5 PART

Glossaries, Abbreviations, Appendices And Information Sources

Glossaries

Term	Definition	For more details see
Aerated wastewater treatment system (AWTS)	*Small domestic wastewater treatment package plants commonly used for on-site treatment of household wastewater. The process typically involves:* • *settling of solids and flotation of scum* • *oxidation and consumption of organic matter through aeration* • *clarification (secondary settling of solids)* • *disinfection if followed by surface irrigation*	*AS/NZS 1547:2000*
Aerobic	*Conditions in which free oxygen (including dissolved oxygen in water) is readily available to micro-organisms such as bacteria*	
Anaerobic	*Conditions in which there is an absence of free oxygen (including dissolved oxygen in water) for micro-organisms such as bacteria*	
Bioaccumulation	*The accumulation by organisms of contaminants through ingestion or contact with skin or respiratory tissue; the net accumulation of a substance by an organism as a result of uptake from all environmental sources. As an organism ages, it can accumulate more of these substances, either from its food or directly from the environment. Bioaccumulation of a toxic substance has the potential to cause harm to organisms, particularly to those at the top of the food chain*	***http://www.glin.net/humanhealth/about/words_w.html***
Biogas	*Principally methane and carbon dioxide produced by bacterial fermentation of organic matter*	
Biological treatment	*Forms of wastewater treatment such as trickling filters, contact beds and activated sludge in which bacterial biochemical action is intensified to oxidise and stabilise the unstable organic matter present*	
Biosolids	*Sewage sludge derived from a municipal wastewater treatment plant that has been treated and/or stabilised to the extent that it is able to be safely and beneficially applied to the land*	***Guidelines for the Safe Application of Biosolids to Land in New Zealand*** *Copyright © New Zealand Water Environment Research Foundation 2003*
Blackwater	*Human body waste discharged either direct to a vault toilet, or through a flush toilet and/or urinal*	
BOD	*Biochemical oxygen demand – the quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature and under specified conditions*	
BOD_5	*The oxygen demand associated with biochemical oxidation, under specified conditions, over 5 days*	
Centralised wastewater system	*An urban wastewater infrastructure that takes wastewater from the source and reticulates it though pipes (sewerage system) to a large central wastewater treatment plant. After the treatment plant, the treated effluent and the sludge (biosolids) are discharged into the environment at a specific location*	
Chemical treatment	*A wastewater treatment process designed around the chemical qualities of the wastewater and its constituents*	
Chlorination	*Application of chlorine to water or wastewater for disinfection or chemical oxidation of organisms by oxidising cellular material. Chlorine can be supplied in many forms, including chlorine gas, hypochlorite solutions, and other chlorine compounds in solid or liquid form*	*USEPA website*

Term	Definition	For more details see
Clarifier	A tank or basin used for reducing the concentration of suspended solids in a liquid	
Cluster wastewater system	A wastewater collection and treatment system where two or more dwellings, but less than an entire community, are served. The wastewater from each group of dwellings may be treated on-site by individual septic tanks before the septic tank effluent is transported through alternative sewer systems to a nearby off-site location for further treatment and ecosystem re-entry. In other situations the full wastewater flow from each group of dwellings may be reticulated off-site to a local treatment and ecosystem re-entry location	
Coagulation	In water and wastewater treatment, the destabilisation and initial aggregation of colloidal finely divided suspended matter by the addition of a floc-forming chemical (coagulant), or by biological processes	
Coliform group bacteria	A group of bacteria predominantly inhabiting the intestines of humans or animals, but also occasionally found elsewhere. It includes all aerobic and facultative anaerobic, Gram-negative, non-spore-forming bacilli that ferment lactose with production of gas	
Composting toilets	Toilets in which human waste (blackwater) is collected, stored and biologically degraded (composted) by predominantly aerobic micro-organisms. They require little or no water	USEPA website
Constructed wetlands	Wetlands designed and constructed specifically for the treatment of wastewater	
Cryptosporidium	A single-celled parasite that lives in the intestines of animals and people. This microscopic pathogen causes a disease called cryptosporidiosis	**Water Quality Information Center**
Decentralised wastewater management	Where all decentralised wastewater systems are under the management supervision of a single management entity, which may be a public authority, a body corporate or other private agency	USEPA website
Decentralised wastewater systems	A group of on-site and/or cluster systems where wastewater is treated and returned to the ecosystem, either on the property or on local land areas. The group of such servicing systems can be managed collectively by a single management agency under a decentralised wastewater management (DWM) programme	
Denitrification	The reduction of nitrates to nitrogen gas and oxides of nitrogen, usually under anoxic (without oxygen) conditions	
Detention time	The theoretical time required to displace the contents of a tank at a given rate of discharge	
Digested sludge	Sludge digested under aerobic or anaerobic conditions until the volatile content has been reduced to the point at which the solids are rendered less offensive and relatively non-putrescible	
Digestive tanks	See Improved septic tanks	
Disinfection	The destruction of the larger portion of micro-organisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used	AS/NZS 1547:2000
Dissolved oxygen	The oxygen dissolved in water, wastewater or other liquid, usually expressed in mg/L or percent saturation. Abbreviated DO	

Term	Definition	For more details see
Domestic wastewater	Wastewater derived principally from dwellings, business buildings, institutions and the like, and consisting of toilet wastes, and wash waters from kitchen, bathroom and laundry, but excluding commercial laundry wastes	
Dose loading	This usually refers to the method of loading from a treatment plant to the ecosystem re-entry system such as a seepage trench. Dose loading is achieved by a pump (usually activated by a float switch) or a siphon system	
Ecosystems	Communities of interacting organisms and the physical environments in which they live. Therefore, by definition, the human species and their built facilities, services and infrastructure are not separate from but are interdependent and integral parts of ecosystems	
Ecosystem services	...the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. They maintain biodiversity and the production of ecosystem goods such as seafood, forage, timber, biomass fuels, natural fibre and many pharmaceuticals, industrial products and their precursors[20]	
Effluent	The liquid discharged from a wastewater system component	
Escherichia coliform (E. coli)	One of the species of bacteria in the coliform group. Its presence is considered indicative of fresh faecal contamination	
Evapo-transpiration	The process by which water in the soil matrix is both transpired through the roots and foliage of vegetation and evaporated from exposed (soil) surfaces	
Evapo-transpiration – seepage (ETS) beds/trenches	In ETS beds or trenches the treated wastewater liquid component is returned to the local ecosystem through processes of evapo-transpiration (to the atmosphere) and seepage into the sub-soils	
Faecal coliform	Bacteria present in waste from warm-blooded animals and used as an indicator of human-derived pollution	
Faecal streptococci	Often used interchangeably with enterococci bacteria, but should indicate only one group of streptococci included in the total enterococci group	
Floc	Small gelatinous masses (of mostly bacteria) formed in a liquid by the reaction of an added coagulant, through biochemical processes or by agglomeration. (Either a chemical or biological floc may be produced but they are generally formed differently.)	
Giardia	A protozoan parasite found in some waters, which can infest the human intestinal tract, causing severe diarrhoea (giardiasis)	
Gravity system	1. A system of conduits (open or closed) in which the liquid runs on descending gradients from source to outlet, and where no pumping is required; (2) a water-distribution system in which no pumping is required	
Grease trap	A device for separating grease from wastewater by flotation so that it can be removed from the surface	
Greywater	All wastewaters from kitchen, bathroom and laundry, other than blackwater. It usually contains fats and greases, organic matter, nutrients and can also contain pathogens (disease-causing micro-organisms). Sometimes referred to as sullage	

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[20] GC Daily, S Alexander, PR Ehrlich, et al. Ecosystems services: benefits supplied to human societies by natural ecosystems. **Ecol** 1997, 2:2-16.

Term	Definition	For more details see
Hybrid toilet	*A toilet comprising a wet vault (pedestal located over a treatment tank) designed to require very low volumes (less than 300 ml/flush) for flushing*	
Hydraulic grade line (HGL)	*A line, the plotted ordinate position of which represents the sum of pressure head plus elevation head for the various positions along a given fluid flow path, such as a pipeline or ground-water streamline*	
Improved septic tank	*A septic tank with improved design and componentry. Either a dual chamber or large-capacity septic tank fitted with an effluent outlet filter. Some multi-chamber tanks have separate chambers for blackwater and greywater. Sometimes referred to as digestive tanks*	
Infiltration flows	*Stormwater and other leakages into sewers*	
Influent	*The liquid wastewater component entering a wastewater system*	
Intermittent sand filter (ISF)	*A sand filter for treating wastewater, which is applied in intermittent doses to allow filtration and aerobic biological action*	*USEPA website*
Imhoff tank	*Two-stage wastewater treatment tank combining sedimentation of settleable solids in an upper compartment and anaerobic digestion of the settled solids in a lower compartment*	
Low-pressure effluent distribution (LPED)	*Following treatment, a pump dose loads through a perforated small-diameter pipe inserted within a drain coil or ceramic drain pipe laid in a trench*	
Low-pressure pipe system (LPP)	*A shallow dispersal system for distributing treated wastewater into a good depth of topsoil. The system is a shallow, pressure-dosed soil absorption area with a network of small-diameter perforated pipes placed about 250 mm deep and in narrow trenches of around 300 mm width. This system in the NZ context may use LPED lines*	
Long-term acceptance rate (LTAR)	*The rate at which liquid residual moves into the sub-soil from an effluent soakage system. LTAR is significantly affected by the aerobic and anaerobic biomass generated on the infiltrative surface of the soakage area, which plays a significant role in determining the appropriate loading rate for design purposes in matching effluent quality, soakage system condition and soil characteristics to achieve the long-term effective performance of a disposal system*	
Methane fermentation	*Fermentation resulting in conversion of organic matter into methane gas*	
Micro-organism	*A minute organism, either plant or animal, invisible or barely visible to the naked eye*	
Mound	*There are various mound systems used for further treatment and dispersal of treated wastewater within a property. These mounds are commonly filled with a particular grade of sand, but may use sphagnum peat instead. Treated wastewater is distributed along the top of the mound, and percolates through the sand or peat to the infiltration surface, which is normally at existing ground level. Such mounds are sometimes referred to as Wisconsin mounds. They are used in areas with high ground-water table and/or impermeable sub-soils*	*USEPA website*

Term	Definition	For more details see
Nitrification	*The conversion of ammonia into nitrates. This is accomplished in two steps; firstly bacteria of the genus Nitrosomonas oxidise ammonia (NH_3) to nitrites (NO_2), then bacteria of the genus Nitrobacter oxidise the nitrites to nitrates (NO_3)*	
On-site wastewater management system	*A small-scale domestic wastewater system comprising the technologies and management protocols for the appropriate handling of household wastewater within the property boundaries of the place of origin of the wastewater. The key components of such a system include some or all of:* • *wastewater source technologies and management* • *wastewater processing technologies and management* • *technologies and management for re-entry of the processed wastewater to the in-boundary physical environment*	*AS/NZS 1547:2000* *USEPA website*
Oxidation pond	*A pond used for the treatment of wastewater in which biological oxidation of organic material is carried out by natural or artificial transfer of oxygen to the water from air and from algae, and bacterial reduction is achieved by long detention and exposure to sunlight*	
Oxygen demand	*See BOD and BOD_5 above*	
Ozone treatment, or ozonation	*Disinfection or oxidation by ozone produced by passing air though a high-voltage discharge*	*USEPA website*
Package plant	*A factory-assembled active domestic wastewater treatment plant such as an AWTS*	
Pathogens	*Micro-organisms that are potentially disease-causing; these include bacteria, protozoa and viruses*	
Permeability (soil)	*The property of a material, soil or rock that permits movement of water through it*	
Physical treatment	*A treatment process based on the physical characteristics of the wastewater contaminants. Examples include grit traps, macerators, screens, physical filters and sedimentation tanks*	
Population equivalent	*An expression of the strength of organic material in wastewater in terms of an equivalent number of persons, normally based on per capita BOD generation, but sometimes based on per capita waste volume*	
Primary treatment	*(1) The first major (sometimes the only) treatment in a wastewater treatment works, usually sedimentation; (2) the removal of a substantial amount of suspended matter but little or no colloidal and dissolved matter*	
Protozoa	*Small, one-celled animals, including amoebae, ciliates and flagellants*	
Rapid sand filter	*A water purification filter in which previously treated water (usually by coagulation and sedimentation) is passed downward through a filtering medium of sand, anthracite coal, or other suitable material resting on a supporting bed of gravel and an under-drainage system. The filter is cleaned periodically by reversing the flow of the water upward through the under-drain and filtering medium, sometimes supplemented by air agitation to remove mud and other impurities that have lodged in the sand*	

Term	Definition	For more details see
Recirculating sand filter	A sand filter designed and operated such that its effluent can be returned to the inlet of the sand filter for further treatment	USEPA website
Residuals	The by-products of wastewater treatment (other than treated effluent). These include sludges, biosolids, grit, grease, fat, air emissions and odour	
Reticulation	A network of pipes, pumps and other devices used to transport sewage to a central point for treatment and/or disposal	
Secondary treatment	(1) A more advanced treatment than primary treatment; (2) the removal of colloidal and dissolved material in wastewater, usually by biological means	
Sedimentation	The process of settling suspended matter carried by water	
Seepage trench	A narrow trench (about 450 mm wide) which may be shallow (about 300 mm) or deep (about 500 mm) in which a perforated effluent distribution pipe is laid on aggregate infill. The trench is backfilled with further aggregate, geo-fabric, soil and topsoil	
Septage	The semi-liquid material that is pumped out of septic tanks, consisting of liquid, scum and sludge[21]	
Septic tank	A wastewater treatment device that provides primary treatment for domestic wastewater, involving sedimentation of settleable solids, flotation of oils and fats, and anaerobic digestion of sludge	USEPA website
Sewage	The spent water of a community. This term is now being replaced in technical usage by the preferable term 'wastewater'	
Sewerage	A system of piping, with fittings, for collecting and conveying wastewater from source to treatment, and then discharge	
Siphon	An automatic, hydraulically activated system that initiates gravity flow from a sump or tank when the water reaches a specified level. No energy is required	
Slow sand-filter	A water purification filter in which water without previous treatment or chemical coagulation is passed at a slow rate downward through a fine sand medium. The filter is cleaned by scraping off and replacing the clogged layer	
Sludge	The material that settles out of wastewater primary and secondary treatment systems	
Sphagnum peat biofilter	A wastewater treatment biofilter system (normally following a septic tank or AWTS) that uses sphagnum peat as the filtering medium	
Stormwater	Rainwater run-off from impervious surfaces (roofs, roads, driveways, paths, parking lots and ground surfaces)	
Sullage	An alternative term for 'greywater'	
Tertiary treatment	The further removal of bacteria (via disinfection processes) and/or the removal of additional organic matter and suspended solids. Where nitrogen, phosphorus and eutrophying nutrient elements are removed by treatment methods, either biological or chemical, this may be called 'advanced treatment'	

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[21] R Crites, G Tchobanoglous. **Small and Decentralised Wastewater Management Systems**. McGraw Hill, Boston, 1998.

Term	Definition	For more details see
Total Kjeldahl nitrogen	Total nitrogen in a substance determined by digesting with sulphuric acid and a catalyst; the nitrogen is reduced to ammonia, which is then measured	
Total solids	The sum of dissolved and undissolved constituents in water or wastewater (in mg/L)	
Tradewaste	Tradewaste is waste water from trade or industrial processes which is discharged into the sewer. It does not include condensing water, surface water or domestic-type wastewater from toilets, showers, kitchens, etc	http://www.crc.govt.nz/Waste/waste-at-work-trade.html
Trench vault and leaching chambers	Trenches can be replaced by galleries made from PVC or other material. Treated effluent is then distributed to the infiltrating soil surface within the gallery by dose loading	
Trickle loading	Typically, the method by which effluent from a treatment plant, such as a septic tank, is loaded to a seepage trench. If it is displaced from the treatment tank by influent, and gravity-fed to a trench, this is referred to as trickle loading. See Dose loading as the alternative and preferred method	
Ultraviolet treatment	Disinfection using light waves with wavelengths of 200–300 nm	USEPA website
Wastewater	Contaminated water from domestic, commercial and industrial activities (see also Domestic wastewater)	
Waterless toilets	Toilets that use no water; includes dehydrating toilets, incineration toilets and composting toilets	
Wet-weather flow	The maximum flow for which a sewerage system is designed; often referred to as 'infiltration' flow	

Māori Glossary

Hapū – subtribe

Iwi – people; tribe

Kaimoana – seafood

Kaitiaki – guardian; caretaker; trustee

Kaitiakitanga – guardianship

Kaumātua – elders

Kawa – protocol

Mātaitai reserve – an identified traditional fishing ground established under regulation 23 of the Fisheries (Kaimoana Customary Fishing) Regulations 1998

Mana whenua – the authority of iwi or hapū by virtue of traditional occupation

Manaakitanga – the act of caring for others, ie, visitors

Manuhiri – visitors

Marae – the traditional meeting place of the Māori people

Mauri – life force; life essence; life principle

Paru – mud; dirt; dirty

Rāhui – a conferment of tapu to restrict access to an area

Taiapure – a local fishery area in estuarine or littoral coastal waters (Fisheries Act 1983)

Tangata whenua – local people

Taonga – treasures; anything highly prized

Tapu – sacred; forbidden

Tino rangatiratanga – self determination; self management

Urupū – cemetary; burial ground

Wāhi tapu – a place sacred to Maori in the traditional, spiritual, religious, ritual or mythological sense

Wairua – spirit

Whānau – family

Sources:

Durie, M.H. (1998) *Te Mana Te Kāwanatanga: The Politics of Māori Self-Determination*. Oxford University Press.

Kawharu (ed.), Waitangi: Māori and Pākeha Perspectives of the Treaty of Waitangi (1989) Ryan, P.M. (1989) *The Revised Dictionary of Modern Māori*. Heinemann Education

Tauroa, H & P. (1986) *Te Marae: A Guide to Customs and Protocol*. Reed Books.

Waitangi Tribunal, *Kaituna River Report* (1984)

Waitangi Tribunal, *Wānanga Capital Establishment Report* (1999)

ABBREVIATIONS

AEE	Assessment of environmental effects
AS/NZS	Australia and New Zealand Joint Standard
AWTS	Aerated wastewater treatment plant
BOD	Biochemical oxygen demand
BOOT	Build-own-operate-transfer
CS	Conventional sewerage
DBO	Design-build-operate
DO	Dissolved oxygen
DWM	Decentralised wastewater management
E. coli	Escherichia coliform organisms
EDS	Effluent drainage servicing
EDTA	Ethylenediamine tetraacetic acid *(a chelating agent that helps to control water hardness ions that can interfere with the performance of household, industrial, and institutional cleaning products)*
ETS	Evapo-transpiration seepage
FC	Faecal coliform organisms
HIAMP	Hazard identification analysis and monitoring programme
HGL	Hydraulic Grade Line
HSNO	Hazardous Substances and New Organisms Act 1996
ISF	Intermittent sand filter
IST	Improved septic tank (with filter)
LATE	Local authority trading enterprise
LPED	Low-pressure effluent distribution
LPP	Low-pressure pipe system
LTAR	Long-term acceptance rate
MCS	Modified conventional sewerage
MEDS	Modified effluent drainage servicing
MST	Multi-chamber septic tank
NTA	Nitrilotriacetic acid *(a chelating agent that help to control water hardness)*
O&M	Operation and maintenance
PEDS	Pumped effluent drainage servicing
RMA	Resource Management Act 1991
RSF	Recirculating sand filter
SBR	Sequencing batch reactors
ST	Septic tank
STEP	Septic tank effluent pumping
TKN	Total kjeldahl nitrogen
TN	Total nitrogen
TSS	Total suspended solids
USEPA	United States Environmental Protection Agency
VGS	Variable-grade sewer

APPENDICES

Appendix 1 *Examples of ecosystem goods and services*

System	*Goods*	*Services*
Agricultural ecosystems	- *food crops* - *fibre crops* - *crop genetic resources* - *flowers*	- *maintain limited watershed functions (infiltration, flow control, partial soil protection)* - *provide habitat for birds, pollinators and soil organisms important to agriculture* - *use atmospheric carbon to form plant material* - *provide employment* - *provide land for absorption of treated wastewater*
Coastal ecosystems	- *fish and shellfish* - *fish-meal (animal feed)* - *seaweeds (for food and industrial use)* - *salt* - *genetic resources*	- *provide moderate storm-impact protection (mangroves, barrier islands)* - *provide wildlife (marine and terrestrial) habitat* - *maintain biodiversity* - *dilute and treat wastes, including wastewater* - *provide harbours and transportation routes* - *provide human habitat* - *provide employment* - *contribute to aesthetic beauty and provide recreation*
Forest ecosystems	- *timber* - *fuel wood* - *drinking and irrigation water* - *fodder* - *non-timber products (vines, leaves, etc.)* - *food (honey, mushrooms, fruit, and other edible plants; game)* - *rongoa (herbal medicines)* - *genetic resources*	- *remove air pollutants* - *emit oxygen* - *cycle nutrients* - *maintain an array of watershed functions (infiltration, purification, flow control, soil stabilisation)* - *maintain biodiversity* - *use atmospheric carbon to form plant material* - *moderate weather extremes and impacts* - *generate soil* - *provide employment* - *provide human and wildlife habitat* - *contribute to aesthetic beauty and provide recreation* - *provide land for absorption/treatment of wastewater*
Freshwater ecosystems	- *drinking and irrigation water* - *fish* - *hydro-electricity* - *watercress* - *genetic resources* - *recreation*	- *buffer water flow (control timing and volume)* - *dilute and carry away wastes, including wastewater* - *cycle nutrients* - *maintain biodiversity* - *provide aquatic habitat* - *provide transportation corridor* - *provide employment* - *contribute to aesthetic beauty and provide recreation*
Grassland ecosystems	- *livestock (food, game, hides, fibre)* - *drinking and irrigation water* - *genetic resources*	- *maintain an array of watershed functions (infiltration, purification, flow control, soil stabilisation)* - *cycle nutrients* - *remove air pollutants* - *emit oxygen* - *maintain biodiversity* - *generate soil* - *use atmospheric carbon to form plant material* - *provide human and wildlife habitat* - *provide employment* - *contribute to aesthetic beauty and provide recreation* - *provide land for absorption/ treatment of wastewater*

Appendix 2 *Legislation relevant to wastewater management*

The Resource Management Act 1991 (RMA)

The RMA controls most of the consents your community will need. The purpose of the Act is to promote the sustainable management of natural and physical resources. It provides for the preparation of regional policy statements, policies and plans, and the preparation of district plans. The control of specific activities is achieved through the rules in these plans and through resource consents.

The RMA does not explicitly provide for the management of waste: it provides for the management of environmental effects, including those arising from the disposal of waste as part of a wider focus on the effects of actions on the environment. The Act requires that adverse effects are avoided, mitigated or remedied.

The RMA is an enabling piece of legislation that provides councils with considerable discretion and opportunity in its interpretation.

The Hazardous Substances and New Organisms Act 1996 (HSNO)

This Act provides for the protection of the environment by preventing or managing risks to the environment from hazardous substances and new organisms.

The HSNO legislation takes a life-cycle approach to the management of hazardous substances, including their disposal, when such substances are no longer wanted and become waste. The disposal of waste hazardous substances is controlled through the Hazardous Substances (Disposal) Regulations 2001. These regulations provide for the treatment of the different classes of waste hazardous substances before disposal so that the substances are no longer hazardous.

The Health Act 1956

This requires territorial authorities to ensure waste is collected and disposed of, promote and protect public health, and report diseases and unsanitary conditions to the medical officer of health. The local authority must 'secure the abatement' of any nuisance likely to injure or be offensive to health.

The Local Government Act 2002

The Local Government Act 1974 was reviewed in 2002. The new Act requires local authorities to take a sustainable development approach. Section 125 requires a territorial authority to assess the provision of wastewater services within its district from time to time. An assessment may be included in the territorial authority's long-term council community plan, but if it is not, the territorial authority must adopt the assessment using the special consultative procedure.

The Local Government Act 2002 contains provisions relating to tradewastes, stormwater, sewage and waste management planning. Tradewastes are generally managed through bylaws. Traditionally the control on tradewastes was to prevent the wastes from harming the sewerage or wastewater network, but increasingly bylaws are being used to control the nature and concentrations of substances in order to manage the type of treatment and final discharge of wastes.

Key themes in the Act which impact wastewater management are summarised below.

- *Sustainable communities*: the overall purpose of local authorities is to promote the community's social, economic, environmental and cultural wellbeing. These four factors have to considered in every significant wastewater decision a council makes. (This handbook has focused on all four factors.)
- *Long-term planning*: councils must determine their community's long-term outcomes and priorities in an integrated way, and this process must include provision for public submissions. In addition, each council must prepare a 'long-term council community plan' which shows what the local authority intends to do towards achieving the desired outcomes.
- *Consultation*: in determining community outcomes and priorities, in planning and when making significant decisions, local authorities must engage in public consultation.

In addition to these general themes there are specific new provisions in the Act relating to the management of wastewater.

- *Part 7* of the Act requires local authorities to make "an assessment" of water services from time to time. This requires an exhaustive examination of the water, sewerage and stormwater functions, including present arrangements, future demand, delivery options and conservation strategies. The assessment is subject to a public consultation process and it (or a summary of it) must be included in the council's long-term council community plan.
- *Section 130* obliges local authorities to maintain water services.
- *Section 131* allows local authorities to close down small water services – but only after a referendum.
- *Section 136* limits contracts for water services operations to 15 years and in these circumstances it must retain control over pricing, management and the development of policy.

Appendix 3 *Wastewater production, water consumption and water-conserving technologies*

Wastewater production

Table A1 sets out information on wastewater production based on data from Christchurch. This information would be typical of most communities on a public water supply.

	Per person (litres)	*100 people* (litres)	*1,000 people* (litres)
Urine	*1.5*	*150*	*1,500*
Total flushing water	*30*	*3,000*	*30,000*
Greywater (baths etc.)	*130*	*13,000*	*130,000*

Table A1 ***The amount of wastewater produced per day***

Table A2 shows the amount of phosphorous and nitrogen produced. Both of these have a major impact on the nutrient cycle and need treatment.

	Per person (kg)	*100 people* (kg)	*1,000 people* (kg)
Phosphorous from:			
urine	*0.001*	*0.1*	*1.0*
faeces	*0.00082*	*0.082*	*0.82*
greywater	*0.0013*	*0.13*	*1.3*
Total	***0.00302***	***0.302***	***3.02***
Nitrogen from:			
urine	*0.0107*	*1.07*	*10.7*
faeces	*0.00123*	*0.123*	*1.23*
greywater	*0.001*	*0.1*	*1.0*
Total	***0.01293***	***1.2923***	***12.923***

Table A2 ***Phosphorous and nitrogen produced per day***

If urine is diverted from the domestic wastewater, and greywater and toilet flushing is reduced by 50% by using more efficient water technologies in each home, the volume of domestic wastewater going to a wastewater treatment plant could be reduced by over 50%. This would also mean nitrogen going to treatment would be reduced by 80%, and phosphorous by 30%.

Water consumption

Water consumption per person varies from town to town and throughout the year. Obviously water consumption will increase considerably in the summer when people water their gardens and lawns.

Waimakariri District Council estimates a peak domestic daily water requirement of 1,000 to 1,500 litres per person. This includes a rather generous allowance for garden and lawn irrigation requirements. For Christchurch City, peak daily per capita water consumption is up to 2,000 litres, while the minimum is 200 litres. The daily average is 450 litres/person. These figures are based on city-wide consumption figures, which will include water consumed by industry and commercial activities.

For a small community in a rural area, industry and commercial uses will usually be quite small. The typical water consumption rate for household activities (excluding uses such as garden irrigation, car washing and swimming pool use) is about 180–200 litres person per day.

Household water use	*Appliances/fixture per capita daily flow (litres/person/day)*				
	Toilet	*Washing machine*	*Shower*	*Washbasins, kitchen, bathroom, laundry*	*Total per capita flow (L/p/d)*
Standard household fixtures: 11/5.5 litre dual-flush cistern, top-load washing machine	*38*	*22*	*90*	*30*	*180*
Full water-reduction fixtures: 6/3 litre dual-flush cistern, front-load washing machine, low-flow showers, aerator faucets	*22*	*13*	*45*	*15*	*95*
% saving	*42.1*	*40.9*	*50.0*	*50.0*	*47.2*

Table A3 ***Comparison of water use between conventional and water-saving domestic appliances***

Data provided by On-Site NewZ, 14 April 1997.

Water-saving technologies

Table A3 is an illustration of possible water savings using water-saving technologies.

Toilets

There are now a number of different toilet designs available in porcelain, stainless steel and plastic. The volume of wastewater coming from the different toilets varies considerably. These systems include:

- water-saving (usually dual-flush) toilets
- vacuum toilets
- composting toilets.

For each of these systems there may be the option of a urine-separating design, or the traditional non-separating design producing blackwater. For those systems with urine separation there is a separate urine-flushing mechanism, which uses considerably less water than the faeces flush.

The older type of single-flush toilets would use up to 15 to 20 litres of water per flush. Many older homes are likely to have these types of toilets. The dual-flush toilets have flushing volumes ranging from full flush to reduced flush volumes of 11 to 5.5 litres, 6 to 3 litres and 3.3 to 1.5 litres.

Vacuum toilets

Vacuum toilets are now used overseas in residential units. Several home units (eg, in an apartment block or cluster homes) may be served by a single vacuum unit. There are also single-toilet vacuum units. The volumes of wastewater from vacuum toilets are very low. Typical daily flush volumes for 1 EDU[22] (representing one average household) using these toilets are given in *Table A4*. It can be seen from this table that volumes of blackwater can vary considerably with the type of toilet used.

Urine-separating vacuum toilets are being used in some countries in Europe. While it can be seen from *Table A4* that this reduces volumes considerably, the other advantage is that it enables the recovery of the nutrients from the urine. Urine is rich in nutrients and typically contains 85% of the nitrogen and 50% of the phosphorus in the total domestic wastewater stream. The other advantage in separating out the urine is that it enables the return of these nutrients back to productive land use. Research carried out on the health risk of separated urine by the Swedish Institute for Infectious Disease Control[23] shows that:

- *E. coli* and other coliforms die off quickly in stored urine
- some micro-organisms such as faecal *streptococci* and the parasite *Cryptosporidium* survive longer than *E. coli*, and probably also some viruses
- the hygienic risks connected with human urine are a lot less than with faeces
- the amounts of hormones are very small compared to other sources, and we do not need to worry about them.

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[22] *EDU = equivalent domestic unit, representing a home with the average number of adults for a community. In this report 1 EDU = 2.65 adults.*

[23] *TA Olssen, H Stenström, H Jönsson. Occurance and persistence of faecal microorganisms in human urine from urine-separating toilets. In:* ***Environmental Research Forum****, vols 5-6, Transtec Publications, 1996, pp. 409-419.*

Type of toilet	*Total volume per EDU (L/day)*
Conventional toilet (older style with 15 L per flush)	*284*
Dual-flush toilet (11/5.5 L)	*122*
Dual-flush toilet (6/3 L)	*70*
Dual-flush toilet (3.3/1.5 L)	*38*
*Vacuum toilet (non-separating)**	*28*
*Vacuum toilet (separating)**	*7.5*
Hybrid toilet	*< 6*

Table A4 ***Typical daily volumes of blackwater per person for different types of toilet***

* It is possible to obtain (although not yet available in NZ) vacuum toilets for residential installation, and some are designed to separate the urine and faeces. Typically the flush volumes used for the faeces flush is about 1.0 to 0.5 L per flush and for the urine 0.1 L per flush. Therefore the total flushed volume for the separating toilets can be very low.

The application of urine separation and recovery technology in Scandinavia has enabled the conversion of urine into fertiliser at central processing facilities. Urine storage tanks associated with apartment blocks enable routine collection of the raw product, which is transferred in bulk to the processing plant. The resulting product is then sold for farm and horticultural use. No such proposals for urine recovery are under development in New Zealand.

Waterless urinals

BRANZ-certified waterless urinals have been installed in a number of men's toilets throughout New Zealand. Each urinal is made from fibreglass-reinforced plastic with a special gel-coat surface. Odour control and hygiene is achieved with a patented alcohol-based sealing fluid with trap.

Composting toilets and greywater systems

See *Appendix 4*.

Other water-using technologies

Washing machines

Low water-use washing machines can reduce laundry wastewater volumes by 30%. Typically, front-loading washing machines use less water than do top-loading washing machines. The September 1999 *Consumer magazine* (No. 385) evaluated a number of New Zealand-available washing machines, including a rating for efficiency of water use. Front-loading machines generally rated higher.

Fittings

There are various fittings that can reduce water use in homes and industry. Aerator fittings for shower heads and tap faucets have the effect of increasing the bulk of the aerated water stream, giving a sense of volume but with a reduced real volume of water. This can be effective in showering and hand washing.

Proprietary flow-control valves such as Jemflow and Aqualoc are inexpensive valves that claim to reduce water consumption by up to 35%. These can be fitted into new homes or retro-fitted into existing homes.

In situations where water pressure is higher than necessary, causing excessive flow rates, the fitting of pressure-reducing valves will save water consumption.

Greywater and blackwater separation with specific management

Separating the greywater from the blackwater enables separate management of these two components. There is at least one commercially available system in New Zealand for greywater treatment and recycling: the East Coast (ECO) Wastewater Recycling System (recently certified by BRANZ). Recycled greywater is used for toilet flushing and garden watering.

Conclusions

The key conclusions are as follows.

- *Table A3* shows that internal domestic water use can be reduced by 50% with the adoption of water-saving technologies in the home.
- *Table A4* clearly illustrates that substantial water volume reductions can be achieved according to the type of toilet installed. The organic and nutrient loading of blackwater from an EDU will not be affected by the type of toilet.
- The greywater component of the domestic wastewater volume can also be reduced by the use of water-saving technologies. Separating the greywater from the blackwater will enable separate and more appropriate management of these two streams. There may also be some situations where greywater recycling would be appropriate. However, on some sites greywater can be managed on-site, and this will reduce the hydraulic loading on centralised sites receiving treated wastewater.
- For existing homes and enterprises the economic benefits of retro-fitting water-saving (and hence wastewater reduction) technologies would need to be considered carefully. However, it is strongly recommended that new homes and commercial and service units give serious consideration to the installation of water-saving technologies and management techniques. The cost-benefit would need to be evaluated for each specific development.

Appendix 4 *Composting toilets*

Composting of human waste is an ancient practice. It is only in the last 30 years that systems for modern living have been designed and commercialised for the modern domestic home environment. (Sweden has pioneered these systems). A composting process relies on bacteria and other micro-organisms to break down the organic constituents of human faeces and other organic wastes under aerobic conditions (where oxygen is present).

For human waste to compost well there needs to be the correct moisture content (not too damp) and a balance of carbon and nitrogen components, and it needs to be well aerated. If not, problems may arise, including:

- odour
- flies and other nuisance insects.

Nature-Loo Classic

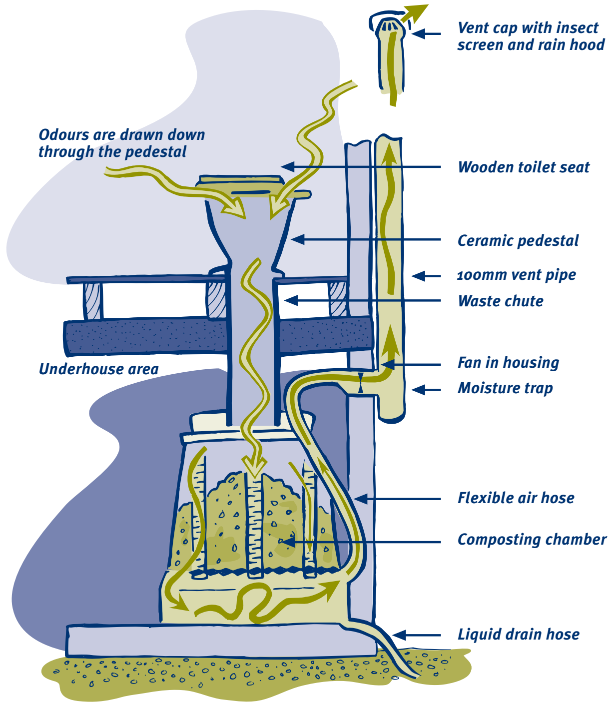


Figure A1 *Typical composting toilet*

Sound design and good management can overcome a number of these problems. Odour – and to a certain extent excess moisture – can be minimised with good ventilation. Most systems employ an electric fan for forced ventilation. Some systems provide additional heating to accelerate decomposition and moisture evaporation. Excess moisture may be avoided by using urine-separating toilets, although these are not common in New Zealand (see *Appendix 3*).

Various measures can be taken to minimise the fly problem, such as the use of insect screens and ensuring the compost chamber is sealed against insect access (keep the toilet lid closed when not in use). Other systems use a light trap to attract flies away from the pedestal, which is the most common means of access by flies to the composting chamber. A healthy composting process will attract fewer flies. However, this cannot always be guaranteed.

Management issues include:

- visual 'uncleanliness'
- the need for regular and acceptable compost removal and disposal.

Porcelain pedestals are generally easier to keep clean than plastic units. The suppliers of the composting toilet normally advise how toilet bowls should be cleaned.

Care needs to be taken in the handling and disposal of the composted material. After 12 months of well-managed composting it is recommended that the solids be stored for another 12 months before returning to land, preferably by burying in an area where potential human contact is low. If well composted there should be no objectionable smell (maybe an earthy, musty odour) and most pathogens are destroyed, making it safe for handling.

Other management issues related to usage include:

- the toilet lid should be closed at all times when not in use
- add no cigarette butts, sanitary towels or nappies, glass, metal, plastic, chemicals or toxic materials.

Composting toilets require on-site management. The obvious advantage of composting toilets is the non-liquidisation (by flush water) of faecal material and the avoidance of problems that liquid waste can cause.

At the same time, any owner wishing to install a composting toilet will need to make provision for the management of greywater. The usual method is to install a reduced-size septic tank in accordance with AS/NZS 1547:2000 followed by a conventional on-site re-entry system such as soakage trenches. Alternative approaches include the use of special grease and sediment traps, followed by a constructed wetland, with the resulting treated effluent being stored for garden irrigation or disposed by sub-soil soakage or dripline irrigation. Where a grease and sediment trap is used instead of a reduced-size septic tank, weekly or monthly maintenance of the trap will be required.

Local authorities have differing attitudes to the use of composting toilets, and you should consult your council to determine their rules related to acceptance and approval of this method of human waste management. It should also be noted that the Ministry of Health does not recommend the use of composting toilets in urban areas.

Appendix 5 *New developments and innovations in wastewater servicing*

New thinking in treatment technologies is tending to blur the boundary between treatment and re-entry systems. The focus now is on working with ecosystems to beneficially treat environmental pollutants. As with most technologies, new wastewater servicing systems are being researched and developed all the time. This appendix describes some of these developments in New Zealand and overseas. Most are not well proven systems under New Zealand conditions.

Constructed wetland developments

Staged planting wetlands have been used in the US, where up to five wetland units in series are each planted with specific plant species aimed at particular treatment functions, such as organic matter control, nutrient removal and bacterial control.

In *septage wetlands* the pump-out contents of septic tanks (the septage) is treated by flooding into a shallow basin, within which dense wetland plantings thrive on the nutrients in the solids. As the basin gradually fills at each dose of sludge and liquid, the root systems of the growing plants climb steadily up the older buried stalks. The whole mature sludge/root mass content is eventually excavated and composted, and the basin replanted for continuing use.

Controlled environment aquatics consist of a series of tank cells housed within a 'glasshouse' or other covered and sheltered environment. Treatment is carried out with a series of tanks containing floating plants interspersed with sub-surface flow cells. Some systems include fish tanks. Patented systems include Solar Aquatics, Living Machine and Biological Aquatics. These systems are not currently available in New Zealand.

Oxidation pond developments

The advanced integrated wastewater pond system (AIWPS) has been used in the US since the 1960s, although only to a limited extent. It is now being trialled in New Zealand. It is a five-stage pond system with a deep anaerobic and facultative first stage, followed by a high-rate algal race-track channel, a five-day settling pond, a deep-polishing pond for bacterial removal, and a final storage and maturation pond. The total through-flow time of 24 days compares with the 60 days for a traditional facultative/polishing pond combination, thus reducing the land area required. However, significant hands-on operational supervision is required to ensure the system performs to its optimum.

Reclaimed water developments

Reclamation of water from recirculating sand-filter systems via UV disinfection to enable recycling back onto properties for toilet flushing and closed-cycle garden irrigation is common in the US. A large Australian scheme known as the Rouse Hill project, to the west of Sydney, has been introduced to conserve the use of potable water in the face of restrictions on natural water availability. There were some initial issues resulting from confusion of the two separate water supplies that have subsequently been dealt with by colour coding the greywater supply lilac and utilising left hand threads on the reticulation.

Such technology is recognised to be a public health risk due to the difficulties encountered with differentiation of these non-potable water supplies from the potable supply. It is unlikely to have a widespread appeal in New Zealand until this issue has been resolved. It has been installed for two new 35 and 37 lot subdivisions, one in the Kumeu area north of Auckland, the other in Coromandel on the coast west of Whitianga (see the case study in *Section 9.4*). The Kumeu project enabled a reduction in the communal land area requirement for final effluent irrigation. The project in Coromandel was required under subdivisional consent to address the issue of water supply availability during the peak summer holiday period.

Ultrafiltration processes utilising membrane filters from the food industry are being trialled in conjunction with disinfection systems to reclaim water for discharge to sensitive environments, and for household re-use applications in Australia. This technology is available in New Zealand.

Greywater recycling for toilet flushing can be provided for individual households in a community situation via a three-stage treatment system that strains, then deodorises, then disinfects household bathroom and laundry wash waters. The resulting product is cloudy in appearance, but entirely suitable for recycling for toilet flushing. It is a New Zealand development, and is applicable for urban households where a saving on both water use and wastewater production is desired by homeowners. It can also be used for existing rural–residential cluster dwellings where reduction in communal land treatment area is desired.

Drip-line irrigation developments

Septic effluent drip irrigation is under trial in the US and in some areas of New Zealand. The septic tank effluent has to be highly filtered by an automatic filter system, with backwash cycling prior to drip-line application. The objective is to provide more effective distribution of primary effluent into aerobic topsoil layers to take advantage of the soil's treatment capacity.

Controlled-drip sub-surface drip-line systems provide a geotextile wick above a plastic strip to ensure that effluent disperses fully along the length of the drip line instead of concentrating at the drip emitters. The objective is to better use the soil system to treat and absorb effluent. This system has been developed in Australia and is available in New Zealand.

Innovations in integrated water wastewater services

There are a range of innovations under trial and investigation overseas as demonstration projects. Some of these are summarised in the box below.

Innovations in integrated water and wastewater services

- A 3.5 ha development with 350 residents at Flintenbreite, Lübeck, Germany, uses vacuum toilets and sewers, decentralised greywater treatment using constructed wetlands, biogas from blackwater and rainwater retention and infiltration in swales (Otterpohl, 2000).
- At the Agricultural University of Norway, in Ås, a student apartment building with 24 flats, 54 students and 26 vacuum toilets has been designed to separate the greywater and the blackwater streams. The blackwater is treated and spread on farmland and the greywater is treated on-site by constructed wetlands before disposal to stormwater drains (Etnier et al., 1999).
- Constructed surface-flow wetland designed to reduce the TN content of the treated wastewater from Oxel sund township (population = 15,000) by 50%. The pre-treatment is mechanical/chemical treatment. There are 22 ha of ponds. Each pond is about 20,000 m^3. The water level variation is about 50 to 100 m^3. The system manages to provide denitrification and nitrification (Etnier, 1997).
- Figtree Place, Newcastle, Australia. This project involved 27 residents on 0.6 ha. It includes rainwater harvesting, stormwater soak-aways for groundwater recharge and water technologies achieving 60% saving (Kuczera et al., 2001).
- Craggs et al. (2001) describe an advanced pond system using high-rate algae ponds for nutrient stripping and harvesting for composting.
- Wild et al. (2001) describe wetlands planted with *Typha* (raupo) for wastewater renovation and production of insulation fibre, as carried out in Donaumoos, Germany (6.2 ha wetland).

References for: Innovations in integrated water and wastewater services

Craggs, R.J.; Tanner, C.C.; Sukias, J.P.S.; Davies-Colley, R.J. *Dairy farm wastewater treatment by an advanced pond system* (APS), pp. 105–111.

Etnier C. and B. Guterstam (eds), 1997. *Ecological Engineering for Wastewater Treatment*. 2nd Edition. Lewis Publishers. (Link to publisher)

Etnier C, Refsgaard K.1999. Economics of decentralised wastewater treatment: testing a model with a case study. Paper presented to the conference: *Managing the Wastewater Resource – Ecological Engineering for Wastewater Treatment*, 7–11 June 1999, Ås, Norway.

Kuczera G, Coombes P. 2001. A systems perspective of the urban water cycle: new insights, new opportunities. *Stormwater Industry Association 2001 Regional Conference*, Port Stevens, NSW.

Otterpohl R. 2000. *Design of Highly Efficient Source Control Sanitation and Practical Experiences*. EURO Summer School DESAR, Wageningen, The Netherlands.

Wild U, Kamp T, Lenz A, Heinz S, Pfadenhauer J. 2000. Cultivation of Typha spp. in constructed wetlands for peatland restoration. *Ecological Engineering*, 17(1): 49–54.

Appendix 6 *On-site systems – key features*

Note: All costs are indicative only, may vary from site to site, and are stated in 2002 dollars.

System 1

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater →	*Single-chamber septic tank (SD)* →	*Trickle loading* →	*Seepage trench*

Technical features

This is a traditional system. Wastewater from the home is treated in a single-chamber septic tank with no filter fitted.

Benefits and/or constraints

This is the simplest (and possibly cheapest) on-site system in the short term. The septic tank effluent quality is poor. Soils would need to be free draining, with a low groundwater table. Using trickle loading rather than dose loading would increase the likelihood of trench failure and shorten the life of the system. The septic tank would need to be de-sludged every 2–5 years. The system cost is around $4,000 to $6,000 per standard home, and $50 to $100 (annual) maintenance cost based on 3-year pump-out and the property location.

System 2

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater →	*Multi-chamber ST (MST) or improved ST with filter (IST)* →	*Dose loading* →	*Seepage trench*

Technical features

This is a modern system. Wastewater from the home is treated in a multi-chamber septic tank or a large-capacity single-chamber improved septic tank with an effluent outlet filter fitted.

Benefits and/or constraints

This is an improved passive on-site system. The septic tank effluent will be of higher quality than for System 1. Soils would still need to be free draining with a low groundwater table. The dose loading and improved treatment would prolong the life of the trench system. The septic tank would need to be de-sludged every 5–10 years. The system cost is around $5,000 to $7,000 per standard home, and $30 to $50 (annual) maintenance cost based on power for pump dosing, 7-year pump-out and the property location.

System 3

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater →	*Multi-chamber ST (MST) or improved ST with filter (IST)* →	*Dose loading* →	*Wisconsin mound*

Technical features

Wastewater from the home is treated in a multi-chamber septic tank or a large-capacity single-chamber improved septic tank with an effluent outlet filter fitted.

Benefits and/or constraints

Ecosystem re-entry is by means of a raised mound, normally constructed with sand fill to provide in-mound secondary treatment. The large base area of the mound enables the sand-filtered effluent to spread sideways into the natural soil all around the edge of the mound. The septic tank would need to be de-sludged as for System 2. The system cost is around $11,000 to $15,000 per standard home, and $30 to $50 (annual) maintenance cost based on power for pump dosing, 7-year pump-out and the property location.

System 4

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater →	*Multi-chamber ST (MST) or improved ST with filter (IST)* →	*Dose loading* →	*Seepage trench*

Technical features

Water-saving technologies such as low-flush toilets, water-efficient washing machines and shower and faucet flow restrictors can reduce wastewater volumes by 15% to 30%.

Benefits and/or constraints

Water saving will reduce the total length of trench required, and hence the overall cost. The system cost is around $4,500 to $6,000 per standard home, and $30 to $50 (annual) maintenance cost based on power for pump dosing, 7-year pump-out and the property location. [Note: If there is any likelihood of future owners replacing the water-saving measures with regular fixtures, trench lengths should not be reduced.]

System 5

Source	Primary Treatment	Secondary Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater	Multi-chamber ST (MST) or improved ST with filter (IST)	ISF or RSF sand filter or textile filter	Dose loading	Sub-surface irrigation

Technical features

The intermittent sand filter is a carefully engineered sand filter that will treat the effluent from the septic tank to a high standard, enabling sub-surface drip-line irrigation of the final effluent.

Benefits and/or constraints

Modern designs such as intermittent or recirculating sand filters or textile filters are proving to be reliable and produce a very high-quality effluent. The cost of this system is around $10,000 to $14,000 per standard home and $80 to $120 (annual) maintenance cost, based on power for pump dosing, 7-year pump-out and the property location.

System 6

Source	Primary Treatment	Secondary Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater	Multi-chamber ST (MST) or improved ST with filter (IST)	Constructed wetland	Dose loading	Sub-surface irrigation

Technical features

The constructed sub-surface wetland is designed to receive the treated effluent from the septic tank. The quality of the outflow from the wetland is of sufficiently high standard to enable sub-surface irrigation of the final effluent. A typical wetland would be about 20 to 25 m^2 in area.

Benefits and/or constraints

The wetlands must be well designed in terms of dimension, sealing, inlet and outlet design and appropriate plants. They may be landscaped to provide a home garden attraction. Maintenance is low. The cost of such a system will be in the range $7,500–$10,000. The septic tank would need to be de-sludged every 5–10 years.

System 7

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater	AWTS	Dose loading	Sub-surface irrigation

Technical features

The aerated wastewater treatment plant will be supplied and installed by a manufacturer, who should then be commissioned to undertake regular maintenance via a maintenance contract. This will involve 6-monthly checks of equipment and effluent quality.

Benefits and/or constraints

The high-quality effluent is suitable for drip-line irrigation. The feeder line must, however, be fitted with a disk filter unit to capture fine solids washed over from the AWTS setting system. Cost is around $8,000 to $13,000 per standard home, and the operation and maintenance contract plus power consumption will be around $180 to $250 annually. Sub-surface irrigation area could be up to 250 m^2.

System 8

Source	Treatment	Loading	Ecosystem re-entry
No water saving. Black and greywater	AWTS	Dose loading	Surface spray irrigation

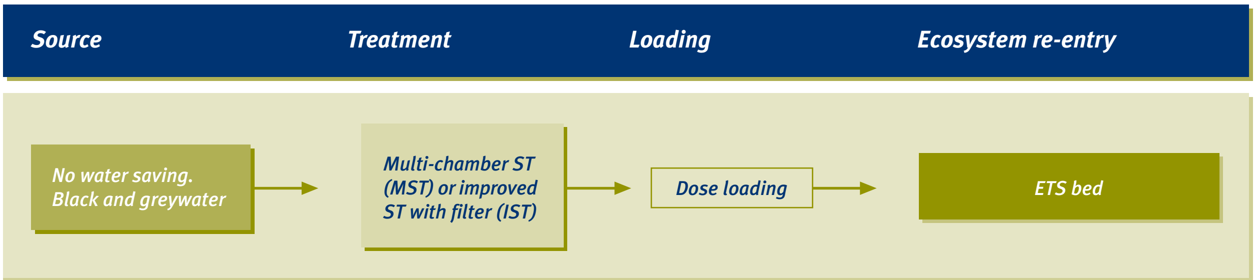
Technical features

The aerated wastewater treatment plant will be supplied and installed by a manufacturer as per System 7.

Benefits and/or constraints

The high-quality effluent is suitable for spray irrigation after disinfection by UV or chlorine tablets. [Note: this is unlikely to be acceptable in most NZ regulatory environments.] Cost is around $7,000 to $11,000 per standard home, and the operation and maintenance contract plus power consumption will be around $160 to $200 annually.

System 9



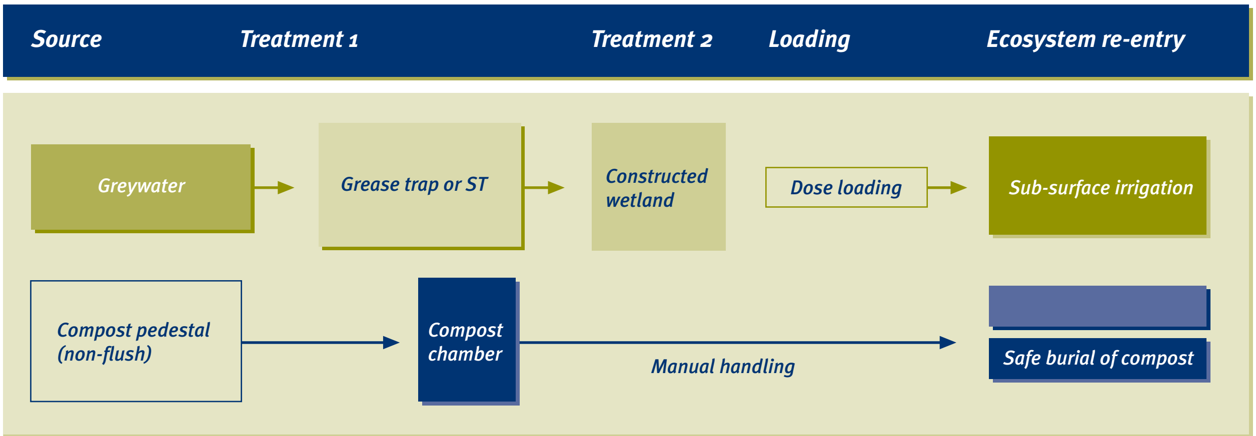
Technical features

The ETS (evapo-transpiration seepage) bed is designed to enhance water removal by both the evapo-transpiration process of the vegetation grown on the mounded bed, as well as seepage to the ground below the bed

Benefits and/or constraints

This system is most appropriate where the soils are poorly drained and it can be sited for good evapo-transpiration exposure and for lower rainfall areas. The required bed size will depend on soil conditions. For a typical home the bed size would need to be about 90 m^2. Costs are around $12,000 to $15,000 plus $50 to $80 (annual) maintenance cost based on power for pump dosing, 7-year pump-out and the property location.

System 10



Technical features

Two separate systems are required: the composting toilet and the greywater management system. There is a range of composting toilet designs. These require sufficient capacity for the household loading and the local temperature variation.

Benefits and/or constraints

This system requires less water than the previous systems and can be designed to return all waste nutrients to the land. Owner management requirements are high, however. The composting toilet must be well designed and managed to avoid heath risks and nuisances such as odours and insect pests. Greywater is contaminated wastewater and requires an approved system for its management. Costs can be high. A good-quality composting system for a standard home may cost up to $4,000 The greywater system could cost $3,000 to $5,000.

Appendix 7 *System Matrix*

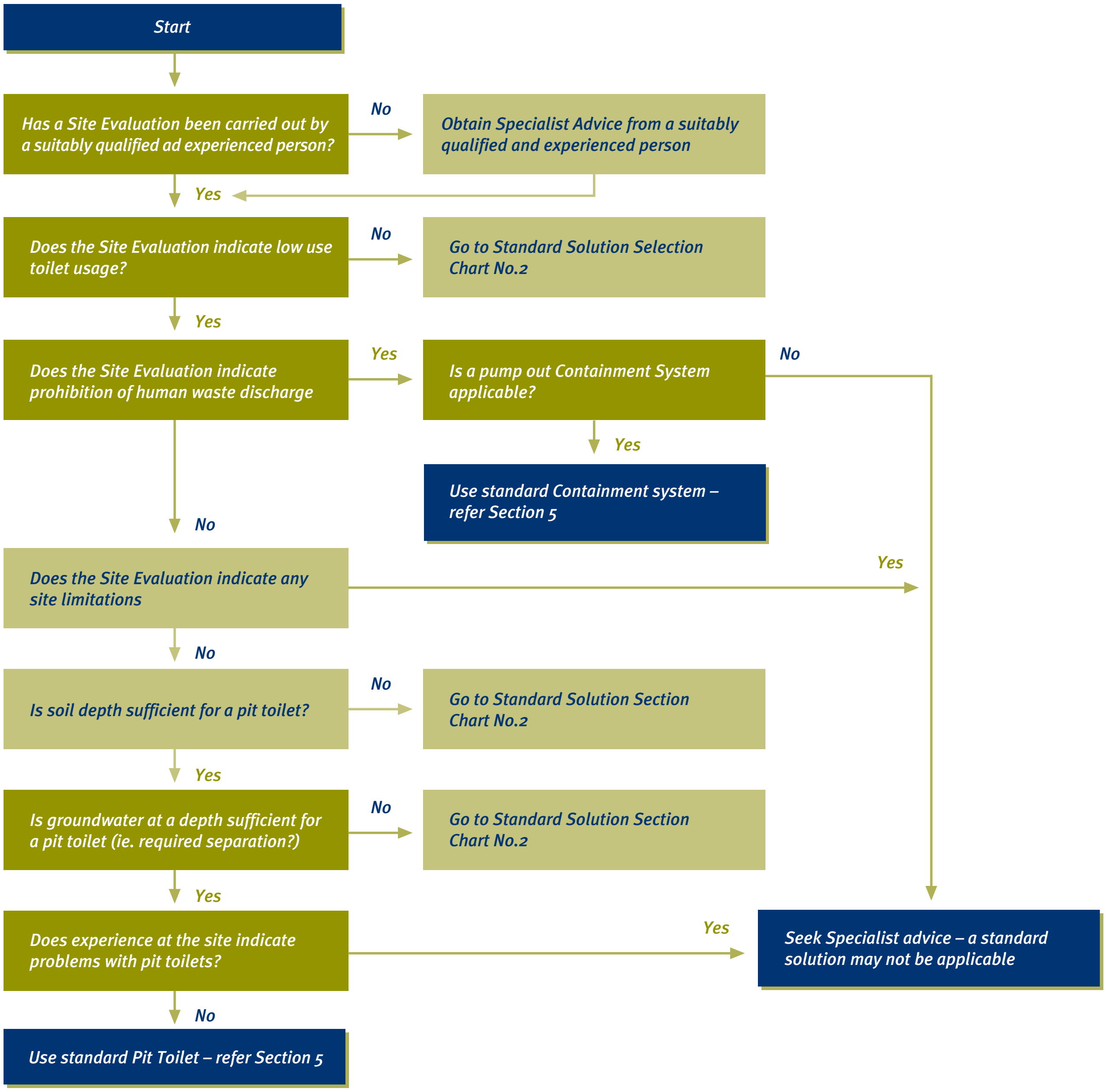
Possible criteria	*Fully centralised system*	*Combination of on-site and centralised system*	*Cluster system*	*Fully on-site systems*
Physical characteristics of site				
Limitation of site or area, (eg, soils climate, groundwater aspect proximity)	*Not applicable*	*The on-site component acts as pretreatment to the central system. This is likely to be a septic tank and/or pump and sump. Suitable area of land required on site. Some limitations of site. Septic tank to be accessible for pumpout servicing*	*Suitable local site location and area required. Specific site conditions and area required, especially for return of treated wastewater and sludge to the ecosystem*	*Site area, soils, topography and ground water conditions may limit on-site options. Septic tank to be accessible for pumpout servicing*
Resilience to natural hazards	*Vulnerable to natural hazards such as earthquakes and floods*	*Vulnerable to natural hazards such as earthquakes and floods*	*Impact of natural hazard event less than a fully centralised system. Flood risk*	*More resilient to natural hazard events. Flood risk*
Ecological				
Impact on surface and ground water, aquatic and other habitats, ecosystem services, soils	*Large conventional sewer network resulting in urban impacts. Older networks can result in stormwater infiltration overflows from sewers and pumping stations. Site and technology specific. Must meet RMA consent requirements. Ecological impact of emissions (treated wastewater, sludges and any odorous gases) will depend on standard of treatment, plant management and sensitivity of receiving ecosystem and proximity of human neighbours*	*Modified or alternative sewer network required. Site and technology specific. Overflows from infiltration substantially reduced or eliminated. Must meet RMA consent requirements. Ecological impact of emissions (treated wastewater, sludges and any odorous gases) will depend on standard of treatment, plant management and sensitivty of receiving ecosystem and proximity of human neighbours*	*Small scale modified or alternative sewer network required. Overflows can be substantially reduced by good design and construction. Site and technology specific. Must meet RMA consent requirements. Each cluster handles a smaller volume than a centralised system, so the ecological impact is likely to be less. Impact will depend on standard of treatment, plant management, sensitivity of receiving ecosystem and proximity of human neighbours*	*No sewer networks required. Ecological impact all on-site. Very dependent on system technology and ongoing management. Will also be depend on sensitivity of receiving ecosystem*
Ecological restoration opportunities	*Highly treated wastewater could be used for wetland resortoration*	*Highly treated wastewater could be used for wetland restoration*	*Highly treated wastewater could be used for wetland restoration*	*On-site wetlands could be fed with secondary treated wastewater*
Resource efficiency – closing of ecological cycles	*Often not considered by central authority. Very dependent on design and management of the system*	*Often not considered by central authority. Very dependent on design and management of the system*	*Local sewer network may save pumping and consequent energy demand. More recent systems are designed for efficient resource use and closing of ecological cycles*	*No sewer networks required. Greater opportunity for closing of nutrient cycles*
Water recycling	*Possible to achieve but would require high-quality treatment as well as provision of separate and readily identifiable reticulation to users*	*Possible to achieve but would require high-quality treatment as well as provision of separate and readily identifiable reticulation to users*	*Possible, but would require high-quality treatment and separate reticulation to user*	*Very possible, but would require high-quality treatment. Greywater recycling for toilet flushing and garden watering is a viable technology already in use in NZ*
Compatibility with Māori perspectives				
Issue of passage through land	*May be an issue but needs to site specific analysis. RMA process will address these issues*	*Maybe an issue - site specific. RMA process will address these issues*	*Cluster schemes provide opportunity for local land application and ecosystem re-entry. May be a site specific issue. RMA process will address such issues*	
Protection of mauri	*Dependent on siting and ecosystem re-enty type*	*Dependent on siting and ecosystem re-entry type*	*Dependent on siting and ecosystem re-entry type*	*All effluent applied to land, hence likely compatible. Unlikely to be a problem*
Other cultural concerns				
Local stewardship/responsibility	*Central system disconnects waste producers from relevant ecosystem's realities*	*Central system disconnects waste producers from relevant ecosystem's realities*	*More opportunities to 'tailor fit' local cultural requirements. Community has closer link to receiving ecosystem*	*Possible to fit to individual's cultural requirements.Very close links with receiving ecosystem. "Neighbourly" conflicts possible*
Re-use of reclaimed water	*Likely to be a general cultural difficulty*	*Likely to be a general cultural difficulty*	*Likely to be a general cultural difficulty*	*Because of individual choice, expect wider acceptance*
Public health				
Operational safety	*Generally a very high standard of public health safety*	*Generally a very high standard of public health safety*	*Generally a very high standard of public health safety*	*Dependent on technology and management. Approved systems that are well designed and subject to an inspection and management programme will be safe*
Impacts on community health	*Central systems generally remove and treat wastewater well away from public contact, thus minimising health risks. Treated effluent discharge to receiving waters must meet health standards for recreation and shellfish harvesting. Stormwater overflows from sewer networks can pose short term health risks. Strict controls apply to land application by spray irrigation*	*Central systems generally remove and treat wastewater well away from public contact, thus minimising health risks. Treated effluent discharge to receiving waters must meet health standards for recreation and shellfish harvesting. Stormwater overflows from sewer networks can pose short term health risks. Strict controls apply to land application by spray irrigation*	*Local cluster schemes mean public closer to treatment and re-entry areas. Health risk low if management of treatment and re-entry system maintained at a high standard*	*Risk low provided well designed and managed. Neglected systems can give rise to failure conditions, effluent surfacing, and high health risk to property dwellers and immediate neighbours*
Residual management	*All residual products are managed centrally*	*All residual products are managed centrally*	*All residual products are managed by the cluster management agency*	*Treated wastewater is managed on-site. Sludge must be managed off-site at an approved location. Composting toilets not favoured in urban areas by MoH*
The technical system				
Reliability	*Usually reliable. Older sewer networks can present a significant infiltration problem. New networks are also subject to infiltration*	*Reliable. Infiltration can be minimised*	*Most modern systems will be reliable. More dependent on management structure, knowledge and skill*	*Dependent on technology quality, knowledge and skill, and a regular inspection and management programme*
Serviceability	*Usually easily serviced, although dependent on system design and management structure*	*More geographically dispersed, therefore serviceability more difficult. Dependent on system design and magagement structure*	*Usually easily serviced, although dependent on system design and management structure*	*Dependent on type of system installed and servicing protocol*
Operational requirements	*Operated by trained technicians*	*Operated by trained technicians*	*Should be operated and maintained by trained technicians*	*Operation and maintenance requirements must be diligent to avoid failure. Council organised management programme or independent operation and management contracts will reduce such risk of failure*
Engineering life of the system	*Long life*	*On-site components possess a medium to long life, whilst central components possess a long life*	*Medium to long life*	*Medium to long life when subject to a management programme*
Resilience to acts of vandalism	*Depends on system design and management. Because of centralised location, easier to reduce acts of vandalism*	*Depends on system design and management. Because of mostly centralised location, easier to reduce acts of vandalism*	*Generally located away from public eye, creating higher risk of vandalism*	*Systems are not normally secure, but vandalism not normally a significant problem*
Linkages with other opportunities and services (eg water supply)	*There are opportunities to recycle water and nutrients, recover energy, restore/create wetlands and provide an ecological education facility. Short-term economics usually constrains implementation*	*There are opportunities to recycle water and nutrients, recover energy, restore/create wetlands and provide an ecological education facility. Short-term economics usually constrains implementation*	*There are opportunities to recycle water and nutrients, recover energy, restore/create wetlands and provide an ecological education facility. Short-term economics usually constrain implementation*	*There are opportunities to recycle water and nutrients, recover energy, restore/create wetlands and other on-site landscaping. Implementation is dependent on individual motivation, funding and regulatory constraints*

Possible criteria	*Fully centralised system*	*Combination of on-site and centralised system*	*Cluster system*	*Fully on-site systems*
Ability to be changed				
Extendability	*Depending on design, most of the older, centralised systems are not so extendable or adaptable to changing requirements. Sewer infrastructure (and required flow velocities) can restrict future changes to other parts of the system. Land can be limiting. Infrastructure locks in system capacity, limiting adaptability. Normally adaptable to trade waste inflows*	*Depending on design, these system tend to be more recent and therefore extendibility may have been included in the design*	*Depends on design, but more likely to be adaptable due to being a smaller system. Funding may limit extendibility and adaptability*	*It is the individual property owner's responsibility to build in extendability and adaptibility. Most likely funding but also land area will limit the ability to respond to changes. On-site secondary treatment systems have limited opportunity to be extended for increased loading*
Adaptability/flexibility		*These systems tend to be a little more adaptable due to the lower cost of reticulation. However, adaptability will be rather limited. Normally adaptable to trade waste inflows*		
Management				
Ownership	*Normally owned and managed by city/district council*	*Normally owned and managed by city/district council*	*Can be owned and managed by city/district council or by corporate body*	*Owned by property owner. Normally managed by property owner, although owners can form a body corporate to oversee O&M*
Convenience	*Having all the operation at a central location simpifies management requirements*	*With some components on-site and most central, management will be less convenient*	*Management of cluster systems may be perceived as less convenient than a larger centralised system and more convenient than on-site systems. Centralised management of a group of cluster systems is recommended*	*Management requirements will depend on type of system installed. Traditionally, management responsibility lies with the property owner. Management may be by contract, or by a management agency, thus providing maximum convenience to the owner*
Operation and maintenance implications	*The centralised nature of this system makes operation and management uncomplicated*	*The operation and maintenace programme will need to be designed for a combination of on-site and centralised requirements*		*Operation and maintenance requirements will depend on the type of system installed. Servicing contracts are often employed, and inspection and management programmes are recommended to ensure long life of the system*
Economic factors				
Capital and operating costs	*City/district council responsibility. Capital and annual operating costs are normally evenly spread across the community served. User-pays possible with water metering*	*City/district council responsible for off-site costs, and maybe on-site costs. In some situations on-site costs may lie with property owner. Capital and annual operating costs are normally evenly spread across the community served. User-pays possible with water metering*	*Capital costs may be the responsibility of the developer or city/district council. Operating costs may be the responsibility of city/district council or a specially constituted corporate body*	*Capital and operating costs are the responsibility of the property owner. Where a council or body corportate management programme is in place, annual charges will be levied for O&M*
Funding	*Rates*	*Rates*	*Rates, or built into purchase price*	*Individual capital funding, and individual or body corporate or management agency fees for O&M*
Local community impacts				
Level of local control	*Community generally has minimal input into the design, operation and management of these systems*	*Community generally has minimal input into the design, operation and management of these systems*	*More opportunity for community input into the design, operation and management of these systems*	*Greater degree of control lies with individual property owners*
Need for external expertise/management	*Usually a significant external input into the design, operation and management of these systems*	*Usually a significant external input into the design, operation and management of these systems*	*External expertise for the design is normally required. Management can be local or centralised*	*External expertise for technology selection and design is normally appropriate. Management can be on-site or centralised*
Community change				
Pressure for future growth	*Stimulates urban growth, including commercial and industrial growth*	*Stimulates urban growth, including commercial and industrial growth*	*The cluster system will enable domestic localised growth. Less conducive to commercial and industrial growth*	*Local geophysical and hydrological conditions can restrict urban growth. Recent systems can overcome some of these constraints*
Capacity to absorb growth	*Depends on both total system design capacity and individual capacity for each component. Modern systems can be designed to accommodate future growth*	*Depends on both total system design capacity and individual capacity for each component. Modern systems can be designed to accommodate future growth*	*Cluster systems tend to be designed for a given cluster of homes. May be possible to absorb some growth, or additional cluster systems may be required*	*Growth will be dependent on the suitability of the property's site for on-site management. However, growth within site boundaries is very rarely an issue*
Other potential benefits				
Leisure and recreation	*Restored wetlands may be integrated with an urban park. Health risks would have to be minimised by appropriate pre-treatment prior to wetland re-entry*	*Restored wetlands may be integrated with an urban park. Health risks would have to be minimised by appropriate pre-treatment prior to wetland re-entry*	*Restored wetlands may be integrated with an urban park. Health risks would have to be minimised by appropriate pre-treatment prior to wetland re-entry*	*NA*
Education	*Opportunities to develop community education activities centred on wastewater, and social and ecological issues*	*Opportunities to develop community education activities centred on wastewater and social and ecological issues*	*Opportunities to involve local community in educational activities centred on wastewater and social and ecological issues*	*Opportunities to educate community to take greater responsibility for their waste*
Research	*Many research opportunities to study the resource value of wastewater*	*Many research opportunities at the centralised level to study the resource value of wastewater*	*Many research opportunities at the local level to study the resource values of wastewater*	*Many research opportunities at the individual level to study the resource values of wastewater*
Formal processes				
Familiarity to decision-makers	*Decision-makers are familiar with these types of systems and traditionally place confidence in them*	*Decision-makers are less familiar with these types of systems but normally have confidence in them because of the final centralised management*	*Decision-makers are less familiar with these types of systems and subject such systems to greater scrutiny*	*Decision-makers are familiar with on-site systems, but often very unfamiliar with recent innovations and the benefits of inspection and management programmes*
Technical demands	*Requires expert engineeering input for design. Requires skilled operators*	*Requires expert engineeering input for design. Requires skilled operators*	*Requires expert engineeering input for design. Requires skilled operators*	*Requires expert engineeering input for design. Requires trained inspection, operation and maintenance personnel*
Public health service	*Strict health standards*	*Strict health standards*	*Strict health standards*	*Strict health standards*
Ease of the consent process	*Site and system dependent. Consenting process usually well resourced*	*Site and system dependent. Consenting process usually well resourced*	*Site and system dependent. Consenting process usually less well resourced*	*Consent under council building controls*

Appendix 8 *Examples of Decision Trees for Wastewater Systems*

(a) Pit toilets

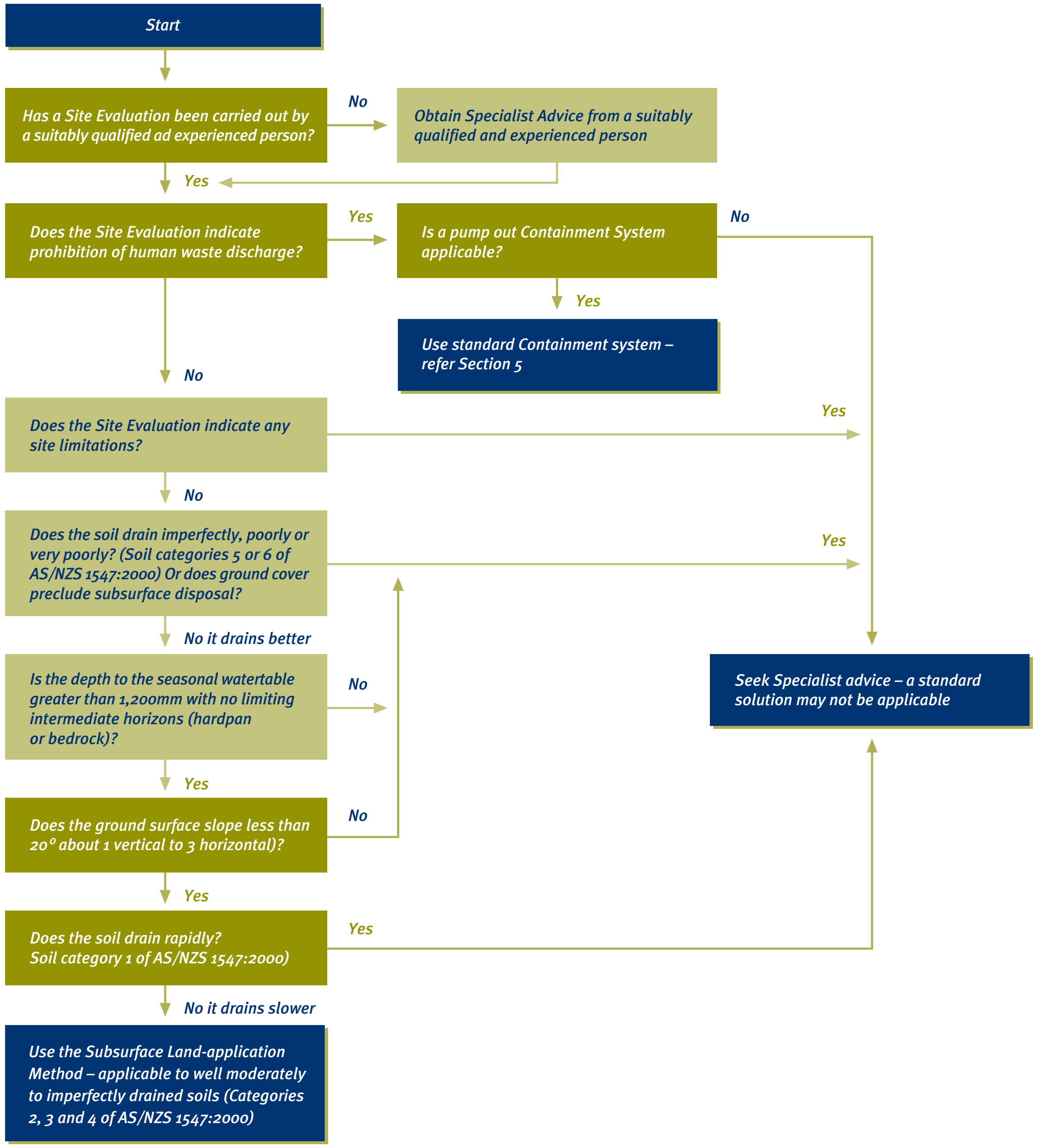
(Courtesy of Department of Conservation from: Standard of Practice for Backcountry Hut Toilets (draft)



Standard Solution Selection – Pit Toilets

(b) Septic tank systems

(Courtesy of Department of Conservation from: Standard of Practice for Backcountry Hut Toilets (draft)



Appendix 9 *Example of protocol for conducting public meetings*

Consensus Protocols for the Whaingaroa Wastewater Working Party

The following are the mediator/facilitator's understanding of the protocols under which the group is working:

1. The personal behaviour ground rules set at the first mediation:
    - one speaker at a time
    - no interruptions
    - separate caucus when need be
    - working towards a resolution
    - stick to the kaupapa
    - "I" statements
    - everyone's issues to be respected
    - cultural protocols to be observed/respected.
2. The Memorandum of Understanding which is now signed and describes the overall goal of the process must be referred back to.
3. That members of the public are welcome to sit in the meetings and to participate if invited by the facilitator but not to be part of the decision making on specific options. Mana whenua are not "members of the public" but a hapū group with their own kawa for decision making.
4. Decision making is worked towards by consensus ie. not by voting, but by a discussion based on developing common ground and developing a position we can all live with, without compromising any bottom lines.

5 The media is not excluded but any formal statements by the group can only happen with full group approval, as individuals and groups need to be aware that separate media statements can damage trust in the process.

6. From now on full minutes will be recorded by the Council secretarial service and circulated at least 7 days prior to the next meeting.
7. That all meeting agendas are set and agreed to by the whole group.
8. That all parties need to state clearly which hat they are wearing and whom they represent in this process.
9. That peer review processes all data be designed by the whole group.

INFORMATION SOURCES

Professional association

New Zealand Water & Wastes Association (NZWWA)
PO Box 1316
Duxton Chambers
Level 8, 170 Wakefield Street
Wellington

Ph (04) 802 5262
Fax (04) 802 5272
http://www.nzwwa.org

Small Wastewater and Natural Systems Special Interest Group (SWANS-SIG) NZWWA
http://www.nzwwa.org

Directory of services

The NZ Infrastructure, Water & Environment Directory
http://www.nzgreenpages.org

Publications

Crites R, Tchobanoglous G. ***Small and Decentralized Wastewater Management Systems***. McGraw Hill, Boston, 1998.

Gunn I. ***On-site Wastewater Disposal from Households and Institutions***. Technical publication No 58, ARC Environment, Auckland, 1994.

Parliamentary Commissioner for the Environment. ***Ageing Pipes and Murky Waters: Urban Water Systems for the 21st Century***. Parliamentary Commissioner for the Environment, Wellington, 2000.

Parliamentary Commissioner for the Environment. 2001. ***Beyond Ageing Pipe***s. Parliamentary Commissioner for the Environment, Wellington, 2001.

Standards NZ. ***On-site Domestic-wastewater Management***. Joint Australian / New Zealand Standard, AS/NZS 1547:2000. Standards Australia, Strathfield, NSW, and Standards NZ, Wellington, 2000.

Standards NZ. ***On-site Domestic-wastewater Treatment Units. Part 1: Septic Tanks***. Joint Australian / New Zealand Standard, AS/NZS 1546.1:1998. Standards Australia, Strathfield, NSW, and Standards NZ, Wellington, 1998.

Standards NZ. ***On-site Domestic-wastewater Treatment Units. Part 2: Waterless Composting Toilets***. Joint Australian / New Zealand Standard, AS/NZS 1546.2:2001. Standards Australia, Strathfield, NSW, and Standards NZ, Wellington, 1998.

Standards NZ. ***On-site Domestic-wastewater Treatment Units. Part 3: Aerated Wastewater Treatment Systems***. Joint Australian / New Zealand Standard, AS/NZS 1546.2:2001. Standards Australia, Strathfield, NSW, and Standards NZ, Wellington, 1998.

Standards NZ. ***Subdivision for People and Environment***. Handbook DZ HB 44. Standards NZ, Wellington, 2002.

USEPA. ***Onsite Wastewater Treatment Systems Manual***. EPA/625/R-00/008. Office of Water Research and Development, US Environmental Protection Agency, National Risk Management Laboratory, Cincinnati, Ohio, 2002.

WRC. ***Guidelines for On-site Sewage Systems in the Wellington Region***. Wellington Regional Council, Wellington, 2000.

Web sites

USEPA
http://www.epa.gov/owm/decent/index.htm

Byron Shire Council NSW Webpage
http://www.byron.nsw.gov.au/on_site_sewage.shtml

Institute for Sustainable Futures, Sydney
http://www.isf.uts.edu.au/

ECO Greywater Recycling Systems, Hawkes Bay
http://www.wastewater-recycling.co.nz

National Small Flows Clearinghouse
http://www.epa.gov/owm/mab/smcomm/nsfc.htm
http://www.nesc.wvu.edu/
http://www.nesc.wvu.edu/nsfc/NSFC_ETI.htm