CERTIFICATE IN ECOLOGICAL BUILDING AND DESIGN (INTRODUCTORY) LEVEL 5

MODULE 5: WATER AND WASTEWATER

Part 2

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In association with:

The Building Biology and Ecology Institute of New Zealand

Creating a healthier and more sustainable built environment

NOTES FOR WATER AND WASTEWATER

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STORMWATER DISPOSAL

Stormwater drains in New Zealand go straight to waterways and the sea. While most people don't actively tip things down stormwater drains any more, many contaminants get hosed down, or those lying innocently around on the ground get washed down in the rain. Pollutants include oil and petrol spills from cars, detergents, mud, fertilisers and herbicides, food and milk wastes, and farm wastes. Biodegradable pollutants can be even more deadly than waste chemicals, as they use up oxygen in the waterways as they biodegrade. Methods of filtering, settling and breaking down pollutants are essential to ensure stormwater enters the natural waterways as clean as possible. This can be done in various ways, including:

- Creating artificial wetlands to capture and filter pollutants. This is the best solution for residential buildings in a non-urban situation, but can be used in a suburban one (see the article on Water Sensitive Urban Design);
- Soils in a water collection area can be enhanced with additives such as coarse grained gypsum and crushed limestone to increase their filtering capacity;
- Alum (aluminium sulphate) can be added to water to attract suspended and dissolved pollutants. This is generally expensive and highly mechanised, as well as involving the addition of chemicals;
- Water can be collected into a chamber that separates the water from the pollutants by means of coarse filtering of larger rubbish, gravity separation (floating off oil and sedimentation of smaller pollutants) or separation of pollutants from water by centrifugal force. Due to expense, chambers are better for large catchment areas such as in urban and suburban situations.

Soil Erosion

Stormwater can also cause havoc even when the ground the rain lands on is supposedly permeable. Places in New Zealand can be deluged with water in a very short space of time, and the ground soon cannot cope with the excess. If the soil is not bound by the roots of shrubs and trees it can easily be washed away, and the rivers that the water ends up in are brown and swollen with sediment. Soil erosion is a huge pollutant of our natural waterways, if you have ever flown over the country after heavy rain you will know the great plumes of muddy water fanning out from the rivers into the sea. Planting steep hillsides and stream gullies and banks with permanent native vegetation will not only reduce soil erosion, but also reduce the water run-off that causes flooding. Keeping stock out of waterways also helps prevent fouling and erosion of stream banks.

Sewage Spills

Another hazard with sudden downpours is when stormwater pipes are directed into the sewage system. An overload of water causes the sewage treatment plants to flood and raw sewage is swept out the outlets and into the sea. Councils are requiring the separation of the two systems when older buildings are renovated, so the problem is gradually diminishing.

Green Roofs

Green roofs are becoming more popular as a way of controlling water run-off. A roof planted with vegetation can absorb a fair amount of water and release it slowly, thus avoiding overloading the stormwater systems in times of heavy rain.

Green roofs come in two main types, Low profile and high profile. Low-profile roofs include a thin layer (50-150mm) of planting medium to support low-ground plant cover, such as herbs, grasses and mosses. Ultra-lightweight versions (20-40 mm), support shallow-growing plants such as sedums. High-profile roofs have much more soil (150mm plus) and can support taller plants, shrubs and even small trees.

Green roofs are made up of the following basic components:

- A waterproof membrane / root barrier;
- An insulation layer (optional);
- A drainage layer;
- Soil growth medium;
- Plants;
- A form of biodegradable wind blanket, e.g. jute, to place over the new plants while the roots stabilise (optional).

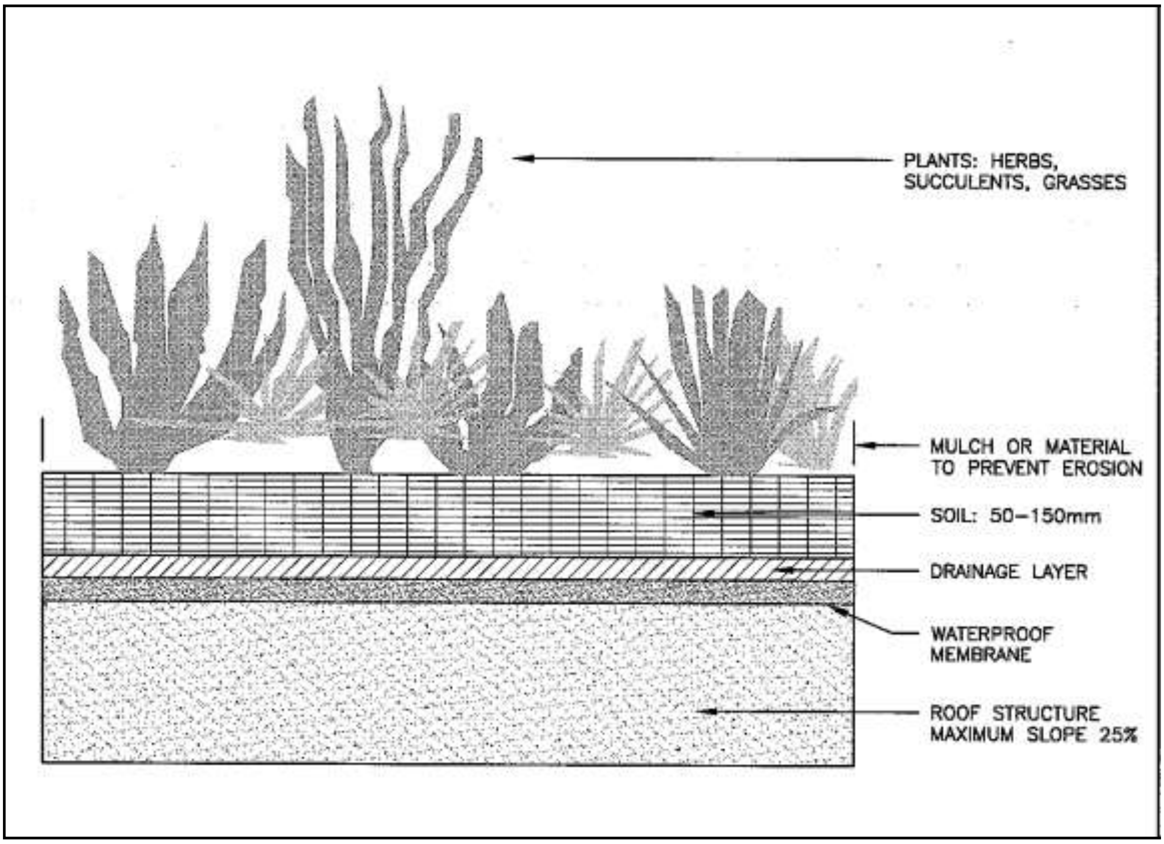


Figure 2: General detail for a low-profile green roof from Waitakere City Council

WATER SENSITIVE URBAN DESIGN

New housing developments provide an ideal opportunity to introduce better water use and wastewater management practices. Although it is not a high priority for most developers, at least some moves are being made by Councils to implement better water management. The following notes have been summarised from the Western Australia State Planning Commission's "Planning and Management Guidelines for Water Sensitive Urban Design".

What is Water Sensitive Design?

Water Sensitive Design describes a new approach to urban planning and design. As water supply becomes more limited, and sewage and wastewater disposal becomes a larger issue, conventional waste conveyance and central treatment and discharge systems cannot be relied on, nor can they be sustainable in the long term. Conventional practices are wasteful of water and public infrastructure, as well as detrimental to wetland, river and sea environments. By contrast the water sensitive approach is economic, aesthetic and sustainable. It places greater emphasis on:

- Storage of stormwater rather than conveyance;
- The use of vegetation for filtering purposes;
- Localised wastewater and sewage treatment systems;
- Water conserving landscaping;
- Recycling/reuse of wastewater to conserve water.

Water Sensitive Design is about managing the water balance of the community environment. It protects the natural water table and flows of local waterways, it helps prevent flood damage in developed areas as well as excessive erosion of waterways, slopes and banks. Maintaining or enhancing the local water quality is another important aspect of Water Sensitive Design. This involves minimising waterborne sediment and pollutants from ground surfaces and sewage.

Design Principles for Water Sensitive Design

- **The planning stages** – It is much more efficient and cost effective to address water issues early in the planning process. Water resource management should be addressed at the catchment or sub-catchment level, not just the area of the development;
- **Site layout** – Local on-site water run-off and storage should be maximised, and designed to be an integral component of the urban landscape. The components of stormwater management should incorporate as much as possible of the features and function of the natural stormwater system, and follow the natural land contours;
- **Lot design and layout** – Housing should be clustered, with reduced private open space particularly to the front and sides of the house, so as to increase the public open space which can then incorporate the stormwater management system. Houses should not be placed in flood zones.
- **Infrastructure** – The road system can be used for stormwater management. Stormwater and sewage treatment should be localised to minimise costly piping.
- **Landscaping** – Stormwater management systems should use vegetation (particularly indigenous vegetation) to promote filtering and slowing of run-off. Landscaping should be in the main with plants that require little water, to reduce the need for irrigation. However, small areas of water requiring plants can be incorporated with appropriate irrigation;
- **Water collection and reuse** – new buildings should be designed to incorporate rainwater collection and water re-use that does not inconvenience the occupants in any way.

The Planning Stages

Identify early on the viability of a water sensitive design development. How much land has to be set aside for stormwater control and sewage treatment? Will reduced lot sizes and reduced infrastructure costs compensate? Is the land contour and soil type suitable for the desired water management system?

Identify what is happening in the larger catchment. This will affect later design decisions. Where are the streams, rivers or lakes your water will eventually drain into? How will your development affect these natural waterways? What is the quality of the water that comes onto the land? Is there potential for flooding to happen from other people's ill managed stormwater?

Site Design and Layout

The natural features of the land to be developed should be utilised for stormwater management. Turning natural depressions into wetlands or ponds, or natural channels into grassy swales that can carry and hold flood waters not only make it easier to manage stormwater, but saves on costly earthworks that can also create havoc with sediment run-off during the development phase. This means the lot layout may not be so efficient, but reduced lot sizes can make up the difference, and there are savings to the infrastructure.

In the design stage the natural water and vegetation features need to be identified, as well as the land contours and the path of water over the land. Housing should be allocated to higher ground where the incidence of flooding is reduced. Lower contours make up the recreation areas and the water management system. Earthworks could be done to divert water from important areas. Existing vegetation should be kept on steep slopes and the borders of waterways, and more planted if necessary.

If there is a natural wetland area, you would need to assess whether using it as a stormwater collection area would upset the ecosystem. If so, it would be better to create an artificial wetland. Here you would plant with plants able to filter and take up pollutants. In some areas the water table is too low or the soil too porous to create a wetland, so other storage systems may have to be used. A depression that is dry for most of the time but can store water in times of flood is one solution. It can be designed to be attractive or used for recreation such as mountain bikes. Alternatively if it is shallow and wide enough it will hardly be noticed as a feature.

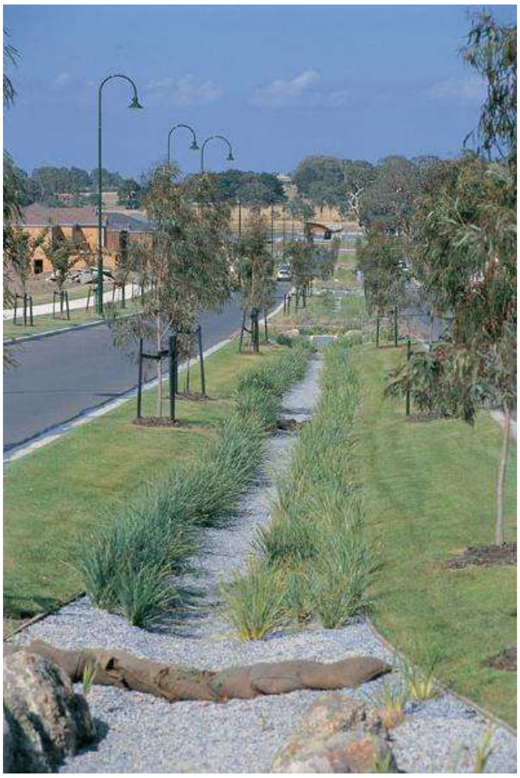
Lot Design and Layout

Conventional house lots contain a lot of space, which is seldom useful for the occupants. Front yards are often far too big for the public "show" function, and too public for any other use. The bigger the front yard, the longer the paved drive to the garage that sends stormwater off into the street drains, and the more superfluous garden there is to water. Side yards are useful for access, but a house only needs one. The private space at the back is where people make best use of their outdoor area. By reducing the size of the front yards and reducing one side yard to zero i.e. the house is on the boundary, the overall lot size can be reduced without inconveniencing the occupant. This means the extra land freed can be used to create more public open space, which would include areas for stormwater run-off and storage.

The house lots should be clustered, situated on the naturally higher ground to keep the houses away from flood paths, leaving the natural low ground for recreation and stormwater management.

The amount of impervious surface in the built up areas should be restricted, so that more water can be absorbed directly into the ground. Harder wearing surfaces can be achieved with porous materials such as porous asphalt, gravel and lime, or with paving with cracks such as bricks, latticed concrete pavers and cobbles.

Infrastructure



The road network collects and channels stormwater. It needs to direct the water towards the water collection areas in the simplest way. Pipes can be used, but one can also consider grassy swales. They are channels wide and shallow enough to be mown and not be an obstacle to pedestrians. In times of severe rainfall, even sections of the roads themselves could carry floodwater, as long as there is still an acceptable amount of road surface left for access.

The use of swales and localised water storage areas reduces the need for putting in and maintaining piping infrastructure for stormwater. Likewise, smaller, localised sewage treatment plants for housing clusters mean no need to invest in large infrastructures. These all however, suit lower density developments.

Local sewage systems can involve individual septic tanks or central septic tanks for housing clusters. There are systems for communal on-site effluent disposal, but if this is not possible, then prefabricated wastewater treatment plants can be purchased for less cost than custom made ones.

Landscaping

Vegetation helps prevent water run-off and the consequent scouring and erosion of soil into the waterways. The more plants there are and the larger they are, the more stems and trunks there are to slow the flow of water, the more leaf detritus there is to absorb the water, and the more roots there are to bind the soil. Vegetation is essential on the fringes of streams and lakes, and steep land, to prevent any water borne sediment getting into the waterways. Native vegetation is especially important in these places as it is a natural ecosystem with canopy trees and understorey providing a dense cover. However, this type of planting should to be balanced with park like areas of grass and scattered trees for recreational use, preferably further away from the waterways. If the waterways are attractive, access for people needs to be created in the form of tracks and boardwalks.

Appropriate plant selection can reduce the amount of water required for irrigation. Xeriscaping is the term for using plants that require no added water once established. Generally natives are best adapted to the local climate, but exotic plants from similar environments can be used.

There will always be a need to use high water demand plants in some situations, such as flowerbeds for show. If properly designed, watering these beds will not use too much water. The water requiring plants should be grouped together (hydrozoning), not scattered amongst plants that don’t need the water. The beds should be well mulched to conserve water. An irrigation system will help prevent water being wasted by the moving of hoses around, and the use of stored stormwater or greywater makes it even more efficient.

Grassed areas need to be designed in such a way that they do not get concentrated wear, otherwise they will need more watering. This can be done with sensible path design, and by making the areas large enough that no one section is overused. The length of the grass should be kept slightly longer in dry spells to prevent water evaporation.

Any earth exposed during development should be landscaped as soon as possible to prevent soil run-off into the waterways.

Water Collection and Re-use

Collecting rainwater from roofs to use for non-potable water use such as gardening, laundry and toilet flushing, reduces the demand on municipal water supply. This only helps the situation, not alleviates it, as the town water supply is always under stress at the same time as when the water tank supply gets low, and in times of heavy rainfall the tanks are full and adding to the already overloaded stormwater system.

Housing clusters may be able to provide their own water from a shared bore or stream, provided that the amount taken does not adversely affect the natural supply.

Water efficient appliances should be used in all new buildings as changing people’s behaviour is a much harder task, (although it should still be encouraged). Systems for reusing greywater are easy enough to install that don’t involve people having to transfer buckets from the bath to the toilet. Again, a good system is more reliable than the goodwill of the occupants.

Image: www.parliament.vic.gov.au

WASTEWATER DISPOSAL

Once we have made use of our water, whether by loading it up with chemical or solid waste, or merely passing our toothbrush through the flow, it disappears down the drain never to be thought of again. But at some stage someone has to have thought about where it goes, and what is done to it when it gets there. With sustainable living, that thought has to have been your own – you need to decide how the water is going to be treated (preferably in the most environmentally friendly manner), whether any can be reused, and how it is dispersed back into the ecosystem.

Wastewater is generally classified into two categories:

- **Blackwater**, which is laden with sewage;
- **Greywater**, which is free of faecal matter and urine, but can contain food particles, grease, suspended solids and chemical compounds and residues.

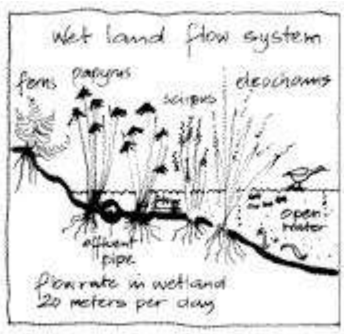
Blackwater and greywater can be treated in different ways, although health authorities are not convinced that greywater is totally free of urine and bacterial contamination. (After all, children do pee in the bath.)

Blackwater Disposal

Blackwater contains high levels of bacteria, viruses and intestinal worm eggs as well as the usual solids, nutrients and heavy metals. Releasing it straight into waterways can have a devastating effect on the ecosystem. Natural sewage treatment on a large scale is a four-stage process:

- Initially wastewater is detained in a still, shallow digester pond to allow a pre-settling of solids. Anaerobic decomposition also takes place, producing methane, which can be utilised for running any machinery required further down the track;
- Then the water is transferred to a facultative pond where algal and bacterial flora (phytoplankton), aid the decomposition process. Zooplankton thrive on the algal food, which turn supply food for fish and waterfowl;
- A third pond is mechanically stirred to aid anaerobic decomposition;
- A final settling, filtering and absorption of any last particles takes place in a rush bed or sand filter before the water is trickled back into the ecosystem.

Smaller treatment systems may not have all these stages. The first stage of settling and anaerobic decomposition is essential and may be done in a traditional septic tank. Then, a simple spreading and filtering through a reed bed and/or sand and rubble and then into the ground can be enough for the other processes to happen naturally. Aeration can be through the use of flow forms, which allow the water to oxygenate by flowing through a series of waterfall sculptures. An artificial wetland can accommodate stormwater as well as the final stage of wastewater run-off.



Greywater Disposal

In the modern western world, we are used to using the highest quality drinking water for absolutely everything. Where there is a need or a desire to help reduce water consumption, water can be reused for tasks that require lower quality water, such as irrigation for non edible plants, washing the car and flushing the toilet.

Separating wastewater into blackwater and greywater means that the greywater can be reused for something else before it drains away. It also can be dispersed without treatment, although in some cases treatment is desirable. However there are problems associated with using greywater, which need to be overcome by a well designed system. They include:

- **The water from baths, showers and washing machines may contain pathogens.** If the water is distributed directly into the soil, the soil organisms quickly deal with any pathogens. Mulches aid this decomposition. The water should not be sprayed or sprinkled around. Preferably it should not used for edible plants, in particular root crops that are eaten uncooked.
- **Kitchen water can contain high concentrations of food particles, grease and soap.** The kitchen sink can be plumbed into the blackwater system to prevent the more highly contaminated water going into the greywater system.
- **Greywater quickly begins to decompose, creating odour and attract insects.** Greywater should be used as soon as possible, preferably without any storage. However, if you do store it, it needs to be treated by settling, filtering and disinfection.
- **Soap and cleaning products make greywater alkaline, which affects plants.** Acid loving plants such as rhododendrons, azaleas and citrus particularly dislike greywater. Seedlings and houseplants also cannot tolerate impurities. But generally no plants or areas should be watered with greywater exclusively.
- **Excessive use of greywater can damage soil quality by a build up of sodium.** This can be counteracted by the addition of gypsum to the soil. Alternatively, special soft soaps are available that contain no additives and are based on potassium salts rather than sodium, which enhance rather than damage the soil.
- **Soapy water can damage bathroom fittings.** Soapy water has been known to eat away the enamel surface of a bath, if water is kept in it for using for “something else”. Alternative storage is needed. Possibly a toilet bowl could be similarly affected.

However, many greywater systems have been developed for places where rainfall is low. If you live in an area of high rainfall, a rainwater storage system is infinitely preferable as a source of “lower grade” water.

Sources: The Toilet Papers by Sim van der Ryn, Permaculture by Bill Mollison
Image: by R. Kanuka-Fuchs, from The Sustainable Home Guidelines

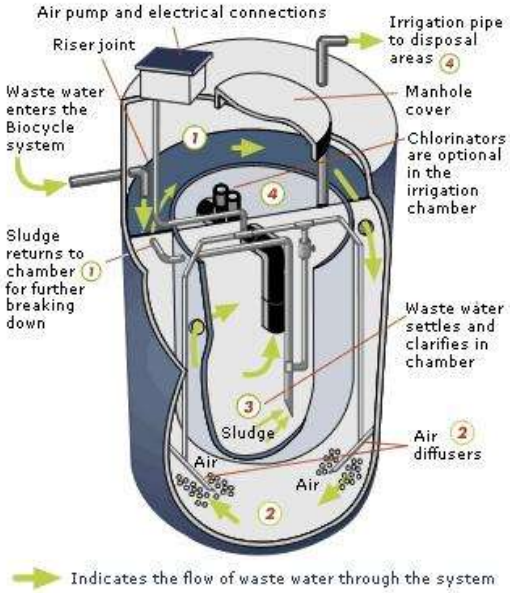
ALTERNATIVE WASTEWATER TREATMENT SYSTEMS

The following information is taken from the product websites or trade literature:

Biocycle

Biocycle is an aerobic wastewater treatment system in a concrete or fibreglass tank with four chambers:

- **Receiving chamber (anaerobic/septic treatment) –** All household waste is pumped into this first chamber. Anaerobic digestion of solids occurs as a primary treatment, achieving a reduction in the Biological Oxygen Demand (B.O.D.) level (organic loading). This chamber also receives sludge returned from the clarification chamber. The introduction of aerated/activated sludge from the clarification chamber promotes the digestion of solids.
- **Aeration chamber (aerobic treatment)** – The partially treated waste flows from the receiving chamber to the aeration chamber. Air is supplied by a blower and distributed evenly via diffusers. The aeration chamber contains a submerged media upon which bacteria grows. A film of bacteria and algal matrix develops on the media, providing biological treatment. Aerobic bacterial action results in a continuous reduction of growth, breaks down nearly all the remaining solids. In the BioCycle system, the capacity of this chamber allows a 24-hour detention time for incoming waste (16 hours is generally sufficient).



- **Clarification chamber (settling treatment)** – After aeration, the effluent flows into the clarification chamber and is allowed to settle. Any bacterial sludge settles to the bottom, where it is picked up and returned to the primary chamber. The method of a continuous sludge return to the primary chamber provides a continuous supply of 'food' to the bacteria and ensures a healthy system during periods of zero flow or extended vacancy of a residence. It also results in a slower rate of sludge accummulation in the receiving chamber. Chlorination (optional) occurs as the treated water flows into the irrigation chamber. Denitrification will also occur in this stage.
- **Irrigation chamber (pumpout and chlorination if applicable)** – From the clarification chamber, the aerated and settled effluent is drawn off at below the surface level and flows to the pump chamber. During the flow, the effluent comes into contact with calcium hypochlorite tablets if in use within the BioCycle chlorinator. The water is retained in this chamber to ensure adequate contact time with the chlorine. Finally, it is pumped to the landscaped areas of the garden or to an on-site disposal area.

For your local Biocycle distributor contact: www.onesandtwos.co.nz

Other variations on the multi-chamber single tank include:

Hynds Environmental – (09) 571 0090, www.hynds.co.nz
Oasis Clearwater Systems – (03) 344 0262, (025) 356 789, www.oasisclearwater.co.nz

Reflection Treatment Systems

The ***Reflection ISF*** uses a graded rock and sand filter instead of aeration to treat wastewater, thus reducing power requirements. No chemicals are required.

- **Primary Treatment** – household wastewater is directed to a large capacity settling chamber. In this chamber, naturally occurring bacteria start the treatment process by breaking down the settled solids through anaerobic digestion. Fats and other light matter float to the surface and form a scum. The liquid wastewater then passes through a special effluent filter which is designed to retain solid material in the settling chamber. With a reduction in organic loading of approximately 50%, the wastewater is pumped onto a buried intermittent sand filter. By careful float switch control a measured amount is dosed at regular intervals throughout the day.
- **Secondary treatment** – the intermittent sand filter is specially graded layers of clean crushed rock and sand and provides "polishing" of the effluent in a natural way. The wastewater percolates slowly down through the layers, with natural processes reducing the numbers of pathogens. At the base, the water is collected and drained to the irrigation pump chamber, ready to reuse in the garden with no further treatment.

For more information contact: (03) 344 0262, (025) 356 789, email: info@septic.co.nz

Eco Wastewater Recycling Systems Ltd

The ***Eco Wastewater Recycling System*** will save up to 70% or more of your water by recycling treated greywater back through your toilet cistern and water your garden and trees. It is the only BRANZ appraised wastewater recycling system in New Zealand.

This system is designed to save water and prevent overloading of septic tank leach fields by recycling selected waste water back through the toilet system. Only waste water from the shower, bath and washing machine is used. It saves flushing good clean water down the toilet, resulting in considerable water savings. It also reduces the amount of water in the septic tank, thus reducing leach field odours. Also where the water pressure is low the shower will not lose the majority of its cold or hot water when the toilet is flushed.

Waste water from the washing machine, bath and shower are collected in holding tanks placed below ground level. The waste water is piped to the holding tanks and when they are full the excess water bypasses the tanks and flows into the gully trap in the normal manner. An aeration device and a flow filter separate most of the soap and lint from the water before it enters the holding tanks. Excess soap is directed into the gully trap and solids are held in the filter until cleaned out. The water in the end holding tank is then piped to the toilet system by an electric pump which turns on when the toilet is flushed. A system of valves allows the toilet supply water to return to the mains water supply if required. This could be when the filter requires cleaning, excess use of the toilet is required (such as a large number of visitors), or any other emergency.

For more information contact: (06) 870 0046, www.wastewater-recycling.co.nz

Enviroflow Wastewater Treatment

The ***Enviroflow*** two tank wastewater treatment system combines anaerobic and aerobic treatment through a natural biological treatment process to produce odourless high quality treated water. It is ideal for all non-sewered locations, particularly sites with poor soakage, high water tables, and locations where a high quality effluent discharge is required for a sensitive environment. It uses a recirculating trickling filter, the same process employed at most modern sewage treatment plants in towns and cities around the world. By miniaturising the treatment process the ***Enviroflow*** system maximises the potential of the process. It reduces the Suspended Solids, Organic Material, Biological Oxygen Demand and the Faecal Coliform levels by over 95%. There are four stages:

- **Anaerobic Digestion** – The raw waste stream enters the first anaerobic digestion chamber, where the solids settle out and separate from the liquids. These solids are decomposed by anaerobic digestion over a period of time, producing simpler organic compounds in a soluble form. The primary treatment stage is divided into multiple compartments allowing for hydraulic buffering and improving the initial settling of solids to enhance anaerobic digestion;
- **Aerobic Digestion (Biofilter)** – The primary treated waste is circulated a number of times through the Biofilter spraying over the Enviromedia and trickling down into the clarification chamber. This maximises aerobic bacterial activity and the removal of organic material by pulsing the treated wastewater and blowing air down through the Enviromedia. The removal of the organic material is achieved by the active bacterial action of micro-organisms located on the Enviromedia. The biological process produces sloughed bacterial material, which settles out in the clarification chamber. The Enviromedia hasthousands of sections of specially designed plastic tube, which maximise surface area as well as air to effluent contact, thus enhancing aerobic action;
- **Clarification Chamber.** This chamber, located below the Biofilter, allows for any free bacterial material sloughed from the aerobic digestion phase to settle out in the bottom as sludge, while the clean treated water passes through an overflow nozzle into the irrigation chamber;
- **Irrigation Chamber.** The final treated water enters the irrigation chamber via gravity from the final clarification stage and is pumped out when the level rises sufficiently to turn the pump on, and discharge to the irrigation system.

Commercial Enviroflow systems may include in the process additional stages:

- **Primary Aeration** – After anaerobic digestion, air is diffused into the effluent;
- **Biofilter Dose Loading** – A separate chamber before the Biofilter acts as a balancing tank between the Primary and Secondary stages of the process. The balancing chamber evens out shock loading, while dose loading the Biofilter aid aerobic digestion;
- **Sludge Return** – Any free bacterial material settled out in the clarification process is returned to the anaerobic digestion phase;
- **Disinfection** – Prior to the treated water going to the irrigation distribution system, it is able to be disinfected to eliminate harmful bacteria. The disinfection is achieved using either UV disinfection or chlorine.

For more information contact: (06) 877 5966, email: enquiries@enviroflow.co.nz

Envirosystems Ltd

The VERM Vermicomposter 2,800 litre system assures passive treatment of all domestic wastes, and ecologically sound disposal into the environment using natural processes. The standard lightweight plastic kit is capable of dealing with waste from a 3/4 bedroom home. Water conservation devices need to be fitted, but in rural areas relying on rainwater this is a real money-saver.

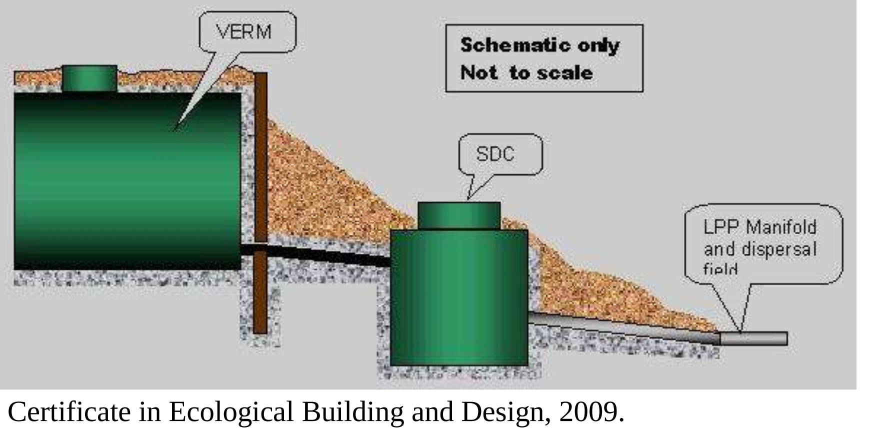
The VERM Vermicomposter deals with black water (toilet and kitchen waste) and grey water (washing and bathing) using a different process in the same tank. Black water is low volume - high concentration, and is dealt with by the vermicomposter. The compost worms in the system breed to consume whatever quantity of waste is fed to them, and thrive on kitchen scraps including grease, which is otherwise difficult to dispose of. The worms reduce the volume of solid waste by 95% leaving valuable worm castings. These are extracted using a clean process at, say, 2- 3 year intervals, and are used as a valuable source of garden nutrients.

Worms do not thrive in the high volumes of (sometimes hot) water from the grey water side of your discharges. This water is contaminated with soap scum, body fats, lint and hair, which clog conventional filters. Our process uses pine bark to filter the contaminants, and the soil and gravel layers promote treatment of the liquid through natural bacterial processes.

The vermicomposter can be installed partly or completely above ground in a timber containment reducing the need for digging. Because it is an aerobic system, generating virtually no odour, it can be installed underneath a house or deck, with the house plumbing separating the black and grey water, led straight to the unit. This can reduce the cost of plumbing because there is no need to lead all wastes to an outside wall and fit costly and messy grease traps. The installer will need to supply the gravel and topsoil media needed inside the chamber, but local sources of these common materials will always be cheaper overall In situations where access is readily available a conventional concrete tank can be used. The standard size is 2700 x 1500 x 1700.

The SDC Dosing chamber receives the treated liquids from the vermicomposter and automatically feeds a measured dose to the disposal field. The "Autoflow AF100" dosing siphon uses gravity so it needs no external power source. It needs a minimum of 600mm fall to operate satisfactorily. If the land is flat, or the field position is above the chamber, a PDC Pumped Dosing Chamber must be used.

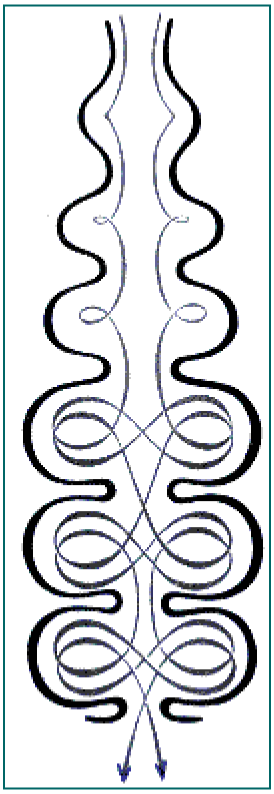
The LPP field kit provides for shallow "low pressure pipe" disposal of effluent into a prepared disposal field. Dose loading at low rates into a field of approximately 150 m^2 optimises treatment of pathogens by natural bacterial soil process and soil dwellers such as worm and slaters. Nutrient uptake by selected plants and water removal by evapo-transpiration reduces the problem of ground water contamination. The disposal field can be laid out in planted wood-lots, sub-tropical orchards, or natural bush, or incorporated in a garden. Your preferences are taken into account at the design stage. We take all care to fit the system into the natural landscape.



For more information contact:
www.trident.co.nz

Flowforms

A flowform is a unique sculpture which is half art and half technology in an inspiring combination of beauty and ecological efficiency. Its signature is a fascinating figure-of-eight side-to-side streaming flow, with calming rhythms and waterfalls in a heart pulse! The rhythmical relaxing sounds of falling water through flowform sculptures have distinctive water therapy qualities, a deeply calming and reassuring effect on people, rather similar to restful gazing into a flickering fire.



With water treatment flowforms have three main functions. Each flowform oxygenates water, revitalises it with rhythms and also mixes and polishes it. Those which mix and polish water best take on a kidney-like shape, those strongest with rhythm are similar to hearts and those which oxygenate best are reminiscent of lungs! Flowforms indeed are designed eco-organs for the regeneration of water's capacity to support life! And water surely needs all of our help.

John Wilkes (Associate Royal College of Art) from England invented the flowform in the early 1970's as a result of his artistic and geometrical research into nature, and the natural forms fluids make. There are many types of flowforms but the central concept is that it is a vessel which brings streaming water into a figure-of-eight flow pattern similar to the liquid flow in the heart. Until recently, such a heart flow only occurred hidden within living organisms, but flowforms have made it openly visible for the first time. *It is this that makes flowforms quite unique.*

As well as being works of art, flowforms are very effective in oxygenation, and in polishing water, while the rhythmic intensification has been shown to increase water's capacity to support life-forms. They are used internationally in agricultural irrigation, effluent treatment and urban water runoff! As such, Flowforms can be seen as organs for the regeneration of water's natural life supporting power.

For more information contact: **Design for Life Company Limited**, (06) 879 4314, 0800, email: info@flow-forms.com

COMPOSTING TOILETS

Up to 30% of the average household water use is for flushing the toilet. If you are living in a place where water conservation is essential, then a compost toilet will go a long way towards reducing your water use. The following information is from the manufacturers of the BIOLOO Composting Toilet:

The system of composting human waste has long been used by many countries in the world. Today it has been refined into a science, and is being used by more and more people as a cost effective, environmentally acceptable method of disposing or recycling of human waste. Modern composting toilet systems are ideal for permanent or intermittent use in dwellings where cost, soakage, conscience or regulations preclude the use of septic tanks or long drops.

Advantages of Composting Toilets

- Low initial and no on-going servicing costs;
- No ground or water pollution;
- No flushing water required;
- No adverse smells;
- Easy to install and maintain;
- Totally natural, chemical free process.

Types of Composting

There are two types of composting – aerobic and anaerobic. Aerobic composting occurs in the presence of oxygen, anaerobic occurs in the absence of oxygen.

Aerobic decomposition is what is required for a composting toilet, as it is relatively rapid, has minimal odours and higher internal temperatures than anaerobic decomposition. Anaerobic composting releases hydrogen sulphide and other compounds that give off the characteristic foul odours associated with long-drop toilets. They also work at much lower temperatures that do not destroy pathogens or parasites in human wastes.

Composting Requirements

Composting is a form of biological decomposition that takes place in a controlled environment, so that the decomposition is achieved in a relatively short time. The micro-organisms that do the work require a relatively stable environment, and it is maintaining this environment that is the key to a successful composting toilet. The four main requirements for composting, and their functions in the composting process are listed below:

Oxygen – This is a basic requirement of all aerobic activity. This is provided in the composting chamber by ventilation ducts that pass through the pile. It is important that sufficient bulky material (eg straw) and worms are added to stop the pile compacting and becoming airtight.

Carbon – This provides the energy source for the micro-organisms. It can be in the form of dry fibrous plant material such as leaves, hay, straw, food scraps and sawdust. Short lengths of material about 25mm long are best.

Nitrogen – This provides the protein source for the micro-organisms. They need it to break down the carbon for food. The nitrogen content of human waste is very high and is considered the activator in the process.

The rate of decomposition is relative to the carbon/nitrogen ratio in the pile and is most effective at 30:1 but some leeway is acceptable. If however the ratio falls below 25:1 then the excess nitrogen is converted to ammonia and foul odours occur.

Moisture – Moisture is needed for other processes to work. Too little slows decomposition, too much forces out air and thus oxygen. The optimum moisture content is about 50%. A sloping floor to the chamber as well as ventilation ensures that the pile does not become waterlogged. It is important that no additional moisture other than urine enters the system. The flue condensation trap should ensure that condensed water does not return to the system.

DESIGN CONSIDERATIONS FOR COMPOSTING TOILETS

If you are thinking about having a composting toilet, it cannot be treated as an afterthought. The composting chambers of the lower maintenance versions are quite large and have to be directly below or behind the pan, depending on the type. So the ancillary space needs to be planned in, as does some relatively easy access for removing the composted material.

If you don't have sufficient space under the floor, you may need to choose a different type of toilet, or dig out a space (ensuring proper drainage). One solution is to have a bathroom halfway up the stairs, serving both floors. This also may help the issue of multiple toilets, for as each pan needs its own chamber, more than one toilet can add your building costs and take up even more space.

The chambers are ventilated, so the flue needs to be accommodated if there is an upper storey. Some require fans, so the noise and power use of the fan needs to be factored in.

Some of the toilet pan designs are not high in the beauty stakes, you may want to consider building a wooden bench seat across the width of the toilet room, rather like in the old long drops, but without the cobwebs. The added bench space might be quite useful for incorporating storage for the extra carbon material (straw, leaves etc) that need to be at hand after use.

READY TO BUY ALTERNATIVE TOILETS

There are many books and manuals available for those who want to design and build their own composting system. However, that is not everyone's dream, and fortunately there are now several tried and tested ready-made products available to choose from. They are all based on slightly different formats, so you need to choose which suits your situation – your budget, how much the unit will be used, your space requirements, your local council regulations and your eagerness to be "involved" in the composting process. The following information is taken from the product websites or trade literature:

Bioloo Composting Toilet

The BIOLOO operates on the same basic principles as the garden compost pile, the container shape with its large air flow and contents provides an environment that with the correct management will allow for the decomposition of human waste into an environmentally safe product. The system uses the method of aerobic decomposition, which doesn't produce hydrogen sulphide, methane and other compounds that produce smells usually associated with long-drop toilets and septic tanks. The addition of household organic waste and other organic refuse such as grass clippings, weeds etc, is also desirable to maintain the correct carbon/nitrogen ratio. The system is completely sealed to prevent leakage into the surrounding soil/groundwater, and requires no water for flushing. As no pollutants leave the system resource consents are not normally required. Bulk is reduced to approximately 10% of its initial volume and with the introduction of worms the bulk is further reduced to highly fertile worm castings. The system does however require the operator to be sensitive to what is happening, as it is a living, dynamic process.

These types of systems have been in use world-wide for the last fifty years and we have toilets locally that are now in their tenth summer, and when maintained properly have been proven to operate successfully. The Department of Conservation uses BIOLOO composting toilets as do various District and Regional Councils. They are also in use by many individuals for their permanent dwellings as well as for holiday homes. Systems are also installed in camping grounds, cafes, Marae, boats, bush huts and roadside rest areas.

Installation is very simple and can be completed on any type of surface or slope. The system is usually installed on flat ground and requires a hole to be dug to accommodate the chamber. This hole has to be lined in some way, as access to the bottom inspection hatch is required so that periodic checks can be carried out to ensure the moisture content of the pile is correct, to enable air to circulate properly and to remove composted matter. The system can also be installed on sloping ground as the floor of the chamber slopes at 40 degrees when in its proper upright position. A fitted cover for safety and hygiene reasons covers the inspection hole.

The composted material will be required to be removed annually after the first four or five years in the large system and after two years in the smaller system. The finished material has a smell and appearance of coarse, damp soil and vermicast. As the systems are a continuous process and only completed composted material reaches the bottom chamber you do not see or have to deal with fresh material as in other systems. Urine is not separated but leaves as water vapour up the flue.

There are two sizes available depending on the type and volume of use anticipated. The small size is 1450 high x 1100 wide x 1900 long and is suitable for family use. The larger size is 2240 high x 1160 wide x 2400 long and is designed for higher volume commercial use such as in campgrounds, tramping huts etc. The toilet comes complete ready to install except for a flue that can be supplied or purchased locally to save freight.

For more information contact: **BIOLOO Composting Toilets**, (0800) 246 566, email: tracey.f@clear.net.nz

Toatrone Composting Toilet

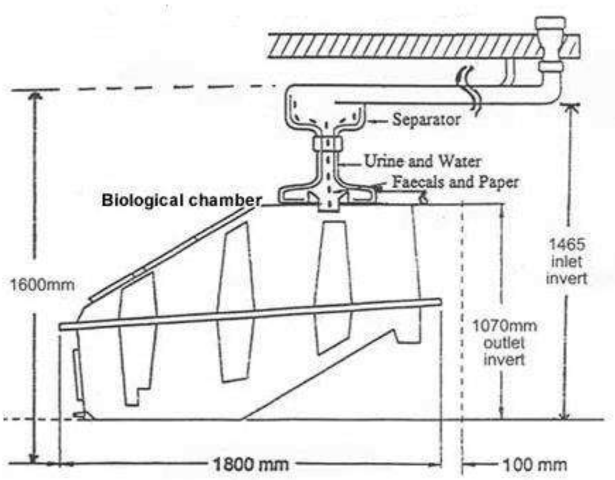
The Toatrone is based on the Clivus Multrum system, the original composting toilet. It uses no water, and the leak proof polyethylene container is easy to install on flat ground in a space below the floor approximately 1.3m high. For best efficiency the bin and top pipe should be insulated. There is a flue which requires an electric fan. A spinning cowl can be used but is better for situations when the system is not being used full time.

It has a specially designed toilet pan with a urine separator and works on the principle that by separating the urine from the solids the composting becomes more efficient. The urine is drained off to a grey water system and can be treated by an ultra violet purifier. Carbon rich material should be added, such as a handful of leaves, hay, straw or sawdust. This is a good replacement for the "flushing" process. A normal household would remove compost once a year. The Toatrone is 1200 high, 1100 wide and 1800 long.

For more information contact: **Eco Toilets and Grey Water Systems Ltd**, (0800) 507 574, Website: www.ecotoilets.co.nz

Aquatron Flushing Composting Toilet

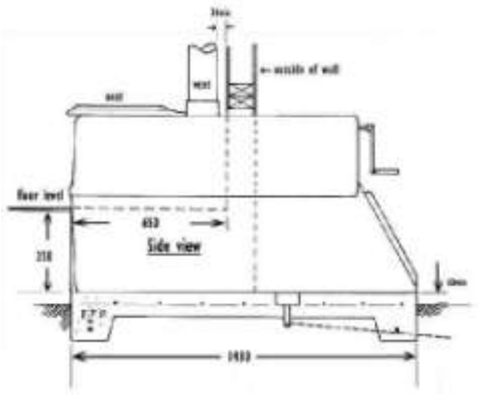
For those who can quite bring themselves to take on board the concept of not being able to "flush it away", or if your council just won't accept the alternatives, the Aquatron is a good compromise. It combines an ordinary flushing toilet and dual flush cistern with a composting chamber. There is a separator which separates the solids from the liquids. The urine and water are separated out by centrifugal force (no moving parts) while the solids fall direct into the composting chamber. The liquid waste is drained to a purifier where it is treated with ultra violet light to kill any bacteria. Then it can be piped to an exterior filter system.



Other advantages of the Aquatron system are that several toilets can be hooked up to the one chamber, and design constraints are not so tight. The chamber can be installed away from the toilet bowl (space is not required directly under it), and can even be outside the house. It can be up to 10m away from the toilet bowl with a 3 litre maximum flush volume, or up to 20m away with a 6 litre maximum flush volume.

For more information contact: **Eco Toilets and Grey Water Systems Ltd**, (0800) 507 574, Website: www.ecotoilets.co.nz

Kakapo Composting Toilet



The Kakapo composting toilet consists of a rotating drum inside a semi sealed chamber designed to achieve maximum decomposition speed by creating the most desirable composting environment. It is not intended that full composting will necessarily occur within the toilet but rather a reducing of the contents to a more 'user friendly' state. The partially decomposed material is placed in a separate compost bin where full thermophilic action is better achieved ensuring a pathogen free, high nutrient end product.

The toilet is used just like any other toilet with two exceptions. After making a solid deposit a handful or two of a high carbon bulking material (such as sawdust or shavings) is sprinkled into the toilet. This material serves the purpose of keeping the compost aerated and friable and also to maintain a favourable carbon to nitrogen ratio required for good composting. Every four or five days, depending on the rate of use, the drum is rotated three or four times using the crank handle provided. When the receiving container is full, it is simply removed from the toilet and the contents emptied into the compost bin and covered with straw or other organic matter which will provide adequate cover while maintaining airspaces within the pile. The frequency of this task is directly proportional to the rate of use. As an indication, during busy times at the Mussel Inn once a fortnight seems to be usual. In a household of 5 people, with continuous use, this may be extended to several months. After a year has passed, a new compost bin is started. At the end of the second year, the compost in the first bin may safely be applied to any garden – vegetable or ornamental – or to a tree crop. Features of the Kakapo Composting Toilet include:

- The bulk of the unit is located outside of the building - with only the 'feed' end positioned inside. The advantage of this is that a larger processing drum can be utilised without compromising space within the building. The larger drum size means more composting can take place within the drum. The removal of processed compost is carried out outside the building, reducing any possible mess factor and odours within the building.
- The unit has a horizontal configuration thus reducing the need for a basement space. This makes installation on concrete slab floors and retro fitting to existing buildings possible without major structural changes. (Retro fitting on concrete floors may require a small step in front of the unit if a normal seat height is desired)
- Excess liquid may be drained from beneath the unit or if not possible may be drained to either side.
- The vent for the unit can be positioned either inside the building (preferred) or outside, which avoids the need for roof penetration but may require the vent pipe to be insulated in very cold climates.
- The unit is furnished with a crank handle with which the drum is turned - no electricity required.
- The unit comes complete with wall and floor flashing pieces and standard seat. Vent kits are also available.
- Standard colour is white. The fibreglass housing will readily take a paint finish enabling you to decorate to your particular taste if so desired.

For more information contact: **Kakapo Composting Toilets**, (03) 525 9241 (after 11am), Website: www.musselinn.co.nz

'Lectrolav Evaporation Toilet

The 'Lectrolav is suitable for holiday homes and any place where an ordinary system is not appropriate. It has an evacuation fan and a thermostatically controlled heating unit to force-dry solid waste to one tenth of its original volume and evaporate 4-5 litres of urine per day. Evacuated air is purified by a double strength carbon filter to ensure no odours. It requires a 240V power supply and is suitable for use by 4-5 people. The dried material can be added to the soil when the contents are fully composted.

For more information contact: **Lewis Gray Ltd** (09) 415 3348, www.lewisgray.com

Separett Evaporation Toilet

The Separett toilet is used mainly for holiday homes, but can be used permanently, requiring servicing every 8 weeks for a household of 4-5 people. Urine is separated and collected in a separate tank or greywater system, depending on regulations. Solids are dried by a fan. A vent pipe must be installed. Some models require the pipe to be insulated.

For more information contact: **Lewis Gray Ltd** (09) 415 3348, www.lewisgray.com

The Kiwi Bog Evaporation Toilet

The Kiwi Bog separates faeces and urine just below the seat. Urine is captured by a tray and piped to your waste system through a connection below the bog front. The way urine is disposed of depends on your situation. Faeces and used toilet paper are accumulated in a plastic bag which lines a large bucket. This bucket will last one person two months or more. A low power fan removes air by flue to the outside as well as dehydrating faeces. Outside any odour rises and is undetectable. Fan noise is usually inaudible outside of the toilet.

It is very important that protective gloves are worn at all times when in contact with the inside of your Kiwi Bog. Gloves should be of the long sleeve type so that no skin can contact any internal surface. Once the bucket is full, fold the top of your bog forward to reveal the bucket inside. Tie the bag and put on the bucket lid before removing it to a place suitable for three to six months storage. Temperature is the prime determinate of time required to make faeces suitable for return to the soil. Faecal coliforms will die off in less than 50 days at 20 to 30oc but in up to 150 days at 10 to 15oc.

Once you have your bucket out, add about half a cup of water and sufficient soil to cover the contents of the bag. Fit the lid loosely so that the bag can breathe while the composting process completes. Another bucket can be placed in the bog with a new plastic bag fitted over its rim. Please note that only one bucket and lid of each size are supplied. Further buckets are readily available from plastic shops.

The bucket should be cleaned after each bucket change. Access to the inside of your bog is easy and all surfaces can be cleaned with the cleaner supplied which has been specially prepared for your bog plastic. Only use cleaners designated safe for acrylics. Cleaning is the main factor influencing the life of your bog.

The Bog has been manufactured to comply with NZand Australia standard AS/NZS 1546.2:2001 which is a joint standard for waterless composting toilets. A 12volt power supply is required capable of supplying 1 watt continuously or a solar installation running on less than 1 watt can be provided. Usual bucket capacity is 20lts.

For more information contact: **Kiwi Bog Company Ltd**, (03) 546 9769, Website: www.kiwibog.com