# 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.

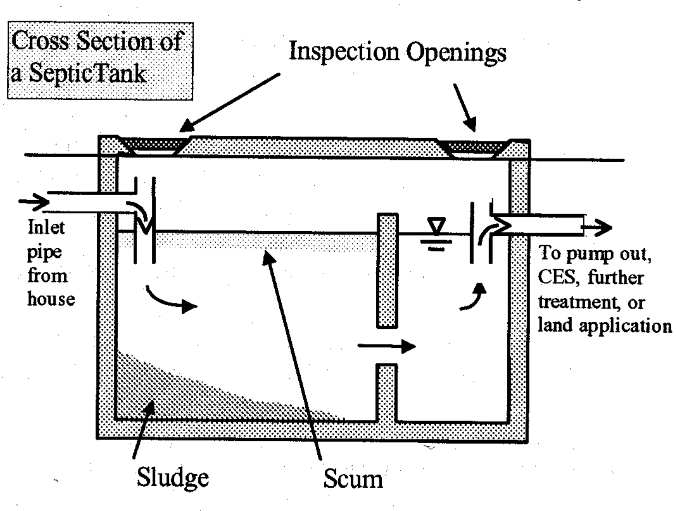


**Figure A1: Cross-section of a typical septic tank**

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.

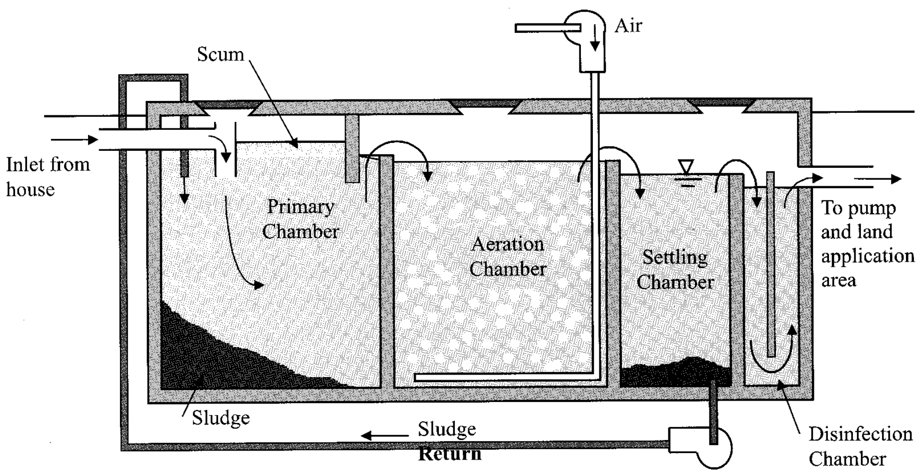


**Figure A2: Cross Section of an AWTS**

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.

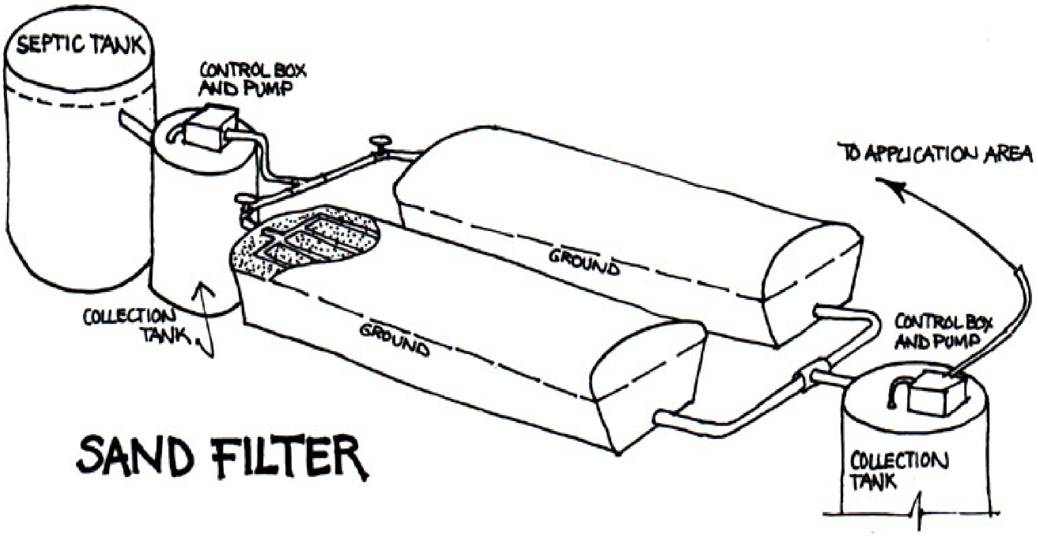


**Figure A3: Schematic of a typical sand filter installation**

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.

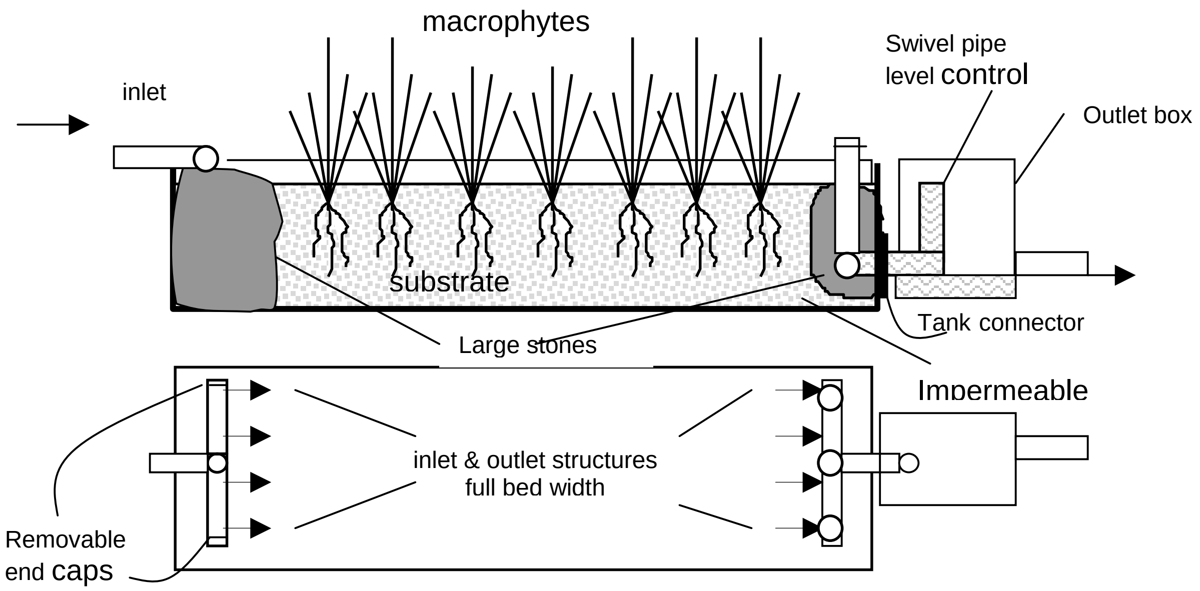


**Figure A5: Elevation and plan views of a simplified reed bed showing major components**

## 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.

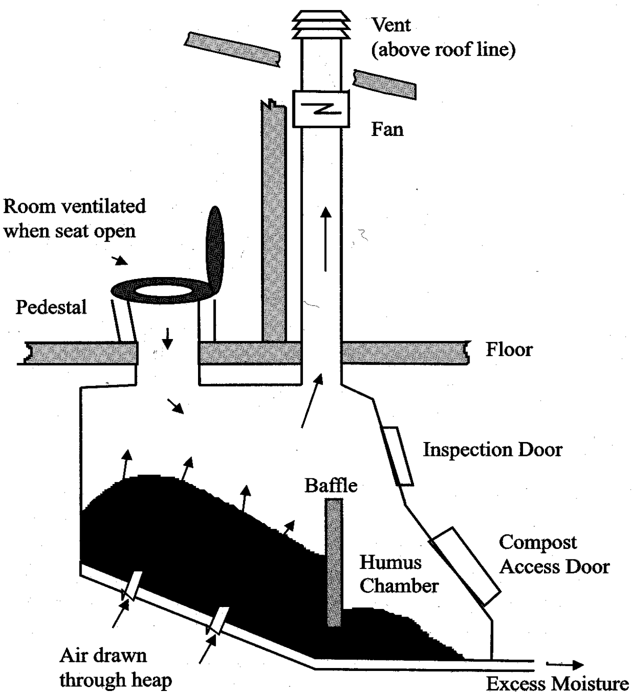


**Figure A6: Cross-section schematic of a continuous–flow type compost toilet**

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.