluent-contaminated run-off during very wet periods. These Design Guidelines do not therefore mandate that wet-weather effluent storage must occur in single domestic installations, but designers should consider wet-weather storage a useful potential tool for improving environmental security on highly constrained sites (e.g. flood-prone lands or those over shallow groundwaters).

6.5.4 Holding Tanks / Pump Wells

Many modern OSMS systems require pumping effluent to or from various components, and this generally necessitates either an internal or external pump well. Pump wells, also commonly referred to as holding tanks or collection wells, enable the storage of effluent until it reaches a pre-set level in the tank at which time a pump is activated and the accumulated effluent is pumped through to the next component or the land application system.

The sizing of pump wells shall be in accordance with the advice provided by NSW Health in their "Septic Tank and Collection Well Accreditation Guideline" (refer Section 1.4 for download address), and provide sufficient storage space for at least seven days accumulated effluent in case of pump failure or blockage. Smaller holding tanks are acceptable for dosing siphons which have no opportunity for mechanical break-down. Audio and/or visual alarms must be installed in a manner that will alert the homeowner to the presence of a high-level condition in the tank. Backflow prevention devices must also be installed where appropriate.

6.5.5 Component Overflows

If overflows occur, it is important that effluent is not contacted by residents but also that the overflow is visible and cannot be readily ignored for sustained periods. Council encourages the installation of appropriately sized emergency overflow trenches, provided that inlets from the component are not sub-surface connections.

6.5.6 Pit or Pan Toilets

Due to the risk these types of toilets pose to human health and the environment, simple pit or pan toilets are now required to be upgraded to more suitable toilets such as composting toilets with greywater treatment.

7. CHOOSING A LAND APPLICATION SYSTEM

Effluent quality plus site and soil-specific parameters largely determine the appropriate land application system for any given situation, but cost and maintenance requirements are also clearly relevant in making the necessary choices. The strengths and weaknesses of various land application systems are summarised in Tables 4.2B1 and 4.2B2 of AS/NZS1547 (2000), whilst a brief description of each option is provided in the following sections. **Greater detail of each land application system may be found in Appendix B, and maintenance requirements are provided in Appendix G.**

The sizing of the land application area may be calculated using the OSMS Design Model, as outlined in Appendix C. Reserve application areas, with equivalent characteristics to the primary field, shall be designated and set aside in all new applications. The reserve field may be required if the primary application field fails over time due to, for example, reductions in permeability caused by interactions with sodic effluent or the soil's capacity to absorb phosphorus becomes super-saturated.

7.1. Absorption Trenches

The traditional absorption trench is the archetypal "disposal-only" system. Because there is little opportunity for reuse or treatment through plant uptake and because it is difficult to distribute effluent evenly in a way that does not pollute in the long-term, traditional trenches are discouraged in new OSMS installations. Systems which rely on soil absorption as the principal mechanism, e.g. absorption trenches, generally do not comply with the requirements of these Design Guidelines or the NSW EHP Guidelines 1998 (p119).

On some highly constrained lots where insufficient space is available for any other form of land application, absorption trenches may be the only viable option for effluent dispersal. In these cases, Byron Shire Council would generally expect that absorption trenches be preceded by at least secondary treatment, and that all necessary efforts would be made to disperse effluent evenly over the entire length of the trenches (e.g. by pumping or intermittently dosing).

On highly permeable soils which are located a sufficient distance above the standing water table beneath, it may sometimes be acceptable to use a "discharge control trench", in which the trench beneath the distribution pipe is deepened and filled with washed sand (refer AS/NZS1547, 2000 for design details).

On other types of highly constrained site (e.g. where only very small land application area is available), it is sometimes appropriate to distribute effluent in "micro-trenches". These micro-trenches comprise narrow, shallow, gravel-filled trenches in which sub-surface irrigation pipes are installed. The advantages of micro-trenches is that by shallowly laying them along the contour and pumping the effluent into them, they can distribute effluent reliably, evenly and intermittently. Assuming that stormwater is adequately diverted, micro-trenches provide a good opportunity for reuse by plants and only a low risk of effluent surcharging during wet periods.

7.2. EvapoTranspiration/Absorption (ETA) Beds

EvapoTranspiration (ET) and EvapoTranspiration/Absorption (ETA) beds are wider and shallower than traditional absorption trenches, thereby providing a much greater opportunity for uptake by plants and reduced dependence on infiltration and soil assimilation capacities to treat the effluent. ET and ETA beds have a number of limitations, discussed in some detail in Appendix B3. Due to these limitations and their relatively high expense, ET and ETA beds are not encouraged in Byron Shire. If they are required to be installed, a great deal of care is required in their design and installation to ensure that effluent is spread evenly over the entire bed space.

Owners of ETA beds should maintain appropriate vegetation on the beds. Mowed grass is the preferred vegetation cover, although shrubs and trees can be planted suitable distances away from the edge of ETA beds (see Appendix B3 for details).

7.3. Sub-surface Drip Irrigation (SDI)

Sub-surface drip irrigation (SDI), also commonly referred to as sub-surface irrigation (SSI), is a good means of distributing treated effluent because it can distribute small, measured doses to evenly spaced centres in relatively undisturbed soil. This ensures a very reliable distribution available for rapid root uptake, and minimises the risk of the irrigation field becoming saturated during extended rainfall. Sub-surface irrigation is particularly appropriate where there are site or soil limitations or limitations, such as steep slopes, on heavy impermeable (often termed “puggy”) soils, and can even be used with care on highly permeable sandy soils.

Sub-surface irrigation systems must be designed and installed by suitably qualified persons, and must be flushed to remove sediment/slime at least once per year, and preferably quarterly, by a qualified professional as part of the maintenance requirements. Suitably located pressure-release valves and flush pits must be provided to allow this regular flushing maintenance without causing pollution.

There are a number of different types of proprietary SDI systems on the market. Council requires that all new installations use pressure-compensated emitters, and strongly prefers the use of non-drain varieties. Additional details regarding design and operation of subsurface irrigation systems is provided in Appendix B4, and operation and maintenance requirements are provided in Appendix G.

7.4. Spray Irrigation

Above-ground spray irrigation requires prior tertiary disinfection of sewage (NSW Health). Within the Byron Shire, spray irrigation of effluent is not favored due to public health risks from aerosol-transmitted pathogens and the particular need to add toxic substances (such as chlorine) to disinfect the effluent before above-ground release. There may be some circumstances (e.g. on larger agricultural holdings in which the proposed land application area is a considerable distance from any houses, where spray irrigation may be accepted.

Refer Appendix G for maintenance requirements.

7.5. Surface Dripper-Under-Mulch Irrigation

Byron Shire includes productive farming area where effluent reuse can be particularly beneficial. The irrigation of effluent by above-ground drippers in plantations may be appropriate in some rural and reafforestation applications. Surface dripper-under-mulch options may be considered for domestic situations in Byron Shire, but higher maintenance and monitoring conditions will be required to ensure that the mulch remains in place over the drippers and that casual access by children, vehicles and livestock is restricted by a vegetative border, fence or similar device. Disinfection of effluent is generally required. Refer Appendix G for other maintenance requirements.

7.6. Special Components Used in Land Application Areas

Besides the components described above and in Appendix B, there are a number of important auxiliary components which are generally found in land application systems:

7.6.1 Indexing Valves

Indexing valves allow for up to six (6) separate land application areas (beds or irrigation areas), to be used. The indexing valve will apply a set volume of effluent to the first application area after which the pump turns off and the valve automatically switches to the next application area where the process is repeated.

7.6.2 **Dosing Siphons**

Gravity-driven dosing siphons are becoming more popular in the North Coast region. These are unpowered devices that ensure effluent reaches the treatment or dispersal system in a periodic “slug” rather than a constant dribble, thus providing more even distribution and more successful treatment and/or dispersal of effluent. Siphons are generally located after the collection tank (grey or blackwater) and may be used to deliver effluent to sand-filters and/or ETA beds. They are recommended in sloping sites where a fall of over at least two meters exists between system elements (refer to product literature for more detailed advice).

8. CALCULATING THE LAND APPLICATION AREA

Once the site and soil assessment has been completed and an assessment made on what effluent treatment and dispersal options are available, the next step is to calculate the size of land application area that would be required for each option. This is often an iterative process, as greater treatment will enable the installation of a smaller application field and vice versa. Consultation with your plumber or other professionals may also assist in determining the most sustainable and cost-effective solution for your situation. In accordance with recommendations in EPHG (1998), reserve application fields are required for new systems.

A computer model is available from Byron Shire Council to calculate the area required for the land application area and to test the relative benefits of the various treatment systems, referred to herein as the Byron OSMS Design Model or more simply as the Design Model. Designers are welcome to submit designs based on any other model or rationale, provided that the calculations and parameters are sufficiently justified and are consistent with the principles and requirements set out in these Design Guidelines. The OSMS Design Model, which comprises a 3 megabyte file in a Microsoft Excel Workbook (in 3 spreadsheets) is available for free download on Council's website – www.byron.nsw.gov.au, or for a cost-recovery fee on CD-Rom from Council's offices in Mullumbimby. The model's theory and operation are described in Appendix C - User Manual for Byron OSMS Design Model. Designers will also soon be able to apply to Council for a copy of a more comprehensive document which describes how the Design Model works and how default parameters have been derived.

In essence, Byron Shire Council's philosophy for land applications areas is to make them big enough to ensure that the treated effluent will have sufficient opportunity for plants within the area to take up all of the water and all of the nutrients applied. Council's OSMS Design Model deliberately includes some risk-based allowances for nitrogen, for example increasing the required land area where systems are built close to creeks and reducing the required land area where systems are built on very large blocks in which the vegetated areas around the land application area can be safely assumed to take up any excess nitrogen before it reaches the property boundary (refer Appendix C). Phosphorus tends to be adsorbed to clay particles and is therefore much less mobile, and so the philosophy with this nutrient is to calculate the capacity of the soils with the land application area to adsorb phosphorus over 50 years, minus that expected to be taken up by plants (refer Appendix C).

The land application areas calculated using these Design Guidelines and the Byron OSMS Design model assume that the site is not significantly constrained (refer Section 5). Where OSMSs are to be installed on blocks which are constrained by one or more factors(refer Section 5), ameliorative actions such as providing additional treatment or larger land application areas are likely to be required (refer Tables 6 and 7).

Note that very high treatment levels can in some circumstances enable the OSMS Design model to allow very small land application areas. To ensure that enough area is allocated to safely disperse the treated effluent without leading to periodic super-saturation, a minimum area of 15 m^2/bedroom (10 m^2/person) must be allocated for greywater–only systems and 22.5 m^2/bedroom (15 m^2/person) must be allocated for systems treating combined effluents including blackwater. Note that these minimum land application areas are based on the assumption that the site has suitable soils (light clays), that the black-water effluents are treated to at least partial-secondary standard, and that no constraints apply to the site. If these conditions are not met, a larger land application area will be required to provide an equivalent level of environmental security.

If using Council's Design Model, the input worksheet, output (Council Report) worksheet and the Design Model worksheet must all be submitted with the application. The model's input parameters should all be determined from the evaluation carried out by the designer for that specific application, and should all be justified in the accompanying report.

The OSMS Design Model will not allow operation for Soil Category 6 (Medium to Heavy Clays, or dispersive or shrink-swell soils). To calculate the effluent dispersal area in this situation it will generally be necessary to provide secondary treatment of effluent and to ameliorate soil conditions if they are dispersive, then to apply the computer model as though the site had a weakly structured Light Clay soil with DLR value of 5mm/day.

OSMS designers must be aware that computers models will not do all the thinking for the them; professional judgment must be used at all times. For example, a system designer needs to think whether the quality of the effluent is suitable for a given land application system, regardless of the area which the model calculates to be suitable.

9. DETAILS REQUIRED IN OSMS DESIGN REPORTS

Once all of the necessary investigations, site/soil assessments, and design calculations have been completed, the information must be compiled into a detailed OSMS Design Report. Two (2) copies of the report to must be submitted to Council as part of the Application to Install or Alter a Sewage Management Facility. The report will need to be submitted with a "Section 68" form available from Byron Shire Council. Assessment and inspection fees will be payable for new or previously unassessed systems, but fee exemptions currently apply where an upgrade is being proposed to an existing, approved OSMS without being tied to an upgrade or extension to the house.

The details required in all consultants OSMS reports supporting an application to Council are as follows:

- *Proposed system*: A summary of the proposed system components is to be presented in the report on or near the first page so that the type and size of system to be installed is clear to Council officers, owners and installers.
- *Number of residents:* This is calculated to be the number of bedrooms times 1.5, unless the actual number of people residing in the dwelling is greater, in which case the number of expected residents should be used (refer Section 2.3).
- *Site Specific Information:* Reports are to be specific, succinct and with information relevant to the site under review. Justification of the type and sizing of system nominated is to be clearly set out in the report. Reports must state the date/s that site inspections were conducted and who conducted them (with qualifications if relevant).
- *Site Limitations:* Reports are to accurately indicate the distances of dry gullies, watercourses or any other environmental features in relation to the land application area. Should a proposed system need to be located within the relevant buffer distance (Section 5.1.1;) or should a site be determined to possess environmental limitations, upfront acknowledgement of the limitation and explanation of how it is proposed for the limitation to be managed is to be reported (e.g. by maximising the distance from waterways, improving treatment such as with a reed bed, sand filter, AWTS, etc, or increasing the size of the proposed application area). It is unacceptable for important relevant issues to be dealt with implicitly or to not be commented upon.
- *Owner's Acknowledgement:* Effluent management reports are to include a statement by the owner that they are aware of the type of system being nominated in the report and of the maintenance schedule required to be carried out for the nominated system. Reports without acknowledgement by the owner that they understand what is being proposed and are willing to commit to the recommended maintenance schedule will be rejected.
- *Irrigation Design Reports:*
  - Irrigation design is a specialised field. Should subsurface irrigation be nominated as the proposed land application system it may be appropriate to have the detailed irrigation design performed by a specialist other than the one performing the soil and site evaluation. For this reason, it is permissible to provide a conceptual plan of the application field, clearly stating the size, type and approximate layout of the proposed irrigation system, with the Design Report. If Council approves the proposed system, a detailed irrigation design in accordance with the relevant Approved Drawing will need to be submitted for approval prior to application for a Permit to begin the installation. Alternately, the detailed irrigation design may be submitted with the Design Report to save processing time.
  - All detailed irrigation designs are to be produced by a person with suitable experience in irrigation design.
  - Irrigation designs submitted to Council are to include the information set out in the Irrigation Design Check List (Appendix F).

- *Site Plans*: All reports are to include two site plans as follows:
  1) a small scale contoured location plan extending to surrounding areas; and
  2) a larger scaled plan showing the location of the following components;
     - the proposed sewage treatment components
     - pegged out effluent application areas including soil analysis bore locations;
     - water supply wells and bores;
     - driveways, buildings and facilities;
     - environmentally sensitive areas including permanent or seasonal waterways;
     - major landforms around the site, including steep and flat areas, built and natural bunds, berms, drains or gullies that might divert run-off onto or around effluent application areas;
     - buffers surrounding the effluent application areas.
- *Layout of land application area:* This may be either a detailed plan or, if stated in the application, a conceptual diagram with a detailed design to be provided and approved before installation commences.
- *Full specifications and engineering details of proposed Treatment System(s):* Details of the chosen systems along with justification for the choice and proposed sizings of system components. Where relevant, calculations used in the design shall be submitted to allow Council to assess all individual components of the sewage management system including construction, installation, operation and maintenance.
- *Printout of all calculations and input parameters used to calculate land application area and OSMS component sizings.* If using Council's OSMS Design Model, the input worksheet, output (Council Report) worksheet and the Design Model worksheet must all be submitted with the application. Justification must be provided if any non-default values have been used as inputs to the model.
- *Completed site and soil assessment forms shall be appended.*
- *Plans of management, designed to be extracted from report and kept in a logical location for easy future reference by the resident/home owner.* A pro-forma for household OSMS management plans is provided as Appendix G. Council recommends that this pro-forma be used as a basis by the system designer to prepare an individualised management plan for each system. Management plans shall include operation, maintenance and service requirements of all components of the proposed sewage management system. This information must be specific to the particular system proposed, and provide all necessary instructions for the occupier/owner or service personnel to manage the system properly, including an emergency action plan in the event of a breakdown. Generic reports irrelevant to the site or type of system installed will be rejected.

  A clear maintenance schedule shall be included in the Management Plan, stipulating the type of system and its components including treatment device and land application area the system. Responsibilities for undertaking inspection and maintenance tasks (i.e. owner or servicing agent), and specific time frames or conditions for servicing the various components must be provided.

  Where possible, component manufacturers and the service agents who will be responsible for maintenance of the system must also be nominated, along with contact details.

  It will be a condition of approval that the completed management plan shall be stored and/or displayed in an appropriate place for the benefit of current and future occupiers, owners and service personnel. A final inspection will not be granted unless the service schedule is displayed, and applications which do not provide management plans will be rejected.

10. INSTALLERS REQUIREMENTS

Once Council Approval for the system design has been granted, licensed installers shall ensure that they have been provided with both the Council-stamped design plans and a copy of Council's Conditions of Approval, and then follow the procedure set out below to begin the installation process. Installers of irrigation systems are required to have a current trade certificate in plumbing, drainage or related trade or discipline.

- *Drainage Permit:* All plumbers are required to obtain a drainage permit from Council prior to commencement of work on site. Inspections will not be carried out unless the plumber has obtained a drainage permit from Council. In order for a drainage permit to be issued by Council, an approval to install the system must have been finalised with Council and a detailed irrigation design will need to have already been submitted and approved.

- *Irrigation Installations*: Irrigation systems are to be installed by a qualified tradesman or a professional with suitable experience in irrigation installation.

- *Maintenance Reports:* All on-site sewage management systems require regular maintenance by the home-owner and periodically also by service providers in order to ensure that the system operates reliably. Most AWTSs and sub-surface drip irrigation systems require quarterly maintenance by appropriately experienced service providers, and most other systems require an annual service by a similar provider (refer to Council's Conditions of Approval for detailed requirements).

  It will be a requirement of all Approvals to Operate that a form similar to those provided in Appendices E (for Treatment System Service Form) and/or F (Irrigation System Service Form) is to be submitted to Council within 7 days of servicing the system or component.

- *Inspections*: Land application areas are to be planted out in accordance with the approval and/or effluent report prior to occupation of the dwelling (suitable plants for effluent application fields are provided as Appendix D). Permission to occupy will be generally refused should the nominated land application area and planting schedule not be completed.

  Inspections of external drainage lines and the whole effluent dispersal system can only be carried out by Council Officers. Private certifiers or designers do not have authority to inspect any aspect of on-site sewage installations or drainage.

  It is a requirement that the installer contacts Council prior to back-filling any sub-surface installation so that the system can be inspected and tested.

  It is necessary to provide a minimum of 48 hours' notice for a Council inspection.

  Consultant's reports and Council Approvals indicating that land application areas on a specific site are to include the application of lime, loam, gypsum, sand dosing or similar are to be complied with. Certification of such activities shall be provided by the plumber/installer and submitted to Council. Final inspection will not be approved until such certification is submitted to Council.

  Failure to obtain an inspection in accordance with an Approval by Council is an Offence under the Local Government Act 1993. Persons breaching this legislation are liable to prosecution or infringement notices which will result in a monetary penalty.

- Variations: Council expects systems to be installed in strict accordance with the plans which it has approved. If it becomes necessary for any reason to substantially alter the design or configuration of the treatment and/or land application systems, a s96 (for systems approved as part of the D.A.) or s106 (for systems approved under s68 of Local Government Act) application will need to be sought and approved **before** proceeding with the amended installation. Where the necessary amendments are of a very small or insubstantial nature (check with Council if unsure), it is permissible to install the altered system provided that a “Works as Executed” diagram is provided within two weeks of the installation. The Works as Executed diagram must clearly show the size of all OSMS components and their position relative to major features (e.g. house, driveway and/or waterways).

11. GLOSSARY AND ACRONYMS

Absorption: absorption and/or uptake of effluent into soil by gravity and capillary action.

Absorption area/trench/bed: a land application system which uses soil absorption and gravity to distribute and dispose of effluent.

Adsorption: physical or chemical attachment of substances to the surface of soil particles.

Aerobic/Anaerobic: In the presence/absence of oxygen. Biological break-down occurs by different micro-organisms adapted to the aerobic or anaerobic conditions.

Aerated Wastewater Treatment System (AWTS): an oxygenated sewage treatment process typically involving: settling of solids and flotation of scum; oxidation and consumption of organic matter through aeration; clarification - secondary settling of solids, and disinfection of wastewater before irrigation.

Batch System: a composting toilet system involving two or more alternating chambers, and in which compost is produced in batches.

Bedroom:: In Byron Shire, the calculations for number of persons for which an OSMS is expected to cater for is 1.5 per bedroom. For the purposes of these Design Guidelines, a “bedroom” is a room in a house which is specified on the Council-approved plans as being one built for the purposes of sleeping within it.

Best Management Practice: practices currently employed and recommended by government and industry as preferred and affordable approaches. In domestic on-site sewage management, current best management practice generally includes partial-secondary treatment and broadly dispersed application of effluent to soils in the root zone.

Biochemical Oxygen Demand (BOD): the amount of oxygen required for the biological decomposition of organic matter, usually measured over a period of 5 days (BOD_5).

Blackwater: human excreta and water grossly contaminated with human excreta, for example toilet wastewater.

Boulder: a rock with middle dimension greater than 600mm.

Compost Toilet: a treatment unit which breaks down faeces and organic material into a compost like material through the action of micro-organisms and invertebrates. See AS/NZS1547, 2000.

Constructed wetland: also known as **Reed Beds**, these comprise a constructed basin in which water or effluent is kept at or near the surface of the gravel substrate. The effluent is treated as it moves slowly through the root zone of densely planted water-plants (usually reeds).

Crop factor: a value utilised in water balance modeling to estimate variations in evapotranspiration due to crop type, seasonal conditions and age of crop.

Design Loading Rate: the rate at which effluent is to be applied, based on the Long Term Acceptance Rate (LTAR) (see definition below), reduced by a factor of safety.

Dispersive soil: a soil that tends to disperse and erode, especially in presence of high-sodicity effluent.

Durable aggregate: aggregate, metal or stones which are graded to AS 2758.1 for single size coarse aggregate for nominal sizes, usually ranging from 20mm to 50mm,

Effluent filter: a device placed in the outlet of septic or greywater tanks to prevent or reduce solids entering the effluent dispersal area or next treatment step. Effluent filters are not considered “partial-secondary treatment” and do not provide secondary treatment (defined below).

Effluent: Liquid which has passed through a treatment system.

Evaporation: the transfer of water from a liquid to a gas

Evapotranspiration: natural process transfers water from soil by evaporation and from plants by transpiration

Evapotranspiration/absorption (ETA) bed: a specially prepared bed or area which promotes evaporation, transpiration and absorption of effluent.

Faecal Coliforms: a type of bacteria that live only in the gut of warm-blooded animals. Can be detected in the general environment if that environment is contaminated with mammalian excreta, and therefore can act as an indicator of recent faecal contamination, possibly by humans.

Geotextile: a water-permeable fabric used mainly to retain and stabilise soils. Care must be taken to ensure that suitable geotextile spacing sizes and thickness are selected for the particular task.

Greywater: the component of domestic sewage which excludes toilet and urinal wastes.

Groundwater: the body of water held in the soil and rock pores; includes water above (unsaturated conditions) and below (saturated conditions) the water table and seepage from springs etc.

Indexing Valve: a device (also called a **K-rain valve**) which allows for up to 6 separate land application areas to irrigated in sequence.

Irrigation Systems: pressurised effluent dispersal systems, such as proprietary Wasteflow or Netafim, which deliver treated effluent to the sub-surface (typically 100 mm depth) of the application area via valves, pipes and emitters.

Infiltration: the downward passage of water into the soil.

Land Application Area: the land area over which treated sewage is applied

Long Term Acceptance Rate (LTAR): the average sustainable rate effluent can be absorbed over the long term into a particular soil, expressed in litres per square metre per day. This rate is influenced by effluent water quality, method of dosing, the soil permeability and by the slime layer which builds up at the interface with the receiving soil.

Nutrients: chemical elements that are essential for sustained plant or animal growth. The major nutrients essential for plant growth are nitrogen, phosphorus and potassium; in excess, nitrogen and phosphorus are potentially serious pollutants encouraging nuisance growths of algae and aquatic plants in waters and (in the case of nitrate) posing a direct human health risk.

On-site sewage management system (OSMS): includes all types of human waste storage and treatment facilities, e.g. septic tanks, cesspits, compost toilets, urinals. Also includes the wastewater application (dispersal) area, e.g. absorption trenches, irrigation fields.

OSMS Design Model: a computer model based on a Microsoft Excel workbook which can be used to estimate appropriate sizings for land application areas and reed-beds.

Pan Evaporation: the loss of water by evaporation measured in a “Class A” pan. The nearest weather station collecting Pan Evaporation data is at Alstonville.

Partial-Secondary Treatment: Post-primary treatment not necessarily designed to achieve secondary treatment quality (see below) is more generally referred to in these Design Guidelines as partial-secondary treatment. In Byron Shire, partial-secondary treatment methods must be able to demonstrate that they can reduce contained nitrogen by at least 20% to be acceptable for blackwater-inclusive systems. Designers should also note that an ability to provide partial-secondary treatment does not necessarily mean that these effluents will be suitable for all forms of irrigation without further filtration, and an irrigation specialist should be consulted.

Pathogens: micro-organisms that may potentially cause disease or sickness. These include, but are not limited to bacteria, protozoa and viruses.

Percolation: a general term describing the downward rate of water movement through a soil or through a biological mat within an effluent dispersal system.

Permeability: a calculated value derived from the rate at which a head of liquid is absorbed into soil, usually measured in m/d as Saturated Hydraulic Conductivity (K_{sat}).

Primary Treatment: In on-site sewage management, primary treatment is taken to mean the initial reduction of suspended solids and organic matter from the household by means of settlement, anaerobic digestion and/or floatation in septic tanks or the primary settling chambers of AWTS.

Reed-beds: see Constructed Wetlands

Run-on: surface water flowing on to an irrigation area because of run-off occurring higher up the slope.

***Scum*:** the floating material which accumulates above the more liquid layer in a septic tank or other primary treatment device. Scum-forming material includes oils, grease, soaps and plastics.

Secondary Treatment: For the purposes of these Design Guidelines, the term “secondary treatment” applies to systems which can produce effluents containing no more than:

- 20mg/L BOD
- 30mg/L Total Suspended Solids
- 30 mg/L Nitrogen
- 10 mg/L Phosphorus

Septage: The semi-liquid material that is pumped out of septic (or interceptor) tanks, consisting of liquid, scum, and sludge.

Septic Tank: effluent storage container in which primary treatment of household effluent occurs under anaerobic conditions. Septic-tank treatment process comprise sedimentation of settleable solids, flotation of oils and fats and anaerobic digestion of sludge.

Sewage: Untreated or partially treated human wastes generated from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

Sewage management facility: a human waste storage facility, or a waste treatment device intended to process sewage, including a drain connected to such a facility or device.

Sewerage: The network of collection drains carrying domestic wastewater or effluent away from properties for off-site treatment.

Sewerage work: for the purposes of Council approvals, sewerage works include the construction, alteration, extension, disconnection, removal, ventilation, flushing or cleansing of any sewerage service pipes or fittings or fixtures communicating or intended to communicate, directly or indirectly, with Council's sewerage system

Single Households: these Design Guidelines apply to single households, which is defined here as the domestic residence of a single family or small group of people (<10 persons).

Sludge: mainly organic semi-solid product produced by wastewater treatment processes

Sub-surface Irrigation: pressurised effluent dispersal system. Irrigation lines are buried 100mm below the ground surface and effluent is emitted slowly and widely.

Sullage: another term for greywater (see definition above)

Tertiary treatment:. For the purpose of these Design Guidelines, tertiary treatment involves disinfection of secondary treated effluent, but may also include further post-secondary treatment, filtration, and nutrient removal.

Transpiration: the transfer of water to the atmosphere through plants.

12. REFERENCES

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Design Guidelines for On-site Sewage Management for Single Households

APPENDIX A

OSMS Treatment Systems

Appendix A – Treatment Systems

There are a number of different treatment systems available in the North Coast area and the performance of these can vary due to climatic conditions, population characteristics, loading cycles, human dietary habits, and influent quality. Only the main options are discussed in the following sections, but designers are encouraged to monitor and take advantage of innovative technologies as they emerge.

The following design constants are applicable to all treatment systems:

- Adequate access must be kept available to safely maintain the system.
- A means of monitoring the vital elements of each treatment component must be provided.
- If overflow occurs from any component, the predicted overflow points must be visible and in as safe a position as possible to reduce or eliminate casual contact.

A1. Septic & Sullage (Greywater) Tanks

The septic tank used for single houses is a small anaerobic settlement and digestion plant, which reduces suspended solids from the wastewater and breaks them down to smaller particles. The resultant effluent is lower in settled solids but still high in biological oxygen demand (BOD), nutrients and pathogens. Septic tank effluent requires further biological treatment before release to the environment. Modern septic tanks have been greatly improved by the installation of at least one internal buffer to reduce solids carry-over (Figure A1), by ensuring that the tanks are large enough to provide sufficient opportunity for settlement of solids, and making the tanks water-tight.

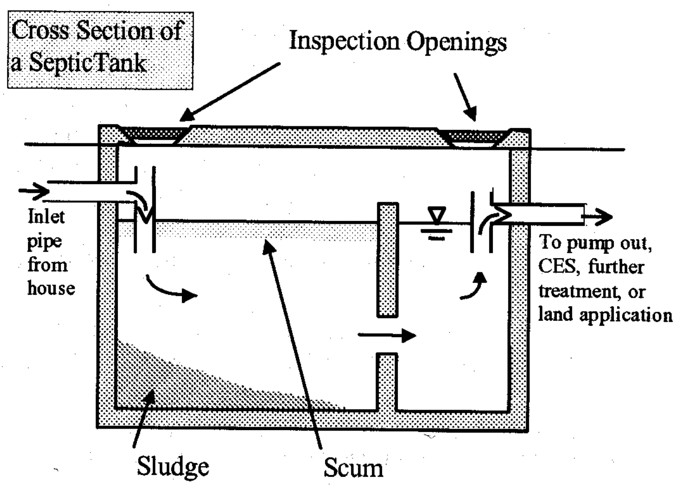


Figure A1: Cross-section of a typical septic tank

When the effluent from the house reaches the septic tank, most solids settle to the bottom (commonly termed “sludge”) whilst most fats, oils and greases float to form a crust at the top, and the middle zone is occupied by effluent which has a chance to settle before overflowing to the secondary treatment system.

The addition of enzymes or other proprietary additives may sometimes have short-term benefits in reducing smells and blockages, but are not strongly encouraged because they can increase solids carry-over and should not be relied on to maintain functionality of the tank. On the other hand, the addition of proprietary bacteria supplements is permitted and encouraged. These proprietary bacteria can assist by reducing the amount of sludge build-up and therefore increasing the time between the pumping out of the tank, and by reducing the smell of the tank.

Induct vents are no longer considered desirable on septic tanks due to these structures allowing flies and mosquitoes to breed in the tank (E&HP Guidelines, 1998). For larger septic tank size (>3000L), grease traps are no longer required. Smaller grease traps are not recommended as they need to be maintained often and have sometimes been found to be too small to trap grease effectively. Kitchen wastewaters can be connected directly into an appropriately sized septic tank with a baffle installed (E&HP Guidelines, 1998). Where it is absolutely necessary for some reason to use a smaller septic tank, consideration should be given to installation of a suitably sized grease trap.

The Australian Standard for septic tanks is AS1546 (1998). All septic tanks need to be manufactured in accordance with this standard, and have an appropriate AS Standards Mark. While alternate tank shapes are mentioned in the standard, in the Tweed-Richmond region the only types widely available “off the shelf” are cylindrical tanks. Cast-in-situ tanks are specified in Section 7 of AS1546. The NSW Health Department Register certifies manufacturers of the septic tanks and collection wells.

The sizing of pump wells shall be in accordance with the advice provided by NSW Health in their “Septic Tank and Collection Well Accreditation Guideline” (refer Section 1.4 of Design Guidelines for download address). Septic tank sizes are nominated for domestic flows of up to 14,000 L per week or daily flows of 2000 L. The serviceable life of the tank is stated as 15 years. The suggested minimum tank sizes **(unless NSW Health Guidelines mandate larger tank)** are set out in Table A1. If the correct size of tank is not available locally, Byron Council requires that the next largest available tank be installed.

Table A1: Conventional Septic Tank Capacities (Litres)

Type of Wastewater	1-3 Bedrooms	4 Bedrooms	5 Bedrooms	6 Bedrooms
All wastewater	3,000	3,500	4,000	4,500
Greywater only	1,800	2,100	2,400	2,700
Blackwater only	1,500	1,800	2,100	2,500

Source AS1547 (2000) Appendix 4.3A

The location of the septic tank must be at a greater distance than 1.5m from any building, and the base of the tank must not be within 45^0 (angle of repose) from the base of any footing or foundation. Allowances must also be made for easy access to the tank in order for the pumping contractor to get a truck near the septic tank so that the contents of the tank can be periodically pumped out (desludging the tank).

Septic tanks do not substantially reduce nitrogen, and the Byron OSMS Design Model does not therefore allocate any nitrogen reduction in its calculations for septic–only systems. In all but greywater-only systems, partial-secondary treatment will usually be required after primary treatment in septic tanks.

Advice on care and maintenance of septic and sullage tanks is provided in Appendix G.

A1.1 Effluent Filters

An effluent filter is a simple plastic filter which is fitted into the outlet of the septic tank. Effluent filters are used to reduce the potential “carry over” of suspended solids. This will improve the efficiency and longevity of the land application system or secondary treatment device. It should be noted that an effluent filter does not provide partial-secondary treatment of the effluent.

Types of effluent filter successfully used in the Byron area include Biotube, Taylex, Zoeller and Zabel filters. It is recommended that the effluent filter should be of a robust type and preferably fitted to the outside of the tank so that owners do not have to place their hands in the tank, and for ease of maintenance. One means of doing this is by fitting a “U” trap on the outlet, another is to install a type of filter that can be cleaned by jetting water through it whilst still in place using a suitable hose attachment (i.e. a hose “wand”).

A2. Aerated Wastewater Treatment Systems (AWTSs)

Aerated wastewater treatment systems (AWTSs) provide a relatively simple solution to OSMS selection. These systems are scaled-down sewage treatment plants, and usually include both anaerobic and aerobic zones and a number of pumps. AWTSs typically settle solids and float scum in an anaerobic chamber, much like a septic tank, and then aerate the effluent in a second chamber (Figure A2). The aerobic process usually consists of injecting compressed air into the effluent to promote the growth of aerobic bacteria for treatment.

Failure or a sustained interruption in any part of the system, e.g. as a result of power interruptions or when a tourist dwelling is unoccupied during the off-season, can lead to a period of poor treatment performance until sufficient micro-organisms are once again restored to adequately treat the effluent.

Disinfection in AWTS is generally required as part of NSW Health’s accreditation procedures, and usually consists of chlorination in the final collection chamber. Byron Shire Council is aware that some people choose not to disinfect their effluent in subsurface applications, and agree that this is largely a matter of choice and warranty obligations. Homeowners should be aware that sub-surface emitters may tend to get blocked if high nutrient loads cause a build-up of biomat in the soil pores surrounding the emitters, and that at least periodic dosing of chlorine should be considered in these cases. Other ways to avoid this problem is to use non-drain emitters or emitters which release miniscule doses of poison to prevent root intrusion and reduce biomass production in the immediate vicinity of the emitter (e.g. Wasteflow, Netafim).

Some AWTSs include an activated sludge process that enables the breakdown of sludge and a theoretically better effluent quality without the need for periodic de-sludging. The aerated section of the AWTS oxidises the wastewater and organic matter is consumed. A clarification process is carried out through secondary settling of solids.

All AWTSs are accredited by the NSW Health Department pursuant to Clause 43(1) of the Local Government (Approvals) Regulations 1999. The AWTS must be installed in accordance with their accreditation conditions issued by NSW Health.

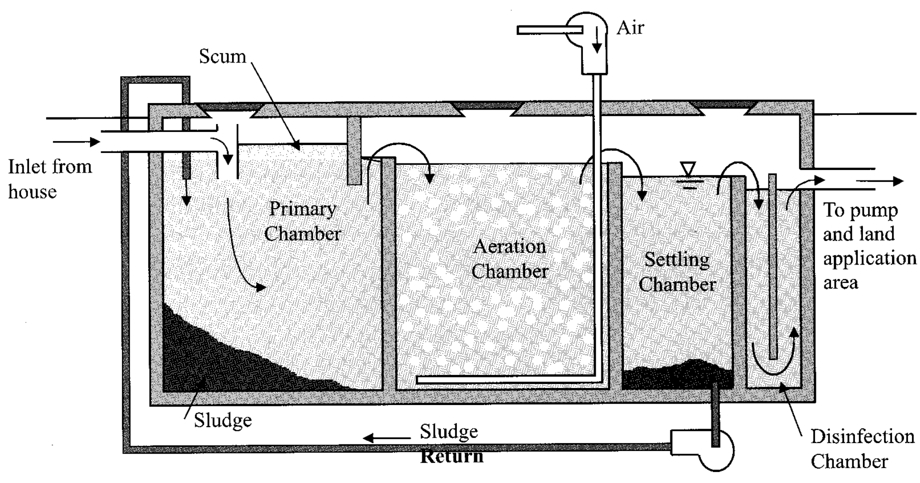


Figure A2: Cross Section of an AWTS

When functioning correctly, AWTS provide a significantly higher level of treatment than simple septic tanks. The Byron OSMS Design model assigns a nitrogen reduction capacity of 20% to AWTS’s.

A3. Sand Filters

Sand filtration systems typically consist of one or more layers of sand or fine gravel contained within an impermeable structure, although a number of systems using media other than sand (e.g. styrofoam balls) are available on the market. Wastewater is applied to the surface of the sand or similar bacterial-growth media, through which it percolates vertically to a collection system at the base of the filter (Figure A3). Micro-organisms attach themselves as a “biomat” around each grain, and biological treatment happens as the effluent contacts the biomats whilst trickling downwards through the media.

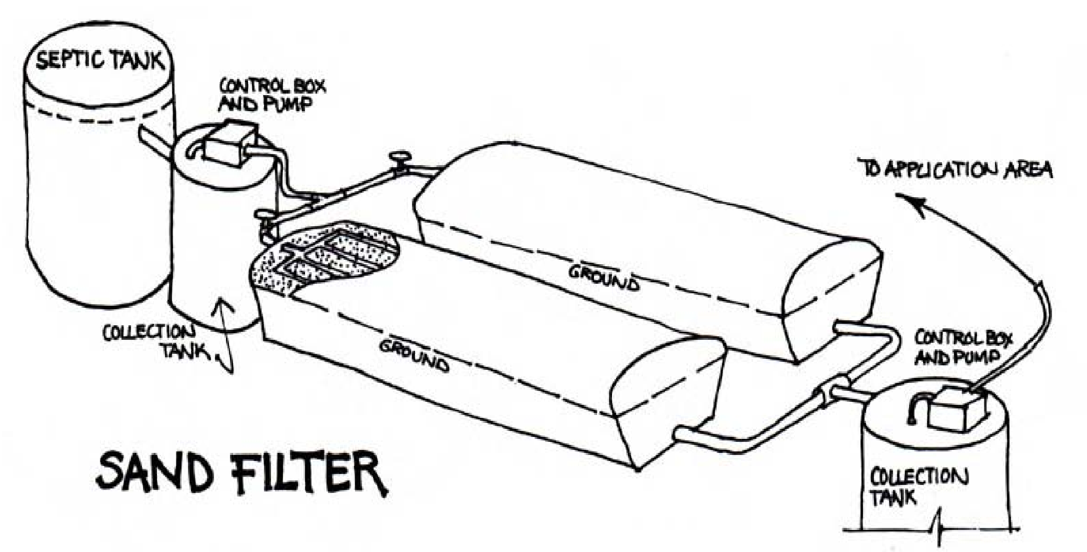


Figure A3: Schematic of a typical sand filter installation

There are two types of sand filter, (1) single pass or (2) recirculating.

Single-pass sand filters are those in which the effluent passes through the sand media only once before collection for dispersal. Single pass sand filters may be designed with the effluent entering the sand filter passively under gravity (i.e. whenever wastewater is generated in the dwelling) or, preferably, intermittently applied by a pump or dosing siphon.

Recirculating sand filters are so named because the effluent is collected from the base and recirculated back through the sand, greatly improving treatment and the opportunity for denitrification. Recirculating sand filters usually exhibit significantly better N-removing capabilities and good performance overall. However they are more expensive and complicated to construct than the single pass sand filter, require more power, and are not yet widely known in our region. Sand media in recirculating sand filters need to be coarser than that used in single-pass varieties due to the higher loading rates.

Unless the sand-filter has been designed to ensure that an anaerobic zone will be present, treatment in single-pass sand filters is likely to be almost exclusively by aerobic treatment. Aerobic-only sand filters typically produce very good TSS and BOD removal but may achieve little or no removal of total nitrogen. If an anaerobic zone (or many anaerobic micro-sites) can be sustained within the sand-filter however, some denitrification can also be reliably achieved. Denitrification rates in sand filters tend to be limited by having insufficient carbon available in the effluent for the conversion from nitrate to nitrous gas. One solution to this design issue is to direct a proportion of 1/4 to 1/3 of the nitrified sand-filter effluent (via an indexing valve for example) back to the primary treatment tank, taking care not to disrupt the crust in the tank. The plentiful organic carbon and anaerobic conditions available in the tank will promote the removal of nitrogen in a gaseous form through the process of denitrification.

Based on literature reviews, Byron Shire Council expects that a reduction of around 30% nitrogen can be achieved either by a suitably sized and intermittently dosed, single pass sand-filter with anaerobic zones or by carefully recirculating between a third and a quarter of the sand-filter effluent back into the primary treatment tank, or 25% without the return. Fully recirculating sand-filters, in which at least 75% of the treated effluent is recirculated back over the sand, which are suitably sized and operating correctly can expect to reduce nitrogen by at least 40%. These values are reflected as defaults in the Byron OSMS Design Model used to size treatment and dispersal systems in the shire (refer Appendix C), but system designers are encouraged to provide submissions based on other nitrogen reduction values, if they can justify these values with independent monitoring results from installed systems.

Domestic sand filters which are available “off the shelf” by retail are required to accredited by NSW Health.

Two important aspects to understand about sand-filter design is the type and character of media used, and ensuring that effluent is evenly and intermittently spread to ensure that maximum contact with all the available sand in the filter is achieved. Passive sand filter designs that dribble directly from the septic tank into the sand filter are not expected to achieve high levels of treatment due to the poor distribution of effluent over the filter surface and reduced contact opportunities with the bacteria-laden sand grains. Therefore, intermittent loading using a dosing siphon or a pump is generally required for new sand filter installations.

An optimal media in sand filtration systems is one in which abundant surface area for microbial growth is combined with adequate pore space to facilitate the movement of water and oxygen through the filter. If the sand filter media is too coarse, wastewater percolates rapidly through the system without allowing sufficient time for the pollutants to undergo treatment. On the other hand, if the filter media is too fine, pore spaces between the particles easily clog, reducing hydraulic conductivity and oxygen transfer rates.

It should be noted that not all of the washed coarse sand available from local suppliers on the North Coast is suitable for use in sand filters; in some cases it will require additional washing and grading. Sand media used in filters may be characterised through its effective size (ES) and uniformity coefficient (UC) (Equations 1 and 2).

$$ES = d_{10} \quad (1)$$

$$UC = d_{60}/d_{10} \quad (2)$$

where: ES = effective size of sand
UC = uniformity coefficient of sand
d_{10} = screen size through which no more than 10% by weight of the sand passes
d_{60} = screen size through which no more than 60% by weight of the sand passes

US EPA (1999) recommends that media have ES >0.25mm and <0.75mm, and UC <4.0. Lienard *et al*. (2000) concur with these specifications for media and add that fines (< 80 µm) should not exceed 3% by weight.

Containment of the substrate can be achieved using a variety of materials. Byron Council recommends the use of solid polyethylene troughs for sand-filters. Unreinforced and/or light-weight flexible plastic liner (e.g. builders plastic) will not be accepted due to the high failure rates and relatively short life-expectancy commonly experienced with sand filters founded on these types of liners.

Finally, sand filters are prone to clogging in their upper layers, depending on effluent quality, dosing rates and the coarseness and “cleanliness” of the sand media. It is essential that sand filters are able to be accessed for regular maintenance. Byron Council also strongly recommends that sand filter designs incorporate a means of monitoring the effluent level and quality.

A4. Reed Beds (Constructed Wetlands)

Constructed wetlands, or reed-beds, comprise a sealed basin containing gravel, in which primary treated effluent is kept slightly below the surface of the gravel substrate. The effluent is biologically treated as it moves slowly through the root zone of densely planted wetland plants (usually reeds/rushes but can also be shrubs or trees) in gravel. In order to minimise the risk of infection and disease through contacting the effluent, reed-beds should be constructed in a way that keeps the top of the effluent at least 5 cm below the top of the gravel bed.

The design of reed beds for sewage treatment is a specialised field. Treatment performance is largely dictated by the time (termed “residence time”) that the primary-treated effluent spends in the reed bed, as this determines the contact-time with the bacteria-coated gravel and roots in the bed. Installers and home-owners should be made aware that installation of a reed-bed will generally necessitate one more Council inspection (with associated fees) than other OSMS systems due to the delay in establishing the reeds.

The following provides a brief summary of the main aspects of design that need to be considered when designing and constructing a reed bed for on-site treatment of effluent.

A4.1 Minimum surface areas for Secondary and Partial-secondary Treatment

Due to the detailed level of monitoring data available for reed beds (Davison et al, 2002; Headley, 2003), Council’s OSMS Design Model permits the designer to install reed bed sized to achieve either “secondary-standard” (refer Section 6.3 of the main report) or “partial-secondary” effluent quality, with the difference in treatment level related to the size of the reed bed. According to the approach adopted by Council in the accompanying guidelines, the area required for land application can be reduced by treating the effluent to a higher quality. Reed-beds which are not big enough to provide secondary standard effluent can be assigned an expected nitrogen reduction factor from the OSMS Design Model, starting at a minimum of 20% nitrogen reduction. Larger application areas are required for lesser-treated effluents in Council’s OSMS Design Model (refer Appendix C).

Recent studies on the North Coast (Davison et al. 2002) indicate that a reed bed with a 5 day residence time will provide secondary treatment (i.e. achieving BOD < 20mg/L, TSS < 30 mg/L, N < 30 mg/L). A reed bed with a 5 day residence time will be also be assumed to remove a default value of 40% of the total nitrogen loading from applied effluent in Byron Council’s computer model. Reed bed designers are encouraged to seek higher default nitrogen reduction values for use in Council’s OSMS Design Model by providing detailed monitoring results from installed systems. Alternatively, systems designed using the Kadlec and Knight (DLWC Wetlands Manual, 1998) methods will be accepted.

A reed bed with a 7 day residence time would be considered more appropriate in constrained sites, e.g. application systems over shallow groundwaters, or within 100 m of a waterway (refer Table 8 Site Limitations).

A4.2 Reed Bed Construction

There are essentially five functional elements to a reed bed as shown in Figure A5. These are:

- the containment system, also termed liner or skin;
- the substrate or porous medium;
- the macrophytes or aquatic plants;
- the inlet structure; and
- the outlet structure.

This section describes some of the constraints and possibilities in relation to each of these elements.

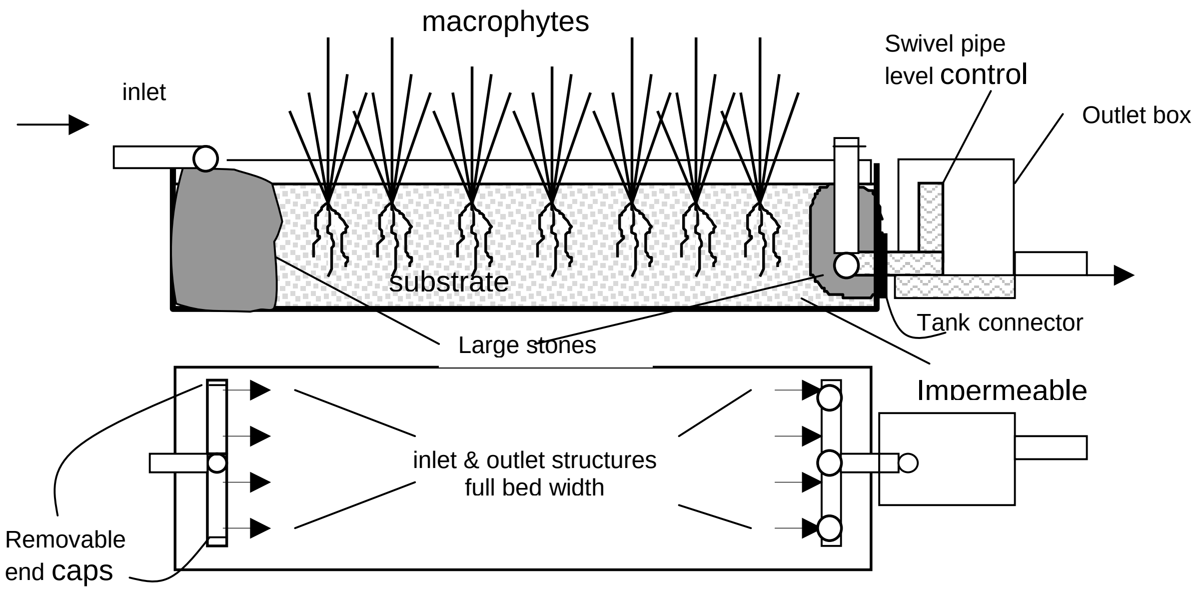


Figure A5: Elevation and plan views of a simplified reed bed showing major components

A4.3 Containment Device (Liner)

The purpose of the reed bed liner, also termed skin or under-skin, is to prevent the loss of wastewater and the penetration of macrophyte roots from the bed while excluding surface water, groundwater, adjacent soil and weeds. It therefore needs to be impermeable, durable and resistant to penetration by macrophyte roots. Materials that have been used on the NSW North Coast include fabricated reinforced concrete slabs, ferro-cement, stainless steel, polyethylene cattle troughs, fibreglass troughs, sealed concrete blocks laid on concrete slab, and flexible liner membranes. Of these, problems have been frequently encountered getting good seals in stainless steel bases and many more problems have been found sealing and maintaining the integrity of light-weight flexible plastic liners.

Moulded polyethylene troughs are available on the market in a number of sizes, and are considered highly suitable for reed-bed (and sand-filter) liners due to their robustness and ease of maintaining a seal on the base and around inlet and outlet fittings. Rectangular troughs are preferred due to the minimisation of “dead spots” where little effluent circulation occurs, however they are less stable on steeply sloping sites. Round troughs are stronger and better on steeply sloping land.

The edge/lip of the reed bed liner needs to be raised and constructed in such a way that upslope surface runoff is diverted around the bed. A minimum lip height of 100 mm above ground level is usually required in reed-beds in Byron Shire in order to prevent ingress of runoff. Diversion drains or swales may also be required. A stronger, higher lip (150 mm) is required for systems installed in slopes of >10%. Internally, Council requires a minimum free-board of at least 100 mm from the lip of the liner to the gravel surface, with effluent remaining a further 50 mm below the gravel surface to provide emergency storage for wet-weather periods or pump failures.

A4.3.1 Hydrostatic Testing of Liners

Reed-bed systems often fail due to leaks in the liner. In many cases a slow leak is not detected until household inputs cease for a protracted period, e.g. when the homeowners go on holiday for a couple of weeks and return to find that their reeds have all died. To avoid this situation, Byron Shire Council strongly recommends that a 24-hour hydrostatic test is performed before the reeds are planted, in which the installed liner is filled with water to a specific level and is checked again 24 hours later.

A4.3.2 Flexible Liners

The use of flexible-liner membranes is strongly discouraged in the Byron Shire due to the common failure to achieve a water-tight seal during installation, indications that the liner will not last 15 years (as required under legislation), and the potential to be easily penetrated by macrophyte rhizomes if not designed and installed correctly. *Pharagmites australis* has a particularly penetrative rhizome and has been known to penetrate flexible plastic liners frequently and even to penetrate the seals of stainless steel liners.

A4.4 Substrate

The choice of wetland substrate will depend on the type and quality of influent, the desired quality of effluent and the need to minimise the risk of clogging. Gravel of 10mm diameter is preferred, but up to 20 mm diameter is acceptable. As a rule, media consisting of larger particles will have higher hydraulic conductivities and be less prone to clogging, but smaller particles provides more treatment surfaces and is easier to spread. It is essential to place larger stones/rocks, >50mm, around the inlet and outlet pipes to allow for ease of checking for root intrusion. However, these coarser substrates inhibit plant growth and therefore should not be used throughout the entire reed bed.

A4.5 Macrophytes

Various macrophytes have been used in reed beds throughout the world with species from the genera *Phragmites, Schoenoplectus* and *Typha* being the most commonly used. Macrophytes that have been successfully used in this region are *Schoenoplectus validus* (river club rush), *Typha orientalis* (bull rush), *Phragmites australis* (common reed), *Bolboschoenus fluviatilis* (marsh clubrush), *Lepironia articulata* (grey rush*), Baumea articulata* (jointed twigrush), *Lomandra hystrix* (not *longifolia*), Carex bichenoviana and.

For the reasons discussed above, *Phragmites australis* should never be planted if flexible plastic or stainless steel liners are to be used.

Tube stock for most wetland plant species may be purchased from nurseries that specialise in wetland plants. These plants can also be propagated vegetatively by dividing root clumps obtained from existing constructed wetlands. An initial planting density of at least 3 plants/m^2 is required for new installations.

A4.6 Inlet structure

The inlet structure for small reed beds, usually trench arch or a slotted 100 mm diameter PVC spreader pipe, should extend almost the full width of the reed bed and should be placed below the gravel surface, with large stones placed around it.

Inlet areas of wetlands are prone to accumulation of sludge, so it is important that the inlet is accessible and monitorable for maintenance or de-sludging. The rocks (50 – 100 mm) around the inlet reduce clogging and allow easy access for maintenance and removal of intruding roots.

A4.7 Outlet Structure

A simple outlet structure design incorporates a PVC pipe spanning the reed bed width and drilled with holes of approximately 15 mm diameter and surrounded by larger stones (up to 100 mm). Figure A5 shows an outlet structure option consisting of a series of 150 mm diameter, capped, vertical towers spaced evenly across the width of the bed. Effluent enters the towers via 15-25 mm diameter holes surrounded by stones > 50 mm diameter. Access to the towers is available should clogging of the holes occur. The reed bed is connected to an outlet box containing a device such as a swivel pipe, which can be used to adjust the water level in the reed bed. A series of variable length stand pipes can achieve the same result. In this way the wetland can be temporarily flooded to help control terrestrial weeds during establishment. If doing so, extreme care should be taken to avoid contact with the effluent by people and pets.

Controlled water level lowering can encourage downward root penetration, promoting oxygenation of the lower level of the bed and thereby enhancing treatment at that level. Being able to lower the water level may therefore be useful for maintenance or repair work if required in the future.

A4.8 Baffles

Baffles can improve reed-bed designs by lengthening flow-paths and demarcating inlet and outlet structures, limiting the clogging growth of reed roots into the structures.

A4.9 Reed bed shape

Having determined the total area of the bed or beds (using Table A2 or the OSMS Design Model) the next step is to decide on its actual shape. Rectangular plans, while not always the most aesthetically pleasing, will be more hydraulically efficient (less likely to have dead zones) than curved configurations. Aspect ratios (length to width) for rectangular beds of 3:1 down to 1:1 (i.e. square) are generally favoured in the literature. The wider the bed, the less likely it is to clog. On sloping ground a long thin bed may be desirable for structural reasons. In such cases a longer section of large stones should be installed at the front end of the bed.

Where multiple tubs are to be used to provide sufficient reed-bed size, designers have a choice to place the tubs in parallel or series. Parallel options are generally preferred but require a reliable means of distributing effluent evenly, e.g. with tipping buckets. Placing one tub after another in series may be an acceptable alternative, but designers must include hydraulic calculations to confirm that the hydraulic loads can be handled by the first tank, noting that this same first tank is liable to clog due to the higher sedimentation and nutrient loads that it is likely to accept.

A5. Waterless Compost Toilets

Dry composting toilets may be either constructed individually on-site (owner built) following a specific design plan, or commercial units such as the Clivus Multrum, Nature Loo and the Rota Loo purchased “off the shelf”. All compost toilets in NSW must meet the *NSW Health Department Waterless Composting Toilet Approval Guideline 1997*. There are two basic types: batch and continuous-flow systems. A diagram of a continuous-flow type compost toilet is given in Figure A6.

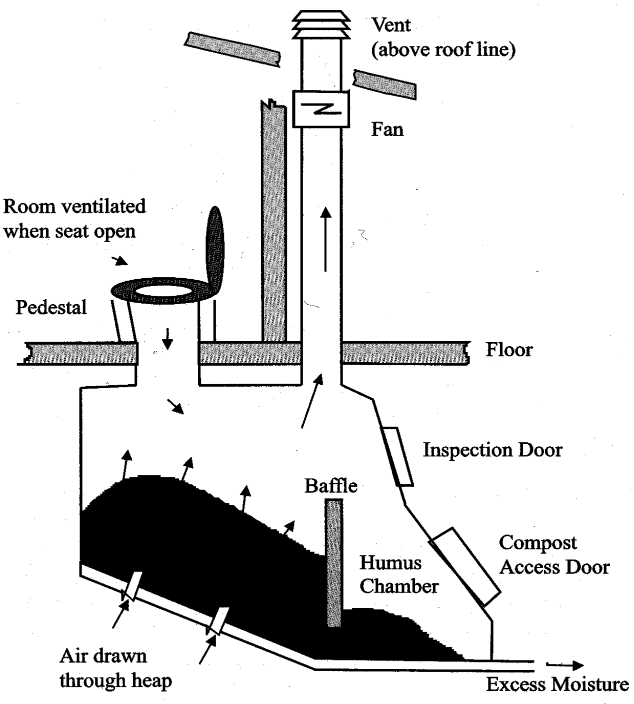


Figure A6: Cross-section schematic of a continuous–flow type compost toilet

Dry composting toilets require a carbon-rich bulking agent such as wood shavings, shredded leaves, shredded paper, or preferably a mixture of these, which needs to be applied after each use of the toilet. This bulking agent also covers the faecal material and aids in reducing any odours from the compost. The toilets must be vented and some have mechanical ventilation to ensure good air flow around the compost heap. After a period of time faecal and bulking material is decomposed into a friable humus-like compost material, which is removed from a door at the base of the toilet.

The use of a compost toilet will remove the toilet component from the wastewater flow of a dwelling or development. However, the household greywaters and the liquid wastes from the composting toilet will still need to be collected and treated in an appropriate manner. The reduced flow rates are incorporated into Councils OSMS Design Model. Greywater can be treated in conventional septic tanks, AWTSs, reed beds, or in systems specifically designed and approved for greywater.

Leachate from the compost toilet must be directed to the greywater tank or its own designated trench. This can actually help the biological process in the greywater tank by adding valuable bacteria. If a reedbed is used the nutrients in the leachate help promote reed growth. Leachate management must be included in any treatment design that involves the use of a compost toilet.

It is important to ensure that flies and rodents are excluded from the interior of the toilet. Thus, stainless steel fly-wire should be placed over any exposed ventilation openings and the toilet lid kept closed when not in use. It is also important to minimise the introduction of excessive moisture to the heap by hosing or cleaning.

Care and maintenance requirements for composting toilets are provided in Attachment G.

A6. Greywater Systems

Greywater is the wastewater produced from sinks, washing machines, showers and dishwashers while blackwater is that produced from a flush toilet. Currently there are no treatment systems approved by NSW Public Health solely for greywater treatment. The basic greywater system expected to accompany composting toilets involves the greywater being collected in a collection tank (minimum size 1800 Litres) before being dispersed in a sub-surface evapotranspiration/absorption (ETA) bed. The size of the greywater land application area will vary depending on wastewater loading and treatment level, and is to be calculated using Council's OSMS Design Model. In general the size of land application area required for greywater will be less than that required for combined blackwater and greywater systems due to the lower nutrient and hydraulic loadings of greywater alone (this can be adjusted as an input in the OSMS Design Model).

A7. Separate Systems versus Combined Systems

There are differing views on the desirability of separate or combined on-site wastewater treatment and disposal systems. The usual split separates greywater from blackwater. Some experts advocate an all waste system in preference to separately treated greywater and blackwater, because of the increased clogging which occurs with greywater alone, due to its higher C/N ratio generating polysaccharides (Laak, 1986 cited in Patterson, 1994).

The use of compost toilets presupposes a separate greywater system. There are situations where the design of the structure and the characteristics of the land require two systems which may or may not be split along strict greywater /black water lines.

A combined system is less costly due to the need to purchase only one tank and install one disposal field, particularly if an AWTS is used. As the minimum size for a septic tank is 3000L the separation of treatment is less economic. On the other hand a separate system provides a slightly longer retention time, hence better treatment, as two separate tanks have a greater combined capacity than one.

A8. Disinfection

There are a number of options for effective long-term disinfection for on-site systems, the most common being chlorination and UV radiation. Disinfection through a UV lamp can be fairly cheaply achieved and is preferred by Council as there is no need to use harsh chemicals. Chlorination disinfection is used with many AWTS installations. Any form of disinfection generally requires a well clarified effluent, low in organic matter and suspended solids (i.e. secondary treated) in order to be effective.

Subsurface irrigation does NOT require disinfection of effluent unless it is a specific requirement of the manufacturer or NSW Health, but does require at least partial-secondary treatment. For surface spray or dripper under mulch irrigation systems the effluent must be disinfected as well as partial-secondary treated (refer Section 6.3 of Design Guidelines).

In designing any OSMS, it is important that the risks to householders and system maintainers from pathogens in sewage and solid wastes. Care should be taken to ensure that contact with sewage can be kept to an absolute minimum during routine maintenance and that no residents or neighbours will be exposed to pathogens during normal operation of the OSMS.

Design Guidelines for On-site Sewage Management for Single Households

APPENDIX B

Land Application Systems

Appendix B – Land Application Options

The E&HP Guidelines (1998) and AS/NZS1547 (2000) describe the various systems that are available for land application areas in some detail. The intention of this section is not to reproduce information that is readily available elsewhere but to expand and highlight points that are particularly relevant to the Byron Shire. Byron Shire features large variability in micro-climates and soil conditions and much of it overlies vulnerable groundwater resources (DLWC Groundwater Vulnerability Map, 1997), and different land application systems will be more appropriate in different localities.

Subsurface land application systems are preferred as they minimise the potential for human contact and rapid release to the environment (Stewart et al., 1983). Evapotranspiration mechanisms are considered the most environmentally means of managing treated effluent because of the ability of the plants to reduce pollution loads while at the same time enhancing the beauty of the locality. The subtropical climate allows a large range of plants to be selected for this purpose compared to other parts of NSW (refer Appendix D).

Land application systems can get overloaded with effluent and fail over time, and an alternate land application area must be designated and set aside for future use should the primary application field become less able to accept effluent or its contained nutrients over time. It is recognised that some existing properties do not have sufficient room for an alternative application area. In these cases it is important that a higher level of effluent treatment be performed, and preferable to be able to alternate the available land application areas, thereby allowing each area to “rest” in an unsaturated state for significant periods each day.

B1. Absorption Trenches

Absorption trenches rely on infiltration of effluent into the ground beneath. Historically this was the only wastewater dispersal method used in the region, irrespective of the soil type. Absorption trenches do not provide for substantial re-use as the effluent is concentrated below the root zone, forcing most of the water downwards to potentially pollute underlying groundwaters. They are also prone to failure due to clogging and hydraulic overloading. For these reason traditional absorption trenches are not generally considered an acceptable or sustainable form of long-term land application system in Byron Shire.

Because absorption trenches offer almost no opportunity for vegetation to pump-out and reuse nutrient-rich effluents, comprehensive justification and secondary effluent treatment prior to dispersal would need to be provided should an absorption system be proposed. Even with secondary treatment, Council generally views absorption trenches as only a short-term solution to an existing problem. If trench designs are to be submitted, they should as a minimum be designed in accordance with AS1547 (2000).

On highly permeable soils which are located a sufficient distance above the standing water table beneath, it may sometimes be acceptable to use a “discharge control trench”, in which the trench beneath the distribution pipe is deepened and filled with washed sand. A standardised design for this type of trench is provided in AS1547 (2000).

B2. Mound Systems

Mounded systems are effluent dispersal devices constructed above the land-surface from imported fill material, usually sand capped with soil. These raised beds are used in situations where drainage of the natural soil is a problem, or where the underlying groundwater seasonally reaches a height of less than 1.2 m below ground level, or areas where flooding occurs periodically. Water dispersal is by evapotranspiration and some soil absorption. Denitrification can be achieved within mounded land-application systems by using intermittent loading.

Careful consideration needs to be given to the installation of this type of effluent dispersal system due to the high rainfall of this region, difficulties in construction and the adverse environmental consequences of system failure. Poor success rates have been experienced with mounded dispersal systems in Byron Shire, and for this reason Byron Shire Council does not recommend their use. If a mounded application bed is proposed, the design and sizing of each mound shall be in strict accordance with AS/NZS 1547 recommendations.

If they are to be used, mounded beds must be carefully constructed and turfed to prevent erosion and to maximise shedding of rainfall off the bed. The down-hill side of the mound should not exceed a slope of 1 in 3 (33%), which can become difficult to achieve even on moderately sloping sites. To enhance maintenance capabilities and to assess the risk of surcharging or other forms of failure, Byron Shire Council requires that observation ports (e.g. made from capped and slotted 50 mm PVC riser pipes) are placed in at least 4 positions per mound to enable regular evaluation during maintenance visits.

B3. Evapotranspiration/Absorption Beds (ET & ETA beds)

An evapotranspiration (ET) bed disperses effluent somewhat like a sand and gravel sponge with a large surface area and shallow depth, sealed at the base and sides to prevent absorption into surrounding soils. Whilst sealing the base is potentially advantageous because it limits pollution of neighbouring soils and underlying groundwater, the high rainfall and limited evapotranspiration experienced in the North Coast region means that sealed-base ET beds are prone to becoming over-filled and periodically surcharging over downstream areas during the wet season.

Evapo-transpiration/absorption (ETA) beds are essentially the same as ET beds but are not sealed at the base and sides. ETA beds allow effluent to be taken-up by evaporation and transpiration mechanisms above the bed as well as allowing some of the effluent to percolate through the permeable base of the bed.

As well as providing treatment and reuse of a proportion of the effluent through evapo-transpiration, ETA beds can be quite robust and needing relatively little maintenance when properly designed and installed. However, ET and ETA beds are relatively expensive and difficult to install properly, and they consume large volumes of non-renewable, imported resources - particularly sand, gravel and transportation energy. In operation, it is extremely difficult to achieve even distribution of effluent over the full width and length of the bed for maximum uptake by plant roots, and both ET and ETA beds also suffer from a propensity to fill up with rain-water during wet periods with consequent risk of periodic over-topping of effluent. For these reasons, ETA beds are discouraged in Byron Shire.

If ETA beds are to be installed, the following design features are required unless sufficient justification is provided for alternative designs:

- Design and installation must comply with the requirements of AS/NZS1547 (2000).
- Distribution of effluent is to be via a minimum of two distribution pipes per 1.5 m-wide bed, with one extra pipe required for each additional metre in width.
- Distribution pipes are **NOT** to have geotextile socks fitted to them as this may lead to the pipes clogging.
- The beds must be installed completely flat, and checked by means of laser level or super-saturating the ground and adjusting any puddle areas.
- Maximum length of each bed shall be 20m, and central-feed systems are preferred.
- The distribution system must be designed and installed to ensure even distribution throughout the beds. Splitter boxes must be accessible and stably installed. Distribution pipes must be installed absolutely flat and should be drilled on the sides rather than the bases, so that effluent wells out evenly rather than seeps out the first few holes.
- Monitoring ports (e.g. slotted and capped PVC pipe) must be installed in at least 2 locations per bed,

- Beds must be mounded and grassed to reduce rainfall penetration and encourage evapotranspiration.
- Shrubs are recommended to be planted no closer than one (1) metre from the sidewall of the ETA bed or trench and small trees no closer than five (5) metres. Large trees, such as, eucalypts, figs or mangoes should be planted a minimum of 20 metres from the beds, to avoid root damage in the distribution system and reduce shading of the ETA beds.
- On sloping sites of up to 10%, ETA beds shall be terraced along the slope and reinforced as required to ensure that they will be stable in the long term. Qualified geotechnical advice should be sought if beds are to be installed on slopes of greater than 10% or on unstable soils.
- Adequate run-on diversion mounds or trenches must be provided to prevent run-on onto the beds. On highly sloping or constrained sites, Byron Council further recommends that a swale be constructed downstream of the beds and planted with vetiver grass or other high-nutrient loving plants to assimilate any occasional surcharges from the beds.

Maintenance requirements for ETA beds, including annual maintenance checks, are provided in Appendix G.

B4. Irrigation Dispersal Systems

The most dependable and most popular means of dispersing effluent in a way that maximises uptake by plants within the land application area is by means of pumped irrigation. Appropriate design of pumped irrigation systems for domestic wastewaters requires a good understanding of pumps, pipes and emitters. For this reason, sub-surface irrigation (SSI), spray irrigation or surface-irrigation-under-mulch systems submitted to Council for approval are to be designed by a person with suitable experience in irrigation design. Byron Shire Council recommends that designers of pumped irrigation systems should be accredited by holding a “Certified Irrigation Designer Agriculture/Micro” certificate. Irrigation designs are to include all the information set out in the Irrigation Design Check List (Appendix E). Sub surface irrigation, spray irrigation or surface irrigation under mulch designs are to be installed by a suitably qualified person with experience in irrigation installation.

All effluent dispersal by irrigation including subsurface, surface drip or spray is to be maintained on a regular basis in accordance with their conditions of approval for the installation. An Irrigation Maintenance Report (refer Appendix F) is to be submitted by the service-provider to Council within 7 days of servicing the irrigation area.

B4.1 Sub-Surface Drip Irrigation (SDI)

Sub-surface drip irrigation (SDI) systems, also commonly referred to as sub-surface irrigation (SSI), are the preferred means of dispersing effluent in the Byron Shire due to their precise and even distribution capabilities. Sub-surface drip irrigation is particularly appropriate where there are site or soil limitations or limitations, such as steep slopes or on heavy impermeable (often termed “puggy”) soils, and can even be used with care and greater spacing on highly permeable sandy soils.

The sub-surface drip irrigation dispersal method is discussed in the E&HP Guidelines (1998) and AS/NZS1547 (2000, Pages 122-126) in some detail.

On some small and highly constrained sites, it is sometimes advantageous to distribute effluent in carefully laid “micro-trenches”. These micro-trenches comprise narrow, shallow, gravel-filled trenches in which sub-surface irrigation pipes are installed. The advantages of micro-trenches is that by shallowly laying them along the contour, they can distribute effluent reliably, evenly and intermittently using a dosing siphon or pump. Assuming that stormwater is adequately diverted, micro-trenches provide a good opportunity for reuse by plants and only a low risk of effluent surcharging during wet periods.

Laterals in gravel-filled trenches are to be spaced 600mm apart unless otherwise justified. Sub-surface irrigation which is installed without the benefit of distribution trenching will be required to have a dripper spacing of 300 mm and will typically need to have three times the density of and linear length of pipework compared to trench-based designs.

Sub-surface irrigation systems must be designed and installed by suitably qualified persons, and must be flushed to remove sediment/slime at least once per year, and preferably quarterly, by a qualified professional as part of the maintenance requirements. Suitably located pressure-release valves and flush pits must be provided to allow this regular flushing maintenance without causing pollution.

There are a number of different types of proprietary SDI systems on the market. Council requires that all new installations use pressure-compensated emitters, and strongly prefers the use of “non-drain” varieties. “Non-drain” emitters have the dual advantage of not draining out after the pump cycle has finished and are also much less prone to root invasion.

The following design features shall be integrated into SDI designs, unless sufficient justification is provided for alternative designs:

- Design and installation must comply with the requirements of AS/NZS1547 (2000).
- The maximum size for a single sub-surface irrigation field is 500 m^2. If a bigger application area than this is required to reliably disperse the household effluent, it should be broken up into smaller fields and the effluent load should be alternated through the fields via an indexing valve (refer Section 4.6).
- Pumps must be sized to match the hydraulic characteristics and requirement of the irrigation system, including friction losses through pipes and filters.
- Flushing velocity in all flush lines shall be between 0.8 m/s and 2 m/s.
- Gravel-filled flushing pits should be adequately sized to accept design flush loads and be located below the bottom point in each field. If return lines are to be provided to the septic tank, they must be inserted below the crust level so as not to disturb the crust.
- Discharge rates from emitters should be matched to the permeability of the soil.
- Pump-out volumes shall be sufficient to charge pipe system for durations of between 15 and 30 minutes, twice to four times per day.

Maintenance requirements for SDI systems, including annual maintenance checks, are provided in Appendix G.

B4.2 SURFACE SPRAY IRRIGATION

Within the Byron Shire the use of surface spray irrigation even of disinfected effluent is discouraged due to public health risks (NSW Health) and the much higher risks of uncontrolled run-off of effluent or effluent-contaminated rainfall. Consideration for surface spray irrigation will be given for those on-site systems on large acreage where the dispersal area is a considerable distance from dwellings. Other possible applications might be for flat sites on heavy clay soils, provided that sufficient isolation from residents and neighbours can be demonstrated. The system must be designed in accordance with AS/NZS1547 (2000) recommendations and installed by a suitably qualified person (refer Appendix G for care and maintenance requirements).

If used, above-ground irrigation should be by heavy droplet sprinklers placed in soil-conditioned garden beds with appropriate warning signs to keep children and others away. Detailed stormwater controls must be installed, and **effluent will require adequate disinfection before being sprayed above-ground.**

B4.3 SURFACE DRIPPER UNDER MULCH IRRIGATION

Surface dripper-under-mulch options are considered appropriate in some agricultural applications, for example where dripper lines can be usefully placed under mulch between rows of trees in a location remote from the house and waterways. In these cases, drippers are placed on the ground surface at the tree base, organic mulch is placed over the dripper lines, and a mound is usually placed around each tree to keep the water at the roots. In some instances owners have also used this type of system to regenerate bushland areas. Such situations, even with appropriate warning signs, are not suitable for children to play in. In plantations, provision should also be made to allow for disconnecting the irrigation line in times of heavy machinery use on the plantation to minimise pipe damage.

Surface dripper-under-mulch options may also be considered for rural domestic situations in Byron Shire. In these cases, higher maintenance and monitoring conditions than sub-surface irrigation options will be required to ensure that the mulch remains in place over the drippers and that casual access by children, vehicles and livestock is restricted by a vegetative border, fence or similar device.

Effluent must be disinfected prior to the dripper system and be designed and installed by a suitably qualified person in accordance with AS/NZS1547 (2000) recommendations. Care and maintenance requirements are provided in Appendix G.

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:

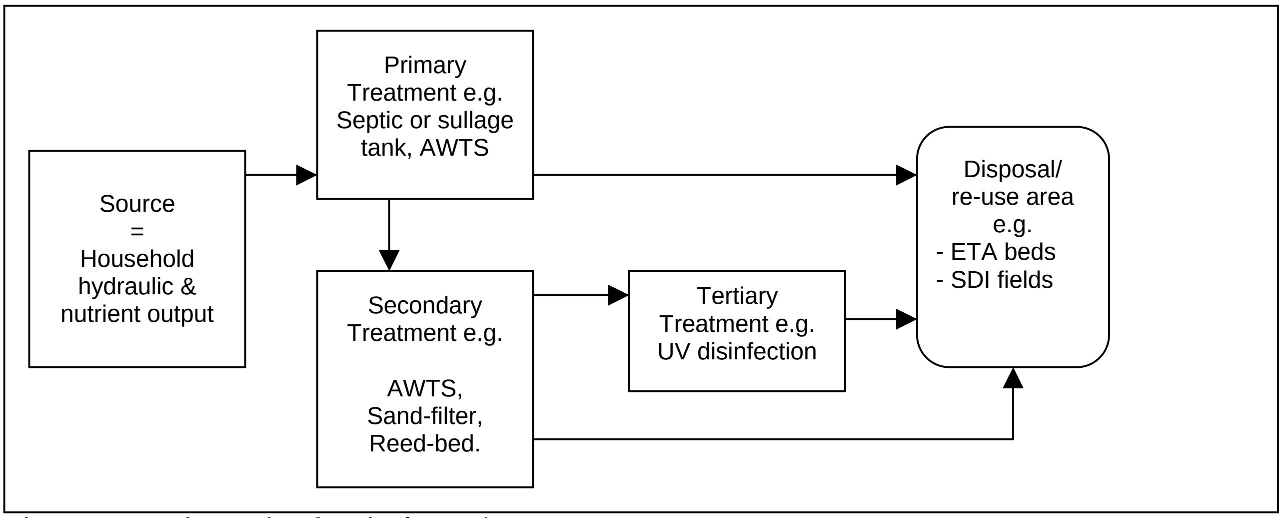


Figure C1: Schematic of typical On-site Sewage Management System components

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 m^2) which will accept the volume of applied effluent for 95% of the time (i.e. the 95^{th} 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:

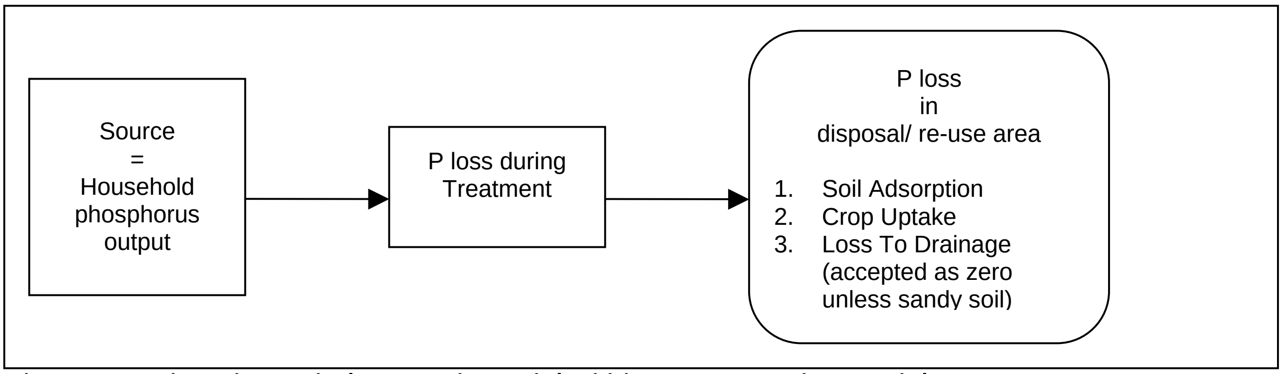


Figure C2: Phosphorus balance sub-model within OSMS Design Model

The equation for the phosphorus application area is:

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

Where:

Area	- land application area required for soil/ plant P removal
10,000	- conversion factor from hectares to m^2
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:

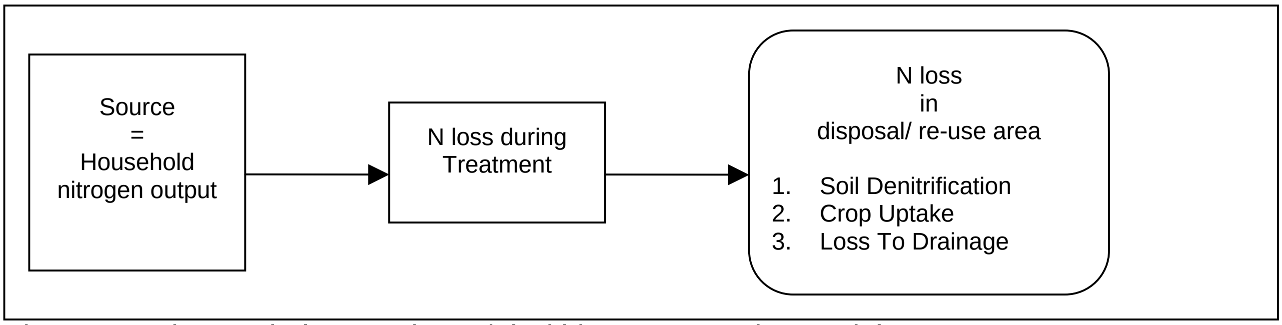


Figure C3: Nitrogen balance sub-model within OSMS Design Model

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:

Area (m^2) = $((N_{load} - N_{denit})/N_{crop}) \times 10{,}000$ .... 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_{lim} = N_{max} [1-exp(-kB)] .... 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;

Area (m^2) = $(1 - N_{lim} /(N_{treat} - N_{denit})) \times ((N_{treat} - N_{denit})/N_{crop})) \times 10{,}000$ .... 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 reapportioning 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 (10,000m^2) 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 krasnozem 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 <u>less</u> than the default value. In this instance there is no nearby waterway.

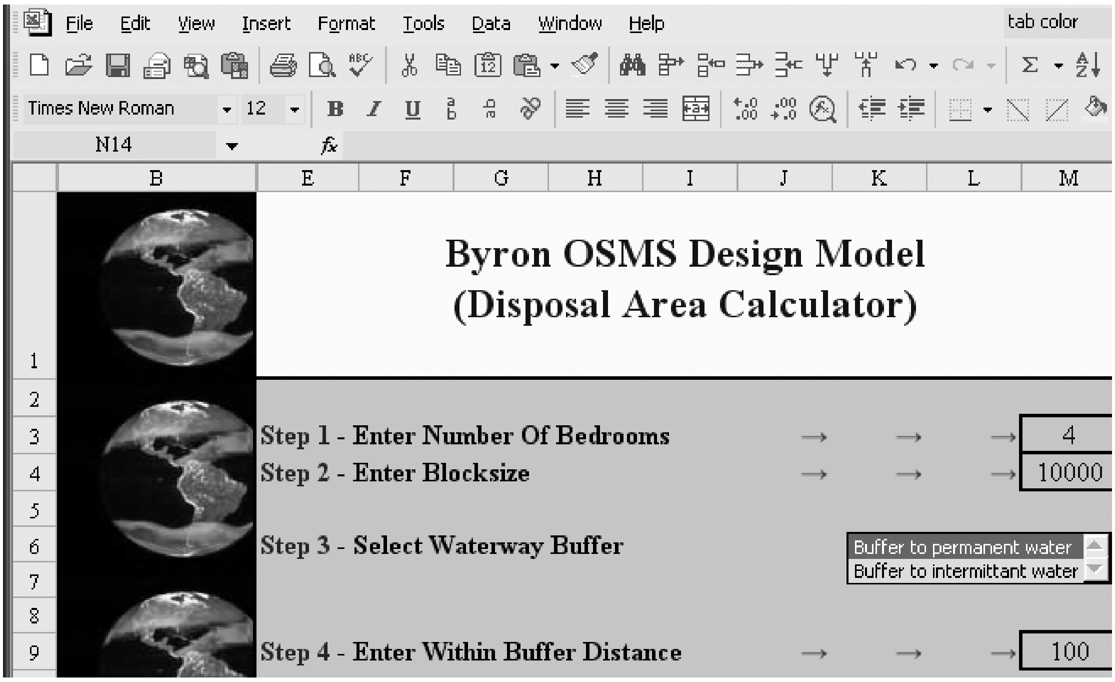


Figure 1: Steps 1-4 Designer Input Sheet

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*'.

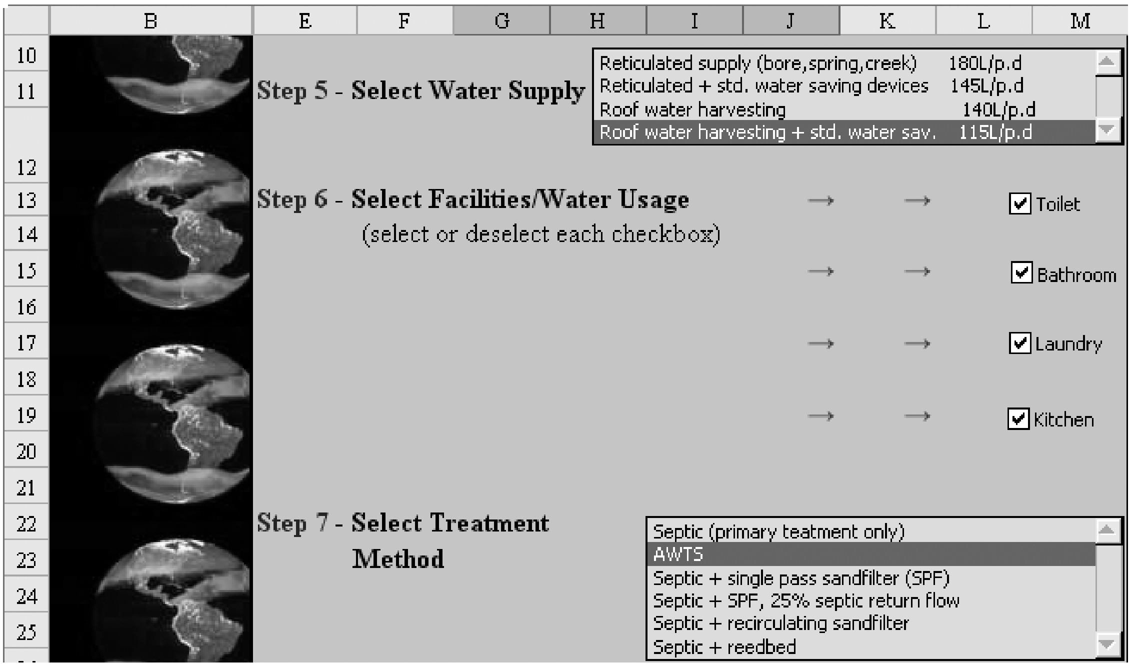


Figure 2: Steps 5-7 Designer Input Sheet

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).

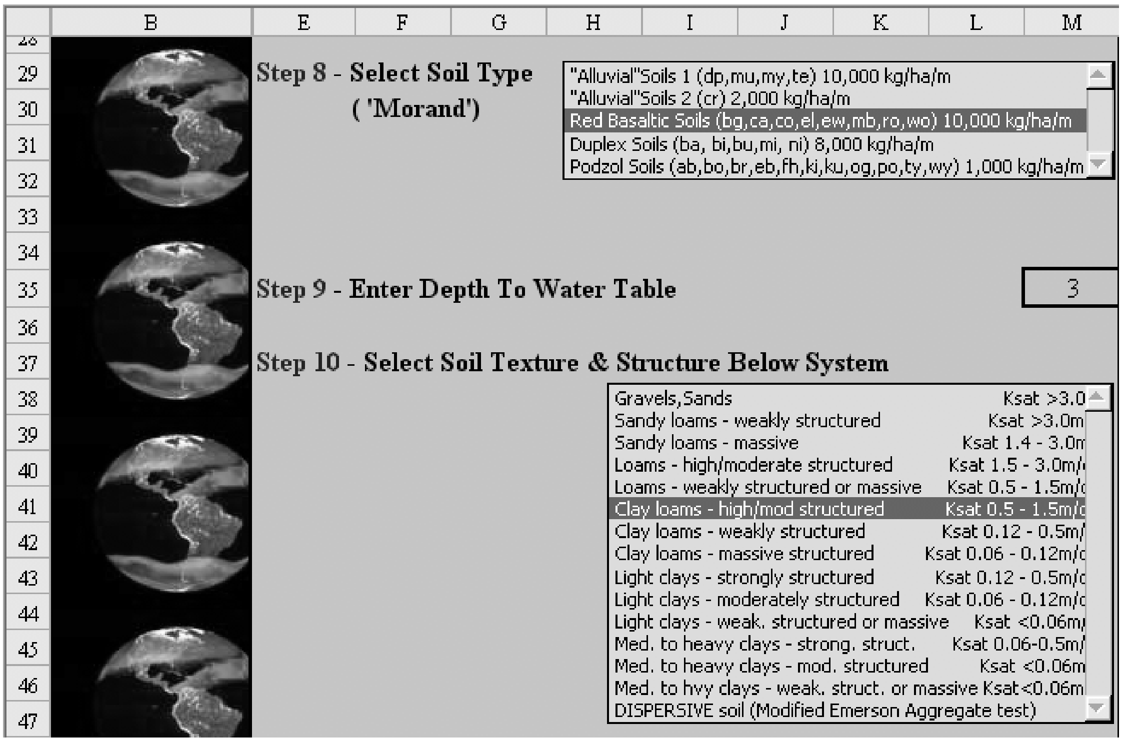


Figure 3: Steps 8-10 Designer Input Sheet

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 m^2) 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.

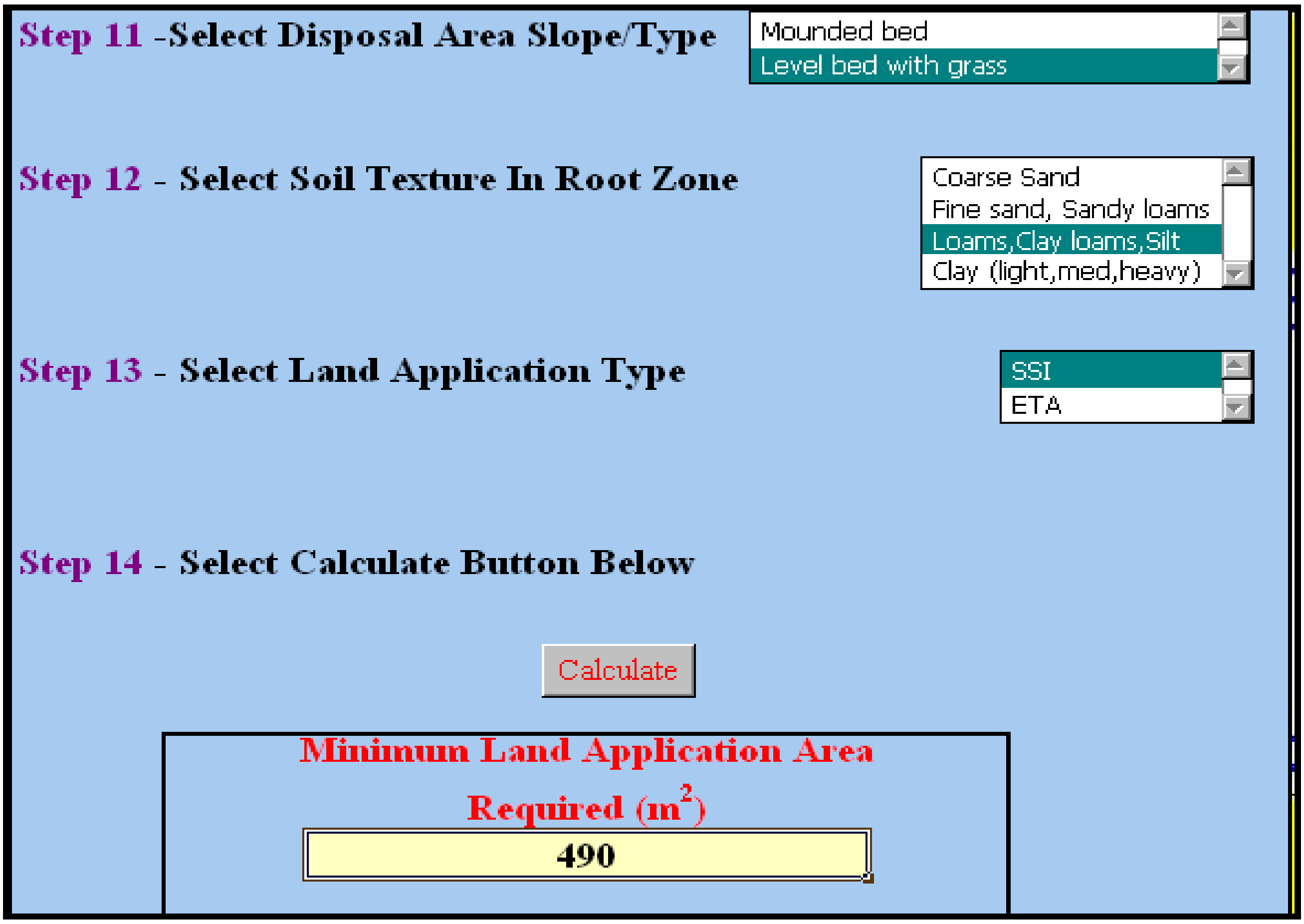


Figure 4: Steps 11-15 Designer Input Sheet

The calculated minimum land application area of 490m^2 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 m^2 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 values[1], 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 (20,000m^2) 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.

Step1
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.

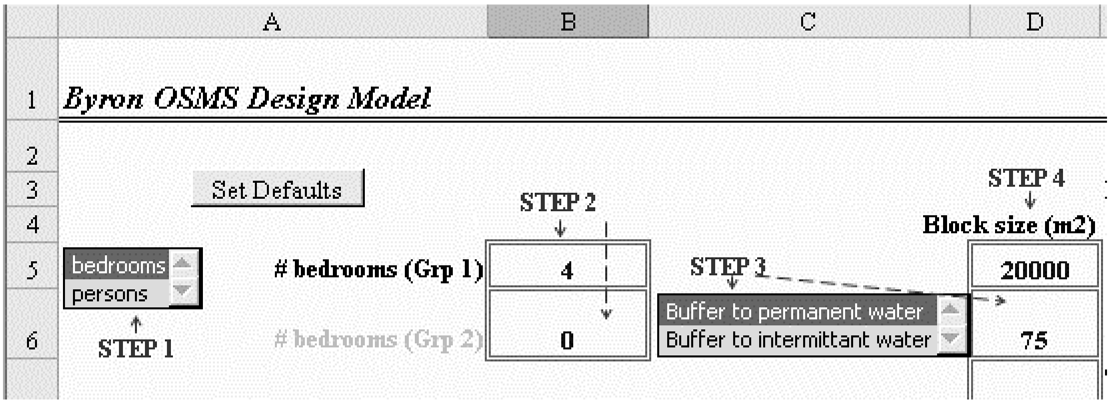


Figure 5: Steps 1-4 Design Model

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*’.

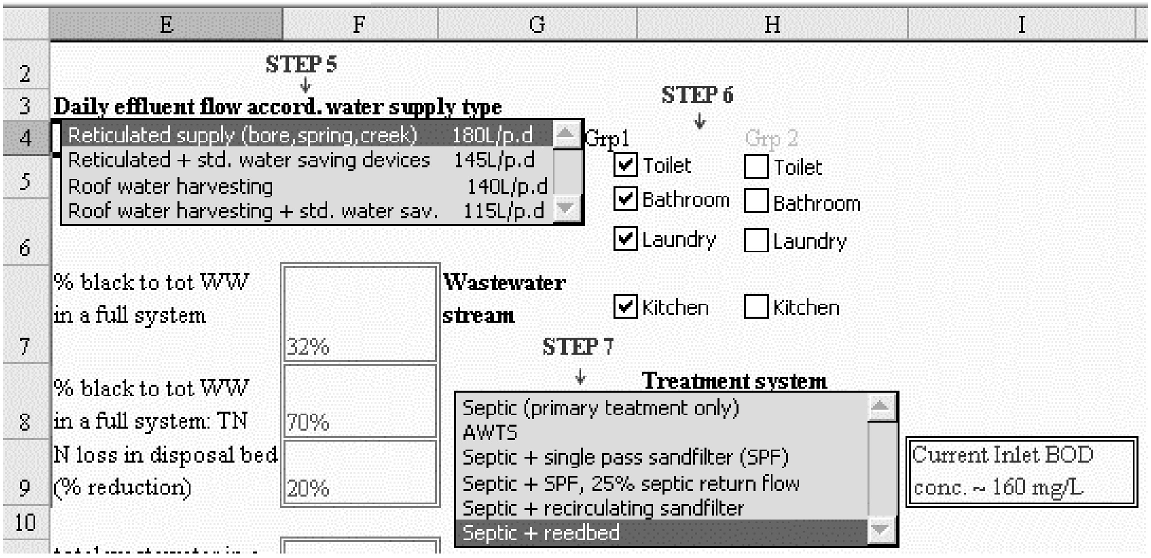
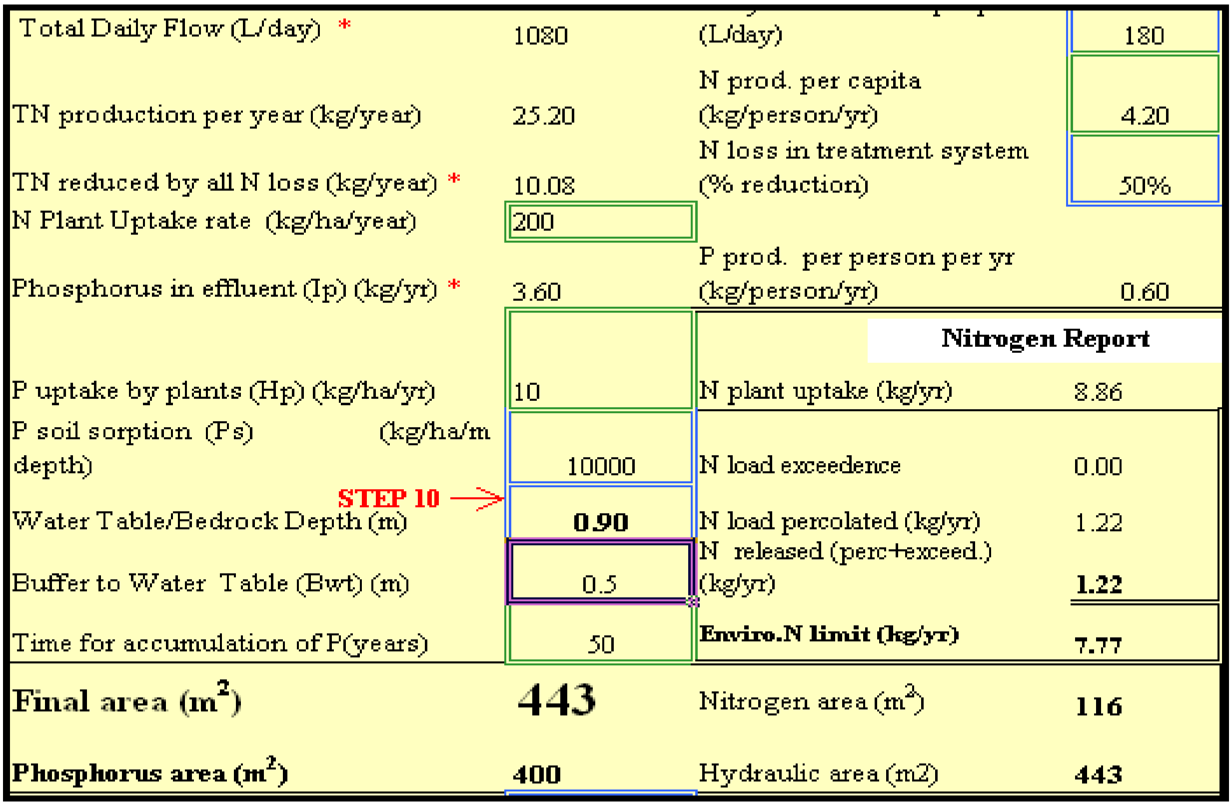


Figure 6: Steps 5-7 Design Model

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 (m^2)	**443**	Nitrogen area (m^2)	**116**
Phosphorus area (m^2)	**400**	Hydraulic area (m2)	**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 m^2.

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.

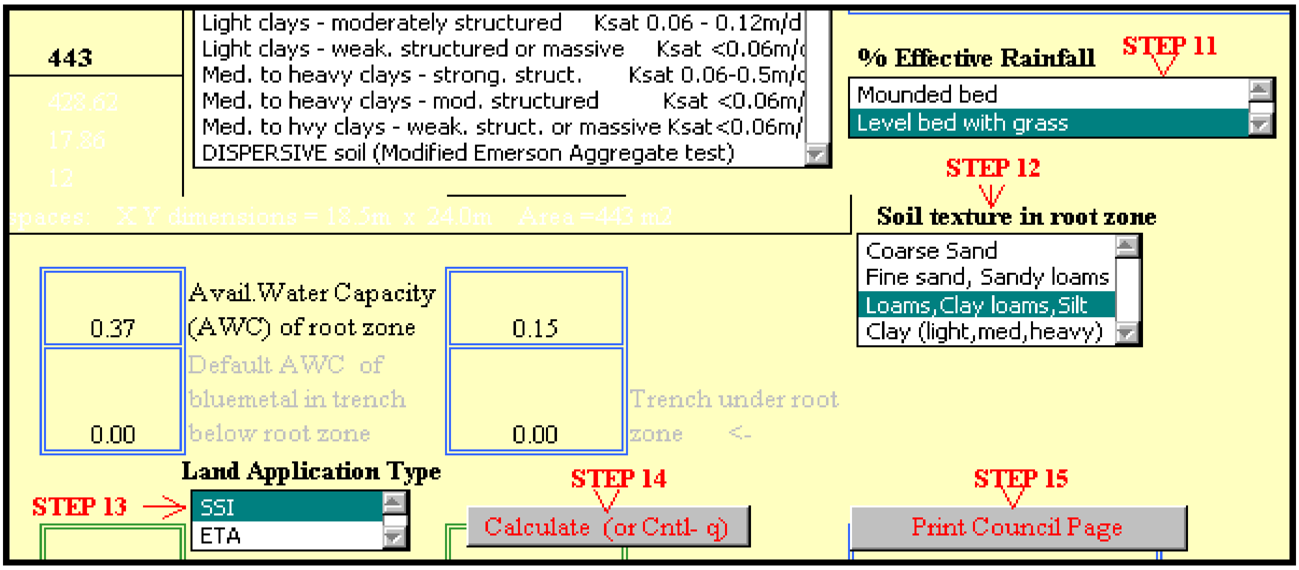


Figure 8: Steps 11-15 Design Model.

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 443m^2 to 379m^2.

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.

Design Guidelines for On-site Sewage Management for Single Households

APPENDIX D

Native (local) plants suitable for Land Application Areas

Native (local) plants suitable for Land Application Areas

The following list of plants is a selection of native plants that would be suitable to be grown in or around the edges of most land application areas in Byron Shire. Council does not require that plants are selected exclusively from the following list, nor does it require that plants used in OSMS land application areas must be exclusively natives or native to the region, though for the sake of maintaining biodiversity in the shire Council does support the use of any local natives which are able to super-accumulate nitrogen and phosphorus into “luxury growth”. Plants to be specifically avoided are those which are best grown on sand or sandstone, nutrient-poor soils. If in doubt, ask your nurseryman or a horticulturalist.

Macrophytes suitable for use in reed-beds are listed in Appendix A4.5.

Scientific name	**Height**	**Common name**
Sedges/Rushes/Reeds		
Baumea articulata	1m	Jointed Twigrush
Baumea rubiginosa	1m	Rush
Bolboschoenus fluviatilis	2m	Club Rush
Carex appressa	1m	Sedges
Carex fasicularis	1m	Tassel Sedge
Carex gaudichaudiana	1m	Sedge
Cyperus exaltatus	1m	Sedge
Eleocharis equisetina	1m	Spike Rush
Fimbristylus spp.	50cm	
Gahnia clarkei, G. sieberiana	1.5m	Sawsedge
Juncus polyanthemos, J. usitatus	1m	Reed
Juncus krausii	1m	Salt Rush
Lepironia articulata	2m	Grey Sedge
Lomandra hystrix	1m	Creek Mat Rush
Lomandra longifolia	1m	Long Leaf Mat Rush
Scirpus mucronatus	50cm	Triangular Club Rush
Schoenoplectrus validus	1m	
Typha orientalis	1.5m	Bulrush
Grasses/Ground covers/climbers		
Bacopa monniera		
Centella asiatica	20cm	Pennywort
Oplismenus ameulus	30cm	Grass
Oplismenus imbecillis	30cm	Grass
Paspalum distichum	50cm	Water Couch
Pollia crispata	80cm	Pollia
Pseuderanthemum variable	50cm	Pastel Flower
Themeda triandra	80cm	Kangaroo Grass
Vetiveria filipes	1m	Native Vetiva
Viola betonicifolia	30cm	Arrow-leaved Violet
Viola hederaceae	30cm	Native Violet
*******Penniselum clandestinum* ***(exotic)***	30cm	Kikuyu
Setaria spacelata* *(exotic)***	30cm	Setaria species
Forbs/Small plants		
Alocasia brisbaniensis	1m	Cunjevoi Lily
Alpinia caerulea	1.5m	Native Ginger

Callistemon pachyphyllus	1m	Wallum Bottlebrush
Cordyline rubra, C. petiolaris	3m	Palm Lilies
Crinum pedunculatum	1m	River Lily
Enydra fluctuans	50cm	
Helmholtzia glabbristylis	1m	Stream Lily
Melastoma affine	50cm	Blue Tongue
Persicaria spp.	50cm	Knotweeds
Philydrum lanuginosum	1m	Frogsmouth
Pipturua argenteus	50cm	White Nettle
Tetragonia tetragoniodes	50cm	Warrigal Greens
Ferns		
Blechnum indicum	1m	Bungwall
Blechnum cartilagineum	1m	Gristle Fern
Christella dentata	1m	Binung
Cyathea australis	3-5m	Tree Fern
Cyclorus interruptus	80cm	
Shrubs/ Small trees		
Banksia ericifolia	3-5m	Heath Banksia
Banksia robur	1-3m	Swamp Banksia
Callistemon salignus	5m	White Bottlebrush
Callistemon viminalis	5m	Weeping Bottlebrush
Evodiella Muelleri	3m	Little Evodia
Ficus coronata	5m	Creek Sandpaper Fig
Hibiscus diversifolius	1.5m	Swamp Hibscus
Leptospermum flavescens	3m	Common Ti Tree
Leptospermum liversidgeii	1m	Lemon Ti Tree
Melaleuca nodosa	3m	Paperbark
Melaleuca stypheloides	5m	Prickly-leaved Paperbark
Myoporum acuminatum	3-5m	Mangrove Boobialla
Omalanthus nutans	3-5m	Bleeding Heart
Trees *(Note that large trees should **not** be grown directly on land application areas, and should be set back a minimum distance of their projected height to avoid shading of the land application area)**.***		
Acacia melanoxylon	15-20m	Blackwood
Acmena smithii	5-10m	Lilly Pilly
Archontophoenix cunninghamiana	10-15m	Bangalow Palm
Casuarina glauca	10-15m	Swamp Oak
Commersonia bartramia	5-10m	Brown Kurrajong
Glochidion sumatranum	5-10m	Umbrella Cheese Tree
Hibiscus tiliaceus	5-10m	Cottonwood Hibiscus
Livistona australis	15-20m	Cabbage Palm
Lophostemon suaveolens	5-10m	Swamp Box
Melaleuca quinquenervia	10-15m	Broad-leaved Paperbark
Melicope elleryana	10-15m	Pink Euodia
Syzygium australe	5-10m	Scrub Cherry
Tristaniopsis laurina	10-15m	Water Gum
Waterhousea floribunda	5-10m	Weeping Lilly Pilly

* Exotic grass species. BSC does not particularly promote the use of exotic grasses. However, if these grasses are already on site then they can be utilised in the land application area.

APPENDIX E

OSMS Treatment System Service Checklist

Appendix E1

OSMS Treatment System Maintenance Reporting Checklist 1 – AWTS Systems

Name and Contact Details of Service Provider
Client Name
Client Address
Client Phone No.
Type of System Installed
- Components Installed (AWTS, sand-filter etc)
- Date installed / commissioned (if known)

Date of Service

AWTS Service
General
- Odours
- Access (OK / Restrictions? / Caps fitting)

Electrical
- Electrical circuitry
  - Working?
  - Signs of wear?
  - Enclosures adequate?
  - Plugs and leads OK?
- Alarm Systems
  - Lights and / or buzzer functioning?
  - Level sensors
- Air blower(s)
  - Pressure in Kpa? (working adequately? / below original pressure setting?)
  - Overheating? (y/n)
  - Noisy? (y/n)
  - Air filters (blocked and cleaned? / functioning / need replacing?)
  - Vents and valves clear (clear / partially blocked / all blocked)?
  - Aeration pattern (even / restricted)
- Transfer pumps
  - Sludge return pump (good pressure, low pressure, not functioning)
  - Irrigation pump (good pressure, low pressure, not functioning)
  - Pump 3 (good pressure, low pressure, not functioning, n/a)
  - Bearings OK?
  - Seals OK?

Septic Chamber
- Sludge Accumulation (High, med., low)
  - Pumpout required?
  - Inlet junction clear (y/n)
- Sludge Return system (working, slightly blocked, blocked)
- Odour (none, low, strong)

Activated Sludge Systems
- SV30 test (%)
- pH
- Water clarity (clear, coloured, turbid)
- Decanter operating? (yes / no/ comments?)

Disinfection Chamber
- Tablets remaining
- Tablets added
- Free chlorine measured (mg/L)

Problems noted and action taken:

Appendix E2
OSMS Treatment System Maintenance Reporting Checklist 2
- Non-AWTS (Septic tanks, sand-filters, reed-beds)

Name and Contact Details of Service Provider

Client Name

Client Address

Client Phone No.

Type of System Installed

Components Installed (AWTS, sand-filter etc)

Date installed / commissioned (if known)

Date of Service

Septic Tank Service

General

Odours

Access (OK / Restrictions?)

Tank condition

Size of tank?

Depth of sludge?

Needs pumping out?

Soundness of tank?

Appearance of crust?

Condition of inlet?

Condition of outlet?

Condition of baffles?

Outlet Filter

Filter fitted and functioning?

Filter cleaned?

Holding Tanks

Soundness of tank?

Alarms working?

Electrical system adequately housed?

Pumps working?

Reed Bed Service

Gravel bed even?

Water level at 50mm below gravel?

Reeds growing well?

Strongly weed infested?

Roots removed from inlet and outlet structures?

Clogging problems noted/fixed?

Condition of baffle (if present)?

Reeds thinned/harvested and removed?

Inspection ports cleaned & functioning?

Electrical system (pumps, alarms etc) OK?

Effluent quality appears OK?

Sand Filter Service

Electrical system (pumps, alarms etc) OK?

Sludge built up on top of bed?

Filter cover OK?

Effluent quality appears OK?

Problems noted and action taken:

APPENDIX F

Land Application System Service Checklist

Appendix F

OSMS Land Application System Maintenance & Reporting Checklist

Name and Contact Details of Service Provider
Client Name
Client Address
Client Phone No.
Type of System Installed
Components Installed (AWTS, sand-filter etc)
Date installed / commissioned (if known)
Date of Service

Absorption Trenches / ETA Beds
Odours
Evidence of surcharging
Fluid levels OK?
Distributor system OK?
Stormwater diversion system functioning?

Irrigation Systems
Pump(s)
- Pressure OK?
- Bearings OK?
- Electrical system OK?

Control System
- Enclosures adequate?
- Plugs and leads OK?
- Level sensors clean and operating well?
- Alarm light and/or buzzer OK?

Filters
- Cartridges cleaned and/or replaced?
- Pressure gauges installed / working?
- Filter loss <70 kPA?

Irrigation field
- Location of irrigation field accurately known / marked?
- Scour valves opened and flushed (>5 minutes)?
- Lateral lines open and flushed (>5 minutes)?
- Evidence of blockages or surcharging?
- Evidence of poor or excessive vegetation growth?
- Warning signs in place?

Problems noted and action taken:

Design Guidelines for On-site Sewage Management for Single Households

APPENDIX G

Looking After Your On-Site Sewage System

OSMS Management Plan for

____

____

____

____

On-Site System Management Plan

This section is designed to be used as a basis for On-site Sewage Management System (OSMS) designers to provide a management plan for the homeowner's permanent use. It is intended that the OSMS designer will fill in the appropriate sections, remove any irrelevant components, and add any relevant comments to make the management plan as comprehensive and useful as possible to the future homeowners. It will be a requirement of consent that a management plan is provided with each design successfully submitted, and a further condition of the Approval to Operate that s copy of the Management Plan is stored in an appropriate location within the home

The following information is to be provided at the front of each management plan.

Street address	
Lot, Deposited Plan	
Council reference no's (if known)	
Author and date of OSMS design document submitted to Council	
DA or s68 Approval No. and date(s) approved.	
Date installed	
Service provider and contract details	

G1. Details of Your Sewage Management System

A domestic on-site sewage management system is made up of various components which - if properly designed, installed and maintained - allow the treatment and utilisation of wastewater from a house within the boundaries of the property. Homeowners should acquaint themselves with what sewage management system is installed at your property and how it works. If in doubt, consult your service provider or Byron Council.

Your OSMS has been designed to cater for ___ people and ___L/day of effluent, based on the understanding that the following water-saving devices are installed. If you are aware that more people are regularly using the system, or if you wish to install extra water-consuming devices (e.g. additional bathroom or installation of a spa), please consult Council to ensure that your system is capable of managing the wastewater loads.

The OSMS installed at your property comprise the following elements ***(designers to add or delete information to make description relevant and accurate);***

System Component	**Number**	**Details** (e.g. manufacturer, size, relevant details)
Water-saving devices		
Treatment System		
Composting toilet		
Septic/sullage tank		
Outlet filter		
Aerated wastewater treatment system		
Sand-filter		
Reed bed		

Holding tanks		
Pumps		
Filters		
Alarms (light / siren)		
Other		
Land Application System		
Absorption trenches		
Mound system		
Evapotranspiration beds		
Sub-surface irrigation		
Surface irrigation		
Other		

A detailed plan and technical details of the various components should be appended to this report.

G2. Advice for Home-Owners

G2.1 Background Information

Wastewater may be blackwater (toilet waste), or greywater (water from showers, sinks, kitchens and washing machines), or a combination of both. Greywater (sullage) can have a high percentage of the same pollutants as blackwater, but composting toilets are strongly encouraged due to the overall reduction in water used and nutrients which need to be taken up.

Additional information to be added by system designer as appropriate

G2.2 How does my OSMS work?

The components listed above collectively treat and disperse the household wastes within your property (refer attached plan). The following section provides a brief overview on how the components work together to achieve this.

An OSMS generally consists of three main parts: the wastewater source, treatment components, and a land application area for the final reuse or disposal of the treated effluent. These components are represented graphically in Figure G1.

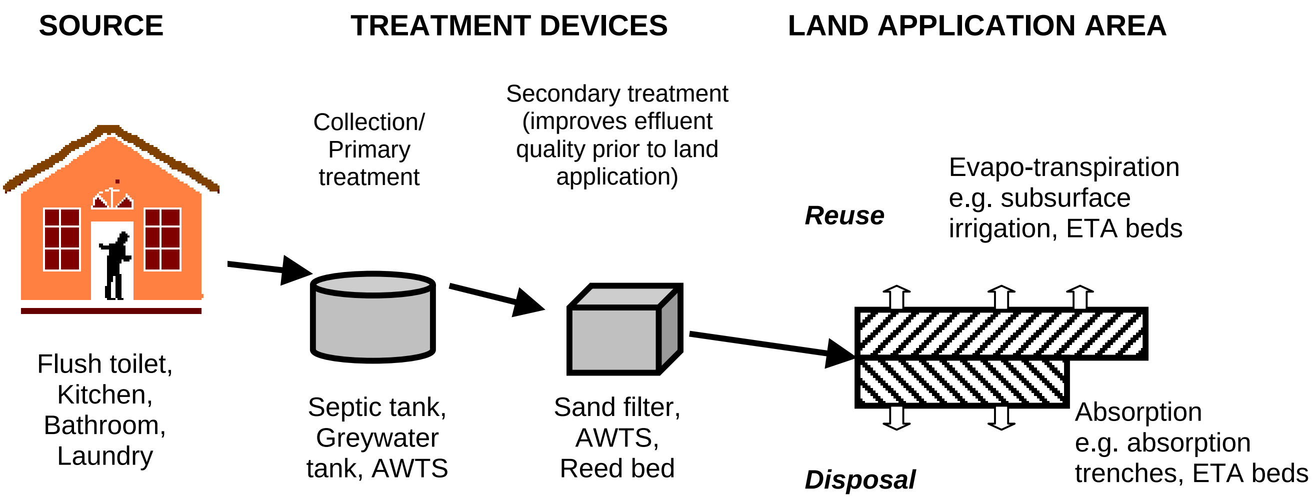


Figure G1: Major Components of On-Site Sewage Management Systems (OSMSs)

G2.3 Source Reduction of Wastewaters and Nutrients

G2.3.1 Recommendations for saving and managing water

Reducing water usage will lessen the likelihood of problems such as overloading with your septic system. Overloading may result in wastewater backing up into your house, contamination of your yard with improperly treated effluent, and effluent from your system contaminating groundwater or a nearby waterway. On-site systems generally work best when the wastewater load is minimised and “shock-loads” (e.g. sudden, heavy loads such as when large numbers of people use the system for a short or uneven periods) are avoided.

- Spread heavy water use activities such as laundry over the week.
- Replace single flush toilets with dual flush.
- Install low-flow shower roses.
- Replace internal taps with low-flow designs.
- Purchase a front-loading washing machine.
- Install a waterless composting toilet.
- Do not install spa baths unless this has been specifically accounted for in the OSMS design. If a spa bath has been installed, use sparingly and release the water slowly.

Additional information to be added by system designer as appropriate

G2.4 What can my OSMS cope with?

G2.4.1 Detergents

The use of detergents low in phosphorus and sodium is recommended for use in households with on-site systems. Detergents high in sodium can lead to soil degradation in the land application area, leading to a reduction in permeability, a consequent risk of surcharging sewage and the need for early replacement of the application area.

Note: Concentrated and liquid detergents often contain much less phosphorus and sodium than equivalent powder detergent products. Potassium based liquid soaps (eg Castile soap) are also recommended.

G2.4.2 Food and Cooking Oils

It is anticipated that some food and cooking oils will be washed into wastewater treatment devices, and all systems discussed in Appendix A of the Design Guidelines are capable of handling a limited amount of these. However, most systems (other than very large septic tanks) are likely to become overloaded if large volumes of food and/or cooking oils enter them. For this reason, the following broad guidelines should be followed to protect your OSMS;

- Food and cooking oils should be kept to a reasonable minimum by keeping food-strainers in kitchen sinks at all times and by tipping larger volumes of oils or fats into garden.
- “Insinkerators” or similar types of in-sink macerators should not be installed unless these have been specifically addressed and accounted for in the OSMS designs.
- Where large volumes of oil or grease are likely to be flushed down sink, a grease-trap should be installed and regularly maintained.

Additional information to be added by system designer as appropriate

G2.5 What should I avoid?

Almost all sewage treatment systems use microorganisms to treat and break down the sewage components. Regardless of the system type, it is therefore vitally important that the health of the micro-organisms that perform the treatment be protected. Any materials or fluids which are toxic to animals (e.g. bleaches, disinfectants, whiteners, nappy soakers and spot removers, fuels etc.) can be presumed to be toxic to microorganisms. Many medicines, e.g. antibiotics, contraception pills, can also have harmful effects on the microorganisms in the treatment system or the broader environment and should not be flushed into the household wastewater system.

Besides not placing poisons in your system, the following should be avoided;

- Don't let children or pets play on land application areas.
- Don't water root vegetables with effluent, and clean thoroughly any fruit or vegetables which could have contacted the effluent.
- Don't extract untreated groundwater for cooking and drinking.
- Don't allow any foreign materials such as nappies, sanitary napkins, condoms and other hygiene products to enter the system.
- Chemicals in cleaning agents, disinfectants, shampoos and bleaches etc. can be detrimental to treatment systems – minimise or avoid their use. Vinegar, lemon juice, vegetable oil based soaps and hydrogen peroxide could be considered as alternatives.
- Do not empty paint, petrol, pesticides, medications or chemicals down sinks.
- Disposable nappies, sanitary napkins, paper towels, plastics etc block treatment systems. Dispose of these separately.

Additional information should be added by system designer as appropriate

G2.6 Problem solving

All on-site systems need to be regularly maintained in order to function well. If particular problems are found, such as:

- gurgling or unusual toilets;
- slow-draining wastewaters;
- unusual odours;
- unusually noisy pumps or other components;
- surcharging effluent from any treatment or land application systems; or
- poor vegetation growth in irrigated areas;

these symptoms should be investigated by your service provider as soon as possible.

Many systems include a light and/or sound alarms to alert the homeowner of any overload problems. If one of these alarms goes off, the householder **must** contact the relevant service provider immediately.

Additional information should be added by system designer as appropriate

G3. Maintenance and Care For Your System

G3.1 Treatment Systems

G3.1.1 Septic/Sullage Tanks

A septic (blackwater and greywater) or sullage (greywater only) tank operates as a “stilling pond” and anaerobic digester. When the wastewaters enter the tank they are allowed time to settle out solids, which fall downwards to join the sludge on the base of the tank, and oils and greases which rise up to form part of the crust at the top of the water column. For this to happen, it is vitally important that sufficient liquid volume is maintained in the tank by pumping it out regularly and that the microorganisms in the tank are not killed off through inappropriate inputs.

Operation & Maintenance

- The householder should check the depth of the crust and the sludge regularly, at least once or twice per year (refer attached sheet for instructions).
- The sludge which builds up in the tank must be pumped out when it occupies more than a third of the tank’s volume, usually every 3 to 5 years.
- Do not flush tampons, condoms or other indigestible inorganic material into a septic tank. Avoid introducing bleach and chemicals harmful to the anaerobic microorganisms.
- If crust above the fluids becomes thinner than 2-3 cm or thicker than 10-15 cm, investigate causes (e.g. thin crust could be due to high throughflow of effluent or toxic materials in influent).
- Do not smoke near the septic tank when undertaking maintenance work due to possible risks from build up of flammable gases such as methane in confined spaces.

G3.1.2 Effluent Filters

An effluent filter is a coarse screen filter that sits in the outlet of a primary treatment tank. Effluent filters need to be maintained regularly to ensure that they function effectively. An effluent filter which is not regularly cleaned will clog and potentially cause the tank to back-up and overflow, or otherwise might be responsible for high levels of solids being carried over to the next treatment component.

Effluent filters should be cleaned by the householder every few months, and cleaned and serviced by a service provider at least once per year (check manufacturer’s recommendations). Care should be taken when cleaning an effluent filter to avoid contact with the effluent, and to clean hands and any affected clothes afterwards.

G3.1.3 Aerated Wastewater Treatment Systems (AWTS’s)

In accordance with NSW Health accreditation requirements, most AWTS’s require *quarterly* maintenance and servicing by a *qualified service contractor* (usually the firm that supplied the unit). A copy of a maintenance report based on the examples shown in Appendices E and F must be completed by the service-provider and sent to Council within 14 days of the service.

An owner-funded contract should exist between the Council-authorised service provider and the owner of the AWTS.

G3.1.4 Sand Filters

Sand filters work by dosing an enclosed sand column with effluent. As the effluent moves past the sand grains, it is treated through contact with the micro-organism which coat the sand grains.

Operation & Maintenance

- Service provider to check and service pumps and other mechanical parts every twelve months
- Home owner and service provider to check for slime or algae build up in intermittent (single pass) sand filters, and remove if necessary, every three months.

- For most heavily used systems or those working under adverse circumstances, sand may need to be replaced every decade or so (check manufacturer's recommendations).

G3.1.5 Reed-beds / Constructed Wetlands

Reed beds comprise tubs filled with gravel, into which reeds (or in some cases shrubs) are planted. Effluent is biologically treated as it moves slowly through the root zone of the reeds.

Providing reed beds are properly designed and constructed, they require minimal maintenance. Harvesting of reeds, while not absolutely necessary, does promote fresh green growth and thus enhance a reed bed's aesthetic appeal whilst at the same time increasing nutrient removal. This job is easily performed using a sharp knife, sickle or whipper-snipper. January (after the spring/summer growth flush) and May (prior to dormancy) are probably the optimum harvest times from the perspective of both nutrient removal and aesthetics. The reeds are cut back to approximately 20cm in height. The cut material should be removed from the bed and can be used as mulch elsewhere.

During macrophyte establishment, weeding of the bed may be necessary. Weeds can be pulled out very easily from the wet gravel. Strategic flooding may also be periodically used to drown out terrestrial weeds.

Because substrate blockage is the primary failure mode of reed beds, steps should be taken to minimize carryover of solids from the primary treatment device. The septic tank should have an effective outlet filter fitted. This filter should be cleaned regularly, sludge and scum levels checked and, when necessary, tank pumpout conducted. Where blockage has already occurred, lowering of the water level can sometimes lead to recovery.

Reed bed Operation & Maintenance

- The person nominated in the Approval to Operate is to check fluid levels are correct and that inlets/outlets are clear of root blockages every three months. Weeds should be removed regularly.
- A service contractor should perform a system check every twelve months.
- The reeds should be harvested at least once per year (contractor or owner).

G3.1.6 Composting Toilets

Composting toilets work by encouraging solid human wastes (faeces) to compost in a chamber beneath the toilet "pedestal". The subtropical climate of Byron Shire is suitable for compost toilets all year round. The process is biological and involves micro-organisms digesting the faecal heap and gradually composting the material to humus. The time taken to reduce the material to humus is variable, and the operator of a compost toilet must recognise that the compost heap is a living thing and needs to be cultivated and protected. There are texts available for those wishing to use a compost toilet and these should be read and understood so that the compost process is encouraged by the household activities.

Dry composting toilets require a carbon-rich bulking agent such as wood shavings, shredded leaves, shredded paper, or preferably a mixture of these, which needs to be applied after each use of the toilet. This bulking agent also covers the faecal material and aids in reducing any odours from the compost. The toilets must be vented and some have mechanical ventilation to ensure good air flow around the compost heap. After a period of time faecal and bulking material is decomposed into a friable humus-like compost material, which is removed from a door at the base of the toilet.

Operation & Maintenance

- After each visit add some carbonaceous bulking agent (e.g. mixture of paper, straw, woodchips).
- Poke/flatten the compost pile to reduce height if a large "cone" of material forms.

- Ensure that urine is able to drain from the compost, it will quickly turn "septic" if the compost is kept too wet.
- Manually clean the pedestal regularly.
- Do not use bleach cleansers or dispose of poisonous cleaning agents into the toilet.
- Remove compost when it builds up or appears full.
- Bury compost for three months before use.
- Use compost only on trees etc, and not on vegetable gardens.
- Use gloves or wash hands thoroughly after each handling, do not allow small children to have access

G3.1.7 Pump Wells

Pump wells are in-ground sealed chambers which enable collection of effluent for intermittent pumping to the land application system or next treatment process.

If installed, pump wells must be checked by the service provider as part of the annual maintenance check. This annual maintenance should include servicing of pumps and electrical components, and a check that the float switches are correctly set and operating. The home-owner is also encouraged to regularly check that the high-level alarm switch is operating and that there are no significant sludge build-ups or other problems.

Additional information should be added by system designer as appropriate to the above sections.

G3.2 Land Application (Dispersal) Systems

Common to all land application systems are the following maintenance principles to protect land application areas:

- A suitable service provider, using the maintenance checklist provided as Appendix F as a guide, must service all land application systems at least once per year.
- Most AWTS (depending on their NSW Health accrediation) must be maintained quarterly by a suitably qualified and experienced, independent service provider, and all pumped irrigation systems must be flushed at least once every three
- Maintain stormwater diversion devices (e.g. swales, drains) to ensure that stormwater does not "run on" to land application area.
- Do not drive over land application areas, except with ride-on mowers.
- Keep stock, e.g. cattle and horses, away from land application areas.
- The corners of each land application area should be clearly demarcated and casual access by children, vehicles and livestock should be restricted. This may be achieved by means of low fencing or preferably with low vegetative borders that don't greatly shade out the area.
- Keep grass short and trim the vegetation when necessary to let sunlight in, promote plant uptake and remove nutrients from the land application area.

G3.2.1 Absorption Trenches

Besides the above generic maintenance advice, absorption trenches should be regularly checked to ensure that they are not surcharging.

G3.2.2 Mounds

Raised effluent application systems, such as Wisconsin Mounds, are sometimes used where natural soils are extremely permeable and/or underlying groundwaters are seasonally close to the ground surface.

Besides the generic advice above, the edges of mounds should be regularly checked to make sure that effluent is not "breaking out" of the mound edges rather than through the base. Where the mound is fitted with observation ports, the levels of effluent within the mound should be regularly checked to ensure that it is not building up and that the effluent is being evenly distributed within the mound.

G3.2.3 Evapotranspiration/Absorption (ETA) Beds

Evapotranspiration/absorption (ETA) beds are essentially shallow trenches, which encourage much better uptake of wastewaters and nutrients by plants grown into the bed.

ETA beds should be regularly harvested and plants replaced if required at regular intervals, e.g. by mowing or pruning to encourage young growth.

G3.2.4 Sub-surface Drip Irrigation Systems

Sub-surface drip irrigation (SDI) is a form of pressurised effluent dispersal in which the irrigation lines are buried 100 mm below the ground surface and effluent is emitted through spaced emitters.

SSI systems need to be flushed and maintained at no more than three-monthly intervals, using the checklist provided in Appendix F as a guide. Annual servicing must include flushing of lines to remove solids that may block emitters.

G3.2.5 Surface Irrigation Systems

Surface irrigation systems are generally discouraged in domestic situations due to the ease of contact between effluent and humans (or pets who may contact humans).

Besides the generic maintenance principles outlined above, particular attention must be paid to ensuring that people, especially children, are not able to contact the effluent. Unless prior agreements have been specifically made with Council (refer to attached Council Approval), effluent must be suitably disinfected before above-ground irrigation occurs.

G3.2.6 Surface-Irrigation-Under-Mulch Systems

Surface-irrigation-under-mulch systems are a type of hybrid between the two irrigation systems described above. These systems are generally only appropriate in agricultural or remote locations when they are installed under dense tree plantings, including orchards.

Besides the generic maintenance instructions described above, it is important that the mulch covering the irrigation lines is regularly renewed to reduce the risk of plastic pipes moving or breaking down under the effect of ultra-violet deterioration. Particular attention must also be paid to ensuring that people, especially children, are not able to contact the effluent.

G4. Your “Approval to Operate” your OSMS

Council ‘approval to operate’ a system of sewage management is required under Section 68(F10) of the Local Government Act 1993 and clause 45 of the Local Government (Approvals) Regulation 1999.

Landowners or occupiers must now nominate a designated person to apply to operate the sewage management system associated with the residence or activity on the land owned or occupied by them.

An ‘approval to operate’ requires the operator to take all reasonable steps to prevent:

- transmission of disease and spread of foul odours;
- pollution of water and degradation of land;
- any discharge to a watercourse; and

- any discharge to land other than the approved effluent application area that may occur as a result of on-site sewage management activities.

Council ‘approval to operate’ a system of sewage management is personal and does not run with the land. It is the activity of sewage management, not the facilities, which is the subject of the approval.

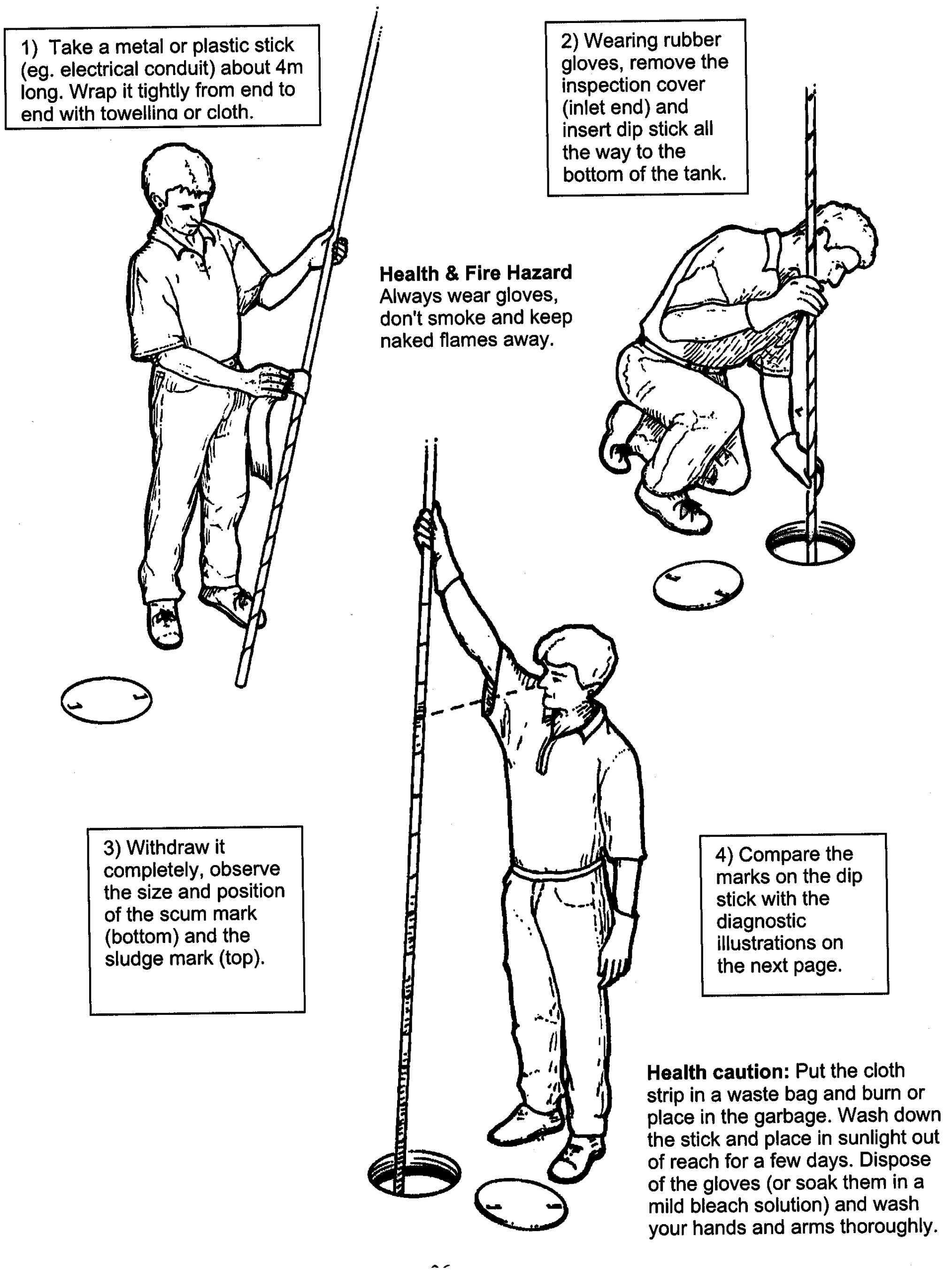
The approval process establishes a relationship between Council and the owner to improve awareness of environmental and health risks and also the maintenance and operating requirements for their system.

Over 3,000 on-site systems were registered in 2001-2002, and when affected properties have changed ownership the new owners have been requested to reapply for an updated Approval to Operate. Anyone who owns a dwelling which is not connected to a reticulated (town) sewerage system is required to apply immediately for an Approval to Operate that system. For more information about approvals contact Byron Shire Council.

G4.1 ATO application fees

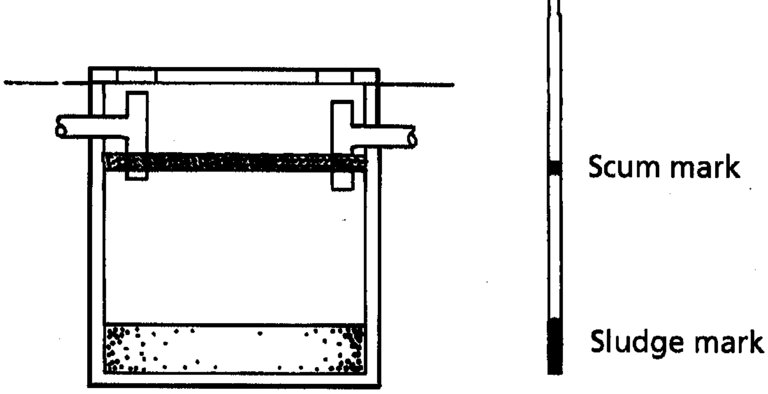
Application fees for approvals to operate are spent on the cost of processing applications, development and implementation of Council’s on-site sewage management strategy, provision of advice and assistance to owners of existing systems and enforcement of legislative provisions.

(1) How to check the sludge and scum depth of your tank



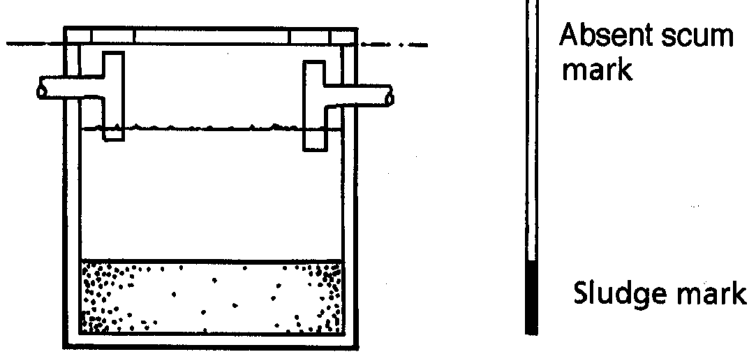
Tank diagnosis

Healthy tank



Sick tank

Bacteria have died.
Needs pumping out, filling with clean water and addition of lime.



Sick tank

Needs pumping out and trench may be blocked or waterlogged or failed