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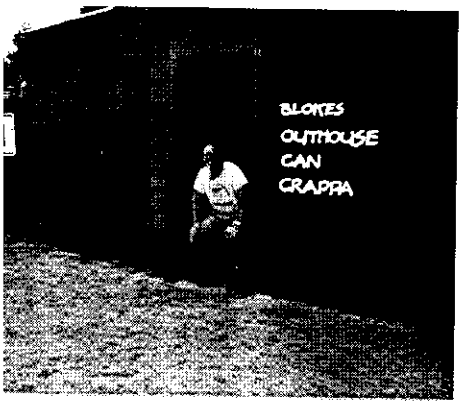
SEWAGE AND SMALL COMMUNITIES

NEW DEVELOPMENTS IN ALTERNATIVE ON-SITE WASTEWATER TREATMENT OPTIONS FOR RURAL AREAS AND HOLIDAY RESORTS.



Ettamogah domestic wastewater

Septic tank and soil soakage trenches have been the traditional method of on-site servicing adopted in NZ for rural and rural-residential areas, holiday resorts and for temporary servicing to handle fringe area urban development until full sewerage servicing can be provided.

There has been a move away from on-site systems due to public perception about septic tanks and poor groundwater quality in some built-up areas due to proliferation of poorly maintained systems. However, due to the cost of providing conventional reticulated sewerage, together with an environmental and cultural swing towards land disposal for human effluent, on-site systems for rural-residential subdivisional and tourist developments will continue to be developed. These developments are generally taking advantage of new treatment and disposal technologies which have the potential to provide quality environmental outcomes.

The RMA requires the consideration of alternative waste water treatment options and discharge environment (Section 88(6)(b) Fourth Schedule (1)(f)(ii) of RMA91) and regional policy is promoting the use of land based practices, as this allows nutrients to be returned to the land where they originated and also takes into account the principles of the Treaty of Waitangi.

ON-SITE SYSTEMS

On-site wastewater treatment involves taking the raw wastewater from the house or other source, separating out the solid from the liquid effluent, treating the effluent to the required standards and then application onto or into land for further treatment within the boundary of the source property.

Two stage tank systems, or large capacity single stage tanks incorporating filters, or high tech aerobic treatment systems (package plants) are now being used instead of conventional septic tanks. Some of these technologies are:

- Multi-Stage Primary Sedimentation Tanks (Ecotank, Skellerup, Goulds, etc)
- Trickling Filters (Ecotower)
- Aerated wastewater treatment systems (AWTS): (Biocycle, Oasis Clearwater, Supertreat, Evolution, Innovative Water Solutions, SEBAS system, etc)
- Intermittent Sand Filters (Innoflow)
- Land Treatment (a) Disposal Trenches (b) Surface Irrigation (c) Subsurface Irrigation.

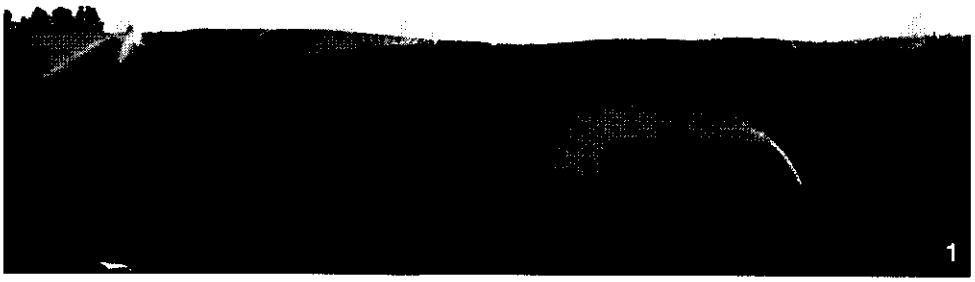
COMMUNITY SYSTEMS

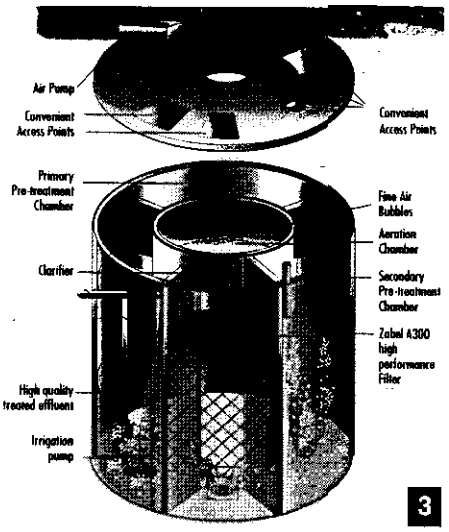
Primary treatment includes screening and solids removed. Larger installations are now finding dissolved air flotation (DAF) systems suitable, but for small communities the cost of a DAF is likely to be prohibitive. It may be more practical to perform primary settling on-site because septic tanks may already exist and downstream pumping and reticulation systems do not require the same solids handling characteristics. Also the costs of primary sludge handling are proportioned by default on a 'user-pays' basis, when performed by a septic tank at each existing or new dwelling.

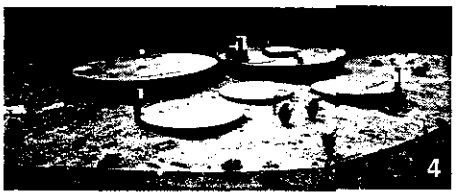
Secondary treatment is usually a biological process employing microorganisms, aerobically or anaerobically, to remove residual organic matter (BOD) and settleable solids as sludge.

• Intermittent Sand Filter (Innoflow): Generally speaking, wastewater treatment systems using sand filters provide small settlements with a simple alternative to package biological plants for aeration of effluent to reduce BOD5 and suspended solids, nitrify ammonia to nitrate and denitrification of nitrates. With modern reliable pumping units for dose loading the filters and then pressure distribution of treated effluent to the disposal area, substantial improvement in the environmental performance of on-site wastewater systems is achievable with sand filter technology compared to traditional septic tank and soakage trench systems of past practice.

• Recirculating Sand Filter (Innoflow): These are similar to intermittent sand filters but the effluent from the filter under drain is collected and recirculated back to the filter to enhance the overall treatment. The filters are often larger than intermittent filters for treating equivalent flows







1: Land treatment – Taupo
2: Land treatment – Pinus radiata
3: Oasis Clearwater
4: Oasis Clearwater
5: Trickling filter-Tokoroa

and use a more coarse sand grade. The primary sedimentation tank effluent enters the recirculation tank and mixes with the treated and oxygenated wastewater. The recirculation tank needs to be large enough to hold one half to one day's flow. The effluent quality from this system can be seen in Table 2. The main advantage of this type of system is the ability to biologically remove nitrogen and phosphorus.

• Trickling Filters: These consist of a static filter medium (eg polyethylene strips, large stones, plastic shapes with high surface area to volume ratio) on which a film of microorganisms develops and absorbs organic material from the contacting waste stream.

• Rotating Biological Contactors (Andrews Environmental): These consist of a series of circular discs that are partially submerged into the wastewater and are rotated. Operation is similar to trickling filters, ie a biological film provides most of the treatment.

• Sequencing Batch Reactors (Scitech, Evolution, Innovative Water Solutions): A SBR is a batch form of activated sludge treatment, ie aeration, solids clarification; solids retention and wasting are all performed but these are carried out sequentially in the same tank. The main advantage of SBR systems is that they can be sequenced to both nitrify and the denitrify the effluent (under anoxic conditions) to biologically remove both nitrogen and phosphorus. Where community numbers suddenly increase by a factor of 2 or more for a number of months per year, then poor effluent quality could be expected for some weeks. However, because treatment is by a batch process a SBR system, should not be affected by flow variations.

• Wetlands: Can be used as either secondary treatment or tertiary treatment systems and can include either surface flow, subsurface flow or a combination wetland, which can provide an efficient form of final wastewater treatment prior to discharge into surface water or irrigated onto land. A surface flow wetland has plants growing in a soil base with the effluent passing above the base through the plant stems. Aquatic plants are utilised to filter and remove nutrients and solids. These wetlands can be set up to include roosting islands and boardwalks and can be an eco-tourism attraction of the development. Wetlands provide an efficient treatment method to reduce organic concentration and nutrient from waste streams and can be specifically designed to reduce BOD concentrations to low levels acceptable for discharge into waterways or onto land. Wetlands efficiently denitrify nitrates as the aquatic plants and microorganisms in the root zone help provide a suitable carbon source under anoxic conditions.

• Oxidation Ponds: Naturally aerated shallow ponds (facultative ponds or oxidation ponds) are most common for domestic wastewater treatment and consist of an aerobic top layer, an anoxic intermediate zone and an anaerobic sludge bottom layer. The sludge layer results from the sedimentation of suspended solids generated by biological treatment and settleable material initially present in the raw sewage stream. A further option for facultative ponds is to use surface aerators to keep the surface layer aerobic while still allowing anaerobic breakdown of the bottom sludge. The advantages of the ponds is that they are relatively inexpensive to construct and operate. The disadvantages are that they require relatively large land areas, further treatment if discharging to surface waters and have potential odour problems.

Tertiary treatment is defined as the additional treatment needed to remove suspended and dissolved substances remaining after conventional secondary treatment. These substances may be organic matter or suspended solids or may be simple inorganic ions such as calcium, potassium, sulphate, nitrate, etc. In small community sewage treatment, tertiary treatment usually involves pathogen removal. Tertiary treatment of effluent is sometimes necessary before it is released into the environment. For example, application onto recreational land or into recreationally used surface water necessitates high pathogen removal. This can be done by using physical and chemical processes, such as sand filters or disinfection, or by using biological methods like wetlands or land treatment

• UV light: The UV radiation penetrates the microorganisms and is absorbed by cellular materials, preventing cell replication or causing cell death. The treatment unit consists of a series of lamps either submerged or suspended near the effluent stream. The UV system can reduce the FC count to less than bathing water standards.

• Ozone: Ozone kills microorganisms by chemical oxidation. It is diffused from the bottom of a deep covered chamber in fine bubbles that provides mixing. Ozone does not leave any residue in the wastewater and with the initial problems associated with health and safety flaws resolved it's an effective solution for small communities.

• Land Treatment: All treatment options require a disposal system, with most councils

requiring a land treatment operation. There are a range of irrigation types which could be used depending on the effluent quality and proximity to public access:

(a) Short Rotation Forestry (SRF): This option applies the secondary treated effluent to a plantation of fast growing trees which are harvested regularly, usually on a 3 – 5 year rotation. Typical plantation management involves harvesting trees which are capable of coppicing (regrowing from the stump surface) and hence eucalyptus and willow species are commonly used. SRF plantations have rapid initial growth which allow a considerable mass of nutrients and water to be assimilated (removed from the soil) and being capable of coppicing reduces the expensive cost component of having to replant each time the trees are harvested.

(b) Conventional Rotation Forestry (CRF): The secondary treated effluent is applied through irrigation into a CRF plantation, typically Pinus Radiata which are grown for 25 – 30 years before being harvested. Other tree species could be used if found more suited to the site.

(c) Pasture Grazing System (PGS): The secondary treated effluent is applied through irrigation (usually spray) to the land on which pasture is grown. The pasture is then grazed by animals, usually sheep. As only a small area is required for land treatment there may be some difficulty in the grazing management of the system. For a grazed disposal area to be effective, an intensive stocking rate and rotation system should be adopted.

(d) Pasture Harvesting System (PHS): This is similar to the PGS above but can offer the benefit of a greater nutrient removal and allow higher wastewater application rates on the same land area. For a PHS to work effectively the pasture has to be harvested regularly in the form of hay, silage or grass. One of the limitations of this system is that the removal of the crop may not be possible because weather and soil conditions will not allow sufficient drying of the cut crop or access to a paddock when the soils are wet. If drying is favourable and access is possible, efficiency and returns from the system can be very favourable.

RETICULATION

Conventional gravity systems are the most common form used. They rely on a constant gradient, along with periodic flushing to keep solids moving through the system. Gravity systems have high capital cost, particularly where ground slopes are unsuitable or the land is undulating.

Effluent Drainage Servicing (EDS) systems utilise on-site septic tanks to remove the majority of solids prior to the reticulation system. This enables pipework to be of smaller diameter and gradients do not have to be constant. A further reduction in pipe size can be achieved by utilising a Modified EDS (MEDS). These systems have an upflow rock or pebble filter following the on-site septic tank and occasionally a surge tank between the tank and filter. These systems enable pipe sizes as low as 50 mm diameter and gradients can be both positive and negative, hence there can be substantial savings in capital cost.

Pressure Systems are becoming more widespread for small communities, particularly on very flat or extremely undulating land or where the community is spread out in a narrow strip. They rely on either the pressure from on-site pumps or a system flushing pump to push the sewage through the system. Design of large systems is complex, hence most systems are limited to small communities or cluster systems. Many subdivisions are now being reticulated with three phase power in order to reduce the installation costs of small macerating pump sets.

The "eco-village" concept provides an option to enable cluster housing on poorer soil areas while reserving good soils for effluent disposal "green-areas". Each dwelling is served by a modern septic tank unit, and then the effluent irrigated into a planted "green-area" as a landscaping feature of the development, or sand filter treated and spray irrigated into wood lots.

CONCLUSION

A combination of the various on-site or community components could be utilised at each small community or tourist development.

The final destination of the effluent dictates the degree of treatment required. Some receiving environments require very high levels of treatment and the treatment option selection must be appropriate for the receiving environment.

Tourist developments with fluctuating loading may require a treatment system with buffering capacity eg pond, wetland, or SBR. Sewage treatment can be set up as a feature of the development and be used for publicity, eg wetlands with roosting islands and board walks.

By utilising land treatment, a financial return can be obtained.

6: Wetland-Waikeria Prison
7: UV sterilised-Tauranga
8: Activated sludge – Waikeria
9: Inn-flow tank filter and pump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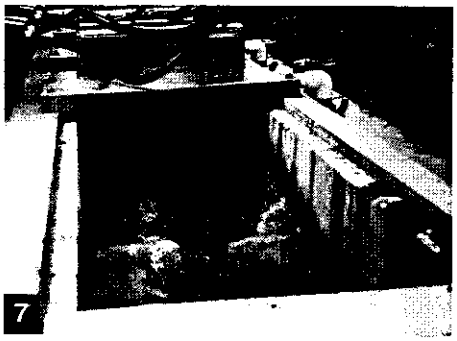
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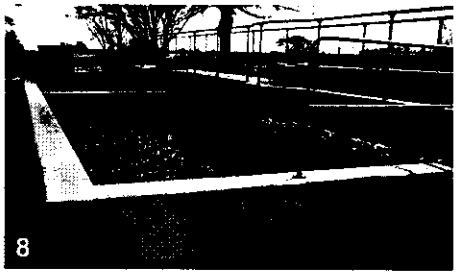
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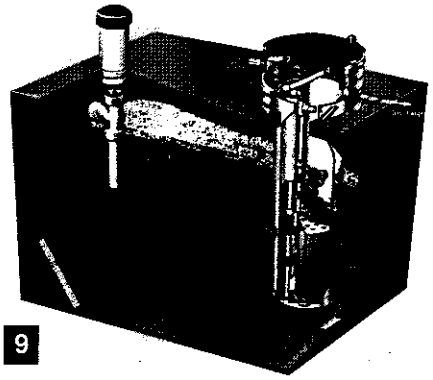
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