



Ministry for the
Environment
Manatū Mō Te Taiao



Sustainable Wastewater Management

A handbook for smaller communities

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CONTENTS

Foreword	5	Section 5: Community planning and decision-making	51
He Mihi	5	5.1 Key features of a community decision-making process	51
Introduction	6	5.2 Getting started	56
<i>Why focus on smaller communities?</i>	6	5.3 Developing a decision tree	60
<i>What ideas have influenced the handbook's approach?</i>	7	5.4 Getting a mandate and keeping it	61
<i>The structure of the handbook</i>	9	5.5 Developing a process with iwi and hapū	61
PART 1: UNDERSTANDING WASTEWATER WITHIN NATURAL AND HUMAN SYSTEMS	10	5.6 Designing how you will explore options	64
Section 1: Natural systems	11	5.7 Information	68
1.1 Ecosystems	11	5.8 Facilitation, negotiation and conflict resolution	71
1.2 The water cycle, water catchments and the 'three waters'	11	5.9 Maintaining an audit trail	72
1.3 The nutrient cycle	13	5.10 Communication	73
1.4 Ecosystem services	14	PART 3: OPTIONS FOR WASTEWATER SERVICING	74
1.5 Māori concepts of natural systems	15	Wastewater servicing scenarios	74
1.6 Taking a systems approach	16	The different servicing systems	74
Section 2: Wastewater – What is it?	21	Section 6: Managing wastewater at source	77
2.1 The kinds of waste	21	6.1 The different types of wastewater	77
2.2 What is in wastewater?	22	6.2 Wastewater and home management	78
2.3 What is in wastewater that causes problems?	22	6.3 Source technologies	81
2.4 Other effects of wastewater	26	Section 7: Collection systems	83
2.5 Māori perspectives on waste and waste impacts	28	7.1 Conventional collection technologies	83
Section 3: Wastewater management systems: A general introduction	29	7.2 Alternative collection technologies	84
3.1 A systems approach to wastewater management	29	7.3 Pressure and vacuum collection technologies	85
3.2 Kinds of wastewater systems	33	7.4 Comparing collection technologies	86
3.3 The parts of a wastewater system: fitting into natural systems	34	Section 8: Treatment systems	87
3.4 National policy about wastewater treatment	35	8.1 Treatment: what does it do?	87
PART 2: NEGOTIATING THE MAZE	36	8.2 Types of treatment systems	88
Section 4: The players and the processes	37	8.3 Types of treatment technologies	91
4.1 Who are the players and what are they responsible for?	37	Section 9: Ecosystem re-entry or re-use	97
4.2 What kind of processes will your community have to deal with?	45	9.1 Re-entry of treated waste into the ecosystem	97
4.3 The kinds of issues each player will need to consider	48	9.2 Types of re-entry systems	98
		9.3 Solids re-entry technologies	98
		9.4 Wastewater effluent re-entry technologies	99
		9.5 Re-use of water and biosolids reclaimed from wastewater	102
		Section 10: System configuration, performance and failure issues	105
		10.1 On-site wastewater system configurations	106
		10.2 System performance	106
		10.3 On-site system failure	106

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PART 4: MANAGEMENT, FUNDING AND SELECTION OF WASTEWATER OPTIONS	108
<i>Section 11: Management and funding of wastewater systems</i>	108
11.1 <i>Management of wastewater systems</i>	109
11.2 <i>Funding</i>	115
<i>Section 12: Criteria for selecting a wastewater servicing option</i>	119
PART 5: GLOSSARIES, ABBREVIATIONS, APPENDICES AND INFORMATION SOURCES	124
Glossaries	125
<i>Māori Glossary</i>	132
Abbreviations	133
Appendices	135
<i>Appendix 1 Examples of ecosystem goods and services</i>	135
<i>Appendix 2 Legislation relevant to wastewater management</i>	136
<i>Appendix 3 Wastewater production, water consumption and water-conserving technologies</i>	137
<i>Appendix 4 Composting toilets</i>	140
<i>Appendix 5 New developments and innovations in wastewater servicing</i>	141
<i>Appendix 6 On-site systems – key features</i>	148
<i>Appendix 7 System Matrix</i>	151
<i>Appendix 8 Examples of decision trees for wastewater systems (a) Pit toilets</i>	153
<i>Appendix 9 Example of protocol for conducting public meetings</i>	155
Information Sources	200



FOREWORD AND HE MIHI

The New Zealand Waste Strategy, launched jointly with Local Government New Zealand last year, identified the need to complete and publish a Sewage Treatment Handbook for small communities.

Coastal settlements, small towns, and low-density rural settlements will all face wastewater management decisions at some time. The issues are complex and challenging, and finding solutions will involve thinking about how big the community will grow, what kind of community it will be, how clean the local stream or estuary will be, even the layout and form of the settlement.

Sustainable Wastewater Management: A handbook for smaller communities, provides a framework to assist small communities identify and evaluate alternatives for improving sewage treatment and disposal. The aim of the handbook is to help communities understand and navigate the issues, plans, legislation, and technical advice provided by consultants.

The government's Sanitary Works Subsidy Scheme will assist small communities to upgrade substandard wastewater treatment facilities and provide a healthier environment. This handbook has been designed to help everyone get involved in the process.



Hon Marian L Hobbs
Minister for the Environment

Ka hoki ki te tīmatanga, ko te pū, ko te weu, ko te more, ko te aka. E takoto mai ngā atua nei ko Ranginui ko Papatūānuku, kei waenganui tonu ā rāua tamariki e noho ana, e whakaora tonu ana. Tēnei te hono hei tūhono i a tātou, kia tūhono, kia tūtaki, kia whiti te noho tahi e, Tihei mauri ora!

Ō tātou mate tuatini, i takoto mai ai i roto i te kōpū o te whenua, e tika ana hei poroporoaki i a rātou. Āpiti hono, tātai hono, te hunga mate ki te whenua; āpiti hono, tātai hono ko te whenua ki te hunga ora.

E ngā iwi, e ngā mana, ka huri ngā mihi ki a koutou. Ahakoa te kaupapa taiao, te kaha ki te kōrero tahi me te mahi tahi, kāore he hua i tua atu. Te tiaki i ngā āhuetanga katoa o te tangata me te taiao kia āhei ai te tokorua te puāwai tahi mo ake tonu atu.

Tēnā koutou, tēnā koutou, tēnā tātou katoa.

We return to the beginning, where life itself began, and, like the development cycle of a plant, earth transformed itself into various stages of evolution. Papatūānuku and Ranginui lay together with their children, and today continue to dwell and sustain all people. This relationship joins people and the land, it binds us and it joins us so that our co-existence will flourish. Long live this life force!

Our many deceased who lie in the belly of the land, it is right that they be appropriately eulogised. Let the deceased then be united with the earth below. So, too, let us, the living, be united with the land above.

All peoples, all authorities, our acknowledgement goes out to you. There are many environmental issues to be balanced, there is therefore no greater asset and benefit to the environment than being able to talk and work together. Through looking after the needs of the environment and people, the two will continue to flourish and sustain each other.

Greetings to you, greetings to us all.



INTRODUCTION

Introduction

This handbook was developed for smaller New Zealand communities that face choices about the kind of wastewater system they will use, and how it will be managed. Coastal settlements, small towns, scattered low-density rural settlements – all will face wastewater management decisions at some time. The issues are complex and challenging, but finding solutions can be exciting and immensely satisfying.

Exciting? Satisfying? This may seem hard to imagine given the topic. But in the end, wastewater management is about issues such as how big your community will grow, what kind of community it will be, how clean your local stream or estuary will be, even the layout and form of your settlement.

Finding answers to these questions means understanding wastewater and its effects; understanding your local environment and the best way of choosing a solution, the technical systems, the effects they can manage, and their costs. It also means understanding the relationship between the technical solution and the shape and form of your community.

An awful lot has been written about wastewater over the years. So why write more about it, why write it now, and why as a handbook for smaller communities?

Why focus on smaller communities?

For a start, smaller New Zealand communities face unique pressures and choices. The most obvious is: do you stay with on-site systems like septic tanks, or move to a community-based system? Is the problem really the technical system, or the way it is managed? People in smaller communities are required to think about and confront wastewater management issues in a way that people in larger communities are not. If your septic tank overflows it is right there, impossible to ignore. The local treatment plant is not hidden away – it is just down the road. If the local estuary becomes polluted, everyone notices it. As awareness about environmental effects has grown, the need to deal with seemingly small-scale wastewater problems of smaller communities has become more pressing.

Smaller New Zealand communities also face growth pressures that large communities do not feel in the same way. Beach settlements or tourist areas must deal with the wastewater problems of seasonal changes in growth. Rural marae can experience huge short-term increases in population. Some smaller communities near larger towns can experience growth that slowly changes their character and seems to turn them into suburbs. Should that growth happen? What happens if that wastewater plant is made bigger – does that increase the growth pressures? In recent years the impacts of growth (and in some cases population decline) have become more pronounced as smaller communities forge their own future in the context of wider economic changes.

For a smaller community, facing up to wastewater management issues can cause tensions and splits. The tasks are not easy and can put a great deal of stress on community vitality and feeling. The quality and nature of the decision-making processes can have a huge effect on people's long-term sense of wellbeing. Getting access to information can be hard for a small, isolated community. More and more, the need for everyone to have access to information is recognised as vital to good wastewater investment decisions.

Finally, there is now an increasing focus on the quality of drinking-water for smaller communities, and associated public health problems. Wastewater can have a huge effect on the quality of the groundwater and streams from which communities may take their drinking-water supplies. It is likely that there will be greater national pressure for smaller communities to improve their water supplies. This will mean greater attention paid to wastewater management, and smaller communities with a limited ability to pay will face increasing financial pressures.

Fortunately, central government has re-introduced a *subsidy* (see *Section 11*) for the construction of wastewater schemes, which will be available to small communities. This subsidy will focus attention on the key issue of whether a community should move to community-based collection and treatment systems. Communities will need information that will help them to balance the choice of the best overall solution with the availability of this subsidy. Making this solution happen involves consideration of public health, environmental, social, cultural and economic factors to determine the appropriate level of wastewater services.

What ideas have influenced the handbook's approach?

This handbook offers a new approach to thinking about wastewater that reflects many of the changes over the last 10 or so years. In the past, wastewater management was very much focused on specific public health effects, but there is now increased consideration of a wider range of effects on people and the environment. The handbook therefore reflects a *sustainable development* framework. Sustainable development is all about linking environmental, social and economic concerns, and developing human communities in a way that melds these together.

This shift in focus from individual effects to interconnected systems means that 'systems thinking' has helped to shape the handbook. This includes looking at natural systems and processes, and how wastewater fits in with and affects those systems. It includes looking at how human communities and systems fit into this natural framework, and the effects wastewater management has on people and their activities.

This system thinking is relatively new to wastewater management (and much public decision-making). The fact that small communities are so much 'closer' to their surrounding natural environment means that it is likely to be relatively easy to introduce this concept into decisions about wastewater.

Ecosystem services are also an important concept in this document. The idea that the natural system provides 'services' to humans (eg, cleansing of water) that need to be protected is a major impetus for the increasing standards that are being applied to the discharge of wastes into the environment. All communities – but particularly smaller communities, which depend on the local environment more directly for their livelihood – must now think about this relationship. The loss of clean water can mean the loss of a marine farming industry, say, a loss of recreational waters, or the decline of tourism.

Linked to this is a greater scientific understanding of the whole nature of wastewater and its effect on these ecosystem services. It is not just a matter of managing the discharge of human wastes. Heavy metals and the impact of other organic material and chemicals must also be managed. This handbook tries to explain how different technical solutions will deal with particular adverse effects, and what this might mean when choosing technical options.



The 2002 *New Zealand Waste Strategy*, central government's plan for solid and liquid waste management (including wastewater), brings together much of this thinking and sets targets at the national level. This includes bringing all wastewater treatment systems up to standard by 2020. This might seem a long way off, but there are many examples of schemes taking 20 years to come to fruition, so you need to start planning now. Cutting down the amount of waste generated and discarded by the country is the long-term challenge that the Strategy is designed to meet, in an attempt to separate – or decouple – environmental pressures from economic growth.

Other targets in the Strategy deal with *tradewastes*, as well as sludges and the treatment and disposal of organic wastes. Obviously these targets have implications for smaller communities. This changing official context is another reason for the 'here and now' of the handbook.

But the emphasis is not just on physical systems and risks to ecosystem services, or hard economic effects. Perhaps one of the most profound changes in the last decade or so has been the greater legal and community recognition of the significance of the Treaty of Waitangi. This has forced communities to recognise and give a place to the cultural values of Māori, including the belief in a spiritual dimension to the world. This has a direct and immediate impact on wastewater management thinking. For New Zealanders this means a greater exploration and scrutiny of land-based wastewater treatment and re-entry systems (where the wastewater ends up), and a greater willingness to take a creative and innovative approach.

Any community will have to take account of these Treaty of Waitangi-based issues, emerging case law around principles of the Treaty, and associated wastewater management issues. Helping people come to grips with this new responsibility in relation to wastewater is a major focus for this handbook. But the focus is also on the personal side of this developing area. Many small communities have a strong Māori, iwi and hapū presence. Protecting and building this wider relationship with the various groups must also be a concern as wastewater issues are confronted.

The increased recognition of Māori perspectives on the environment has also made it easier for the wider community to speak about and include other cultural perspectives on water and the environment. Increasingly, wastewater management must fit and accommodate people's desire to live within natural systems and to protect the beauty and wonder of the natural world. This means the design of systems must take account of impacts on the landscape, for example, and not just the need to solve public health issues.

There has also been a shift in thinking around formal decision-making processes used by local authorities. The Local Government Act (2002) 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.

This is important, because most communities will need to work with their local council on wastewater issues. There is increasing pressure on local authorities to work directly with communities and to encourage grass-roots involvement. This handbook reflects this by exploring possible community planning processes and looking at some case histories. It is important that people have the tools to help them negotiate and run community-based processes, since wastewater is one of the most important development issues a community will face.

All these changes have led to a greater range and choice of wastewater management systems, and this handbook aims to show the range now available.

This is not just an issue for smaller communities, though. In the end, the handbook can be used by any community – for 'greenfields' sites on the edge of towns, say, or for 'eco-villages', or perhaps even for older urban areas. We hope that it will be used as widely as possible. But in the end, the focus is on smaller communities, and on helping those communities drive their own wastewater decision-making.

The structure of the handbook

The handbook does have a story to tell, starting at section 1 and working through to the end. But you can also dip in at various points, and we hope you will find it a useful ongoing resource. To facilitate this it has been structured into four parts, each divided into a number of sections.

Part One provides an overview of wastewater and its relationship with human and natural systems. *Section 1* discusses these natural and human systems, and introduces the idea of ecosystems services, while *Section 2* looks at the nature of wastewater and its effects on the environment. *Section 3* introduces the reader to wastewater management systems, a topic that is returned to in much more detail in *Part Three*.

Part Two elaborates on the human system that must be negotiated when deciding on a wastewater management system. *Section 4* looks at the formal regulatory processes and the important players you will encounter on the way, while *Section 5* sets out some ideas for running and managing a community-driven process.

Part Three is where the nuts and bolts of wastewater management systems and technologies are discussed. There is a lot of technical detail here, so to try and make the material more accessible, it has been divided according to which part of the wastewater management process you are concerned with. Thus *Section 6* looks at managing wastewater at its source, since how well you do this will influence the technical solutions (and costs) you need to consider. *Section 7* then addresses collection and treatment systems and technologies, while *Section 8* looks at options for dealing with the treated wastewater and other products (residuals). *Sections 9 and 10* look at options for how all of these aspects (source management, treatment, collection and re-entry) can be configured together, and at system performance and failure.

Part Four examines the prevention of system failure, and introduces the idea of management and responsibility of wastewater systems. This is covered in *Section 11*, along with various funding options. Along the way an important message of the handbook is reiterated and explored: how the technical systems are managed ultimately decides the success of any technical solution. Finally, *Section 12* provides several brief guides and checklists for making wastewater management decisions.

It may seem as you work your way through the handbook that discussion of technical solutions comes late in the piece. This reflects another major message of the handbook: that a community can no longer develop technical wastewater solutions independently of natural systems or wider community concerns. The legislative framework makes it harder and harder to take the old path of simply finding engineering solutions at the least cost. Nor will communities accept this kind of approach any more. More and more, wastewater experts are advising that community-driven solutions are essential.

Finally, the handbook comes with a CD-Rom, which provides more detailed technical information, references and links to further information. It is hoped that these layers of information will help your community negotiate its way through the process.

So, have fun and good luck for your wastewater and community future.

1 PART

UNDERSTANDING WASTEWATER WITHIN NATURAL AND HUMAN SYSTEMS

Communities have different reasons for looking at wastewater management. Sometimes people are worried about pollution in the local estuary or river, or loss of kaimoana, or possible public health problems. Or there may be population and development pressures that mean the current system simply won't cope with further growth.

Whatever the initial reason, your community will need to explore a number of general ideas before getting down to the detail of choosing a particular technology. It will have to take account of new thinking about wastewater systems, about new (and old) technologies that might avoid problems you are facing now, and about new (and older) ways of thinking about natural systems. You will have to think about a much wider range of effects than has been considered over the last hundred years.

This part begins by talking about the natural systems your wastewater system will have to operate within. This includes looking at the idea of the 'water web', the 'three waters', how natural ecosystems work, and the 'services' and assistance they provide to ensure the survival and health of your community. The impacts of wastewater on these 'ecosystem services' will be looked at, as well as the more traditional concern of public health. After this discussion of natural and human systems, and the place of waste and wastewater management within them, we will take a brief introductory look at the general technical range of wastewater systems, which are covered in detail in Part Three.

At first glance this might seem like the wrong order. Surely it would be better to look first at the kind of technical wastewater systems available and their costs and benefits in terms of managing health risks? How they can be managed to reduce impacts on the environment could be considered later.

These issues of health and cost are extremely important. Preventing health problems is the main reason communities have provided a wastewater system in the past. However, this handbook offers a different way in to thinking about choosing a wastewater management system. Any system must, of course, protect public health, but there is increasing recognition that a wastewater system must be designed as part of the surrounding natural systems. It is now not a matter of 'throwing away' waste – even treated waste – into an environment which is somehow separate from your community. The issue is more one of designing a wastewater system that works within the natural systems that support the clean water, swimming areas, estuaries and rivers, and soils that everyone in your community uses and enjoys.

Ultimately this kind of approach will also reduce health risks from damaged soils, water supplies and ecosystems. Focusing on natural and human systems and understanding the biophysical characteristics of your area will help your community to choose systems that best deal with more immediate public health problems. For example, knowing your local soils and water table and their capacity to absorb and naturally purify wastewater will help you choose between wastewater systems.

Rather than overloading the natural processes that purify water and maintain soils, your wastewater system should be designed to *work with* rather than *against* these processes. Increasingly, both people's concerns and legislation require that a community think about the survival of natural processes as well as obvious environmental effects (see Appendix 2 for legislation relating to wastewater management). Understanding these processes *before* launching into the business of technical systems is fundamental to your community process for choosing a wastewater management system.

1.1 Ecosystems

An ecosystem is a community of interacting organisms and the physical environment in which they live. Humans and their buildings and settlements are part of this community, which can include birds, plants and insects, as well as inorganic matter (such as rock and metals) and natural forces (such as the flow of water, fire, or the chemistry of photosynthesis¹). All of these link together and interact as a complex web of life.

Western culture has a tradition of thinking of people as separate from natural systems and not part of their environment, although the natural world can still be highly valued. This separation is so easy on a day-to-day basis because of the ability people have to change and – to a limited extent – control their physical environment. It is also partly because our ordinary day-to-day systems and technologies tend to make it easy to feel separate from the natural processes. You can turn on a tap and get fresh water without having to think about the impact of taking the water from a nearby river or from underground. You can flush the toilet without having to think about where it goes.

This is changing as many people are finding that taking water or the impacts of wastewater are disrupting natural processes that sustain them in other ways. It is becoming more obvious that humans are *embedded* in their surrounding ecosystem, and that the built and engineered parts of our communities need to fit the processes of the wider natural ecosystem if the whole system is to survive in the long term.

Ecosystems overlap, and also exist at various levels – from a whole estuary to a small community in a single rock pool. But even if it is hard to see where one begins and ends, you can see quite clearly the functions of different systems. What makes each one a system are the links and dependencies of one part on another. These dependencies become obvious when one part begins to fail and stresses appear in other parts of the system.

It is worth thinking about the kind of ecosystem that exists in your area. Some broad types are coastal, estuary, river, lake, forest, agricultural and urban, and various combinations of these.

¹ Photosynthesis occurs in all green plants. It is the process by which sunlight is used to turn carbon dioxide and water into sugar and oxygen.

1.2 The water cycle, water catchments and the 'three waters'

Water plays an essential role in the natural nutrient cycle or 'waste conversion system'. It helps move wastes down into the soils and assists with the absorption of nutrients by plants. The natural water cycle is shown in Figure 1.1.

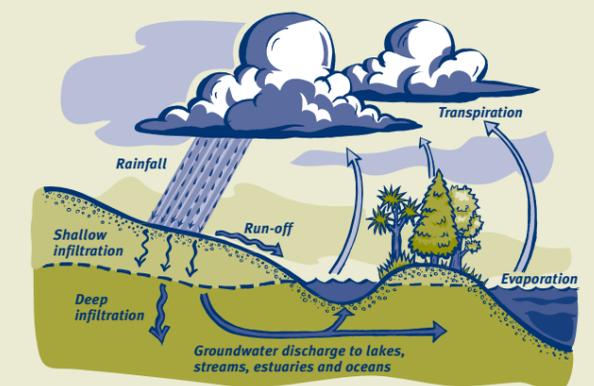


Figure 1.1 The water cycle

Catchments

The water cycle shown above takes place everywhere. Where the water flows to, how fast, whether it goes underground and how quickly will depend on the physical shape or 'topography' of the land, the land cover and the soils it falls into. This channelling system is called a catchment – a system of surrounding hills and valleys which channels the water down along streams and through the soils and rock, sometimes into lakes but finally into the sea at a common point. Different catchments can feed into one lake. It is important to understand this process because the lake or sea that might receive some of your community's wastewater may also be receiving wastes from *other* places.

So when you are thinking about the effect of your community's wastewater treatment system, you will need to think about what is flowing down through the catchment from farms, businesses, the bush and other towns. The run-off may all be flowing into a river, lake or estuary and the total effect may be more than the overall natural system can handle. At the very least, it could have an impact on public health that you may not have taken into account when thinking about the effect of just your own community's wastes.

The 'three waters' – water supply, stormwater and wastewater

Humans use water for drinking, washing, industrial processes, irrigation and transporting wastes; for recreation, swimming, fishing and spiritual purposes. As a result of some of these activities, wastewater is created. In addition, human settlement contributes to stormwater run-off.

Stormwater is the rainwater that has hit surfaces and runs off rather than seeping down into the soils. There is usually more run-off from impervious surfaces such as roofs of houses, roads and footpaths than from more permeable surfaces such as farmland, sportsfields and lawns. If it is not managed, this stormwater will cause flooding. Generally it is channelled on to roads or into open water courses, then down into a piped system and discharged into the streams, rivers, lakes and the sea. Sometimes – but less often – stormwater is combined with sewage in a drainage system.

There are two reasons why it is important to keep stormwater in mind when thinking about wastewater management:

- untreated stormwater contains pollutants that will affect the same catchment and 'receiving waters' that receive the treated wastewater
- stormwater can infiltrate your wastewater treatment system – cracks in pipes or the septic tank can allow stormwater to enter, or some people may have roof downpipes discharging into the wastewater pipes. This can put an extra load on your treatment system and cost extra money.

Wastewater includes natural liquid wastes created by humans (such as urine and bathwater), and water that has been combined with other wastes (such as faeces and the end-product of some industrial processes) to allow their easy transportation. More on this later.

The important point here is that the 'three waters' – water, stormwater and wastewater – must be taken into account when thinking about human wastewater management. They are created either when humans divert water from the natural water cycle for their needs, or because of human settlement. The human water cycle and the three waters and their inter-relationships are shown in *Figure 1.2*.

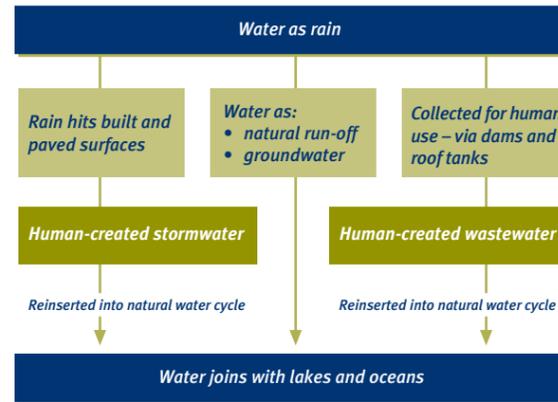


Figure 1.2 The three waters

1.3 The nutrient cycle

The various parts of an ecosystem are intricately interwoven by food chains and the 'nutrient cycle'.

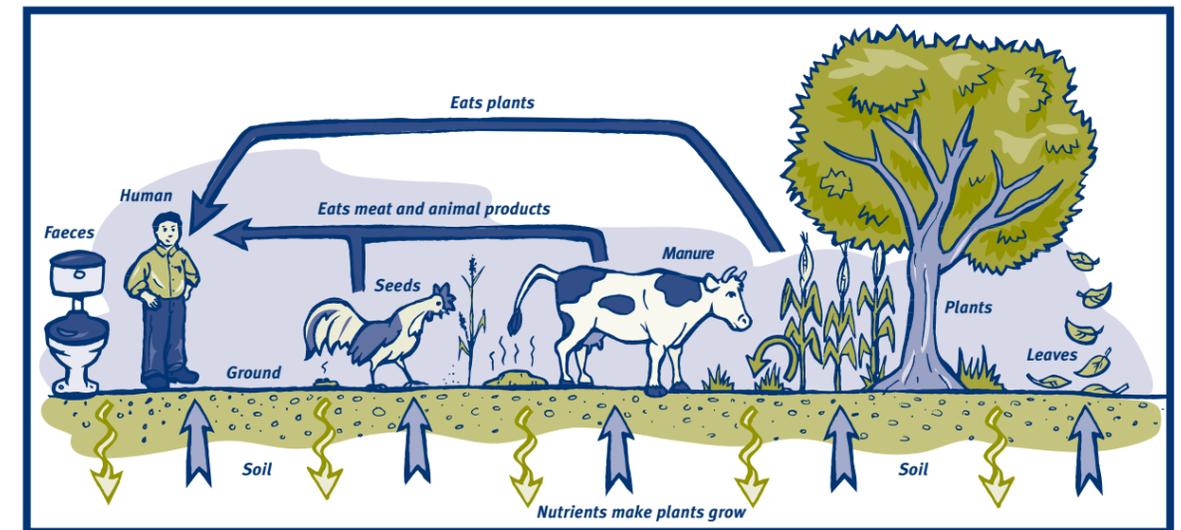


Figure 1.3 A simplified nutrient cycle

Different nutrients (eg, phosphorus and nitrogen) are subject to different mechanisms, but they all follow the same basic pathways of *Figure 1.3*. 'Waste materials' from one organism are either used directly by another, or are converted (by natural processes) to something that is usable by something else. For example, when an animal dies its body decomposes (via bacteria) and becomes part of the soil. The soil holds minerals and nutrients from a variety of sources, which are taken up by plants, the plants are eaten by animals or harvested and eaten by humans, and then returned to the soil as wastes, which are then absorbed back into the soil as nutrients.

The breakdown of organic waste is the most important step in the nutrient cycle. It involves many types of microscopic plants and animals, mainly bacteria, fungi and protozoa. One organism may break down an organic compound making some residual by-products available as food for other organisms. Or it may itself provide a meal for another micro-organism. These in turn will go through the same process, with the continuing breakdown cycle eventually yielding nutrients and minerals in the soil in a form that is available for use by higher plants and animals.

The nutrient cycle does not only take place on land. Rain and surface-water run-off will carry un-decomposed organic matter, nutrients, minerals and gases dissolved from the air into streams, rivers, lakes and the sea. Here, a similar breakdown process takes place. This water cycle is sometimes made more complicated in that fish and other aquatic life have to compete with the micro-organisms for the oxygen dissolved in the water. If the micro-organisms' food supply is too high, they proliferate and use up most of the dissolved oxygen, leaving insufficient for the rest of the aquatic life.

This oxygen-deficient environment then enables a new group of micro-organisms, called 'anaerobes', to flourish. They also break down organic matter, but instead of producing carbon dioxide as a by-product they generate methane, hydrogen sulphide and other smelly sulphurous gases often associated with septic systems.

The nutrient cycle can be viewed as the natural waste management system, although in reality there is no such thing as 'waste', since one organism's waste is another's resource. Nutrients and substances such as metals move around the cycle, sometimes accumulating at different places in the food chain. This 'bio-accumulation' can be an issue for human health.



1.4 Ecosystem services

This nutrient cycle, which is common to any ecosystem, can be seen as a free service to all ecosystem members, from micro-organisms, soils, plants and birds, through to animals, including humans. It provides food, and deals with materials that might be harmful unless absorbed back into soils or water. This idea of an 'ecosystem service' was first used by economists, who recognised that nature was providing humanity with a wide range of services that were not being valued.

These services, which are essential to human survival, include:

- keeping water clean and uncontaminated
- keeping the air clean
- pollinating plants, which then provide food
- recycling nutrients – in effect a waste management system
- providing a gene bank for crops.

Some examples of the services provided by a number of ecosystems are provided in *Appendix 1*. Often these services are ignored when people make decisions about wastewater management systems. Considering them doesn't mean that a community now has to look at completely different wastewater treatment systems than in the past. It *does* mean that you will need to:

- understand your local ecosystem services and how they work in your area
- recognise that these ecosystem services are at least as important as the services provided by the economy (a wastewater system needs to provide not just for the needs of local industry, the local school or residents, but also for the needs of the overall ecosystem which includes these things)
- design a system that avoids overloading natural processes (eg, reducing the volume of wastewater entering the system, reducing the toxicity of the waste entering the system, or avoiding discharge at one single point)
- choose a system that 'mimics' natural processes as much as possible.

It really means understanding your wastewater system as a subset of natural systems – not as an alternative. This theme will be looked at again later.

Questions your community needs to think about when looking at the natural water cycle and the 'three waters'

1. What is the effect of taking water from the natural processes (eg, the amount of water flowing in the local river)?
2. What are the connections between the three waters? How do the water supply and the plumbing fixtures affect the wastewater quality and quantity?²
3. How can you manage your wastewater to minimise this kind of impact?
4. Do you really need to generate the amount of wastewater or stormwater you do?
5. How is the re-entry of the stormwater and wastewater being managed now? (Eg, is it completely bypassing the natural process of water percolating into soils and going straight to streams or rivers? Is there an alternative?)
6. What nutrients are being transferred as part of the water streams? Where do they come from and where are they returned to? What happens to the nutrient cycle?
7. How well can our community design its wastewater system to mimic these natural processes?

These are not idle questions. Remember the idea of ecosystem services? Understanding the water cycle will be a key to maintaining them. In particular, how wastewater re-enters the natural water cycle and what wastewater has in it will have a profound effect on the nutrient cycle and its life-supporting capacity.

² For example: The use of copper pipe and brass fittings can cause heavy metals to leach into the water supply. They then reappear in the sludge at the sewage treatment plant and may end up in any compost made from the sludge.

1.5 Māori concepts of natural systems

So far this account of natural systems or ecosystems has emphasised the physical. However, for many people there is something more than this. Many cultures hold a spiritual belief in the environment. The nature of this spiritual dimension will vary across and between cultures. Groups may also have beliefs about the 'right way' to behave in relation to the environment, whether or not there is an obvious physical outcome from their actions. In other words, a person's relationship with the environment results in a series of principles about the best way to behave. Environmental effects are important but are not always the main driver for behaviour. Views on how these principles will be given effect will vary from culture to culture and between individuals.

The issues of waste management can bring these more complex feelings to the surface. Often, there is uneasiness about the idea of drinking water that contains even treated reclaimed water from an upstream community, whether or not it can be proved that there is no physical human or ecosystem impact. The reason for this uneasiness can be difficult for people to explain. The idea of stewardship and care is often overlooked in formal processes in favour of a focus on effects. Communities often attempt to group these ideas into categories such as effects on landscape, heritage values, character and amenity. Sometimes these categories will align with and indicate these beliefs – sometimes they will not.

This focus on effects, especially physical effects, can deny a view that there are principles of behaviour that should be considered in wastewater management. This is an important issue in New Zealand. Many Māori have a very clear view of the world, which goes well beyond a purely physical focus. It is one that leads to an equally clear position about what makes a good wastewater system.

This perspective is often described as being a holistic approach to the environment, deriving from a view of the world that links people and all living and non-living things. Although the degree to which individual Māori, iwi or hapū adhere to these ideas and views will vary, it is clear that a traditional relationship with the environment remains an important part of the lives of many Māori today. Accordingly, decisions about the right way to act may often be based on principles linked to the relationship between humans and the environment, rather than effects. Recognising this is a key step to understanding the different priorities Māori may have in terms of wastewater management, and the different issues it may create.

Such a view of the world also appeals to many non-Māori. This section describes some of the concepts that have been identified as fundamental to Māori in relation to wastewater management. Although these ideas may be well known to many Māori readers, it is important that the concepts that often become a part of wastewater decision-making at a local level are also well understood by the wider community.

The concept of mauri

The traditional Māori world view involves a belief in a spiritual dimension that permeates the physical world, binding all things together. Each life form is imbued with its own force or essence, through which it makes its contribution to the cosmos, and to everything around it. This essence is known as *mauri*.

Given the interconnectedness of all things in the Māori theory of the origin of the universe, any actions that change or degrade the mauri of one thing will have a corresponding impact on the form or integrity of another. In the traditional context, for instance, it was never simply enough to demonstrate respect for the physical environment; a corresponding obligation to protect and safeguard the mauri at the heart of it was also created.

Indeed, it is the kaitiakitanga and protection of the mauri of each part of the natural environment – and of people – that is still the focus of environmental management for many Māori today.

Kaitiakitanga

In the traditional world view that has been maintained through to the present day, care for the environment is not seen as being limited to stewardship, but is inseparable from care for oneself and for others. The exercise of this responsibility is known as kaitiakitanga, and it requires the active protection and responsibility for natural and physical resources by tangata whenua – the people of the area.

Persons charged with this responsibility are known as kaitiaki.

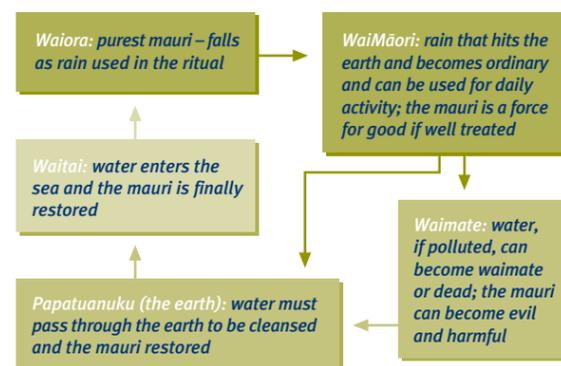




The water cycle

A highly simplified interpretation of the traditional Māori view of the water cycle reflects this idea of parallel and linked physical and spiritual worlds. Water passes in its purest spiritual form (*waiora*) as rain down to the earth. Here the *mauri* is at its most pure. Reaching the earth it will be affected by a range of natural events and actions. Failure to protect water quality harms not only its physical nature, but also its very essence, or *mauri*, which can only be restored as the water passes through the earth and into the sea (and then back to rain). In a purely physical sense this reflects the idea that water can be cleansed of many pollutants by passing through vegetation and the earth before entering the sea. If the spiritual dimension is to be restored, water must pass through the earth, or *Papatuanuku*.

A very simple form of the water cycle is depicted by the following diagram:



The mixing of waters

It is notable that in the traditional Māori world, harm to one part of the environment could not simply be offset by protecting and improving another. The *mauri* of each aspect of the natural environment is particular to that aspect – to a specific stream, river, bush, tree, mountain or person. If the *mauri* of one place was mixed with that of another it could cause harm.

This is especially relevant in terms of streams, rivers, lakes and harbours. If waters from a river in one catchment are transported into another catchment, these spiritual forces will be mixed. Something that often happens with wastewater systems, where water might be collected in one catchment and piped to another for use by a community, with the wastewater system emptying into yet a third catchment, is likely to be significant for Māori and others taking a traditional approach to ecosystem or environmental management.

The human place in the natural world

The traditional Judeo-Christian view, which has fashioned much of the heritage of non-Māori New Zealanders, sees humans as apart from nature but having a duty to God to care for its well-being. The traditional Māori view, however, is premised upon a *knowledge*, which defines the origins of the universe and the place of humans and other life within it. All life forms – animate and inanimate – have divine origins, with each having a genealogy or *whakapapa* back to the gods as the source of their life and being.

These traditional views should not be seen by non-Māori as threatening. In fact, there are many similarities between these beliefs and modern environmentalism, in which people, all living things and the inanimate world are interlinked in mutually beneficial ecosystems. Some environmentalists see the earth as a single living organism, or *Gaia*, and view their relationship to this natural system in a spiritual way.

1.6 Taking a systems approach

Taking a systems approach means thinking about the relationship between wastewater management and the social and economic systems or structures that encompass your community. This has three parts:

- the physical and natural resources and the environment within which a community lives
- the kind of local economy and social community that currently exists
- the pressures for change that may alter these arrangements.

All are important. Your wastewater system needs to fit current circumstances. For example, your community may be primarily a beach settlement with some permanent residents and some visitors in the summer and weekends. It may also have one or two families that make a living from fishing, running the local garage and shop, or perhaps some other small business. It is important to design your wastewater system so that it has the capacity to cover all these needs, and to see provision for business wastes – no matter how small – as part of the package, not as an afterthought.

Your community may also experience long-term change. Coastal communities, especially those close to a major centre (eg, Waikanae on the Kapiti coast) may be growing rapidly. A small rural community in the south may be experiencing population decline. Your community may be dependent on one major business, such as a dairy company, meat works or food-processing factory. That business may grow, it may decline, or it may simply move if it can see that it is cheaper to operate somewhere else.

How your community designs its wastewater system around these changes will be important. This section briefly discusses some of these issues.

Coping with a growing community

The physical pattern of settlement of houses and buildings that exist to support your community will have been created by four main factors:

- the original historical reasons for the settlement
- past population growth pressures
- consequent decisions that were made about wastewater systems
- how the local council regulates and controls growth
- economic drivers.

Your community may have been established as a service town. It may have grown up as a small coastal port or landing area, as a beach resort, or as an employment base for a local industry. To some extent, the size of the sections will have been set by the ability to manage wastes on-site.

The kind of wastewater management system you have inherited will depend in part on how fast your town grew, or was expected to grow. If the population pressures were large, even in the early years, then the sites would probably have been relatively small, pushing the community into alternatives to on-site privies and septic tanks. Sometimes a wastewater system will have been built in the expectation of growth or as a way of attracting growth – by providing businesses and developers with certainty about waste disposal.

Since the introduction of the Town and Country Planning Act in 1953 (now replaced by the 1991 Resource Management Act), a local authority has had the ability to manage growth. Local communities can control the amount of land that is released for development and the effects of activities on the environment via rules in their district plan. This means the community has a significant say in the direction the settlement takes and the kind of investment it wants in wastewater systems.

But the process of settlement change is more complex than the development of simple growth-control rules. In reality, a council will manage growth with two tools.

- *Deciding the level of community investment in infrastructure, including wastewater systems:* this, along with the natural ecosystem, will set the capacity for growth and change. For example, if you have on-site systems, it will be difficult to subdivide. Your community may increase but it will be dependent on the release of new land. If that land can't be released, then your community will remain relatively small. In some cases the decision to fund infrastructure is a direct decision to manage growth pressures.
- *Setting rules for the extent of settlement:* these rules will be influenced partly from a community's vision of what it wants, partly by whether there are adequate services to deal with the effects of development. Even if land is released, if the wastewater system is inadequate then development will not be possible. Or it will be made much harder.

Sometimes a community will be examining its wastewater system because of growth pressures. There may be community agreement that population or business growth would be good for the local economy. A barrier to that may be that the wastewater system cannot cope with the growth, or there may be pressures from individual developers to allow more settlement and the general community is opposed to that. They are opposed not just because it would require investment in a new wastewater system (and other services), but also because it would fundamentally change what the community is. There will be many and varied views of how development should or should not occur.

Oneroa Village, Waiheke Island, Auckland City

Waiheke Island has traditionally been serviced by conventional septic tank and soakage field systems. Clay soils and difficult topography limit the use of this approach, however, and over recent years a variety of alternative systems have been utilised, such as pre-treatment via aerobic treatment plants or sand-filter units, and disposal via evapo-transpiration beds or drip irrigation systems. These can be satisfactory for lower-density residential development, but for the commercial centre of Oneroa Village, with its high water-use activities, on-site systems have become unsatisfactory.

During the late 1990s council consultants undertook a detailed options study, which included community input. One objective set by the community was to examine a part on-site, part off-site scheme whereby the site capacity to handle effluent soakage was determined for each lot, and any excess wastewater unable to be accommodated was then to be diverted off-site to a limited-capacity community reticulation scheme.

The practical implications of splitting wastewater effluent flows for individual property on-site soakage and off-site diversion proved unmanageable, and led to the finding that a full off-site reticulation and cluster treatment scheme was the most appropriate option. A council-conducted consultation process involving the public and iwi then proceeded to develop a centralised scheme for the village commercial area and several surrounding residential streets. Nevertheless, many residents were not satisfied that the consultation process was adequate.

The final scheme was commissioned in 2002. The council consultation identified the most appropriate effluent discharge method to be via a constructed horizontal-flow wetland into an existing natural wetland. A recirculating sand-filter system was selected as the most appropriate secondary treatment system prior to tertiary treatment in the constructed wetland. The sand-filter system has a stable treatment process, low maintenance requirements, and the ability to accommodate large load fluctuations. The whole treatment plant site has had a native tree and shrub planting programme to provide visual screening, and to offset the loss of native plants due to upgrading the site access.

Often local authorities have used decisions about whether they will extend access to a network to small rural communities, or pay for a local treatment system, as a way to control growth pressures. Lack of access to more treatment capacity becomes the rationale for limiting growth.

Development can encourage growth

Sometimes communities press for a community system because they feel it is the only way to solve public health or environmental issues. This may increase the capacity for growth. For example, even if new land is not released, the limits set by septic tanks on existing sites no longer apply. Subdivision can now take place. Many people may not be aware that changes to the ways the community deals with sewerage open up opportunities to increase growth.

This is a key issue for coastal communities. For example, do you want to stay a low-key bach community, or do you want to grow? There will be tensions, and often they will be played out around what seems to be a simple question of providing a better wastewater system. Improving the water supply and disposal facilities may increase the desire of others to live there, encouraging growth. This is a complex issue. Decisions about wastewater systems can become decisions about your overall community vision.

Developing a better wastewater system does not have to lead to this kind of problem if there is clear community debate about what kind of community people want – and careful selection of a system that fits that vision. It is very important that each player in the process thinks about and is prepared to debate how their views on issues and risk will affect the community's vision about the size and nature of their community.

Coping with a declining community

Some parts of New Zealand are dealing with population decline. Much thinking about wastewater systems is focused on the relationship with population growth and the impacts of increased volumes of wastewater on the environment. Not much has been said to help a community deal with population loss and what it means.

A community experiencing population loss will be placing less pressure on the environment, but it may face problems because the wastewater management system no longer fits the social and economic realities. Your community may find that the system developed in the past is no longer needed, yet it still has to be paid for.

For your community the real question is: Should you disinvest ('get out of') your current system and develop something more in keeping with your needs? This is a question that is not often asked or contemplated. It seems that once a community has gone down one path it cannot turn back and try something different. But it is possible.

You may decide that it is better to abandon the old system and reinvest the money you spent on maintenance on a new, lower-key technology. You may even decide a return to on-site systems is possible. This is radical stuff, but just because you have one system now doesn't mean you can't change. It is not an issue of going from the primitive (on-site systems) to the modern (centralised). It is an issue of finding the system that best fits *your* community.

If you were to do something as radical as abandoning your existing system, you would need to be very sure that the population would not stabilise or even increase in the future. At the very least, you would need to be reasonably sure that this would not happen during the life of your wastewater management system. For example, most pipes have a life of 80 to 100 years and treatment plants will probably have a similar life if well maintained. ('Life' in this context means how long they will last before they wear out). You would need to be sure that your community is likely to continue to decline or stabilise at a level that does not need the current system.

A local authority is required to fund the depreciation of its physical assets; in other words, to fund the replacement of those assets over time. This requirement means that a community would have to make a transparent decision that it wished to change the level of service, or re-invest in a different kind of system. Levels of service include both provision for health concerns and such things as convenience of service. It is important to make a distinction between levels of service to do with health and environmental issues and those standards that relate to the particular kind of system your community has. For example, on-site systems may be less convenient because they require more monitoring by residents, but they may provide a higher level of service in terms of environmental impacts. These issues would need to be worked through carefully.

If you are considering this kind of approach, the important questions become:

- When should we think about investing in a different system?
- How can we maintain health and environmental standards while the changes are achieved?
- Is it cheaper to invest in trying to capture growth than to find a new system? Is that a realistic goal?

You can continue to maintain the system for the normal length of its life and then change when it needs replacing. Or you can reduce the levels of maintenance, which will shorten the system's life, invest the money short term in other methods to protect environmental and public health, and reinvest in new systems over time, which might risk non-compliance with consents. Or, you can simply cut your losses and reinvest in a new system, provided there is an overlap in terms of protecting public health and the environment. It will come down to a simple matter of cost. Does it cost more to continue or less to reinvest now or later?

Coming to grips with this kind of question means a community needs to step well outside the immediate issue of wastewater management to think about what might be the real nature of the future population and economic opportunities. The essential point is that a community does not have to be locked into increasingly complex wastewater systems. It can choose.



The people in your community: now and over time

The issue of population decline makes the link between wastewater management systems very real. If the system does not fit the social make-up of the community as well as ecosystem processes, it won't work. Because there will be intense external pressures to maintain the system – from public health authorities and regulatory agencies – the cost of this 'poor population fit' will be borne by individual households. This will either be in the form of rates payments or, if wastewater charging is brought in, as a direct charge. This has huge implications for what are often poor and isolated communities. While a new treatment system may seem desirable, the costs may themselves contribute to social and health problems.

This is also true for communities which, even if they are not declining, may be ageing or may have a high proportion of families on small or fixed incomes. You will need to make some estimates about the changing nature of your community over time. You may have a young working population now, but it will get steadily older and will probably be replaced by fewer younger people. This is a national trend, but your community may age at a faster-than-average rate. You will need to consider this when choosing a system.

Managing your wastewater system

The issues of population decline and change may well force you to think about whether a large and/or expensive system with a very long life is the best kind of approach to take. The ability of people to manage the systems they have, particularly on-site systems, needs to be thought about carefully. Older people on a fixed income may not be able to afford the upkeep and maintenance of a septic tank. Seasonal visitors may not understand the need to do so.

There is a range of solutions available. For example, the community may pay a small rate to the council to have them undertake the maintenance. Or they could band together more informally to take care of the issue. A technical engineering response of moving to a centralised or cluster system, say, may not be necessary. Management of the final system should be seen as part of the wastewater system design – in effect, linking wastewater management to the local social make-up of the community.

Whatever else is done, it is a good idea for all communities to consider the benefits of continual monitoring of local systems (see *Section 6* for a discussion of management and monitoring and *Section 11* on management and funding of wastewater systems).

Human systems: the issue of flexibility

What this adds up to is the need for a more subtle or sophisticated way of thinking about how wastewater management systems fit the 'human bit' of your local ecosystem. The changing nature of that human bit is often not well thought through. This is not just a simple issue of making sure that cost is not a hardship for communities. It has a great deal to do with the kind of system you choose. How flexible is it? Can you add to it and take away from it? How long are you locked into that system? What sort of future does it push your community towards? Can people manage it over time?

It is extremely important in making your decisions about what wastewater system and what technology you want that you think about these long-term issues.

Castlepoint sewerage scheme: development follows wastewater

Castlepoint is an historic beach settlement located to the east of Masterton in the Wairarapa. As late as the 1990s the area continued to have some long-drops, but most sites had on-site systems. A community scheme was suggested in the 1970s but this was rejected. By the 1990s there was increasing concern about beach pollution and the community began to take action. The process was one of initial community concern, followed by consultants developing options, with one option finally chosen by the community. The final choice was for a central treatment system with oxidation ponds.

The implications for development were never discussed as part of the options development process. Since installation of the system, the area has developed rapidly. The problems of beach contamination were solved but as a result the pressure to develop this quiet seaside settlement has increased. Smaller lots have been created and there has been a rapid increase in property values and population. This may be acceptable to the community, but the changes were unanticipated at the time. The opportunity to think through both wastewater and development issues was passed over.

WASTEWATER – WHAT IS IT?

The New Zealand Waste Strategy defines waste as: *“any material, solid, liquid or gas, that is unwanted and/or unvalued, and discarded or discharged by its owner”.*

As we saw in *Section 1*, in many cases what people call waste is capable of being re-used. There is also value in that re-use, especially if you think of the environmental impacts of simply discarding it. In this section we look at the different kinds of waste, and the kinds of things that can get into wastewater that can cause problems.

2.1 The kinds of waste

With a focus on wastewater you will be most interested in liquid wastes, but sludges, odours and other residuals are also very important. Liquid wastes include:

- wastes that originate as natural liquids, such as urine or drinking-water, or from laundry uses in a house
- a mixture of wastes and water used for their transport – wastes are mixed with water as the 'medium' by which they are transported away from a site for safe disposal. In a sense, a large part of wastewater is 'created' as a transport system.

The relationship between solid and liquid wastes is shown in *Figure 2.1*.

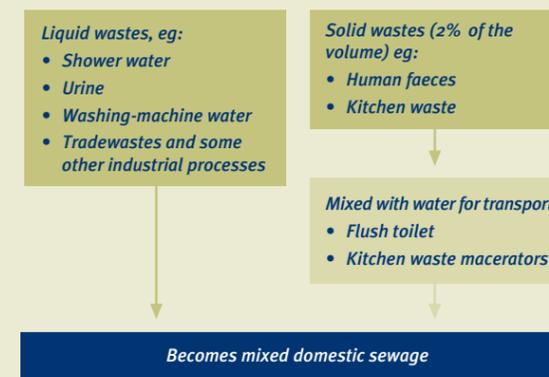


Figure 2.1 Water as a liquid waste and as a medium for solid wastes in the domestic situation

Understanding these relationships is important to understanding the available choices. You don't have to use water to transport wastes (eg, sewage or human waste can be managed with composting toilets). The costs of providing water to transport sewage, or the need to dispose of a large volume of wastewater, may lead some communities to explore alternatives to water-borne waste treatment. This kind of thinking is fairly new in New Zealand and it will not always be the cheapest, most useable option. But understanding that there are choices about 'creating' wastewater is important and worth considering when exploring options.

Wastewater includes dissolved contaminants, suspended solids and micro-organisms. Various levels of wastewater treatment separate the wastewater into sludge and a dissolved fraction containing much of the water, organic material, bacteria and salts. What is left behind is called sludge or biosolids. It is important to see sludge as one of the wastewater management issues for your community. Often sludge is ignored as a wastewater problem because community attention is solely focused on treating the remaining water to a level that reduces harm to waterways, and the nutrient cycle in particular.

Liquid waste, especially wastewater containing human wastes, will also produce an odour (from gases and aerosols). Odour is not a public health issue, but it can be a major source of nuisance and concern in a community. It will be part of your wastewater management challenge.

As will be obvious by now, the three types of waste (solid, liquid and gas) overlap in a variety of ways. The focus in this handbook is on the management of wastewater (liquid waste) and sludge. These overlaps, and the focus, are illustrated in *Figure 2.2*.



Figure 2.2 The overlaps between the different types of waste

2.2 What is in wastewater?

It is important to remember that wastewater is what goes down the pipe, and that the management of wastewater includes its impacts and infrastructural requirements. Your community therefore needs to think of itself as managing:

- the total impact of all wastewater in your surrounding catchment on public health and natural systems and processes
- the physical systems (infrastructure) that channel some of these wastes for treatment and controlled 're-entry' back into the ecosystem.

If you take the total impact aspect first, there are probably four broad sources of wastewater in New Zealand, each with its own mix of substances that eventually find their way into wastewater:

- household systems
- factories and industry
- commercial businesses/offices
- farms and horticulture.

Wastewater from farming tends to be dealt with separately. Increasingly, farmers are being required to set up on-site treatment systems for such things as animal effluent. Households, industries and commercial businesses can all use on-site systems, but often, depending on the size of the community, their wastewater will be combined and managed together.

This means that the wastewater in your area will be unique. An essential factor in determining the kinds of wastewater you will need to deal with will be the kinds of industries and processing businesses in your area. For example, if there is a local cheese factory, your wastewater system will have to deal with whey as a waste. If there is a metal-processing factory, your system may have to deal with water that has been used to wash down machinery.

Wastes from industry and businesses are known as tradewastes. It will be important to take account of these tradewastes when designing your system, and important to take account of initiatives being undertaken by industry to reduce the volume and toxicity of their wastes. It would be worth working with these industries in order to help them to deal with their own waste streams.

You will need to understand the mix of what is in your local wastewater and what effects the various components may have on human health and ecosystems. We will turn to look at this now.

2.3 What is in wastewater that causes problems?

Organic material

The organic content of wastewater is made up of human faeces, protein, fat, vegetable and sugar material from food preparation, and soaps from cleaning. Some of this is dissolved into the water and some exists as separate particles.

Ecosystem health effects

Naturally occurring soil and water bacteria eat this organic waste and use it to grow rapidly. In a natural or dilute water environment where there is plenty of oxygen dissolved in the water, aerobic (oxygen-using) bacteria eat the organic material and form a slime of new bacterial cells and dissolved salt-waste products. If undiluted wastewater is left on its own, however, anaerobic (non-oxygen-using) bacteria decompose the waste organic material and release odorous gases such as hydrogen sulphide, as well as 'non-smelly' gases such as methane and carbon dioxide.

It is the amount of oxygen removed or the too-rapid growth of the bacterial slime that can cause the harm (see below).

The important thing is to measure how much oxygen will be used by aerobic bacteria to convert the organic material to new bacteria. This is the 'biochemical oxygen demand' (BOD), and the standard measure is the amount of dissolved oxygen needed by aerobic bacteria over a five-day period at a water temperature of 20° Celsius (called the BOD₅). The BOD₅ strength of wastewater indicates its potential polluting impact if it is not treated. It is measured in parts per million (ppm), or in the metric system the number of grams of organic material per cubic metre (g/m³). The BOD₅ of untreated wastewater is around 200–300g/m³, while the BOD₅ for a healthy aquatic ecosystem would be less than 5g/m³.

Relating these scientific measurements to everyday experience, a central issue is how much oxygen is left for fish to breathe after aerobic bacteria have used the oxygen to break down the organic material. If BOD₅ levels of less than 4 g/m³ occur in a stream that has naturally healthy levels of dissolved oxygen, then the stream system can deal with the amount of waste without affecting the fish. A good-quality healthy level of dissolved oxygen in water is around 8 to 10 g/m³. At a dissolved oxygen level of 5 g/m³ the fish become stressed, and at 2 g/m³ the fish will die from lack of oxygen unless they are able to move to more oxygenated waters.

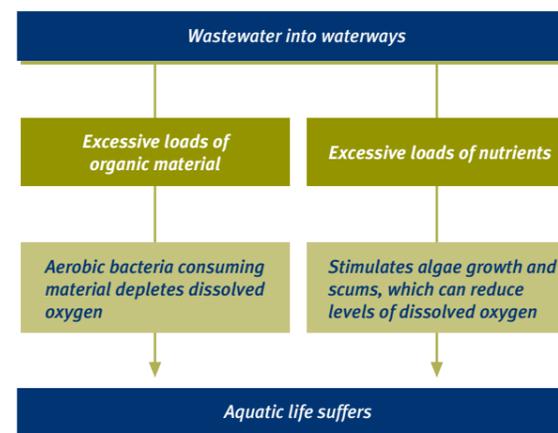


Figure 2.3 The effects of organic material and nutrients released into waterways

Where there is an overwhelming amount of wastewater, all the oxygen will be used up and the anaerobic bacteria will take over. The water will go septic (anaerobic) and the fish will die, as will other forms of oxygen-dependent life. This is partly why wastewater is treated to remove as much organic material as possible. But the content of even treated wastewater can be an issue for your community. Sensitive streams and estuaries are particularly vulnerable.

In effect, ecosystem services can be damaged, and these problems may be felt well before the level of pollution directly affects human health. For your area, you will need to know how much wastewater is entering – or may enter – your local stream or river, and the level of dissolved oxygen. Talking with the regional council may help with this.

Suspended solids

The portion of organic material that does not dissolve but remains suspended in the water is known as suspended solids. The level of suspended solids in untreated wastewater is around 200 g/m³.

Ecosystem health effects

If effluent is discharged into streams untreated, any solids it contains will tend to settle in quiet spots. Oxygen levels will soon be depleted in the area of the contamination, causing it to decompose anaerobically. If there are high concentrations of this contamination the water in the stream will go septic because the oxygen will be used up. This will not only smother the fish, but will also kill off the life at the bottom of the stream, creating dead zones.

Dissolved salts

The most significant salts in wastewater are nitrates and phosphates. These occur naturally to some extent. Nitrate also derives from the breakdown of organic nitrogen in protein waste matter, and the oxidation of the ammonia in urine. Phosphates are present in detergents used in washing and laundering, and are also produced by organic breakdown. The total nitrate in wastewater is around 40 g/m³, and phosphate is around 15 g/m³.





Ecosystem health effects

Nitrates and phosphates are essential elements for growth. When nitrates and phosphates are discharged into natural waters they fertilise the growth of microscopic algae and water 'weeds', which can lead to green algal suspensions and weed mats. This overgrowth results in their death and decay, and means further consumption of dissolved oxygen and smothering of aquatic life. The nutrients that caused the initial growth can then be released back into the water, initiating another cycle of weed and algal growth and decay.

Bacteria and viruses

The human gut produces a huge quantity of bacteria, which are excreted as part of faeces on a daily basis. The most common and easily measured organism is *E.coli* (Escherichia coliform group), which is referred to by wastewater scientists and engineers as 'faecal coliform' bacteria. This is called an 'indicator' because its presence indicates the presence of faecal matter from warm-blooded animals. More extensive testing is required to tell if the source is human or not.

Special tests are needed to distinguish between the amount of pollution produced by humans and the amount produced by birds and other animals that gets into the water.

The amount of faecal coliform is measured per 100 ml of water – around half a cup. Each person excretes about 140 billion faecal coliforms a day. In untreated wastewater the faecal coliforms can be around 10 to 100 million per 100 ml. It is the presence of these faecal coliforms that the drinking-water standards and recreation standards are concerned with.

The main class of viruses are the enteric viruses, which cause gastro-enteritis; for example, calcivirus (Norwalk virus), rotavirus, enterovirus (polio and meningitis) and hepatitis. Generally viruses do not replicate in the outside world, but they may survive for a long time. Spray irrigation may shock viruses into die-off due to exposure to ultraviolet light or drying out of their surroundings. Poliovirus 3 has been found in aerosols at a wastewater treatment plant.³ In a marine environment some viruses have been known to survive a number of days, possibly protected in suspended solids.

Human health effects

Many of the faecal coliform bacteria in human waste are harmless. However, there are disease organisms – or 'pathogens' – that can cause harm. These can be bacteria such as typhoid, or viruses such as hepatitis B. Direct contact with these pathogens or pollution of the water supply can cause infections. The Ministry of Health has national responsibility for developing drinking-water standards, which will guide your community's understanding of the risks it might face from local wastewater. Sewage can pollute shellfish-gathering areas and, if eaten, the shellfish will cause illness. Shellfish filter food by passing several litres of water an hour through their system. The food concentrates in the shellfish, which means that any pathogens will also accumulate.

Relatively high concentrations can also make an area unsafe for swimming and 'water contact recreation'. National guidelines developed by the Ministry for the Environment help local communities to classify their harbours, streams and lakes in terms of safety for swimming, fishing and shellfish gathering. Local regional councils will set standards for discharges for these areas. These standards relate to the amount of bacteria present in a certain volume of water.

Ground water can also become contaminated. Wastes can percolate through the soils into underground water or aquifers. Given that many smaller communities and farms obtain their water from bores or wells into these aquifers, this contamination can be a serious issue.

During the nineteenth century the large quantities of sewage in the bigger towns and cities were identified as a health problem. Finding solutions to cholera epidemics from infected water supplies was a major issue. The wastewater system you now have may well be a direct heritage of these concerns.

Other dissolved constituents

Wastewater contains metals, chemicals and hormones from households (via food, medicines, cosmetics and cleaning products) and business processes (eg, mercury from dentistry, which can easily be removed by installing a centrifuge in dental surgeries). It can also contain halogenated hydrocarbons and aromatics, plasticisers, polyaromatic and petroleum hydrocarbons, organochlorine pesticides, PCBs and dioxins.

There are two issues: if large quantities are discharged into small, highly localised areas, such as a stream or small lake, there may be pollution problems. The other issue is the 'bio-accumulation' of these substances in various parts of the food chain. This can bring unacceptable concentrations in humans and aquatic life, which can lead to health problems.

Human health effects

Long-term health impacts of residues in water supplies and food

The issue here is one of long-term impacts of various wastewater residues on the human system. Water naturally contains such things as iron, zinc and manganese, but industrial processes can introduce higher concentrations. If the concentrations are high enough, exposure to some metals and chemicals may have an impact on how the body's system works.

The long-term impacts of these substances on human health are not always well understood. Wastewater will carry a range of substances, which can pass into the water supply or be returned to the soil in heavy concentrations. Some treatment systems will remove metals and chemicals from the wastewater, but the sludge produced as a result of this treatment will then contain a high concentration of these substances. The New Zealand Waste Strategy calls for such wastes, by 2007, to be beneficially used or appropriately treated to minimise the production of methane and leachate. Whatever use the sludge is put to, it should comply with the Biosolids Guidelines.⁴

Endocrine disruption

The endocrine system in the human body is a complex network of glands and hormones that regulate many of the body's functions, including growth, development and maturation, as well as the way various organs operate. The endocrine glands – including the pituitary, thyroid, adrenal, thymus, pancreas, ovaries and testes – release carefully measured amounts of hormones into the bloodstream, which act as natural chemical messengers. They travel to different parts of the body to control and adjust many life functions.

An endocrine disruptor is a synthetic chemical, which, when absorbed into the body, either mimics or blocks hormones and disrupts the body's normal functions. This disruption can happen through altering normal hormone levels, halting or stimulating the production of hormones, or changing the way hormones travel through the body. This is a new area of scientific investigation and is not yet well understood. There are concerns that, for example, the decline in fertility levels in all animals in the food chain, including humans, could be as a result of excessive discharge of these chemicals. Such investigations are now being considered in New Zealand.

The issue is relevant to wastewater issues because many of these substances will enter the food chain – either on land or in waterways – from wastewater. Of course some of the chemicals (eg, some pesticides) will also enter the ecosystem via run-off from farms and roadways. Wastewater treatment systems will remove some of these chemicals, but generally treatment processes are not currently designed to deal with this problem.

Ecosystem health effects

Endocrine disruption

The issue raised for human health is also relevant to aquatic ecosystems. There is some concern that the hormone-producing systems in fish are under pressure. High levels of oestrogen released from wastewater can affect the reproductive cycles of fish. The degree to which this is an issue in New Zealand is not known.

³ Froese, KL and Kindziarski, WB (1998) Health Effects Associated with Wastewater Treatment, Disposal, and Reuse. *Water Environment Research*, 70(4):962-968.

⁴ *Guidelines for the Safe Application of Biosolids to Land in New Zealand* Copyright © New Zealand Water Environment Research Foundation 2003.



Toxic effects on freshwater and marine life

These can have the immediate effect of killing fish, invertebrates and even plant life. This can be a serious loss in itself, but there are also flow-on effects. The dead fish or plants will be broken down, and can contribute to further depletion of oxygen in the water.

The key point to remember is that wastewater management is not just about toilet flushing, bathing, cooking and washing water. It is likely your community will have tradewastes, even if just from the local garage. Your overall catchment will have a huge variety of different wastewaters that will need to be considered. *Table 2.1* summarises the different components of wastewater that cause problems.

Type of material in wastewater	Comment
Organic waste: <ul style="list-style-type: none"> human waste food waste industrial and commercial wastes animal effluent 	<ul style="list-style-type: none"> faeces, urine, blood increasing volumes of wastewater – possibly due to the advent of kitchen waste macerators tradewaste – processing farming – not usually managed via community infrastructure
Oils and fats	<ul style="list-style-type: none"> households – usually from tipping down drains tradewastes – garages, manufacturing
Metals	<ul style="list-style-type: none"> households – found in foods, via human wastes aggressive water supplies (outside the limits pH6-8) tradewastes
Solvents	<ul style="list-style-type: none"> households – tipping down drains, cleaning tradewastes – garages, manufacturing
Chemicals	<ul style="list-style-type: none"> households – via human wastes households – via cleaners, soaps etc, washing, bathing and cooking tradewastes
Paints	<ul style="list-style-type: none"> households tradewastes

Table 2.1 The problem-causing components of wastewater

2.4 Other effects of wastewater

Soil depletion

This is not so much an effect of something in the wastewater itself, but has more to do with how the management of nutrients in wastewater systems bypasses natural processes. It is worth discussing here because of the link with ecosystem health.

Over the last hundred years or so waste management design has favoured using water to transport wastes. It has also favoured direct disposal into rivers, lakes and the sea. The remaining sludge has tended to be landfilled. One effect has been to bypass the nutrient cycle, whereby wastes would be slowly returned to the soils to be taken up as a food source by plants. Some would enter the streams and rivers via groundwater but most would remain in the soils.

The depletion of nutrients from the soils has been raised as an issue in parallel with a wider concern with sustainable environmental management. This depletion means that if soils are to successfully support plant life (and farming), they must have nutrients returned through alternative processes. This can be costly.

In effect, bypassing the natural nutrient cycle means that many wastewater systems contribute to nutrient depletion in soils. Conversely, streams, rivers and lakes face risks from overloading with nutrients – with many of the problems mentioned earlier.

Soil structure

Sediments, metals and salts can affect soil structure. For example, sodium ions can be found in high concentrations in wastewater. If irrigated on to land they can damage soil structure.

Summary

Table 2.2 summarises the range of effects on receiving environments and ecosystem services.

Receiving environments		
Air odour, aerosol spray and vapour: <ul style="list-style-type: none"> spreads pathogens a nuisance to those living and working in the surrounding area 	Water <ul style="list-style-type: none"> increased nutrients; organic material encourages plant growth and micro-organism growth reduces oxygen can cause ecosystem death accumulation of metals, chemicals accumulation of hormones 	Land <ul style="list-style-type: none"> wastewater systems can deplete soils of nutrients or cause an imbalance
Ecosystem services		
Freshwater <ul style="list-style-type: none"> failure of food sources – fishing reduced ability to absorb wastes loss of amenity, unsafe for recreation loss of spiritual health 	Coastal <ul style="list-style-type: none"> failure of food sources – fishing and shellfish gathering reduced ability to absorb wastes loss of amenity, unsafe for recreation loss of spiritual health 	Forest <ul style="list-style-type: none"> nutrient cycle can be disrupted – long-term impacts on watershed functions, soils, habitat, employment
Grassland <ul style="list-style-type: none"> depletion of soils 	Urban <ul style="list-style-type: none"> public health systems can fail high infrastructure costs reduce the ability to provide other social services 	Agricultural <ul style="list-style-type: none"> depletion of soils accumulation of heavy metals; hormone levels affect food health

Table 2.2 Summary of the range of wastewater effects on receiving environments and ecosystem services

2.5 Māori perspectives on waste and waste impacts

Naturally Māori would have concerns about the impacts of chemicals, metals, human sewage and other effluent on the physical health of ecosystems, especially food-gathering areas, and these are likely to align with the concerns identified by the wider community. Further to these, however, is the traditional significance many Māori continue to place on the health of the mauri (see *Section 1.5*) within human and other life forms, including water, and the extent to which this is likely to be irreparably harmed through the introduction of unacceptable biological influences.

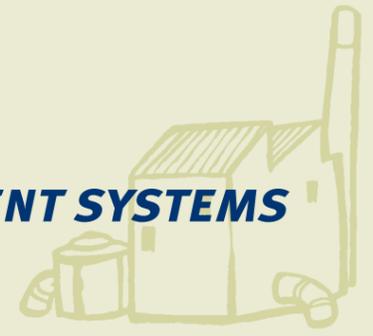
For example, the *spiritual* harm that is considered to result from consuming shellfish collected from water that may have been subject to effluent and other pollution is unacceptable to many Māori. These types of concerns are particularly prevalent in relation to the treatment and subsequent disposal of biological waste from hospitals and funeral parlours. Similarly, the use of human waste in products, including fertilisers, intended for agricultural and food production (even if these have been treated and mixed with other organic matter) can be problematic, particularly for Māori who maintain a traditional view of environmental protection.

As discussed in *Section 1.5*, from a traditional Māori perspective polluted water needs to pass through the earth to be purified and to have its mauri, or essence, restored. This is considered necessary, irrespective of whether treatment to remove or dilute pathogens, chemicals and metals has occurred. Even human waste found in *treated* wastewater must first pass through the earth before re-entering any water. In effect, it is the process undergone for treatment that is the issue, as much as the removal of pollutants.

Responding to these concerns requires us to focus on how wastewater and sludge *should* re-enter the ecosystem. Land re-entry appears to be the preferred approach, with wastes entering the soils before they become absorbed by plants. What this could mean for wastewater management systems is explored later in this document.

WASTEWATER MANAGEMENT SYSTEMS

A general introduction



Two important themes are threaded through the first two sections.

- *Humans live within an ecosystem* – failure to manage human-generated waste within the boundaries of any ecosystem can lead to that system's failure, and such a failure will bring major costs and risks to the community.
- *Human activity is part of an ecosystem* – not only must wastewater management solutions protect ecosystem processes and services, but where possible they need to fit the social, economic and cultural needs of that community. Of course, protection of public health and the ecosystem must be the primary concern, otherwise the local economy and community will ultimately suffer.

Section 3 builds on these themes by looking first at what wastewater management systems might look like if they were organised within ecosystem capacities and processes. In other words, it takes a systems approach to wastewater management. The way systems might be managed over time to accommodate the changing local economic and social environment is also discussed. This time-focused or dynamic view of wastewater systems management is not often discussed, but it is an important issue for any community. This is especially true for smaller communities, which may be strongly affected by economic and social change.

3.1 A systems approach to wastewater management

Part Three will discuss the technical wastewater management systems in detail. This section briefly reviews the concept of integrated wastewater systems management that underpins this handbook.

When choosing how to manage wastewater and wastes in your community, a distinction needs to be made between the 'system' and the technical engineering solutions that might be used within that system. Thus you can talk about *wastewater systems* and specific *wastewater treatment and disposal technologies*, such as a septic tank. These are different things.

A wastewater system will include technologies, but will also include the processes that occur within and between the different technological components. Wastewater systems also include people and their actions and behaviour, as well as the natural ecosystem processes within which the technologies operate.

For any community, the most important thing is to realise that choosing the 'system' is the first and most important step. Choosing the technology comes second. Small communities have a wider range of wastewater systems available to them than large cities. For example, on-site systems can be used more easily. Your decision will depend on understanding the possible effects of different systems on the community's vision of where it wants to be in the future. It will also depend on the physical characteristics of the local soils and water tables; closeness to streams, rivers, lakes and the coast; and how the overall ecosystem works.

A brief history of wastewater systems in New Zealand

A wastewater management system is a human-designed and -created system to manage wastes. In New Zealand over the last hundred years or so these systems were thought of, built and managed as if they were largely separate from the surrounding natural ecosystem.

On-site systems consisted of the pit toilet and early septic tank technologies. Understandably the focus was on health issues, and overflows into waterways were not a marked concern. Often on site-systems were seen as unsafe by their very nature, waiting to be changed to a 'proper' waste management system when the community had sufficient resources. Small New Zealand communities were characterised in these early years by on-site systems and would continue with them well into the 1960s and 1970s. Controls on expansion and development because of the capacity of on-site systems also became more common. Some communities invested in outfalls for untreated wastes, often ignoring Māori protests against pollution of wāhi tapu and kaimoana. From the 1970s central government subsidies gave some funding for wastewater systems, and a large number of communities took the opportunity to invest.

The subsidies improved conditions but also brought new costs for some areas – in the form of development pressures, or extra rates for what were small communities. The subsidies were withdrawn during the 1980s, and then reintroduced in 2003 for communities of up to 10,000 population.

With the rapid increase in the size of towns and increased understanding of wastes as a source of human disease, the concern has been to transport the wastes away from towns and settlements and pass them into rivers, streams or the coast, where it was expected that dilution of the waste would occur. One effect was to concentrate the wastes and place pressure on the receiving ecosystem.

Reticulated systems that transported wastewater away from the settlement allowed some sectors of a community to forget or ignore the environmental effects, and to see management of wastes as independent of natural systems. There was no requirement to think about water quality. Issues such as soil types and water tables were irrelevant, because the system bypassed the natural process of waste management. It seemed a wastewater management system could operate separately from natural systems.

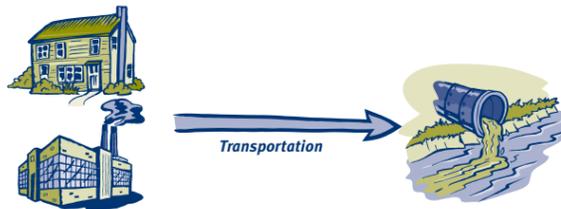
But the rivers and coastal areas were eventually overwhelmed by the volumes of waste they were expected to handle. Given that the rivers and streams were also often a source of water, from the early twentieth century there was increasing concern for the effects of contamination on human health. Developments in water supply systems, such as the use of sand-filter systems for drinking-water, allowed polluted rivers to be used as a water source.

From the 1950s, concern about effects on the ecosystem, and on amenity and recreation, forced the treatment of wastewater. In the early years this was mainly a health focus, but in later years it expanded to include treatment to a level that tried to minimise some adverse impacts on ‘receiving waters’. The wastewater system still bypassed natural land-based percolation of wastes into soils, but it had been partly reconnected to the natural system by a minimum requirement to think about effects. The treatment ‘bit’ was added to the wastewater system.

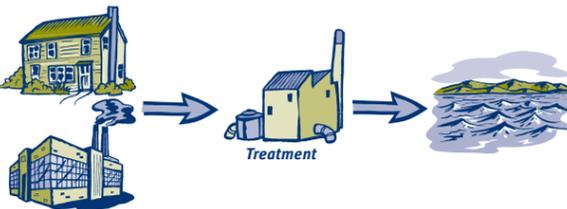
Current wastewater systems

In the last 30 years or so the focus has been on treating wastes before they re-enter the natural nutrient and water cycle. But in recent years there has been an emerging view that rather than just ‘manage the end effect’, human wastewater systems should be integrated into natural processes. They have to exist within the natural system.

Late 19th/early 20th Century



Mid-to-late 20th Century



(Re)-emerging concepts late 20th, early 21st Centuries



Figure 3.1 The evolving nature of wastewater systems

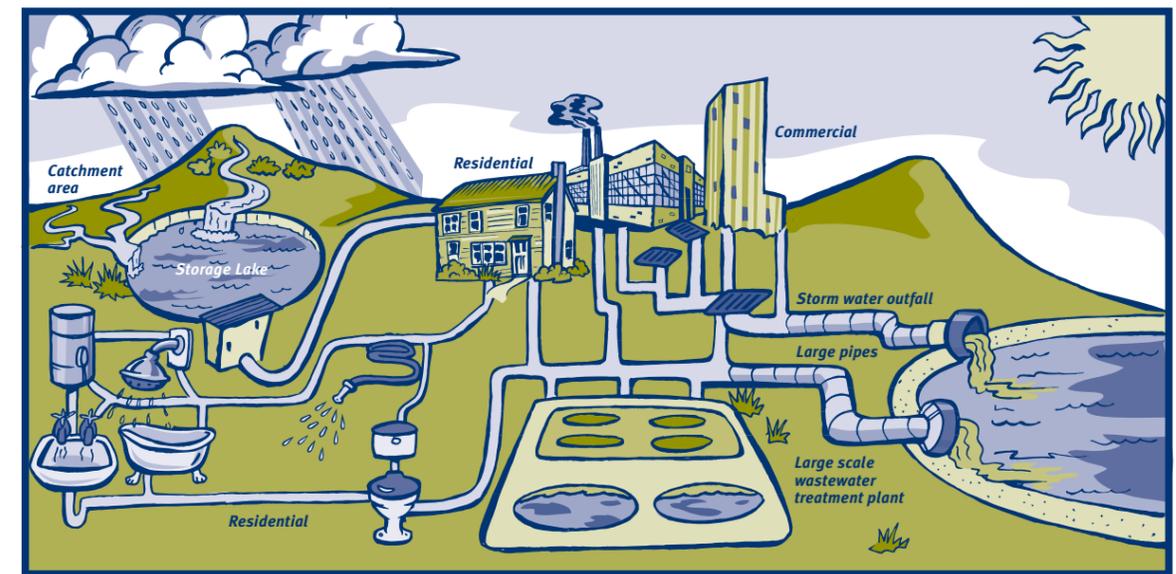
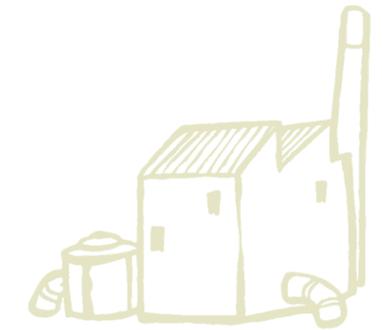


Figure 3.2 The conventional wastewater system

Of course, the so-called new ecosystem-focused or integrated wastewater management approach is not new. It has been used for centuries and forms the basis of Māori waste management thinking. Many smaller communities and some farms and businesses use ‘on-site’ systems that more closely fit this kind of approach. The non-systems approach to waste engineering of the last century was to simply focus on end-of-pipe treatment followed by disposal of the treated wastewater. Engineering and technology was then applied to meet minimum regulatory standards. Now we know that this is often an inefficient use of resources and human effort, particularly in the longer term.

Wastewater ‘infrastructure’ is often designed so that industrial wastewater (with all its toxic components) is mixed with our personal domestic wastewater. All this is generally piped to a single point within a community’s ecosystem. The system has been designed so that all this wastewater – with its mix of valuable nutrients, toxic chemicals and pathogenic organisms – goes to one point for return to the natural system. Stormwater doesn’t normally enter the same wastewater system, but is directed to the nearest waterway, not via the wastewater treatment plant. It shouldn’t be a surprise that there is an ecological problem.

This approach reflects the sheer size and speed of urban development and the need to deal with the wastes that result. It occurred at a time when decision-makers thought that humans could act without thinking about the capacity of natural systems to absorb effects.

Linear approaches to problems, in which resources are used and converted into wastes, only to be disposed of, represent a failure in human ingenuity and a flaw in technology design.

Dr Steven A. Esrey, UNICEF

The New Zealand Waste Strategy (2002) takes significant steps to change the way in which wastes are regarded. A major focus is on creating a circular process which involves re-use, rather than a linear process from use to disposal.

Māori objections about direct disposal to water raised the question of the way wastewater re-entered the natural system or ecosystem. This concern has joined with a wider concern about the effects of large volumes of wastewater re-entering the environment at single points. The result is an adding of a re-entry management ‘bit’ to the collection and treatment parts of the system.

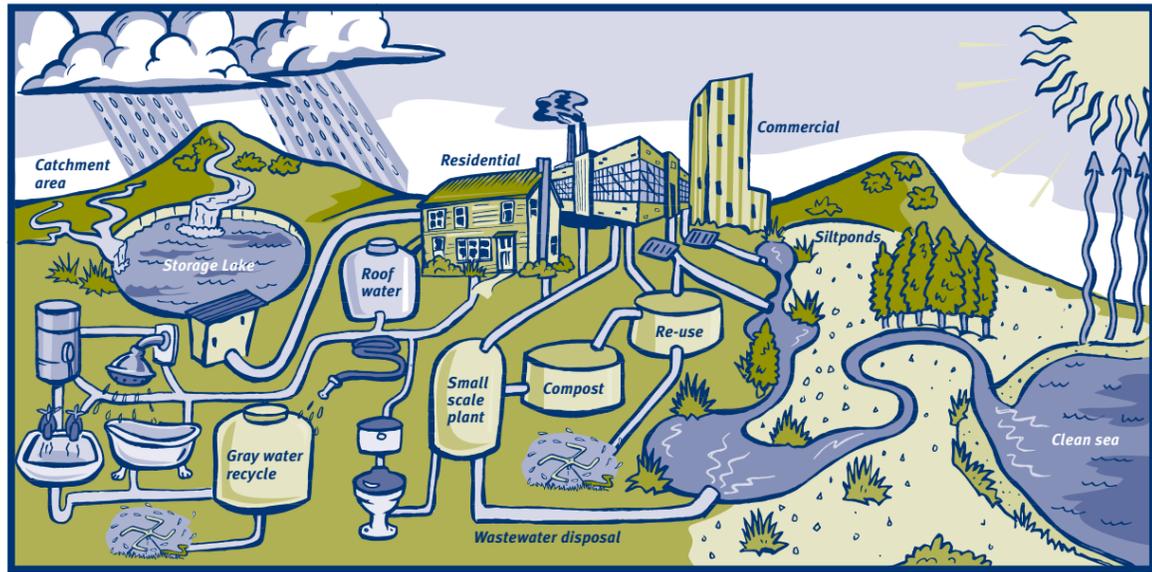


Figure 3.3 A sustainable wastewater system

In recent years, especially with limited subsidies for community wastewater systems, the costs of wastewater systems have sent some communities looking for ways to reduce the burden. This has resulted in thinking about the front end – the management of waste at source – and the reclamation of treated wastewater to provide a re-useable water source.

Finally, changing environmental standards and community expectations are demanding that communities think about the whole catchment. This is the whole valley with all the streams that flow down through it to a main river and into the sea. This means thinking about all the wastewater pressures on your local environment and trying to manage them as a whole.

In terms of designing the physical technical solutions for the wastewater system, there is now a shift from the conventional, linear, end-of-pipe technology to *integrated water and waste water systems*. If you want to read more about this, the report by the Parliamentary Commissioner for the Environment, *Beyond Ageing Pipes* (2001), gives an idea of the new thinking that is based on sustainable development principles.

Rather than linear thinking about systems and technical solutions, your community will need to think more about ecosystems and the ‘water web’. A systems approach is to evaluate the whole system in relation to the social, cultural, economic and ecological environment within which it exists.

Note: this example uses a small-scale treatment plant, but it is quite possible to manage larger systems in a more sustainable way.

Wastewater management is not only about the provision of a wastewater service. It is also linked to water supply and stormwater services.

Wastewater management is also about the wise use of our natural resources such as water, nutrients and even energy. The ecosystem, social and resource problems in urban settings are all interrelated. In particular, better management of the water resource, stormwater and wastewater can often be achieved by addressing the total urban water system.

When a reticulated system is proposed, or already exists, problems can be made worse when stormwater has not been adequately excluded from the system. Stormwater is often polluted, and adding and conveying stormwater in the same system as wastewater just adds to the volume of water the treatment system has to deal with, which creates unnecessary costs. Finally, flow patterns in stormwater are affected by rain events, which are quite different and require different handling regimes from wastewater flows.

Using seawater as the transport system for the solids in sewage is not recommended either. While this can be an attractive alternative in areas with water shortages, the salts present in seawater play havoc with the biological treatment processes and make beneficial use of the resulting sludges very difficult.

3.2 Kinds of wastewater systems

Domestic wastewater system

This is a wastewater system that processes wastewater from a home, or group of homes. The system includes the source of wastewater in the home, technologies for treating the wastewater, and technologies and processes for returning the processed wastewater to the ecosystem. Figure 3.4 is a simplified illustration of this total wastewater system for a single home. It comprises:

- the home itself – how it is built may affect how wastewater is created
- the technologies in the home, such as washing machines and toilets
- ‘inputs’ – such as food (nutrients), household cleaners and water
- the people and their behaviour
- the resulting wastewater
- recycling and treatment – on-site or off-site
- the ecosystem within which the home is embedded.

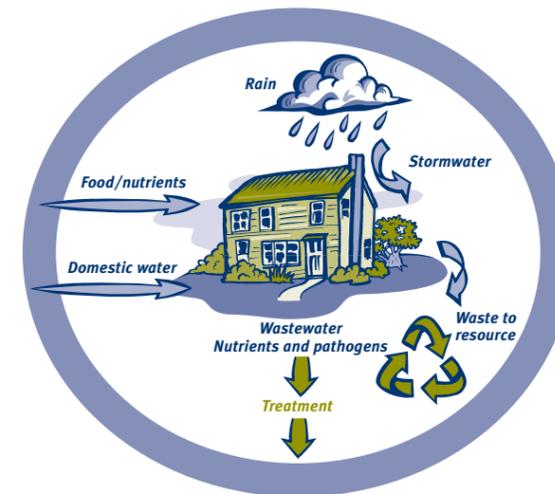


Figure 3.4 Domestic wastewater system

Industrial wastewater system

This is a system that processes wastewater from an industrial unit, such as a factory. As with the home system, the boundaries extend from the wastewater source (the industrial processes) through to the technologies and processes for returning the processed wastewater to the ecosystem. Figure 3.5 is a simplified illustration of this. It differs from the home system in terms of:

- the types of technologies producing the waste
- the way wastewater is managed at the source
- what goes into the processes (eg, chemicals/metals)
- the kind of waste produced.

The system is similar in that it includes people, recycling, the treatment technologies and the ecosystem within which the industry sits.

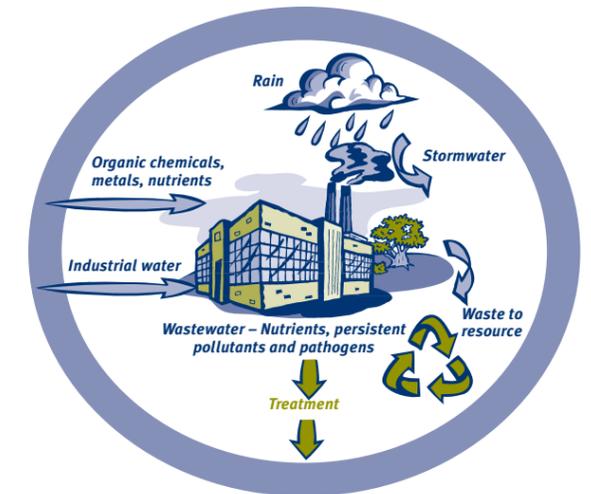
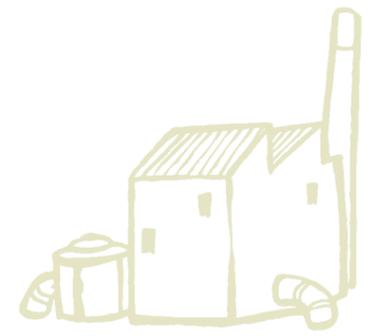


Figure 3.5 Industrial wastewater system





3.3 The parts of a wastewater system: fitting into natural systems

Whatever the kind of system – industrial, domestic or combined – there are four stages or parts to any wastewater management system:

- managing wastewater at source (including water conservation and recycling)
- collection and treatment
- re-use of treated wastewater and sludge
- re-entry of treated waste into the ecosystem.

Instead of the traditional end-of-pipe approach, a systems approach involves considering the total physical wastewater system, from the source to eventual return of the wastewater to the environment. This can offer more economic and sustainable solutions. For example, it may be more appropriate and more sustainable to reduce the amount of wastewater at the source by looking at the types of technologies (eg, washing machines, toilet systems) used. Or it may be cheaper and better in the long term to change the types of household cleaners used in the home to ones that do not damage your septic tank, rather than pay for complex and expensive treatment.

The scale of wastewater treatment systems

Cutting across these stages is the issue of the scale of the physical technical solutions – whether the solutions deal with one house, a business, a farm, a group of sites, or a whole community. There are three general categories of overall technical framework:

- *individual*: serves separate households, farms or businesses
- *cluster*: designed so that treatment of wastes serves groups of households or businesses, but not a whole community
- *central*: usually designed so the treatment of wastes for an entire community is managed at once in one place.

Variation is possible within these. For example, a cluster framework can have some on-site pre-treatment and the final treatment plant can be located off-site, or on-site among the houses. By ‘on-site’ is meant treatment or re-entry on the site where the wastewater was originally generated; ‘off-site’ means treatment away from where the waste was treated.

Re-entry of wastes can occur on-site or off-site. A centralised overall technical system can have some on-site pre-treatment, while individually focused technical solutions will always be on-site. Cluster and centralised systems tend to be managed by an overall central agency, such as a local authority. In contrast, technical systems focused on individual households or business can be managed by their users, or they can be managed and maintained as a group by a central agency.

These management arrangements, as well as more detail on the different systems, are discussed in *Part Three*.

3.4 National policy about wastewater treatment

The Ministry for the Environment and Local Government New Zealand published *The New Zealand Waste Strategy* in March 2002. It identifies wastewater management as an important issue, and signals that it wants to reduce the amount of sludge going to landfill. It has set targets for the improvement of wastewater treatment systems. You will need to read this strategy and keep up to date with the various parts of the action plan that will unfold over the next few years. It may affect your long-term decisions.

The Ministry of Health has re-introduced subsidies for the development of sewerage systems for small communities. It does not fund on-site systems. Information about this can be found in *Section 11*. You need to be aware of this funding opportunity, but you still need to weigh up what is the best physical system for your community.

Kawakawa Bay, Manukau City, Auckland region

Kawakawa Bay is a coastal settlement of about 280 dwellings on the southeast coast of the Hauraki Gulf. There are around 520 permanent residents, with some seasonally occupied holiday homes. Septic tank and soakage fields provide wastewater servicing for the majority of properties. Environmental monitoring over several years indicates faecal contamination of surface water drains, coastal waters, and local shellfish from time to time. The most likely contamination source has been assessed as effluent from on-site systems.

During 2002 a community-wide survey and inspection programme was instituted in accordance with the 1998 ‘Community Reticulation Criteria’ assessment protocol set out in the 1998 Auckland Healthcare Services report to the Ministry of Health. This document sets out “proposed criteria for introducing reticulated sewerage systems to small communities based on risk assessment of individual on-site wastewater systems”. Due to very evident problems of effluent surfacing under high winter water-table conditions in Kawakawa Bay, consultants undertook a detailed inspection in terms of the assessment protocol.

Over 180 of the 280 priority sites were inspected, and information gathered in order to grade the performance of individual systems. A scoring system is set out in the protocol based on (1) assessment of environmental factors relating to soil conditions, soakage rates, groundwater level and climate; and (2) an assessment of site factors such as occupancy of dwelling, size of septic tank, maintenance frequency, and age of system. These scores are then integrated into a grading chart.

Inspections showed that for around 50% of all properties visited, where the on-site system could be located (around 115 systems) there was evidence of present or past ‘failure’. These systems were located on slowly draining clay soils. The evidence of both site inspections and scoring results indicates the most likely solution is a reticulation scheme.

However, as of January 2003 Manukau City Council were still going through a detailed options assessment process to determine how best to respond to the problems that have been identified.



THE PLAYERS AND THE PROCESSES

2 PART

NEGOTIATING THE MAZE

This handbook focuses on giving local communities the tools and information they will need to understand wastewater issues, to set up community processes for decision-making, and to develop local sustainable wastewater management systems. In Part Two we look at ideas about community planning and decision-making in detail, and give an overview of the processes and players that will have a place in your community's decision-making.

Communities can fall into a passive reaction to options and choices presented to them, rather than actively becoming involved in community development of vision and options. This can result from unfamiliarity with complex and seemingly difficult formal processes and a lack of understanding of who should be involved. It can also result from nervousness in dealing with agencies and experts.

You should read *Section 4* almost as a checklist of issues, processes and players to think about – *before* you begin to design your own community process. Don't let the kinds of issues and the range of interests overwhelm you. Remember that each of these players has a lot of expertise in their particular area. Make use of that, make personal contact with people and develop a friendly approach. Remember that each of these players has a particular responsibility and that they are trying to manage a particular risk to human and/or ecosystem health. Respect that.

Also, remember that your community has the responsibility for finding the best fit for your area. Don't be afraid to challenge and debate ideas about risks, and ideas about solutions.

Above all, remember that many experts and communities alike are trying a whole new way of working with wastewater management 'inside' ecosystems. Old certainties about systems and technologies may not always hold true in all situations. Players will need to compromise and think about their particular concerns within this wider picture. This requires everyone to think about the impacts of technical systems on community change and on local economic systems, as well as on health and ecosystems.

For the expert and the relevant agencies, the challenge will be to manage risks while finding flexible sustainable solutions. You will need to understand the local circumstances, listen to the community's vision, and work with the people to find solutions.

4.1 Who are the players and what are they responsible for?

There are five main groups of people in any wastewater systems decision process:

- local community – residents and business people
- local government
- tangata whenua
- central government
- developers, individual land owners and interest groups.

Of these, the local community, tangata whenua and local government probably take the most integrated overview of the community and its wastewater needs. All three are concerned with social, environmental and economic issues, and deal with them on a day-to-day basis.

Central government tends to be more fragmented, with different ministries and departments having responsibility for particular issues. They will tend to comment on and deal with risks from their own perspective, but increasingly they are being required to work across areas. New 'all-of-government' initiatives expect that each central government player will take account of the impact of their focus on wider wellbeing. With the creation of the position of Minister of Urban Affairs and the development of a sustainable development strategy, there is likely to be even more focus on a holistic approach.

Developers, individual landowners and interest groups can be from the community or from outside, but in terms of wastewater issues they will have a very specific focus. 'Commentators' has been used as a term to cover outside interest groups such as environmental groups, who may not have a direct role in the area but wish to comment on its direction. Some may have a role in formal statutory processes. The Parliamentary Commissioner for the Environment might be considered as part of central government, or due to his/her independent status, as an independent commentator.

Each of these groups is now looked at in turn.

Local community

Residents and business people

Roles:

- users of the wastewater system
- funders of the wastewater system
- owners of any community decision-making process
- relationship with iwi and hapū.

Risk concerns:

- fit of wastewater system to needs
- impacts of wastewater decision on the character/growth of the community
- affordability of the system
- ability of people to manage the system
- impact of the decision-making process on community relationships
- environmental, public health and amenity impacts.

Your own community, including how it is structured and how it works, should be well known to you. People will have strong views. Some will be focused on the future shape and look of the community and what the wastewater system will mean for that; some will be focused on cost, some on environmental effects. They are all important points of view, but each person will need to learn to look at the big picture.

Local government

Regional Council

Roles:

- regulates discharges to the air, land and water – air discharges include odour, which is a key issue for wastewater management
- will set the standards for the volume and quality of wastewater disposal to water and the depositing of sludge in landfills
- monitors environmental quality
- may act as a funder of restoration projects for waterways (this may be a source of assistance for innovative ecosystem re-entry projects, such as wetlands).

Risk concerns:

- harm to ecosystem processes
- safety for contact sports
- safety for non-contact sports
- safety of fishing and food gathering
- harm to habitat.



Each community will have a regional council that covers its area. Usually the council is separate from the local district council, but sometimes they are combined in what is known as a ‘unitary council’. The regional council will cover a large area and may have its central offices some distance away, but there may be local offices in one of the larger nearby towns.

The regional council may be a source of information on environmental quality issues and will have mapping and monitoring resources that the local authority may not have. It is important to involve them in discussions, but at the same time they will need to maintain their role of regulating discharges. Some are reluctant to move beyond this regulatory role. They may be able to help you explore options, but will only be able to give final approval of options in terms of discharges via the resource consent process.

Some regional councils have extensive river, coastal, wetland and lake-edge restoration projects, either as part of their flood management work or as part of a wider restoration strategy. They may be interested in working with you to look at innovative schemes to manage the re-entry of wastes into the environment.

City or District Council

Roles:

- regulates the effects of structures and activities on the environment
- regulates building quality via the Building Act
- manages the rate and quality of growth
- is frequently the funder of new wastewater systems
- may fund river, stream, wetland and coastal restoration projects, which may assist with re-entry options
- may be the local landfill owner and manager – wider landfill policies may affect how biosolids are re-used
- has major interactions with the community on a range of social, economic and environmental issues
- is generally responsible for:
 - the designations for sewage treatment sites
 - pipeline approvals.

Risk concerns:

- harm to public health
- harm to ecosystem services and processes
- long-term social and economic impacts of wastewater decisions
- impacts of local community decisions on wider communities
- maintenance of a positive relationship with tangata whenua.

The local district council has a number of complex and overlapping roles. In many cases it will be the route by which funding of a scheme is organised. The ability of the council to take out loans on behalf of the community and to structure the repayment of loans in various ways will be an important influence on what options are chosen. The funding options that are often available are discussed in *Section 11*.

While considering funding issues, the council also has a responsibility to think about the wider effects of development on the community. This will not always be straightforward. The council may express a wider community vision about benefits and costs, and may be aware of development pressures that need to be managed and reconciled with local aspirations. With this role, the council and council officers will need to take a partnership approach to working out the relationship between local wastewater issues and further development. In return, the local community will need to be prepared to think about this wider picture. Trust needs to be developed between council and community on these issues.

The responsibility to regulate the effects of activities and development is an important role. The council will have an established vision set out in its district plan, which it must administer, but its own wastewater thinking may not always fit with this. There are processes that can be used to protect the integrity of the district plan rules, or to change them if they no longer fit new standards or expectations.

The council may also fund local projects, or provide other wastewater services that will affect how options are developed. For example, it may already own a wastewater treatment plant, which will be made more viable if the local community hooks up to it. This may not fit with local desires. It is the kind of issue that would need to be discussed as part of the decision-making process.

Māori

Tangata whenua

Roles:

- kaitiaki for the physical and spiritual health of the environment, including the waters, land and food sources.

Risk concerns:

- loss of the health of the mauri in people and the environment
- loss of the physical health of ecosystems
- Treaty of Waitangi breaches
- maintenance of health of the water cycle in particular – at the spiritual and social centre of Māori life
- protection of wāhi tapu
- maintenance of food resources, land and seafood
- general community health and wellbeing
- economic wellbeing of local communities.

Whatever the nature of your local community, you will have to work with the local hapū and/or iwi, especially that which has mana whenua status, and with Māori residents on wastewater issues. You will need to work with mana whenua representatives in particular because of the recognition in law of their traditional kaitiaki and environmental management roles. The Resource Management Act 1991 (RMA), which sets out the various resource consent processes you will have to go through, gives particular recognition to the Treaty of Waitangi and the role of Māori in environmental management issues.

This brief subsection sets out the basis for this role, while *Section 5* provides some pointers and tips on how to build a good relationship.

Why is the Treaty relevant to the development of wastewater systems?

Despite the fact that the RMA does not refer directly to waste management, it does deal with the link between environmental management and the Treaty of Waitangi. The RMA controls the discharge of contaminants to air, land and water through rules in regional plans, and manages the effects of activities on the environment through district plans. As required by section 8 of the RMA (above), when preparing plans and implementing the resource consent process, local authorities must recognise the principles of the Treaty of Waitangi. This means that local authorities need to be vigilant in ensuring that any proposal for development has properly considered Māori concerns.

Although the RMA and other laws in New Zealand refer to the principles of the Treaty, before discussing these in detail, it is useful to provide a brief explanation of the Treaty, and its provisions, or Articles, as they are commonly known. The Treaty of Waitangi has two texts, one in Māori and one in English, neither of which is an exact translation of the other. Despite the differences between each of the versions, both represent an agreement in which Māori gave the Crown the right to govern and develop British settlement, while the Crown guaranteed Māori full protection of their interests and status and full citizenship rights.

Essentially, **Article 1 of the Treaty** gave the Queen of England (the Crown) the right to establish government in New Zealand. This right was qualified by **Article 2 of the Treaty**, which guaranteed to Māori continued authority over their property and other ‘taonga’ or treasured possessions, and **Article 3 of the Treaty**, which guaranteed Māori the same rights as other British subjects.

A major issue within the Treaty is the Māori and English concepts of sovereignty. The English version gives to the Crown ‘all the rights and powers of sovereignty’ but guarantees to Māori ‘tino rangatiratanga’ – a concept similar to sovereignty – of their properties and other taonga. These issues are important and will continue to be debated. They will be important issues for wastewater management because wastewater has such a potential impact on resources, on development vision and on relationships between groups.

If your community is mainly non-Māori, people will need to be aware that iwi and hapū will often be keen to explore these concepts in the area of wastewater management. What that will mean will be a matter for discussion around the key issues affecting an area. If your community is mainly Māori, being aware of the rights and responsibilities under the Treaty will assist when working with the wider community, local government and central government.



Crown obligations and local government responsibilities

Sometimes there is a perception that local government (city, district, regional and unitary councils) is an agent of central government or the Crown. This is understandable, as councils exercise governance functions at a local level. However, local and central government are separate and have different Treaty responsibilities.

Put simply, the Crown is the Treaty partner and has a moral obligation to observe the Treaty, except where the Treaty is given the force of law and confers legal obligations on the Crown.

Local authorities on the other hand are not Treaty partners, but they do have legal obligations to recognise the Treaty and provide for Māori interests when carrying out their functions. One of these obligations is to take into account the principles of the Treaty when managing natural resources.

The next section talks about some of the Treaty principles and explains how councils may apply them when making decisions about wastewater management.

Some of the principles that have been developed include:

- *partnership – more than mere consultation, this explores the idea of acting jointly on issues*
- *the duty to act reasonably, honourably and in good faith*
- *reciprocity*
- *mutual benefit – the need to explore solutions that benefit each Treaty partner*
- *the duty to make informed decisions – this is key in terms of how information is made available, and is important to the wider community as well*
- *active protection – this means that a council must take active steps to protect those things of importance to Māori, and not just consider them*
- *redress – the need to remedy or rectify a wrong or grievance.*

The development of the Treaty principles themselves arose out of the need to apply the Treaty to modern circumstances and to overcome the differences between the Māori and English texts of the Treaty. There is no complete or definitive list of Treaty principles. Principles have been developed by the Crown, the courts and the Waitangi Tribunal,⁶ and they continue to evolve as the Treaty is applied to new situations.

⁶ Te Puni Kōkiri. *He Tirohanga o Kawa kit e Tiriti o Waitangi: A Guide to the Principles of the Treaty of Waitangi as expressed by the Courts and the Waitangi Tribunal*. Te Puni Kōkiri, Wellington, 2001.

⁷ Ministry for the Environment. *Taking into Account the Principles of the Treaty of Waitangi: Ideas for the Implementation of Section 8 of the Resource Management Act 1991*. Ministry for the Environment, Wellington, 1993.

As we discussed above, *Section 8* of the RMA gives status to these principles, which, in a sense, provide the basis for how Māori and non-Māori might work together on environmental management issues. They are also aimed at making sure that Māori concerns are protected – whether or not Māori are a major part of the population of your local community. The purpose of this section is to alert the reader to the fact that local authorities, when managing the use, development and protection of resources, must take into account the principles of the Treaty. This may require a consultation process with the local iwi/hapū to find out their views about a proposed project, such as the development of a wastewater system, and its implications.⁷ (For more detailed information about the application of the principles to environmental management, further reading is recommended.)

This is particularly relevant where local authorities are required to consult with local iwi/hapū if they are identified as an affected party in the consideration of applications for resource consents. The provision creates a need to build effective working relationships between local iwi/hapū and those involved in resource management processes, including communities.

Other provisions in the RMA

In addition to providing for the principles of the Treaty of Waitangi, the RMA also recognises and provides for Māori interests, values and environmental practices. Under the Act, all persons who exercise functions and powers shall:

- recognise and provide for the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu (sacred sites) and other taonga (treasures or anything highly prized) (section 6(e))
- have particular regard to kaitiakitanga (section 7(a)).

The RMA also contains provisions that recognise the special place of tangata whenua as holding authority or mana whenua over an area through traditional occupation. These provisions include the requirement for local authorities to consult with tangata whenua when preparing a proposed policy statement or plan (clause 3(1)(d), schedule 1). (It should be remembered that not all iwi or hapū are recognised as tangata whenua in a particular area, and not all Māori identify with a hapū or iwi.)

As part of this requirement, local authorities must have regard to any relevant planning document recognised by an iwi authority (such as an iwi management plan) affected by the regional or district plan. This obligation is repeated in sections 66(2)(c)(ii) and 74(b)(ii). These sections state that when preparing or changing a regional policy statement or regional or district plan, the relevant authority shall have regard to any relevant planning document recognised by an iwi authority affected by the statement or plan.

Be aware that some local authorities provide for the assessment of effects on the mauri of an area. This means that more than just physical concerns can be taken into account – indeed, there may even be no obvious physical effect.

Section 1.5 showed how water lies at the very heart of the traditional Māori world view, and discussed the resulting approach to wastes and waste management. Choosing a wastewater management system will involve many aspects of Māori culture. In addition, discharges from wastewater systems often affect seafood-gathering areas and burial grounds, many of which can be found in coastal areas, dunes and estuaries. Your wastewater management process will involve looking at how the kind of wastewater system you choose fits with Māori perspectives *and* at the effects of discharges and structures on sites and places of value to Māori.

Whether your community has Māori residents or not, you will have to have regard for the Māori perspectives on wastewater management. At the very least, the resource consents process requires that iwi, hapū or whānau who have authority or interests in an area must be involved in the decision-making process. This may sound difficult, but it isn't. *Section 5.5 'Developing a process with iwi and hapū'* provides some tips on how to make this work.

The decision-making process tends to focus on the physical impacts of discharges – for example, on kaimoana and wāhi tapu. Māori have had very limited success in having their views influence actual wastewater management system design. Yet there are immense benefits in exploring Māori views on wastewater management with Māori residents and/or iwi. As wastewater management practices shift to fit a 'natural systems' focus, there is more and more common ground with Māori ideas of wastewater management. Given that wastewater management is a core concern for Māori, it is a good opportunity for relationships to be formed.

On the other hand your community may be based around a rural or town marae, or located on Māori land. It may be entirely comfortable with the Māori world view and be looking for assistance to argue this view in formal processes. There is an immense amount of case law and material that can assist you. You will find some assistance on where to go for material at the back of this handbook.

Mahinga mātaītai and taiapure

Provision has been made in fisheries legislation for the creation of mahinga mātaītai (seafood-gathering areas) and taiapure (fisheries management areas). These provisions recognise the special purpose of these areas and also allow for some direct mana whenua management⁸ of them. There may be different standards for discharges in these areas. You will need to explore this issue with local people and with both the regional council and the territorial local authority.

Special management arrangements

Increasingly, arrangements within Treaty settlement negotiations are coming to include provisions for direct iwi or hapū management of certain key areas, including those of specific cultural significance. Alternative arrangements may include joint management protocols with the Department of Conservation, the regional council, or the territorial local authority. You will want to establish whether any arrangements of this type are in place in your community, and who to contact in relation to them, when making plans for your longer-term wastewater management.

⁸ An iwi or hapū that has authority in an area by virtue of traditional occupation.



Māori as land owners

The RMA requires considerable attention to be paid to the role of iwi/hapū and associated kaitiaki in environmental management. But there may be areas of land in your region under Māori ownership. You will want to ensure that the relevant landowners have the opportunity to become engaged with the process from the earliest possible point, including sufficient opportunity to become involved in the design of any wastewater management initiatives affecting their land, and that sufficient emphasis is given to any issues or concerns Māori may have with what is proposed. In this case you need to remember that there will be many individuals who have an ownership interest in that land, all of whom have a right to be involved in decisions about its future.⁹

If the options you are exploring involve use of that land for wastewater management, or if the land may in some way be affected by your proposed options, then a good amount of time will need to be set aside for discussion.

Use of rāhui and tapu

It may be that one of the mechanisms your community uses to manage the risks associated with your wastewater system is to control people's use of beaches and streams that are near points of discharge. This is a tool often used by local authorities and by the Ministry of Fisheries. Māori also use the concept of rāhui to control access to a site where the resource is under stress. Tapu is used to restrict access where some serious spiritual disruption has occurred. Some communities have used a combination of rāhui and other restrictions. It may be worth exploring a joint approach.

Central government

Ministry of Health

Roles:

- sets and monitors national health standards
- monitors and grades drinking-water quality
- sets the policy framework for managing public health risks
- funds community wastewater systems.

Risk concerns:

- provision of safe, sanitary conditions (drinking water, wastewater treatment and discharge, solid waste management etc.) to all communities.

Drinking-water

The Ministry of Health does not have a direct 'regulatory' role, whereby it can require communities to take a particular approach to wastewater management. It is responsible for setting overall standards and takes a major role in setting drinking-water standards and ensuring they are maintained. The Ministry takes an interest in the development of local wastewater systems because of their capacity to pollute water supplies and because of the risks of disease.

The drinking-water standards will have major importance for your community because of possible risks to drinking-water supplies from wastewater pollution. The most common is the seepage of effluent from septic tanks into groundwater when the soils cannot absorb the wastes.

The Ministry of Health has prepared guidelines to help communities identify the possible risks to their water supplies and the plans prepared to reduce that risk. The guidelines are called *How to Prepare and Develop Public Health Plans for Drinking Water Supplies* (2001). These guidelines, together with the *Drinking-Water Standards for NZ 2000* and other material relating to drinking water, are available on the Ministry of Health's web site at: www.moh.govt.nz.

Funding for wastewater systems for small communities

The Ministry's role in funding wastewater systems has been reactivated because of the actual and perceived public health risks from substandard wastewater systems in small communities. This funding role will mean that it is likely to be more directly involved in the process of choosing a wastewater system (if your community wishes to apply for the funding available). The subsidy scheme is discussed in detail in *Section 11*.

The Ministry of Health is participating in the whole-of-government initiatives (see 'The Whole of Government Programme', below) for certain parts of the country. This means that its approach to managing public health risks in communities that are vulnerable to other problems will be linked to issues of income, the affordability of the system in the long term, and housing design issues.

Public health service

Roles:

- provides public health services in the district, including administering the provisions of the Health Act 1956
- carries out Ministry of Health policy for managing public health risks, including those related to drinking water and wastewater.

Risk concerns:

- provision of safe, sanitary conditions (drinking water, wastewater treatment and discharge, solid waste management etc) to all communities.

Public health services employ medical officers of health and health protection officers, who are statutory officers with functions, powers and duties under the Health Act 1956. They work closely with the environmental health officers of the territorial authorities (city and district councils), who also have duties and functions under the Health Act.

Before 1990 these public health services were the district offices of the former Department of Health. Today most public health services are a part of the District Health Board for the area, although a number provide services for several health board districts (eg, Canterbury Health provides public health services for the Canterbury, South Canterbury and West Coast regions).

Most public health services can be found in the telephone book under 'Hospitals and Other Health Service Providers' at the front, just after the 'Registered Medical Practitioners' section. If you can't find your local public health service, ring the District Health Board or main public hospital, who will advise you on how to make contact.

The public health service role is guided largely by the public health priorities developed by the Ministry of Health.

Ministry for the Environment

Roles:

- sets and monitors national standards for managing environmental effects, including:
 - discharges to water (no national standards exist as yet)
 - discharges to land (no national standards exist as yet)
- sets the national policy framework for:
 - sustainable management of natural resources, ecosystems, etc.
 - a national approach to wastewater management systems (see the *New Zealand Waste Strategy*)
- monitors the implementation of the RMA, which is the main piece of legislation you will have to use to get permission to develop any wastewater management system
- funds innovative community projects via the Sustainable Management Fund (this may be relevant if your community wishes to explore new systems or innovative processes).

Risk concerns:

- protection of natural processes
- risks arising from unbalanced, unsustainable general development.

The Ministry for the Environment is unlikely to take a direct role in the development of a wastewater system, but it is the key agency with an overview of decisions as they relate to the environment. The Ministry is also unlikely to fund actual wastewater treatment plants and systems, but may be prepared to fund the exploration of innovative ways of involving the community in waste management. This would be through the Sustainable Management Fund. Details about this fund can be found at <http://www.smf.govt.nz/>.

The Ministry is taking a broader interest in sustainable development issues and will provide advice to the Minister of Internal Affairs. This is likely to lead to an even greater focus on sustainable development, and a greater interest in the links between the economy, social concerns and the environment. Given the huge impact of wastewater systems for a community, there is likely to be a greater focus on wastewater issues – both from an ecosystem perspective and in terms of community management and economic development issues.

⁹ Māori land means Māori customary or freehold land as defined in Part VI of Te Ture Whenua Māori Act 1993.



Minister of Conservation

Roles:

- responsible for approval of activities within the Coastal Management Area.

Risk concerns:

- impacts on the natural character of the coastal area and impacts on coastal ecosystems.

Department of Conservation

Roles:

- looks after the Department of Conservation estate – DoC's responsibility is to protect the natural systems, native habitat and wildlife
- responsible for developing the National Coastal Policy Statement, which sets the framework for managing activities along the coast
- can comment on the general environmental effects of actions affecting the DoC estate
- may act as a funder of restoration projects for waterways – this may be a source of assistance for innovative ecosystem re-entry projects, such as wetlands.

Risk concerns:

- loss of native vegetation, habitat and wildlife on the DoC estate
- failure of ecosystem processes.

There is a good chance that the Department of Conservation will be directly involved in your processes. As a land owner it will have direct concern for the effects of any developments and discharges on its lands. The Department can be the owner of quite small areas and reserves that at first glance you might think belong to the local council. The best thing to do is to check with your local council or talk to the nearest conservancy office.

The Department of Conservation may also administer marine reserves in your area. You will need to check this, or check whether there is a proposed reserve. Standards for discharges into these areas may be different from those in other areas and could have a major impact on your options.

The Whole of Government Programme

The Government has set up a Whole of Government Initiative on Substandard Housing, concentrating on the North Cape, East Coast and Bay of Plenty areas. The aim is to improve the health and social wellbeing of people by sustainable programmes to improve their housing and economic and social welfare through a project organised and funded by Housing New Zealand, but involving a number of different ministries.

Ministry of Health involvement is through information sharing, subsidies for community sewerage schemes, and encouragement of those health professionals on the ground to identify and prioritise housing needs. The Ministry for the Environment is providing a supporting role.

Parliamentary Commissioner for the Environment

The Parliamentary Commissioner for the Environment is an independent Officer of Parliament appointed for a five-year term under the Environment Act 1986. 'Independent' means independent of the government of the day.

The Commissioner's job is to review and provide advice on environmental issues and the system of agencies and processes established by government to manage the environment. The primary objective of the office is to contribute to maintaining and improving the quality of the environment in New Zealand through advice given to Parliament, local councils, business, tangata whenua, communities and other public agencies.

The Commissioner has taken an interest in wastewater management issues, publishing *Ageing Pipes and Murky Waters: Urban Water Issues for the 21st Century* in June 2001. A local community may ask the Commissioner to investigate planning and consultation processes and issues in their area. This is an extreme approach, and should only be used if it is felt that there is no other way of working through the issues. The Commissioner will not become involved in finding solutions, but will review the overall thinking and processes.

Developers, individual land owners and interest groups

Most people will be concerned about what any general decisions will mean for their land and what they can do with it. It is important to remember that people who may be on low and fixed incomes will be concerned about the impacts of the decision on their income. People may also be concerned about the impact of any development decisions on their ability to release some of the value of their land as income later on.

These are legitimate concerns and will need to be considered and discussed as part of any exercise to explore the effects of wastewater decisions on the future of the community. At the same time, land owners will need to be willing to step outside their particular concerns and think about the big picture.

There may be developers who are keen to release some of the development potential of an area. Others will see the value of land being increased by allowing some development but limiting surrounding development. Often wastewater decisions will be key to their aspirations. They will certainly seek to be involved in the process.

This can be a positive thing, but will need to be managed. With the range of systems available, particularly cluster systems (see *Part Three*), it is possible to pull together solutions that satisfy a range of interests. Some developers may be prepared to use relatively new systems in order to achieve the developments they want.

There may be interest groups that will want to comment on your wastewater decisions. For example, environmental groups may have an interest in the impacts on the local estuary because it is of regional or national significance. Recreational fishing groups may also have a perspective.

It is very important that these groups are recognised as part of any processes, and that they do participate. It is also very important that they are made to participate in the process of discussion that will be needed to find a solution. Sustainable development means finding solutions that recognise social, environmental, economic and cultural linkages and working with them. This does not mean that environmental bottom lines and basic ecosystem needs should be compromised. It does mean there will be solutions that need to be worked through and tested from a range of points of view.

4.2 What kind of processes will your community have to deal with?

There are six kinds of relevant process:

- identification of the problem and the need for different wastewater management procedures
- an initial community-driven process to develop options and choices
- a formal statutory process to establish the council's funding policy
- a formal consent process to gain permission to construct the wastewater system
- a formal process that manages any growth implications linked with the wastewater management decisions (not always needed)
- various processes to apply for funding assistance from outside agencies.

The community process is discussed in *Section 5*. This section looks briefly at the formal processes.

Funding processes

As options are developed and tested they will need to be costed. Often the local district council will fund the development up front and recoup the costs through rates or charges. The Ministry of Health also provides funding for community-wide treatment systems for smaller communities. This recognises that the cost of new systems can often be beyond the ability of people to pay.

Local authority funding processes

The council must go through a formal process to look at the impact of any proposal on the wider community's long-term and annual costs. This process has four parts.

- Generally, a three-yearly process *identifying the community's long-term vision*. This can be a chance for the community to put forward its ideas. The passage of the Local Government Act during 2002 has created a focus on long-term community planning for a district. Local authority strategic and financial planning will be expected to fit in under this framework and link to the actions of other agencies. You will need to check the Local Government Act 2002 for details of this new approach. It provides a major opportunity for a community to discuss wastewater management.



2. Generally, a three-yearly round of *identifying the long-term costs to council* of any proposal and including these in a financial strategy. It is then consulted on formally – usually in April–June of the relevant year (each council is a little different, but fits within this timeframe), just before the final decisions about annual spending are made. This will be linked to the idea of the community plan in the new local government legislation.
3. Formal processes, following both three-yearly and annual cycles, to *identify how different services are funded*. This is very important because it will affect how the costs for a wastewater system are borne by the community. Choices for funding options are discussed in detail in section 11.
4. *An annual round to establish spending* based on the Long Term Council Community Plans (LTCCP). The annual spending proposals are consulted on in the same April–June period. This is another chance to make sure the proposals are considered.

If there has been a joint process with council to identify the preferred option, then it will be automatically included in discussion of long-term overall financial costs. This makes it much easier than trying to get your solution absorbed into costs after a council has set its draft long-term budgets. It is a very powerful reason for working with your local council. Certainly for larger engineered options, this joint approach is essential.

If you have developed a proposal independently and if you want wider community help to fund it, then you can make submissions to the LTCCP and annual plan processes. This kind of approach is probably most appropriate if you are seeking such things as assistance to manage on-site systems.

Once a proposal has been agreed to, it will be included in the detailed asset management plans, which tell asset managers what to do over a 10–20-year period.

It is important to be familiar with these processes. There will be people in your local authorities who are there to help people get involved in these processes.

Relevant legislation

New Zealand does not have a particular piece of legislation that oversees the management of wastewater other than the Local Government Act 2002. The other main relevant pieces of legislation are the Resource Management Act 1991, the Hazardous Substances and New Organisms Act 1996, and the Health Act 1956. For information on how this legislation impacts on wastewater management, see *Appendix 2*.

Getting consent for a proposal

There are two councils you will need to work with:

- the regional council, which is responsible for consents regulating the effects of discharges on the environment (water, air and land)
- the district or city council, which is responsible for managing the location and nature of activities and structures, and their effects on the environment and the surrounding community.

Where the scheme impacts on the coastal marine area, the consent of the Department of Conservation will also be required, but the regional councils usually run the process and administer the consent. If a wastewater system proposal has been developed with the district or city council, they are likely to take the proposal forward to apply for consent. Because the council is applying for the consent under the rules it has also developed, it must use a commissioner to hear and decide on a proposal. If the proposal is an on-site system, then individuals will apply. In either case, your community needs to be familiar with how the processes work.

Discharge consents (regional council)

Consent will be needed from the regional council for any discharge to land, water or air. This means that any treated wastewater and sludge re-entry system will require a regional council consent. The regional council will also be interested in the overall system if there is any risk of failures and overflows into water or onto land.

The issuing of consents will be guided by the regional policy statement and regional plans (eg, a regional freshwater plan).

Resource consent – location and effect of activities (district or city council)

The district council will need to issue a resource consent under the RMA for any physical system. For example, you may be proposing to locate a treatment plant in an area where such systems are not usually allowed. Special consent will be needed. The district council will be interested in the effect of the activity, but does not have the power to approve discharges into the environment.

The rules and guidelines for managing these effects are found in district plans. Some councils will have rules in their district plan that focus on the effect of an activity rather than on the kind of activity it is. Others may have lists of activities that will be allowed in some areas and not others, no matter what the case-by-case effect. If you need help to work your way through the detail of these requirements, your local council will have staff who can help.

There will be different kinds of processes you will need to go through, depending on the level of the effect and how far it departs from the usual standards. If your proposal is for some kind of community system, you more than likely will have to publicly notify your application so that people can comment.

This is where your earlier community process will be so important. If your community has run a good process, this is unlikely to be a major issue. Of course you may not have been able to get total agreement and it will be up to those hearing the application to consider all sides. Failure to get agreement does not mean a failed process if all people have had a chance to participate. The process has failed if people object to the proposal *because* they haven't had a chance to be involved.

If your proposal is for on-site systems, it is unlikely that you will have to publicly notify your application.

Subdivision consent

In some cases subdivision of land may be necessary. For example, a cluster treatment and associated re-entry system (see *Part Three*) may have an innovative site layout where houses are clustered on one or two sites. Subdivisional consent under the RMA is required, and is often obtained at the same time as the resource consent. Doing both together may allow for a more innovative approach to be negotiated.

Subdivision and resource consents are guided by the local district plan, which sets out general policies along with rules for controlling activities.

Discharge, resource and subdivision consents are given under the general authority of the RMA. Sections 5–8 set out the overarching framework within which the regional and district plans must be developed. The focus is on sustainable management of the environment and protection of a range of values. There is a requirement to have regard for the relationship of Māori with their lands, waters, wāhi tapu and other taonga, to give effect to the concept of kaitiakitanga and to take account of the principles of the Treaty of Waitangi.

Building consents

Building consent will be needed for any structures and for new plumbing systems that may be used to reduce wastewater production. The Building Act focuses on achieving certain standards rather than requiring a particular approach to building and wastewater systems.

A council often has a code of practice, which gives examples and basic requirements for subdivision and which, if followed, is intended to make it easier to get a consent. Be aware that some of these codes can be quite old and may not have examples of some of the more innovative approaches being used around the country. Check this out and discuss with council officers.

Council officers will be called in to advise on consents and, again, some will be very familiar with new ideas and some will not. Standards New Zealand, an organisation that develops guiding standards for a wide variety of issues, has developed guides for innovative approaches to subdivision, and these and other guides will be influential. It is important that the staff administering the consents are up to date with new ideas.

Environment Court

Any community or individual with a direct interest in the issue is free to challenge consent decisions. It is possible to obtain finance to pursue this course of action under certain circumstances. It is also possible for the Environment Court to determine that the costs of hearing and defending a frivolous or vexatious appeal could rest with the appellant, where they are considered to be an abuse of the system causing extra costs and delays for personal agenda reasons. These appeals are considered by the Environment Court, which deals with contentious issues and interpretation. It is possible to take an appeal on a point of law to the Appeal Court.



Dealing with the overall development framework

Your community may find that the overall vision for development and the associated wastewater management systems simply don't fit the current district plan policies and rules. Your local council has to review the district plan every 10 years, but many councils use a 'rolling review' process which timetables different sections for review over that period. If things are seriously out of kilter the council may undertake a one-off review.

There is also the ability to apply for a private plan change, but this can prove very expensive and time consuming. You are better off talking to council officers about the issues, and how the overall development control framework might be reviewed.

4.3 The kinds of issues each player will need to consider

There will probably be one particular issue that will start a community looking at its wastewater systems. The main ones are quickly outlined below. It is important to remember that different groups and agencies will cluster around the various areas, but in the end all the issues will need to be addressed. Each of the players set out earlier in this section will need to consider how their conclusions about the particular risks and issues they wish to manage affect other outcomes and the overall community vision.

Environmental issues

Ecosystems and ecosystem services

This has been covered previously in general terms (see *Section 1*). It will be an important factor in deciding on a solution. There may be tensions between managing health risks (often a centralised system is preferred) and managing the effects of single point discharges on the environment. There will be a range of groups interested in these issues – from environmental protection agencies such as regional councils, to hapū, to recreational fishing organisations. It will be important to make links with them all.

Other impacts

The specific effects of particular technologies and treatment processes will be an issue. Odour, impacts on groundwater and the water table, impacts on soils from disposal to land, slope and water run-off, and impacts on cultural sites and the landscape will all have to be taken into account. You will need to work with a wide range of groups and organisations, especially the local council and land-use planners.

Health impacts

Sometimes it will seem that in order to solve health problems, technical engineering solutions are unavoidable. For example, there will be the potential in your community to reduce health risks by reducing the volume of wastes. However, some of the water conservation solutions, such as re-use of 'greywater' (see *Section 6.1*) or composting toilets, can have their own health risks. Some agencies may support traditional solutions that can deal with large treatment volumes as the most proven way of dealing with human health risk.

Solutions to immediate environmental or health risks may, however, exacerbate health problems that arise from poor housing or diet because of the extra burden on income. These issues are increasingly recognised by central government agencies responsible for housing and health. Formal whole-of-government programmes are being developed to deal with these issues.

Cultural issues

These have been discussed at various points. There is a statutory requirement to pay particular attention to Māori cultural concerns and processes. But there is also a need to think carefully about other cultural values to resolve on-going conflict. These values might be expressed as a desire to keep the local beach settlement small, low-key and casual. This is not necessarily a simple 'anti-growth' sentiment that some might feel needs to become more sophisticated. It can also derive from a strong sense of place and a feeling that a community and its environment are unique. This is likely to be the case for smaller communities that are more closely attached to their local environment. These perspectives need to be acknowledged in discussions.

When you enter any formal resource consent stage, a formal assessment of environmental effects (AEE) of options will be needed. This is required under the RMA and has a number of considerations that have been shaped by case law. The range of effects that need to be assessed includes natural environment impacts and impacts on the people's social, cultural and built environment.

Cost, funding and social impacts

The cost of new systems – be they on-site or off-site – can be a problem for communities. There is now the benefit of the Ministry of Health grants to help poorer communities to make changes.

The issue of the cost of a wastewater system is an important one,¹⁰ but often the immediate costs of buying the system are the focus rather than the long-term social impacts of the wastewater decision. It is important to remember that a wastewater system, even with grants assistance, can impose high long-term costs on people with low or fixed incomes. For example, the benefits of improved public health may be offset by health problems associated with poor housing because people cannot afford decent housing. This is a recognised issue in some of the more remote rural areas of New Zealand.

The whole-of-government initiative is a step towards central government agencies thinking about the links between decisions. It is important that all participants think about these issues. A more linked approach may lead to different funding decisions, or a new approach to managing the existing systems. It may even lead a community to a different choice about the type of system they want.

Choices about community change

This was discussed in some detail in *Section 1*. Underpinning any wastewater decision will be the impacts on the future direction of the community. These need to be thought about in an open and inclusive way.

Kauwhata Marae sewage treatment system: making the system fit your needs

The Kauwhata Marae is located on one hectare of land near Feilding in the North Island and serves the descendants of Kauwhata. The wastewater system was a 3,300-litre septic tank with the overflow going into a heavy clay stratum, which was not the best for soakage. An area of only 400 m² was available for disposal. There was concern that the soakage was making its way into the nearby stream; about 30% of the disposal field was only 20 metres from the stream edge. The system also became overloaded when manuhiri were at the marae. Effluent would come to the surface and cause health and odour problems.

It was estimated that any system needed to be able to deal with about 12,000 litres per day. A marae working committee made up of marae trustees and marae committee members was set up. Over two years the committee worked with marae members and the engineer to explore options. The committee also took responsibility for consulting with adjoining land owners to gain their permission for the system chosen. This meant that the proposal could go through a non-notified rather than a notified consent process. There was a review of the site and its characteristics, and discussion of a range of options, each with potential costs. Marae members rejected any system that included disposal into the stream, and were clear that the wairua must be protected. A key step was to provide marae members with information about the different kinds of systems available and to show them the quality of the treated effluent that was possible.

The marae members chose a system that allowed them to store peak loads in three 25,000-litre septic tanks. A timer allowed the stored effluent to be treated at a constant rate by filtering the effluent over a sand bed, where micro-organisms broke it down. The treated effluent was then 'dosed' into the ground using trickle irrigation tubing at a rate of 3 mm per metre a day. The general system is known as a packed bed reactor, and overall the cost was about \$25,000.

The marae was able to build a system which satisfied their fears about the impacts of paru (effluent) on the stream and mauri. They achieved it on a small site and were even able to have the disposal area within 10 metres of the stream. The system catered for manuhiri and for day-to-day needs. They ran the process, made sure that everyone had the information they needed to make a decision, and consulted directly with neighbours.

¹⁰ This is addressed in more detail in *Section 11: Management and funding of wastewater systems*.

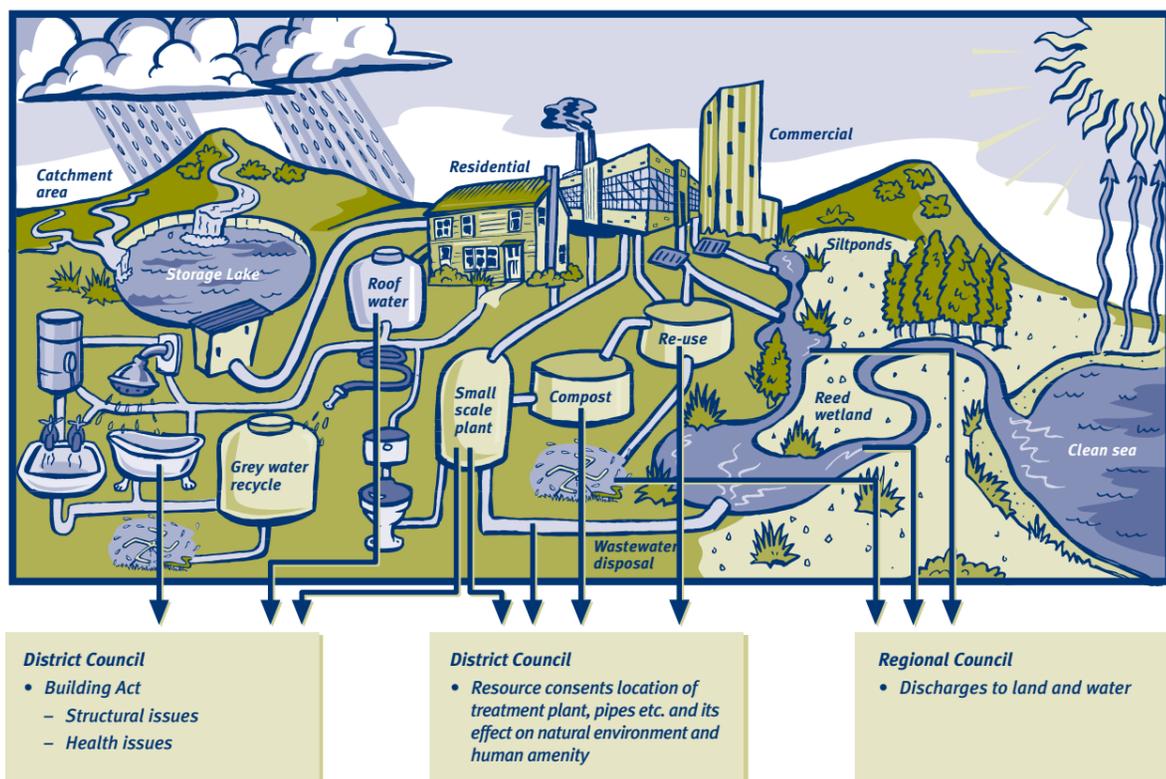


Figure 4.3 Where the responsibility lies...

COMMUNITY PLANNING AND DECISION-MAKING

5.1 Key features of a community decision-making process

Deciding on a wastewater system is probably one of the most important decisions your community will make. Not only will it deal with the wastewater itself, but it can influence how the community develops. It will have a major impact on the local environment and on day-to-day expenditure for each household.

This section focuses on a community-driven decision-making process. This is not because of any belief that local councils and experts resist or are uninterested in community involvement. The focus is based on the view that because wastewater management is so fundamental to a community's future, there is immense benefit in having real and meaningful community participation. If nothing else, it is likely to reduce the often huge lead-in times for developing a new system. Resistance and objections can often arise from lack of understanding and frustration. The costs of that frustration can be huge, not least in the costs of challenge in the courts.

The focus on community planning and decision-making is not intended to suggest that the community should 'go it alone'. Professional experts, agencies responsible for health and environmental standards, engineers and the local council will need to form part of the team and the discussions. But the handbook does take the approach that communities need to be supported and encouraged to take a lead.

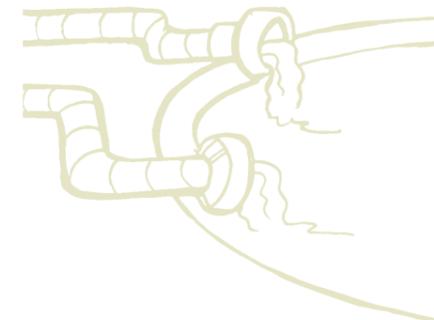
This section is written with the view that meaningful participation is most likely to occur if the community drives the process. This does not mean excluding or disregarding the expert's view or the council's viewpoints. It simply means that if people can have access to information and ideas before options are developed, and if those choices are transparent and driven locally, then a more successful process will result.

The ideas in this section are based on a community decision-making model, whereby the final decision on the best wastewater option sits clearly with the local community, in partnership with the local council. The emphasis is on encouraging a community-led process and on helping community groups with the nuts and bolts of how that might work.

There are many books and kits available on community planning and decision-making, and there is a list of helpful sources at the back of the handbook. This section acts more as a checklist of issues and hints you will need to explore in more detail as you work your way through your process.

The table below broadly describes the kind of decision-making process that smaller communities often experience when making wastewater system decisions. Usually the local authority initiates the process, sometimes in partnership with the community. The community's wider ideas or vision for their community will be sought as a kind of framework for making the detailed waste management decisions. Experts will be commissioned to develop and review options. There will then be consultation with the community, usually when the options have been narrowed down to a limited number.

Most local authorities try to consult in a genuinely inclusive way. Some will attempt a partnership approach in terms of managing the project, but a joint analysis of options is rare. This is where the experts and council officers work on the same footing with the community – where information is made available first and then there is joint development of the options and final choices. This needs skilled facilitation and a willingness to take time.



Project stages				
	Initiate	Plan (choose options)	Implement	Maintain
Self-help Community control	Community initiates action alone	Community plans alone	Community implements alone	Community maintains alone
Partnership Shared working and decision-making	Authorities and community jointly initiate action	Authorities and community jointly plan and design	Authorities and community jointly implement	Authorities and community jointly maintain
Consultation Authorities ask community for opinions	Authorities initiate action after consulting community	Authorities plan after consulting the community	Authorities implement after consulting community	Authorities maintain with community consultation
Information One-way flow of information; public relations	Authorities initiate action	Authorities plan and design alone	Authorities implement alone	Authorities maintain alone

Table 5.1 Summary of levels of involvement for a process initiated by council

Note: The shaded areas indicate the more common planning and decision making processes used.

As can be seen from the shading in the table, it is most common for the council to control the process. Both the Local Government Act and the RMA require consultation, so an information-only approach is unlikely to be used by a local authority.

A community-driven process is outlined on the next page (Table 5.2), using the same grid for comparison. A community is more likely to have confidence in a project if it initiates and designs the process. In that situation it can invite the involvement of external authorities and set clear 'rules' of behaviour and involvement. The most successful variation on this is a partnership model where the community and the authorities initiate a project together.

In terms of the second stage – the planning or options stage – it is essential that there is a joint process. This will have a big effect on how and when information is developed and made available. The community will need access to information before any options are developed. That information must be available in a way that everyone can understand, and they must be given time to understand it.

With this process some clear protocols will need to be worked out. Often a local authority will be the source of funding for the project, and often they will commission any technical studies. It will be important to agree how things like project briefs are signed off, and you will need to make sure that community people are present at discussions with any experts. It is often during these face-to-face discussions that the shape of studies and the directions of conclusions are worked through.

A self-help community control model is not useful when dealing with wastewater systems. Whether you are planning for a system for a marae, for your small bach or crib, a community, or a small town, the authorities and experts are likely to have a role. There may be some exceptions to this. For example, your community may be just looking at ways to improve how everyone manages their on-site systems. You may go to the council for information, but the real focus may be on setting up a community maintenance plan.

By far the most useful process will be to involve everyone in the planning and design stage. Indeed, a joint planning and design stage is the most important part of any process – be it community-driven or council-driven.

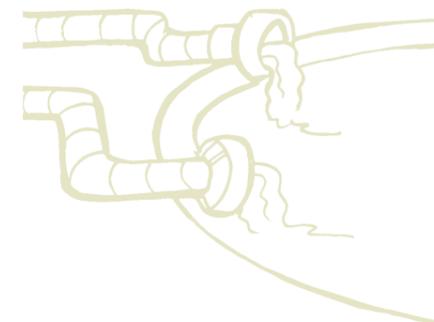
Project stages				
	Initiate	Plan (choose options)	Implement	Maintain
Self-help Community control	Community initiates action alone	Community plans alone	Community implements alone	Community maintains alone
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Information One-way flow of information; public relations	Authorities initiate action	Authorities plan and design alone	Authorities implement alone	Authorities maintain alone

Table 5.2 Summary of levels of involvement for a community-driven process

Note: the shaded areas indicate the community-planning process. The joint planning options choice stage (dark shading) is essential.

It is important to any community decision-making model for the community to keep its influence over the implementation and maintenance stages. There will always be decisions to be made, although some may be years away. For example, a system may be built and then new standards may be imposed that require some changes, such as requiring greater treatment of wastes. It would be easy to say this is a simple operational problem, but it could have as much impact as the original decision. A joint implementation or maintenance group is one way of dealing with this. Or it may be useful to sign an agreement with the council about how and when reviews and consultation will occur.

It is also important to remember that any community will be complex. The willingness to take time in the early stages will be important; it will save time in the later formal stages.



Raglan wastewater and community consultation

In 1994 a resource consent was issued to the Waikato District Council to increase the maximum sea discharge from the Raglan oxidation ponds from 1,000 to 2,600 cubic metres per day. The consent period was five years, with the condition that alternative options be investigated and trialled. The decision was appealed by tangata whenua representatives.

To resolve the appeal, a consultative group was established comprising tangata whenua representatives and an equal number of other community members appointed by the Raglan Community Board. The consultative group developed a number of options during an agreed one-year period and resolved by majority vote that a pond/wetland treatment system incorporating an extended sea outfall be adopted. The treatment standard was to meet bathing water guidelines. However the pond/wetland system did not receive the backing of tangata whenua. Consents for the pond/wetland system were granted in 1999 for a peak discharge of 3,400 m³ per day, and were subsequently appealed by mana whenua representatives, council and other individuals. The mana whenua appeals concerned the continued discharge to sea and wāhi tapu issues relating to the existing treatment site.

A mediation convened by the Environment Court was held in 2000, where it was decided that the views of council and other appellants were too divergent to allow mediation to occur. It was agreed that a less formal, facilitated meeting process might be helpful in reaching resolution. A series of facilitated meetings was held between 2000 and 2002. The meetings were funded by the council and a meeting allowance paid to appellants. A number of treatment and disposal options were put forward for consideration by appellants, council, consultants and specialist companies. Several preferred options were investigated in greater detail.

In 2002 agreement in principle was verbally reached between mana whenua appellants and council for an immediate upgrade to the treatment process to produce a shellfish-

quality discharge of 2,600 m³ per day, a 15-year consent term, and the commitment of \$1 million of council funding toward investigation and implementation of land disposal within a five-year period. The wāhi tapu site would be restored by removal of the front treatment pond. However, the agreement was not formally signed by the mana whenua appellants, who subsequently sought a five-year consent term and financial penalties on council if land disposal is not in place within five years. Mana whenua's stated bottom line is that there be no discharge to sea. Also, they retain a historical distrust of council arising from past events.

Council is reluctant to give a cast-iron guarantee that land disposal of all treated wastewater can be practically achieved within five years. This is due principally to the poor soakage characteristics of local clay soils and the potential effects on small tributary streams.

The council's perspective was that the facilitated meeting process allowed full and open discussion and provided a forum where options could be fully investigated, criticised and evaluated in light of all parties' concerns. It allowed the parties with widely differing views to come very close to reaching agreement.

The perspective of some of the appellants was that there was a recognition of equity issues and there was a genuine attempt by council to investigate alternatives and address issues. However, from the appellant's perspective, this was only a small step towards an inclusive and open process. This reflects the importance of good process in resolving these differing points of view.

After almost \$1 million expenditure of public money on the process and investigations since 1994, a full court hearing still appears likely. The old oxidation ponds are still in service awaiting a major upgrade, while the township of Raglan continues to grow rapidly. Designing a process involving community and Māori at the beginning would probably have reduced these costs.

The remainder of this section explores some suggestions about how to get started and how to start looking at options. It also provides some general suggestions on how to survive along the way.

Riversdale Beach: sticking with the process!

Riversdale is a small coastal community east of Masterton in the Wairarapa. It was first developed in the 1950s and has a permanent population of about 90 people. There are about 230 houses, so in the summer the population more than doubles. The lagoon that was used in the past for swimming is now unusable, and there is a general perception that the groundwater is contaminated by septic tanks. Future development potential is limited, but if a new system was put in it would mean further land could be developed. The community must decide on the system it wants while thinking about this wider development issue.

The community process began in the early 1990s and is still under way. The process began with the local ratepayer association taking the initiative and holding public meetings with the Wellington Regional and Masterton District Councils. A consultant was commissioned to develop a report, but the results were not agreed to at a public meeting. The report was updated three years later in 2000 and there was a community survey, which showed positive but qualified support.

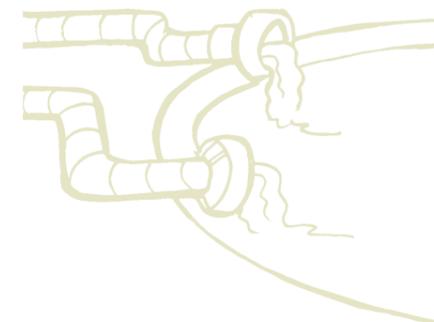
A community steering group was set up comprising two people each from the Residents and Rate Payers Association, from the wider community, from large-scale activities such as the campground, as well as two district councillors. Support was to be provided by the regional and district councils. During 2001 the group identified its objectives and further work that was needed. This included sampling on-site septic tank systems to assess their condition and undertaking a groundwater survey. It was found from these that most septic tanks did not meet modern standards and that there was groundwater contamination. It was agreed that the group would also look at water supply issues. The community was kept informed through newsletters.

A public meeting outlining a preferred option was to be held at Labour Weekend 2002. In September it was decided more detailed information was required before that presentation could go ahead. It was also agreed that the group would be extended to include local iwi and hapū and other community representatives. The group met in October and a further timeline was set. This included looking at what detailed information was required and how the wider community was to be kept informed.

The process is ongoing. It has been a long process, with times when there has been little progress. At the same time, the community has started to broaden their focus to look at water issues as well. The implications of decisions for the future development of the settlement are also understood.

Choosing a wastewater system for your community can take years from starting to think about it, setting up the process, doing the investigations, looking at technologies, getting funding and building the system. It will be slow, time- and energy-consuming, and frustrating. Meanwhile there will be pressures to move faster. It will be important to make progress, and you will need to be flexible. It will be equally important to make sure that what your community felt was a good process at the beginning is being followed through.

The project will be complicated. You will need to get a feel for the community's attitudes to growth, understand the technical options, environmental conditions and standards, different ways to fund and how the rating system works, and how formal resource consent processes work. You will need to find out who the movers and shakers are and who the politicians to work with are in the council.



How to survive: some advice!

- *Accept varied commitment and people's limitations. People will have different levels of time they can give. Don't get resentful if it is small, and take what you can get.*
- *Be prepared to repeat yourself. People will come and go – seasonal residents will have varying involvement. Be prepared to provide updates and to repeat information.*
- *Run a positive process – avoid the 'agin the government' approach. It is easy to get angry or dump other frustrations with authorities on the process. Try to be positive – it will allow you to explore options more easily.*
- *Give yourself a break – make it okay for people to move in and out of the project. The process will use up energy. The more tired people get, the harder it is to try out new ideas.*
- *Give people room to change their views. People will have strong views about the 'right' wastewater system. Focus on providing information and ideas that will allow them to change without losing face.*
- *Avoid the inner and outer circle approach. This is especially an issue for coastal communities where permanent residents and visitors don't always interact. Everyone's views are legitimate, and tolerance of different views is essential.*
- *Make sure the process makes it possible for everyone to take a leadership role. There is a danger of confident people dominating the decisions and ideas. There is also a danger that you will run out of steam when the leaders get exhausted. You need to encourage a pool of talent and be open to new people. Encourage people to take new people under their wing.*
- *Use different ways to communicate. Don't rely on endless papers and reports – only some people will engage with that. Use discussion, drawings, pictures and maps to convey ideas.*
- *Be honest about what is possible, or the size of any task. Don't suck people into the process with the idea that there may be only small involvement. Feeling trapped into participation is not going to be helpful in the long run.*
- *Be prepared to use outside help, such as a facilitator, to resolve conflict. You will run into conflicts – there is no doubt about that – within the group or outside. If you feel you can't fix it, get someone who is independent to help. Don't feel you have failed by doing that.*
- *Acknowledge that there are differences in power and influence right from the beginning of the process.*

5.2 Getting started

A community decision-making process usually starts in an informal way, with people slowly deciding that something needs to be done. There will be discussions among individuals, and then at some point things will need to 'go public'. There are different ways of doing this depending on the focus for your community. It might be via your local residents and ratepayers group, or the local school trustees group, or the local sports club.

Once you have started talking to each other and have agreed that something needs to be done, the first thing to do is sit down as a group and draw up a 'risk management plan'. This might seem a bit technical and bureaucratic, but it is absolutely essential if you are going to be successful. It is a simple process that needs to be documented as you go.

Getting on board with the idea of risk

Whatever the decision-making process your community chooses, you will not have perfect information to give you complete certainty about what the right decision is. You will have to work with the idea of risk, which involves understanding that problems may arise, the nature of those problems, their potential impact, and the probability of when they might occur. You will need to put things in place around these risks to either reduce the probability of the problem happening, or to deal with the problem when it arises.

There will be risks associated with the decision-making processes themselves: for example, a poorly run process brings the risk of increasing costs in formal resource consent processes. Over-confidence, listening too much to 'false alarms' and not listening to 'silence' around key issues are all risks.

There will be risks associated with each kind of technical solution; some will be acceptable to the community and some will not. Or, you will need to set in place processes to deal with them. For example, on-site wastewater systems can reduce the risks of water pollution, but there are risks that people will not look after them and they will fail. The community can either choose another system, or put in place processes to avoid the risk of people's neglect of their septic tanks.

It is important that the idea of risk and steps for managing it are part of every stage of the process you are working your way through. This needs to be done in a formal way, and you need to record your thinking.

The four steps for risk management

Risk management has four separate steps that need to be worked through.

Step 1: Understanding the issues

You need to understand the various stages of the overall process you are going to go through so that you can consider the risks associated with each of them. Overall there will be three broad levels of risk to think about:

- risks to your process of decision-making
- risks associated with the technical solutions you choose
- risks associated with the receiving environment.

In terms of process, you will probably pass through the following stages.

1. Getting a community mandate to start.
2. Initial design of your community decision-making process.
3. Gathering information about and understanding:
 - environmental problems
 - public health problems
 - how the natural systems work in your area
 - the social and development pressures on your community and people's expectations
 - types of technical wastewater systems, what they can deliver and their ability to deal with risks
 - the relationship between the possible systems and the realities of your area.
4. Choosing the best option.
5. Developing the best option.
6. Managing it in the long term.

You need to understand the risks associated with each stage. You will not necessarily understand all the risks at the beginning, and you will learn a lot. Don't worry about that, but make sure you review things as you go. Talking to other communities who have been through it will help.

In terms of risks in relation to technical systems, there is a range of things you can think about. These are explored in detail in Part Three, but some examples are:

- treatment process failure
- the reliability of the engineering systems and plant
- impacts of re-entry on the environment (eg, odour)
- re-use of recovered water and biosolids
- the ability of the community to manage the system
- development pressures and the capacity of the system
- ongoing running and maintenance costs.

Step 2: Risk or hazard identification

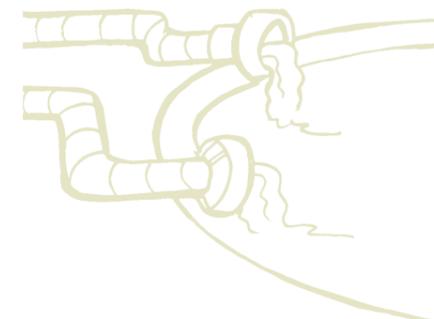
This step involves identifying each source of risk for each stage or issue. This is a very important part, and a number of the sections in this handbook will help with tips on what the risks might be and will provide information to help.

A particular issue for understanding risk in relation to the technical systems will be understanding how things will perform in normal conditions and in abnormal conditions. Normal conditions would involve understanding issues around the impact of discharges on the environment. Abnormal discharges might involve understanding how the treatment system might work if extra toxic waste suddenly went down the pipe into the plant, or how the plant would stand up to an earthquake.

Step 3: Considering the consequences of each risk

This involves thinking about the consequence of a particular risk and the probability that it will happen. For example, a risk might be that you could be challenged in the Environment Court by parts of the community, or they don't agree with the final option. The consequence might be that you have to start again. A key question is: is it likely to happen, for example, if you fail to keep people informed or fail to get them involved? This does not have to be a complicated process, but it can be enlightening and very useful.

There will be some technical issues to do with risks that you will need help with and that can be dealt with as you go.



Step 4: Managing the risk

This is the process you will put in place to deal with the risks. Often the process risks are neglected while a lot of effort goes into the technical risks. Within the technical area a lot of effort often goes into understanding the ability of the technical system to deal with health risks and environmental risks; less effort goes into dealing with the risk of the community not being able to manage the systems once they are built.

Your risk analysis may have layers, with a simple analysis of risk for each stage and then more detailed thinking for ‘bits’ within each stage. It may be worth developing simple sheets to record your risk thinking. They could look something like *Table 5.3*.

Process risks			
Stages	Risks	Possible effects	Management
Obtaining mandate	<ul style="list-style-type: none"> Others challenge process 	<ul style="list-style-type: none"> Delays Increased costs Diverse community – moderate risk of happening 	<ul style="list-style-type: none"> Make sure all groups are involved in setting-up process Develop communication plan (eg, newsletter)
Gathering information	<ul style="list-style-type: none"> People do not understand technical issues Important information not gathered in time 	<ul style="list-style-type: none"> Unnecessary conflict over options Delays All options not considered Technical issues complex – high risk of this happening Options cannot be fully reviewed Time delays 	<ul style="list-style-type: none"> Work out a process to introduce technical information Choose experts who can communicate Set timetable and do not proceed to next stage until people are comfortable with info
Misinformation	<ul style="list-style-type: none"> Information from one person, group or the media distorts facts 	<ul style="list-style-type: none"> Unnecessary conflict Lost time as issues are relitigated 	<ul style="list-style-type: none"> Have a communication plan Get someone respected by all groups to write up and send out information
Lack of resources	<ul style="list-style-type: none"> Overestimation of what can be achieved 	<ul style="list-style-type: none"> Unrest if don't deliver on promises (eg, about the process) Exhaustion for key people Some people excluded 	<ul style="list-style-type: none"> Think carefully about the process and what is needed at the beginning Negotiate resources – don't participate until this is in place
Consenting approvals	<ul style="list-style-type: none"> Major challenges through to Appeal Court 	<ul style="list-style-type: none"> Failure to include all groups and consider perspectives Failure to consider alternatives to proposed options Poor communication 	<ul style="list-style-type: none"> Spend time on planning the project Identify the full range of interests Involve them from the beginning Ensure you have the right information available

Table 5.3a Process risks

System risks			
Issue area	Risks	Possible effects	Management
Treatment process	<ul style="list-style-type: none"> Unable to handle normal circumstances (for your area) of both domestic sewage and food-processing tradewaste Abnormal – major sudden toxic load Odour and noise Plant breakdown 	<ul style="list-style-type: none"> Treatment system shut down – have to find short-term alternatives Low risk in normal circumstances High risk in future – area growing and new businesses coming in 	<ul style="list-style-type: none"> Set standards for normal treatment performance <p>Either:</p> <ul style="list-style-type: none"> set standards for tradewaste entering the system – restrict those the system cannot deal with <p>or:</p> <ul style="list-style-type: none"> restrict business growth <p>or:</p> <ul style="list-style-type: none"> identify likely tradewastes in future and design system to fit have a back-up plan in place if system fails resource consent and discharge permit provisions.

Table 5.3b System risks

With system risks, this process does not give you the final answer about the best system, but allows your community to assess the cost of designing the treatment system to reduce the risks. It also pushes you to assess the costs of a back-up process if the treatment system fails, or the costs of restricting some business development.

You won't know all the risks you need to consider before you begin the detailed thinking about technical options. But if you are going to use a community-based decision-making process, you will need to begin thinking about these issues early on. Often the traditional approach is to have experts go away and assess systems and risks, rank them, and then ask the community to make choices. A community-based system requires your community to understand the issues and risks prior to exploring options. Therefore, as part of your community design process you need to plan for time to gather and make information available to people about the kinds of risks and issues that exist.

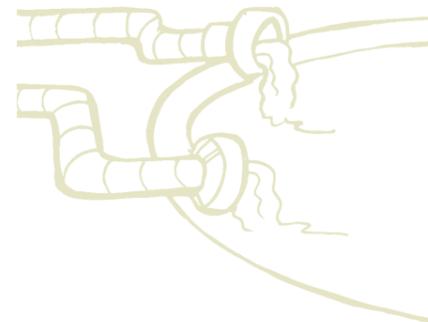
Many of the environmental and health issues will be discussed by professionals in terms of risk. For example:

- What is the risk of health problems if there is some leakage of sewage from pipes or a septic tank?
- Should pipes and a treatment plant be designed so only a certain number of overflows occur?

- Is it a problem if the overflows are cleaned up immediately?
- Is it better to design the wastewater system so that people will never come into contact with overflows?
- Or is it more realistic to allow for some overflows, but put up signs to keep people away from beaches or discharge points when it happens?
- What is the risk that people will take no notice?
- What is a reasonable compromise between health risk and building heavily designed systems that are extremely expensive?

There are further questions:

- How likely is it that there will be a failure in the nutrient cycle in the local lake if a certain volume of nitrogen is deposited in a nearby stream?
- Will there be an immediate effect, or will the amounts need to accumulate to have an impact?
- What is the level of risk if the volume of water in a stream is low because of drought over the summer?
- What is the probability that drought will happen?
- What is the risk of pollution of groundwater and soils if there is heavy rain and the water table rises?
- What is the likelihood of heavy rain and flooding?



These last issues are particularly hard to understand because the experts talk about such things as a one-in-five-year drought or a one-in-100-year flood. This doesn't mean that the flood will only happen every 100 years – it could happen any time. It means that a flood of a certain size occurs more or less frequently. The risk management issue is making sure the system is capable of dealing with that volume of water if and when it happens.

Understanding this language of risk is important. A good community process will depend on people having a general understanding of the technical issues so they do not feel forced to accept options and decisions. This does not mean everyone needs to become an expert, but experts will need to be prepared to explain the technical language and the way they think about risks. Your community process will need to work with each expert to understand the risks they are trying to manage and the trade-offs and compromises between them.

The remainder of this section looks at designing your community-planning decision-making process.

5.3 Developing a decision tree

Some risks to be managed include:

Issues coming from 'left field'

- information is not ready when you want to start making decisions
- the formal consent process fails or is slowed.

These risks are heightened if you have not:

- thought through all decision-making points or stages
- thought of all the material 'inputs' at each stage
- factored in the thinking about risks at the right time.

It is all very well to think about the risks and issues. But how do you string them together in the right order? There is a logic to decision-making that is often only possible to see if you build up a road map of the key routes, intersections and give-ways. This visual approach is sometimes called a decision tree.

A simple decision tree is shown in *Figure 5.1*.

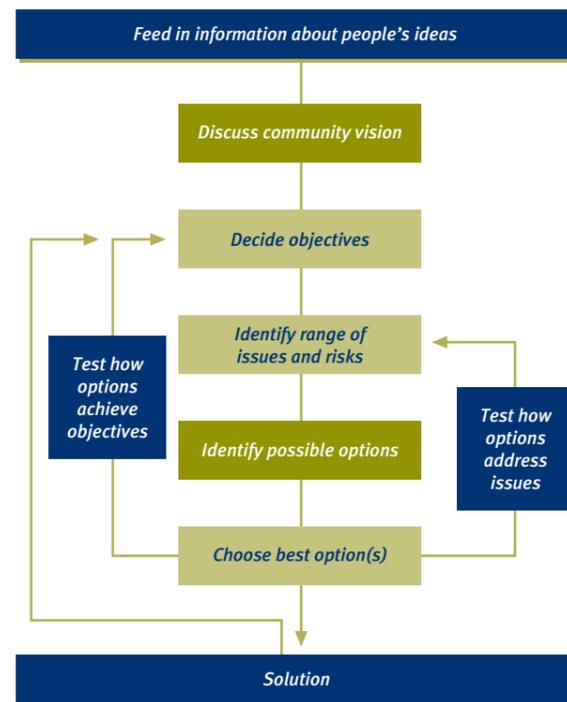


Figure 5.1 An example of a simple decision tree

There are some examples of decision trees, flow charts or 'logic processes' in *Appendix 8* which have been used for some wastewater options. They include:

- a process for deciding whether pit toilets are the best option
- a process for deciding on a septic tank system.

The focus of these is on the important decisions that will need to be made about technical options. The process can also be used to describe and plan each stage of the community process. For example, the next subsection is on how to get a mandate and how to keep it. It may be worth drawing up a flow chart or 'road map' of the main things that need doing, and the decision points.

A decision tree can be used for the 'information gathering bit', for any process that you might use to work through with the local council, for any part of your overall task. In fact you can have a series of layers, with a broad overall process, and then a breakdown of each part. This might seem excessive and overly detailed. But if you remember the length of time (it can be years), the amount of effort and the complexities of the formal consent processes, it is worth doing.

Remember that the potential impact of the wastewater decision will determine the complexity of your processes. If it is a simple issue of whether to upgrade the septic tanks in your area, this may involve less complex processes than if the issue is whether to build a big system that can accommodate major new growth. This is discussed further below.

5.4 Getting a mandate and keeping it

A key thing will be to talk to the people you think have influence in the local community (it may of course be you!) and get them on-side about doing something. This is called having a mandate.

You face a choice, at some point soon, about whether you go to the local council or whether the local community builds up its own mandate. You may be tempted to go to the council because you can get money to help in the early stages. In fact it may be useful to try to put off doing that until you have a clearer idea of what you want to do.

Even if the pressure to look at wastewater issues is coming from outside, make sure you have got your own process well pinned down before you respond to that timetable. It may be worth letting someone know that the community is looking at a process, so that a formal one is not designed and under way before you know it.

Think about bringing people together and get a mandate to start a process. At that meeting:

- get agreement on the way forward (eg, are you going to work via an existing structure?)
- get agreement about who would like to be involved (don't worry if the group is large)
- be prepared for the wider group to start taking the initiative and leadership
- get agreement about how things are to be reported back and how people are to be kept informed
- agree when any positions of leadership and representation are going to be reviewed.

Some risks to be managed include:

- challenges during formal processes, such as when going for a resource consent
- splits in the community that lead to long-term tension
- having to go back and repeat parts of the process.

These risks can be reduced if:

- an effort is made to involve all groups
- people in the process feel that their representatives are expressing the wider views of the group.

5.5 Developing a process with iwi and hapū

If your group is driven by your local iwi, hapū or marae then this is not going to be an issue, although, as occurs in any situation, the processes among these groups do not necessarily always work well. Otherwise, now is the time to make sure you have a partnership with your local iwi or hapū, or their representatives.

Remember:

You should not treat your relationship with iwi as a sort of consultation process. You need to have an agreed joint process with them from the beginning.

Communities becomes frustrated when authorities press ahead with ideas and develop proposals and options before seeking to involve them in the process. Māori communities are no exception. The role of Māori in any wastewater management initiative extends beyond that of simply being a stakeholder – they have a formal role in the decision-making process.¹¹

Certainly, as part of any later formal consent process, you will come to know what local Māori groups, including iwi and hapū, in your region think of your proposed options. However, the collaborative approach (in terms of the principles of the Treaty of Waitangi and provisions of the RMA) assumes a level of participation by Māori which is more comprehensive than that of endorsing (or challenging) your final proposals. The best way to do this is to start early.

Your picture of partnership with various groups could look something like *Figure 5.2*.

¹¹ See *Section 4.1*.

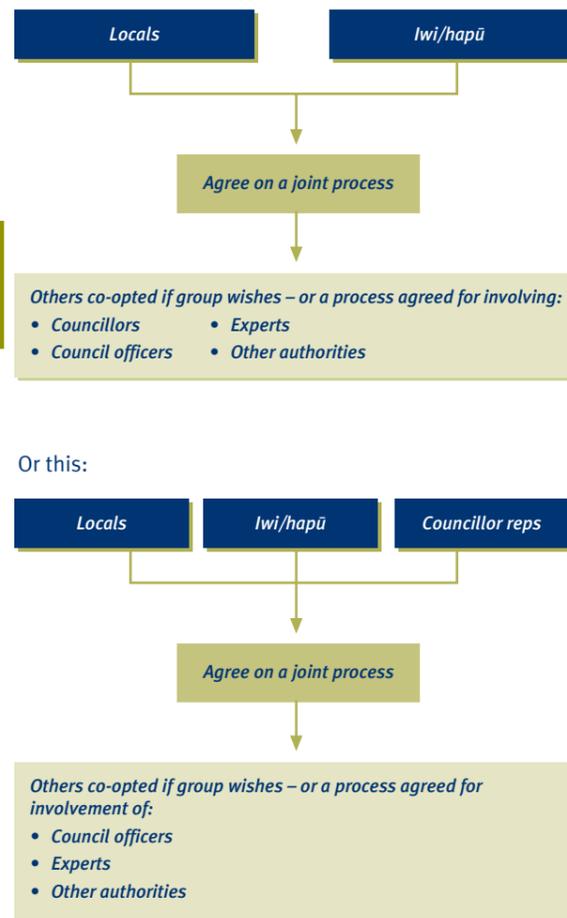
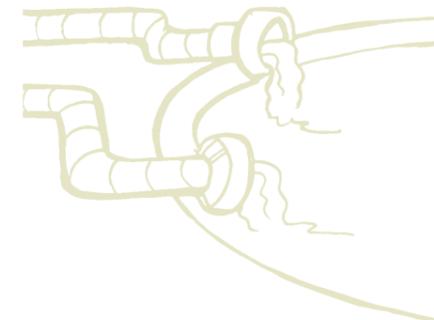


Figure 5.2 Examples of community partnerships

Working with iwi and hapū organisations and with Māori residents: some tips for those who are unfamiliar with the area

- Don't assume that local Māori residents are members of the local iwi. If they aren't, they cannot be expected to speak on their behalf. They *may* however, be able to help you identify the relevant representative body with which you should be making contact.
- You will still need to talk with those residents, for they will not only offer a relevant cultural perspective, but as community members, they may also have views on your proposed initiative. It is important to remember that engaging with Māori at this level is not a substitute for working with the relevant iwi or hapū authority.
- Your council may be able to help you to determine whom to contact, but don't rely on that – not all councils know or will have got it right.
- Once you have made contact with the appropriate iwi organisation, it may also be appropriate to engage directly with various hapū in the region. This is a bit like talking to a regional council: it may have responsibilities for some things and the local authority will have responsibilities for others, often with more direct day-to-day involvement. Representatives from your local iwi authority will be able to advise you on what level of consultation, beyond the representative body, might be necessary, and may also be able to provide assistance to ensure you get it right.
- You may find local hapū to be marae-based, including a marae committee, and you can make contact through them.
- In addition to iwi and hapū structures there will be family or whanau groups who may own land in the area or have an interest. They should also be approached to see if they have an interest in being involved. They may also be happy to work through the other groups.
- You may find that tensions exist between the various hapū and the iwi organisations on these issues. There may also be conflicts and tensions between individual people – this is no different from other groups. Don't get bogged down in the issues. Don't expect groups to agree – there is no reason why they should. After all, local and regional councils don't always agree.

- Remember, too, that there may be other groups who have had a history there in the past who have moved out of the area long ago. They may have urupa (burial grounds) or other wahi tapu, which they have an interest in protecting. This is akin to having a family grave in a town that you no longer live in. You still have an interest in protecting the site.
- Talk to as many of these groups as possible about how they may want to be represented on any steering group. Don't be afraid of having a number of people there. They have a responsibility (called manakitanga) to look after the wider community as well, and they will. They may prefer to agree to a good process rather than having representatives. That's fine, but you will need to take responsibility for making sure that talking and discussion occur.
- Remember, like other members of your community, many Māori are working full-time. As well they may be heavily involved in marae and a host of other activities. Don't assume that because they are unable to commit a lot of time to something, they are not interested in the issues, or are not concerned.
- If, as a part of your over-all project you will be seeking funding assistance, remember that many marae and other iwi organisations also operate on limited resources. Take into account that they may need assistance to participate in any community planning process.
- Wastewater management often affects wahi tapu and seafood-gathering areas. You may need information about sensitive sites to manage discharges. Be aware that often, only certain people will hold that type of information, especially where wahi tapu is concerned. Past desecration may make people reluctant to give out information. Talk this through and work out a way that can allow good decisions to be made without endangering the sites. Something may have already been developed with the local council. Check this out.
- There will be protocols used in meetings and discussions – make yourself aware of them and see how they can be respected in any wider processes the community may have.
- In the end, the key issue is likely to be whether treated wastewater is passed directly to water or passes through the land. You will need to include this in your thinking. You will also need to be honest about whether the community is really committed to examining this issue. The partnerships set up at the beginning of the process may need to make a formal commitment to looking at this approach so that it does not get lost.

- Remember that iwi/hapū members will be involved in any resource consent process and have a formal statutory right to be there. They will reserve that right. They will also reserve their right to challenge some issues. This is a bit like the council: it will involve itself in discussions and develop options, but it also has responsibilities through formal processes to protect the environment. Like iwi and hapū members, the council will protect its regulatory role.
- This may all *seem* complicated, but it is no more so than trying to cover all the other residential groups and interests, the ratepayer groups, the recreational fishing groups, your project will bring you into contact with. Do not assume that in talking with one person, you will have addressed all possible issues.

Remember:

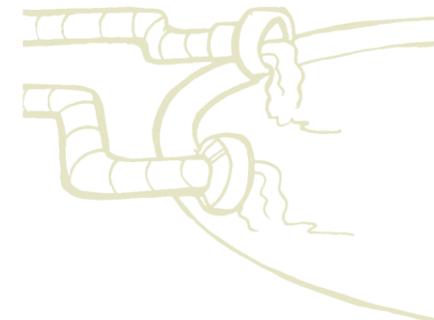
- don't worry about getting things wrong at first
- talk things through with your iwi, hapū or marae organisation
- people will welcome a process that is done in the spirit of partnership.

Risks to be managed include:

- rejection of your community process by the local council if it has a commitment to working with iwi and Māori residents
- loss of trust between Māori and the wider community and council if the wastewater issue is poorly managed
- challenges during formal processes, such as when going for a resource consent – considerable weight will be given in formal processes to how the community has worked with iwi and hapū
- splits in the community that lead to long-term tension
- having to go back and repeat parts of the process.

These risks can be reduced if:

- iwi, hapū and other Māori residents are involved early in the process and work in a partnership framework, including at the decision-making design level
- wider kaitiaki responsibilities are respected and statutory requirements understood
- the particular spiritual concerns of all groups are recognised and given respect
- iwi organisations work well with local hapū or marae groups, and vice versa
- there is willingness to seriously consider Māori perspectives about waste treatment and re-entry into the environment
- all people who have a right to speak for the groups are included and consulted
- enough time is set aside for internal discussions.



5.6 Designing how you will explore options

Once the community has decided on doing something and has established some sort of structure to take it forward, the next stage is to design the process for choosing wastewater options.

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One tip for designing your process is to understand the level of agreement in the community about where people want to go. What is the *long-term vision*?

There may be a remarkable agreement about what that vision is. There may not only be agreement among locals but with the wider council and with possible future developers. It may be that your community is not under a lot of population pressure (either growth or decline) and there is little pressure from tourism. It may just be that the current wastewater system is old and needs replacing, and you want to review what is available. Or it may be that the community is not sure if it is right on the ‘cusp’ between continuing with an on-site system or changing. You need to know whether you really do have to change your system or whether you have flexibility.

Suppose you want to get a better system, but you don’t want to change or grow. In that situation you don’t need any elaborate exercise of matching choices about community development to wastewater systems. You just want a simple technical fit to your circumstances.

Straightforward? It seems like it. You had better be sure, because if you make assumptions and get further down the track – invest in a system and then face major pressures – it’s going to be a big problem.

This suggests you need a ‘community vision-checking’ exercise. This is really just bringing people together to look at people’s expectations for the area, what the pressures are, how real it all is. The questions the community can ask itself can go something like this.

1. Are there any existing plans for some land owners to build and develop?
2. Does anyone have a development gleam in their eye?
3. Do people want to subdivide their backyard (eg, to fit a bach for the daughter’s family on it)?
4. If everyone did that how much growth would there be? A lot?
5. Does anyone know of any outside developers who are keen to do something?
6. Does the council have any grand plans? Check for an Urban Growth Strategy and what is in the LTCCP.¹²
7. Is there going to be a major oil or gold find in the area that will mean a boom?
8. What are the tourism operators up to?
9. Is our town ever going to attract a tourist?
10. What does the district plan say?
11. Do you generally mind if things change? Are there differing views on this?
12. Is the population declining?
13. Is your community growing?

If there are conflicting views you don’t have to find a solution. In fact don’t even try – it will just become messy and it is unnecessary. You just have to know what the pressures are and whether there are differing views in order to develop a process. Once you know, you can put together the best planning and design process to fit your circumstances. You can find this information out in various ways, and you don’t have to spend a lot of time doing it.

Some tips

- Check whether this sort of thing has been done in your area in the last few years. Local authorities do visioning exercises more and more. Don’t reinvent the wheel.
- Don’t spend too much time getting information at this stage. Getting the local planner, or local land owners/ developers to present ideas to the community may be useful.
- Above all, talk to land owners, hapū and groups such as local women’s and service organisations.

¹² Long Term Council Community Plan

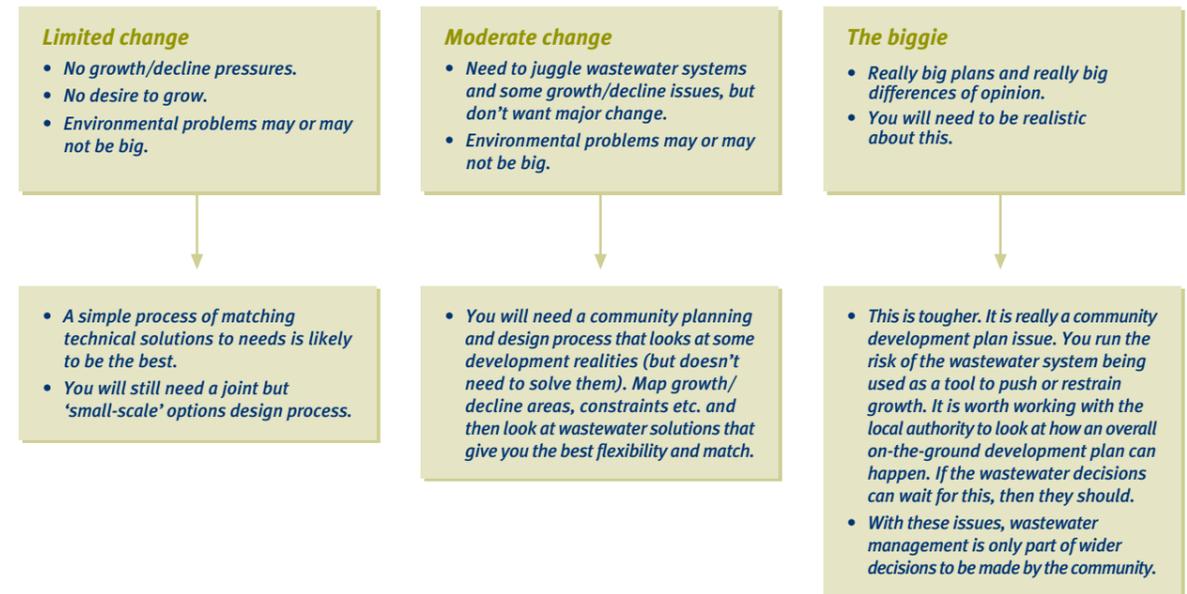


Figure 5.3 Examples of community classification

Remember that you are not trying to solve future community development issues – only find out what is going on. Once you know the attitudes and possible pressures, you can probably classify your community into something like Figure 5.3.

Community control over analysing options

To ensure a community-driven process for selecting a wastewater system, it is essential that the community manages the way that options are developed and selected. Often the model used by an external authority is to seek preliminary views from the community – usually about general values and development intentions – then develop options. The information used to develop the options is developed by the professionals for professional use in the options analysis.

The community process means the information is developed for use by the community and professionals, who will combine for a practical analysis of the options. The community will need to have a major involvement in setting the framework and signing off work commissioned for the project. It will have to insist that the community understands the background information and the possible systems before the actual joint community design/options analysis happens.

Developing options: some ideas on how it might be done

Whether it’s the ‘limited change’ approach for your community, where the wastewater issues are dominant, or ‘the biggie’, where the development issues dominate, a community-based options design process is important. Whatever the process you choose, there are three broad elements that probably should be included.

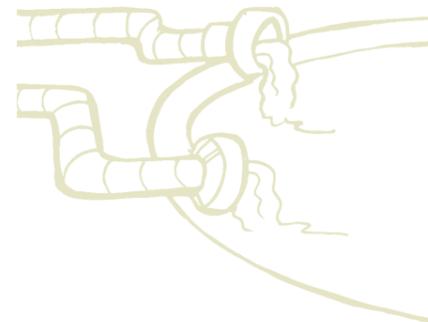
1. Pull together the information needed to think about options and get it out to people first. This needs to come before any joint options/solutions session.
2. Then hold a *joint community options process* – in conjunction with the experts and key players.
3. Finally, design a *follow-up period* where people can consider the ideas developed, think about them, get them checked for detail, and work through any further choices.

It is important that whatever the process, the community has access to information first and can take a lead role in a meaningful way. From an expert and council perspective this can be very valuable, provided everyone has the same level of information and the process is not captured by a few informed members of the community.

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A joint community options event: a possible approach

One approach to bringing the community together to choose a range of options for detailed analysis is to have a ‘short sharp event’ that takes place over a set time – perhaps a week or a weekend. Experts and the community would work together in the same room on plans and in discussions. The focus should be on the actual physical place – you cannot choose a system without stepping out the door and looking at the area you are planning for.

This means going beyond general vision statements such as ‘to have clean beaches’ or ‘to ensure that where possible the wastewater system replicates natural processes’. The process needs to focus on actual maps, visiting sites, and deciding exactly which part of the landscape might be modified to take a plant. It is really just old-fashioned physical planning based on the place, while trying to select technical wastewater solutions that fit your community’s social and economic needs.

This options process should not be a general overview of the issues. It should get down to where, what and how, and should be able to test for costs as you go. The wastewater experts you work with ‘shoulder to shoulder’ should be able to produce a general range of costs for different systems easily. If there are conflicting views, try to fix them on the spot by finding practical on-the-ground solutions. *Figure 5.4* provides a template for a community options session, providing goals for what you can expect to achieve.

There are variations to this approach, but the main idea is to avoid a long process of community vision statements, consultant reports on technical issues, then separate development of options, then submissions, then a decision. A ‘place’ focus allows everyone to take all the factors together, test options, and discard some at an early stage without fixed positions being taken. Local knowledge is just as important in this process as expert knowledge.

With this kind of process, the preliminary information stage is essential to ensure that everyone participating in the process has equal access to information. There should be no surprises.

This isn’t a magic solution, nor is it guaranteed to be problem-free, but it does help people to look at things in a fresh way. It helps people to work together and deal with the detailed issues, rather than looking at general principles and leaving the experts to develop the options. It will require some intensive project management pulling all the information strands together for the joint options work.

Some risks to be managed include:

- *resistance to a community decision-making approach on the part of agencies (low risk: most agencies are committed to community processes)*
- *loss of community influence during the process (medium risk)*
- *it can become a long, drawn-out process, with high costs, loss of influence and burnout (high risk)*
- *people dropping out of the process (high risk)*
- *capture of the process by particular interests and groups (high risk)*
- *external agencies may not trust the process and therefore decisions, and will challenge outcomes in formal processes (medium risk)*
- *the process bogs down in debates about the future development of the area.*

These risks can be reduced if:

- *people feel empowered by having access to knowledge and information*
- *agencies feel a community-driven process is designed to include them and their particular responsibilities and concerns about risk*
- *people recognise that the wastewater issue is intertwined with questions about the future of the community (development issues)*
- *the community is involved in the commissioning of information*
- *the process is designed to consider development issues ‘head-on’.*

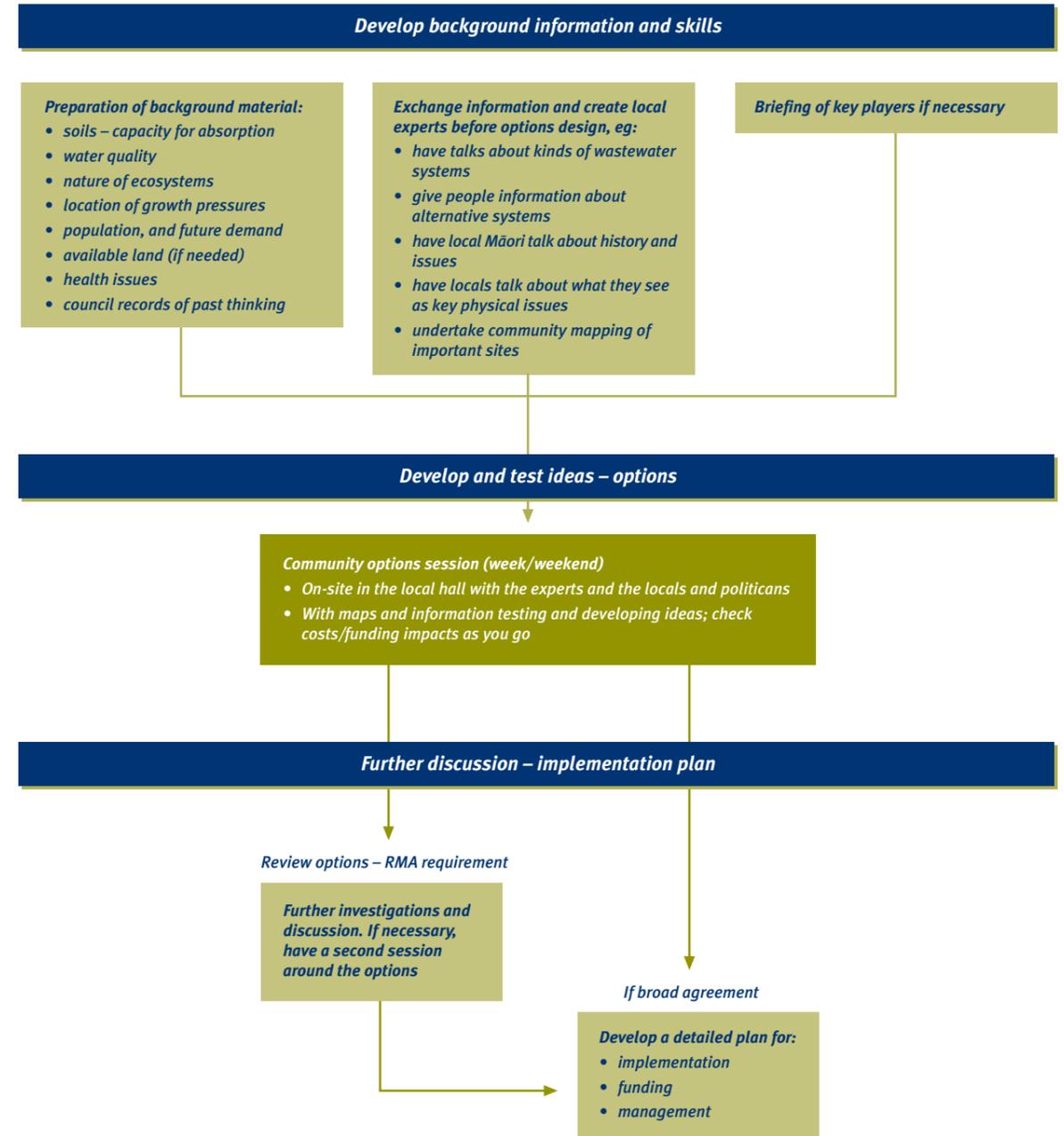
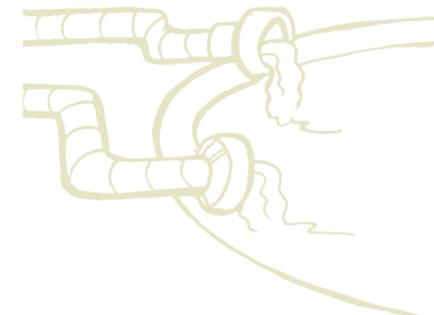


Figure 5.4 Developing a community options session



5.7 Information

A community-led process means having access to information about issues and opportunities in a form people can understand. The information you will need will fall into four broad areas.

- *an overview of pressures and people's vision for their community:* to help understand the kind of community options process you want to use
- *the legislative framework:* including the local land-use and environmental management rules set out in the local district plan or the regional plans
- *technical information to bring people up to speed so they can participate in developing options:* if the information is being commissioned via the council, don't fall into the trap of getting an expert 'options analysis' done before any community design process. This may foreclose on perfectly acceptable systems. The options thinking should be developed once everyone has had access to the necessary information. You may use a formal risk analysis process that helps you to identify all the information you are going to need
- *expert peer review of the solution developed by the community to see if any technical issues have been missed:* don't fall into the trap of this part becoming the real options analysis, with the community design process being just an information exchange forum. The community design process should have people there who can look at options in terms of funding and costs, as they are discussed.

The information gathering should emphasise pulling in people who are able to talk about information and explain technical matters and ideas. People in the community will have to do their homework and read written material. This does not mean they can become experts. It does mean they should be able to hold their own in discussion, challenge ideas and act as full players in any options decisions.

How to gather the information

You may choose to depend on a relationship with the local council to gather information and engage experts. How this is done will be important to the integrity of your options process. If the commissioning of the work is left to the council, it may fall back into the old process of commissioning an options analysis and then consulting. This won't be because of a desire to ignore the community-based approach – it will happen because people are used to working that way. A community design process needs the information to be gathered and made understandable, with the options analysis happening later as a team process.

So, if you are working with the council, consider developing a process that provides for the following.

1. Issues and options development stage

This will involve:

- joint exploration of information gaps
- identifying how these might be filled
- jointly commissioning an expert to develop information if there is a gap
- jointly interviewing and assessing the ability of experts to:
 - convey information in lay terms, verbally and with graphics
 - listen to local information and ideas and respect them
 - work in combined design groups
- development of a process for formal assessment of environmental effects (AEE).

The last of these skills are important and may not be so easy to find. There will be some land-use planners (planners will need to be involved) who are used to such a process. Some engineers may be less familiar, but will be more than willing to participate.

2. Technical peer review of options, environmental effects, costings and analysis against objectives.

Jointly commission the peer review with a clear project brief.

Avoiding re-inventing the wheel: where to go for assistance

It may be useful for the community to explore the availability of experts and establish a pool of people who would be useful, before starting any formal process. This will include those who can undertake assessment of the environmental effects of options. Some engineers specialise in wastewater systems for smaller communities; it will be worth searching them out and getting them to talk initially about concepts. There are also organisations that have an interest in the improvement of wastewater management and the use of alternative systems.

Many small towns and settlements – especially coastal towns – have struggled with wastewater issues. It would be worth hunting them down and talking to people, maybe even getting them to come to talk to your community. The case studies used in the handbook will give you some ideas but there will be more. Professional experts might be able to point you to others, while local authorities should be able to help you with examples in their area.

Finally, there is a very good chance that wastewater issues have been investigated for your community or nearby communities by the local authority in the past. It is worth digging for this. Current staff may have limited knowledge of the work; if so, try to get someone to go back through drainage records to check. The technical information and systems may be dated, but there may be perfectly useful information about soils, hydrology and even water quality.

Your community may have attempted to get to grips with the issues in previous years. Check this out and try to track down the person who holds the records.

General checklist of information needed for a design process

(a) Understanding future demand for wastewater services

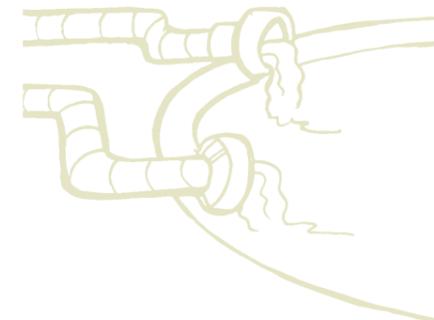
Your local council should have some feel for this. It can be commissioned or it can be pieced together from various sources.

Information needed	Suggested sources
Expected population growth	<ul style="list-style-type: none"> • local authority • Statistics New Zealand • be careful about assumptions underlying the figures – check against your 'gut' feel
Number and type of households	<ul style="list-style-type: none"> • as above
Number and type of businesses – future growth	<ul style="list-style-type: none"> • hard to do and will depend a lot on local knowledge (eg, camping ground owner wants to expand)
Current wastewater volumes of an existing system – in wet and dry weather	<ul style="list-style-type: none"> • local authority

(b) Understanding current problems

You will have a feel for this, but the impact on water and ecosystems will need to be quantified. Any health problems will need some sort of assessment. Your local council should have some feel for this. It can be commissioned or it can be pieced together from various sources.

Information needed	Suggested sources
Water quality, groundwater, streams etc.	<ul style="list-style-type: none"> • local council and regional council • local iwi • local people • expert assessment of impacts
Human health	<ul style="list-style-type: none"> • local council / regional council – especially for impacts from bathing • local medical officer of health • GPs
Ecosystem health – just dealing with water quality information may not let you really understand final impacts on ecosystems	<ul style="list-style-type: none"> • You probably need to commission an independent assessment – expert advice is important for this. • You will need to talk with iwi members and locals. • Remember – look at water ecosystems as well as things like the local condition of soils.



(c) Physical constraints and local conditions that might affect the choice of system

Information needed	Suggested sources
Soils – condition, capacity to absorb wastes and wastewater	<ul style="list-style-type: none"> local council and regional council local iwi local people expert assessment
Hydrology – water flows, etc.	<ul style="list-style-type: none"> local council will hold some information related to flood management local iwi and local knowledge expert assessment
Marine and coastal environments – issues such as whether there is an adjacent marine reserve, seafood-gathering area, valuable bush or wetlands	<ul style="list-style-type: none"> local council, regional council and local knowledge Department of Conservation local iwi local environmental groups you may want to get an independent assessment of implications

(d) Social and cultural constraints and local conditions that might affect the choice of system

A key issue may be the age of your community: are people going to manage on-site systems? It may be the overall level of income: what sorts of systems can people afford?

Information needed	Suggested sources
Types of households, age, future age, income (eg, are people on fixed incomes such as superannuation?)	<ul style="list-style-type: none"> local authority Statistics New Zealand local assessment of issues
Information about what people value about their area	<ul style="list-style-type: none"> local expertise – discussions, community mapping, survey (maybe) remember your seasonal populations if you have one
Tangata whenua concerns and issues	<ul style="list-style-type: none"> local iwi and hapū

(e) Understanding the wastewater systems

This is obvious, but you will need to get the information in a form everyone can understand. The handbook is a start, but there is no substitute for face-to-face discussion and summaries.

Information needed	Suggested sources
Types of system	<ul style="list-style-type: none"> expert who knows how to communicate handbook and technical back-ups networking with other communities local authority (only after you have canvassed things first)
Pros and cons of each system	<ul style="list-style-type: none"> independent expert – get one who is interested in small community systems expert who knows how to communicate handbook and technical back-ups networking with other communities local authority (only after you have canvassed things first)

(f) Understanding funding and management

Information needed	Suggested sources
How does the rating system in your area work?	<ul style="list-style-type: none"> local authority
What are the available funding options?	<ul style="list-style-type: none"> independent expert – get one who is interested in small community issues
What are the management options available to go with your wastewater system?	<ul style="list-style-type: none"> get the wastewater systems expert to include this in their discussions find out the local authority's attitudes.

Where possible, the information needs to be mapped, in pictures and diagrams, and summarised. Nobody should be expected to wade through detailed reports – at least until they have become experts on the systems.

Risks to be managed include:

- developing options that don't fit people's vision for their area or the problems that exist
- formal and individual challenges to the process
- people withdrawing from the process.

These risks are reduced if:

- information is provided with the aim of involving people in decision-making
- information is provided in a form people can understand
- anecdotal information is given a status in the process
- information about what people want for their community is gathered
- information is gathered about the community, what it will be like over time and what systems it is capable of managing
- people are provided with the tools to participate in developing options rather than being confined to choosing between them
- information about risks is well understood.

5.8 Facilitation, negotiation and conflict resolution

Organising and running a community process where people have differing views, or where sheer numbers make it complicated, takes real skill. Often the loud and the powerful will dominate. Thinking about how to facilitate events and discussions is very important. There may be people in the community who have those skills, or you can bring someone in who has those abilities.

Some key times when facilitation may be useful are:

- negotiating any partnership or relationships with the authorities about how they will be involved in your process
- running the intensive community options process (this is probably essential)
- prior to and during the resource consent process.

There will be times, particularly during the community options period, when negotiation skills will be needed. For example, there may be a perfect option, provided the council is prepared to be flexible around some requirements – or a large land owner may be fixed on what they want to do. The beauty of having a range of wastewater systems to choose from means that it could be possible to negotiate a solution that fits everyone's particular needs. The developer's needs might be covered if they use a cluster system while others use on-site systems – provided the developer does the development in a sensitive way.

During the formal resource consent period there will be formal opportunities to negotiate solutions and seek mediation around choices and positions. This will require particular kinds of skill and familiarity with the RMA and legal requirements.

The ability to negotiate during an intensive process is a valuable skill. Rather than bringing in someone from the outside who has general skills, you need to gather technical experts and locals around the process who can negotiate in this way.

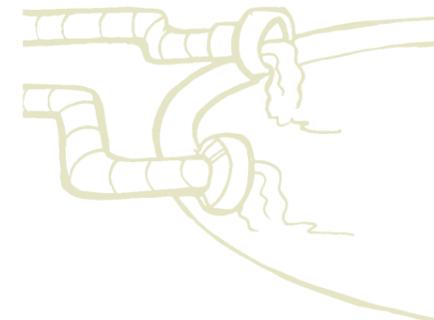
Finally, there may be quite serious conflicts on an issue – about the process, the actual wastewater systems, the community goals for the future shape of the area, the environmental effects, and tangata whenua concerns. You need to design in a conflict resolution process at the beginning and stick to it. Get agreement about who might be used: they need to be independent and acceptable to everyone.

Risks to be managed include:

- domination of group processes by strong individuals
- domination by experts, councils and major interests
- rushing the process.

These risks can be reduced if:

- processes share responsibilities, talking time and information
- the decision process is open and transparent
- everyone's agendas are out in the open.



Piha-Karekare wastewater options study

The Auckland west coast communities of Piha-Karekare in Waitakere City comprise three settlement areas separated by two streams. The estimated permanent population in 745 dwellings for 1995 was 2,660, rising to a peak summer holiday level of 5,215, with a further 6,000 day visitors. Both streams, which discharge to popular recreational areas, exhibited high enteric bacteria levels above those set for bathing-water quality. This was considered to be due to failed and poorly performing on-site wastewater systems, exacerbated by high population levels at peak recreational times. Poor soils, difficult topography, substandard installations, and lack of system maintenance contributed to the problem.

A partnership approach to resolving the issues at Piha-Karekare was instituted by Waitakere City Council and community representatives. This began with a community consultation programme, following which three main initiatives were developed. First was the provision of community information, including resource material on operation and maintenance and upgrading of on-site systems. Second, participatory community projects were introduced. These included demonstration projects for alternative technologies together with stream clean-up events and stream monitoring programmes. Third were on-property investigations and system performance assessments. These identified some 177 faulty septic tank and soakage systems on 671 properties.

For the 25% of all properties found to have faulty systems, average upgrade costs were estimated (1996) at \$15,040 per upgrade. Full upgrade for all properties with effluent outlet filters retrofitted on septic tanks and with ETS beds or LPED trenches to replace failed existing soakage systems was estimated at \$8,860 per lot. To retrofit all properties with new septic tanks and new disposal fields was estimated at \$16,107 per lot. Community off-site reticulation and treatment options varied from \$15,170 to \$18,790 per lot.

The least-cost option of upgrading faulty on-site systems and retaining all other on-site systems would only achieve an effective long-term solution provided that all systems were placed under a maintenance and management programme. This was recommended to involve twice-annual (summer and winter) system inspections, along with continuance of the council-organised septic tank pump-out scheme.

5.9 *Maintaining an audit trail*

Maintaining an audit trail (so that anyone can see what you have done) will be important because at some time you will move from a community process into the formal process of application for resource consents. Then you will need to show:

- how the consultation and community discussion have occurred
- the process whereby iwi, hapū and Māori residents were involved
- the assumptions and reasoning behind the key 'inputs' into the options (eg, what did you assume about population growth?)
- the technical information used
- the process for formal peer review of the issues and options
- the decisions made and the reasons for them.

Key to this audit trail will be keeping records of meetings, and this should be as formal minutes. Records of meetings should include:

- any formal set meetings, such as a working group or committee
- meetings with experts and external groups where decisions were made about key issues – not just actual options, but also decisions about key assumptions, etc.
- any formal notices of meetings.

It is worth keeping file notes of conversations with any key players so that people are clear about any day-to-day decisions that have been made. Keep copies of newspaper articles, council committee reports, background technical documents, etc.

This might seem like a huge paper trail, but if you do this your case will be so much more powerful in any situation where there is a formal challenge. It is also possible that the project will be long. People will come and go and it is important that anyone taking over the records can trace the history. If your structure includes a secretary, it is worth appointing a helper (if you can get one!) because it will be a big task.

You will probably be working in conjunction with the local council, and will both be generating a paper trail. It is worth agreeing on some sort of protocol or process that has your record-keeping 'in sync'. Council records will have their own record/file number and it is worth getting a list of those being used so you can gain access to records quickly, even if you don't hold hard copies.

Finally, keep paper copies *and* electronic copies!

5.10 *Communication*

This is one of the most important factors in maintaining a successful community decision-making process. Without good communication it will fail. It's as simple as that. If people don't know what is happening they will become suspicious. Publish a regular update – even if nothing obvious is going on. If the timetable is falling behind, explain why, and talk about any knotty issues up-front.

The local council has a stake in the process working well and it is worth having a joint discussion about communication. It may be possible to have something in a council-published paper, provided it is made clear that it is a joint report on progress. The local newspaper may be willing to make space for a regular update.

Beyond this, have regular contact with key players. This could include key land owners who might not even live in the area; it *must* include iwi, hapū and marae groups. It is worth touching base with key council officers and other agencies. The best way to do this is by having a joint working group.

3 PART

OPTIONS FOR WASTEWATER SERVICING

Part Three provides technical descriptions of the various wastewater servicing systems, and presents criteria that can be used to evaluate them. There is a wide range of technologies and a number of servicing systems to choose from. This part of the handbook focuses on those that are likely to be of most interest to smaller communities. Ongoing research and development mean that our knowledge about the various technologies and servicing systems is constantly improving, and the number of options will increase. (See Appendix 5 for new developments in wastewater servicing.)

Wastewater servicing scenarios

Small communities in unsewered rural-residential areas generally fall within one of the following five servicing scenarios:

- (a) a small community currently being serviced by septic tank and soakage fields, which are performing satisfactorily, who wish to continue with on-site systems and ensure ongoing satisfactory service by initiating better individual (or communal) operation and maintenance oversight

- (b) a small community currently being serviced by septic tank and soakage fields, some of which are not performing satisfactorily, who wish to upgrade poorly performing on-site systems, and put all systems on to an operation and maintenance programme so they do not have to convert to an off-site community sewerage scheme
- (c) a small community currently being serviced by septic tank and soakage fields, of which a significant number are not performing satisfactorily, and where the district and/or regional council is initiating investigation of options for upgrading to a community sewerage scheme
- (d) a developer in a rural or holiday resort area who is proposing to subdivide rural-residential lots for sale to the public, these lots to be serviced either by on-site wastewater systems or on-site/off-site cluster servicing, or an off-site community sewerage scheme
- (e) a small community that because of unacceptable risks to public health is required under the Health Act to upgrade or install a wastewater servicing system.

In all of these cases a community finds itself having to look at how it deals with its wastewater, and how it can improve on this. It is having to look at what kind of wastewater *system* would be most appropriate, as well as at the appropriate wastewater *technologies* – for example it will need to make a choice for the components of their wastewater servicing system; a septic tank, a land disposal scheme with a wastewater treatment plant to or to send its effluent to an ocean outfall.

Any wastewater system involves four components of wastewater management:

- management at source
- collection and treatment
- ecosystem re-entry, or re-use
- operation and maintenance.

In turn there are three main types of servicing systems that deal with these management components:

- on-site
- cluster
- centralised.

The operation and maintenance aspect of wastewater management is critical to the sustainability and long life of that system. For privately owned on-site systems, this operation and maintenance responsibility has traditionally been left in the hands of the householder. However, householder neglect has been a significant contributor to the problem of poorly performing systems that eventually have to be replaced or upgraded to cluster or centralised servicing. By adopting a managed maintenance programme for on-site systems, such poor performance may be preventable, and the system life extended indefinitely. This is discussed further in *Section 11*.

The different servicing systems

On-site systems

Technically, on-site wastewater servicing refers to any system where wastewater produced on the site is treated and returned to the ecosystem within the boundaries of that site. This may be a farm (which is likely to include animal and domestic wastewater), a factory or a single home. Usually, however, ‘on-site systems’ refers to domestic or single-home systems only. In such cases not all residue is always dealt with on-site. It is common for sludge (septage) from the on-site treatment system to be removed off-site and returned to the ecosystem in an approved manner.

The Australia / New Zealand Standard on *On-site Domestic Wastewater Management* (AS/NZS 1547:2000) defines an on-site wastewater system as 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 on-site physical environment.

Cluster systems

Cluster wastewater servicing systems are community systems for two or more dwellings. They are generally much smaller in scale than a centralised system. The wastewater from each cluster 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 cluster may be reticulated off-site to a local treatment and ecosystem re-entry location. As in the case of an on-site system, sludge or biosolids may be managed independently.

MANAGING WASTEWATER AT SOURCE

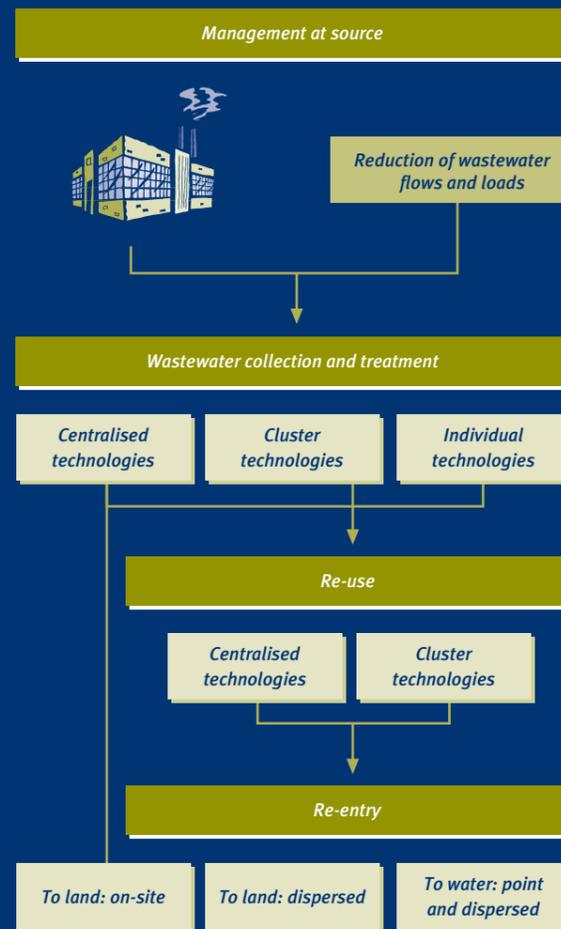


Centralised systems

Here all wastewater is collected at its source and then transported (through sewer pipes) to a central site for treatment. After treatment, the resulting effluent and sludge (biosolids) is discharged at a particular point, thus re-entering the ecosystem. As in the case of cluster systems, some treatment may occur on-site prior to the wastewater being transported to the central treatment site.

Sections 6 to 9 look at the servicing options (on-site, cluster, centralised) for the different parts of the waste management process (management at source, collection and treatment, re-entry and re-use). Section 10 looks at system configuration, performance and failure issues, and Section 11 looks at the responsibilities for managing and funding wastewater systems. The final section provides summarised criteria for selecting a wastewater servicing option.

The relationship between servicing options and the elements of the wastewater management process are illustrated in the diagram in the next column.



Whether the overall wastewater system you choose is a centralised system, cluster system, on-site system or some combination of these, there are some things people can do at the source that can be adopted to ease or reduce the cost of the ultimate treatment and ecosystem re-entry system requirements. While this section will only address domestic wastewater issues, there are also source management options for industrial, trade and commercial wastewater systems. Contact your local council for information to assist you in this area.

Options for management at the source include:

- water-saving practices in and around the home
- choice of household products that will enter the wastewater stream.

The amount of water used by a community will be a major factor in deciding the size of a wastewater system. Fairly obviously, water conservation can reduce the amount of wastewater that needs to be dealt with. It is possible to calculate whether water conservation will affect the system design and final costs.

The design of a wastewater system must also take account of what materials are going down the drains. The presence of different toxic materials may demand a higher level of treatment than would normally occur. What goes down the drain also has a huge impact on how well septic tanks and on-site systems work. Again, a full-system review, which manages the amount of toxic materials, greases, fats, oils, etc. going down the drain, will influence the design of the final system.

6.1 The different types of wastewater

Some kinds of wastewater can be re-used even before they leave the house or business to be treated. To do this it is worth thinking about the four kinds of water that are part of a household system:

- *water*: for drinking, washing, cooking (potable); for transporting wastes (non-potable); and for other uses such as watering gardens and washing cars (non-potable)
- *greywater*: from baths, washing machines, showers and sinks
- *blackwater*: human wastes (urine, faeces and blood)
- *stormwater*.

You can reduce the amount of water used for potable and non-potable purposes. This reduces the amount of greywater and blackwater being created, and therefore the amount needing treatment. It is possible to re-use greywater and stormwater for non-potable purposes. Stormwater may enter the pipes on your section that are carrying the wastewater for treatment, and this can also be managed.

Remember:

Reclaimed water sourced from greywater and stormwater cannot be used for cooking, washing or drinking.

An important issue will be the ability to change or 'retro-fit' older houses and businesses. It is worth your community looking at how much wastewater is being produced and how much this can be reduced *before* estimating how big your treatment processes need to be. You need to consider:

- How much water is being used, and can you reduce it?
- What are the opportunities to re-use?
- How much stormwater is getting into your system?

Your local council can probably help you with the information needed to find answers to these questions.

Alternatives for urban water and wastewater management, North Shore City

In recognition of the holistic approach taken to wastewater management by its Project CARE¹³ working party, North Shore City commissioned a study into alternative technologies for household water conservation, excreta disposal, and stormwater management. The project evaluated a wide range of technical, environmental, social (including public acceptability) and financial criteria, from which a short list of the most promising technologies was formulated. The outcomes of the study were reported in March 1999.

The servicing scenarios considered included partial use of the community sewerage system by uncoupling blackwater for on-site treatment and disposal (with greywater to the sewer), cluster systems (on-site primary treatment, off-site secondary treatment for groups of dwellings), and full on-site management. However, current provisions under the Building Act do not enable disconnection from an existing sewer service.

¹³ Project CARE is North City's \$250 million, 20-year project aimed at establishing and meeting the community's beach water quality expectations.



Four shortlisted schemes were costed. Schemes A and B are based on 'greenfields' development. Some of the technologies used could be retrofitted into properties within existing urban areas as well as being applied to new infill housing. Schemes C1 and C2 could be applied to existing (and infill) urban areas. However, the Ministry of Health does not recommend the use of composting toilets in urban areas.

Scheme A: Individual roof-water supply, greywater recycling, individual on-site wastewater disposal, communal stormwater capture and storage for firefighting (cluster of 15 properties):

On-site water and wastewater facilities (per property)	\$19,500
Communal stormwater treatment and storage (per property)	\$3,333
Total per property cost (1999)	\$22,833

Scheme B: At-source separation of urine (with communal collection and recovery), communal capture, treatment and storage of roof water, greywater and communal stormwater and recycle for toilet flushing and firefighting storage; blackwater on-site septic tanks plus EDS transfer of effluent for communal cluster treatment and drip irrigation (cluster of 15 properties) [Note: Cost excludes the 4,000m² land area required for effluent management]

Total per property cost (1999)	\$20,800
Scheme C1: Waterless composting toilet retrofit (per property)	\$3,000
Scheme C2: Composting and greywater vermiculture system (per property)	\$13,000

6.2 Wastewater and home management

Minimising the quantity of wastewater

Water use within a property boundary will either be for internal or external purposes. Water used for external activities – such as irrigation, car washing or swimming pools – does not normally enter the wastewater stream. Figure 6.1 shows the water use for a single family unit, as presented in a Christchurch City Council Water Conservation Report.

This report suggests that, on average, internal use accounts for 60% of the annual water use and the remaining 40% is external. However, the proportion of water used for external purposes will vary considerably. A home with a swimming pool, or boats and cars to wash or gardens to irrigate, will use very large quantities of water compared to a home without such demands. (See Appendix 3 for more information on water use.)

Reducing water use within the home through modifying individuals' behaviour will not only lead to reduced water consumption, but also to reduced wastewater production. Clearly not all water-saving measures will reduce wastewater volume (eg, wise lawn and garden irrigation, mulching to conserve water, fixing leaking outdoor taps). Water-saving actions that will reduce domestic wastewater volumes include fixing indoor dripping taps, reducing showering times, and avoiding wasteful teeth-cleaning practice. The major internal water consumers are the toilet, laundry and shower (see Figure 6.1). Showers generally do save water compared to baths.

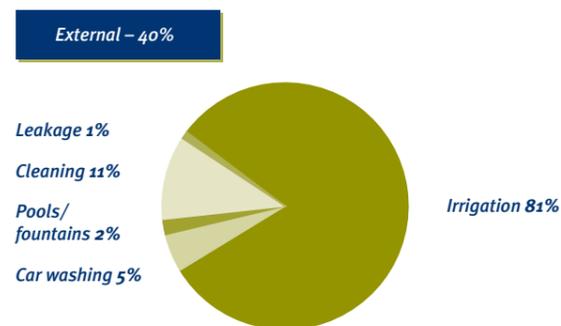
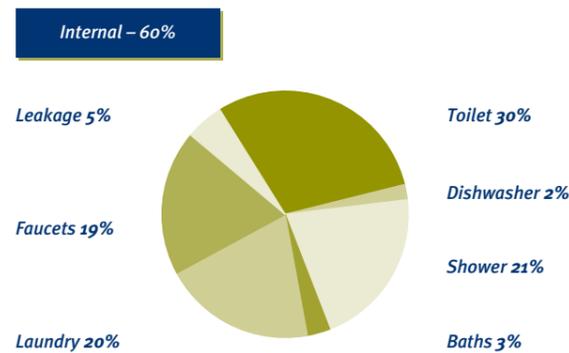


Figure 6.1 Domestic water uses (Christchurch)

Minimising the polluting content of wastewater

In addition to wastewater volumes, the polluting qualities of the wastewater are important when considering the measures that might be taken at source to reduce pressure on the wastewater management system, and the final impact when the treated wastewater is returned to the ecosystem. For example, a garbage grinder can increase the biochemical oxygen demand (BOD, a measure of the polluting strength of wastewater) by over 35% (see Section 2.3 for information on BOD).

The products that home-owners flush into their wastewater system include paints, pharmaceutical mixes, antibiotics, hormones, oils and volatiles, pesticides, herbicides, detergents, cleaning agents, polishing agents and other products with active ingredients which can be both a health risk to humans and impact detrimentally on wastewater treatment and eventually ecosystems.

Dr Robert Patterson, Director of Lanfax Labs, Armidale, in Australia, has been researching the effect of different household products on wastewater management for some years. He points out that:¹⁴

The range of household products available for disposal to the sewer is uncontrolled. While stringent requirements are placed on liquid trade waste discharges, domestic discharges are immune from either monitoring or control.

Patterson also notes that the two major effects of using laundry detergents are elevated sodium salt levels in wastewater and a significant increase in alkalinity. Both effects will result in destruction of soil structure if applied to land. Swedish research suggests it is possible to reduce the phosphate in our wastewater by more than 40% if everyone uses low-phosphorous household products.

The elements contained in cleaning agents are detailed in Table 6.1.

Examples of other ingredients from household products that can enter the wastewater stream are listed in Table 6.2. This is by no means a comprehensive list. In addition to these, heavy metals such as zinc from sun-screens, copper from copper pipes, mercury from dentistry, and chromium from metal plating can enter the wastewater stream and will accumulate in the sludges produced by the treatment plant.

1. Bleaches:

- washing powders, toilet cleaners and dishwasher powders usually contain chlorine-based bleach. The chlorine can combine with organic compounds to form highly toxic, and carcinogenic, organochlorine compounds. Non-chlorine bleaches are available, and washing powders with separate bleach are a good choice (for several reasons)

2. Phosphates:

- phosphates are added to washing powders (but not to washing-up liquid) to soften the water. They can lead to eutrophication in watercourses

3. Optical brighteners:

- these substances do nothing for cleanliness but give an illusion of whiteness. Problems include allergic reactions, poor biodegradability, and mutation and inhibition of bacteria in your treatment system

4. Other additives:

- NTA¹⁵, EDTA, enzymes, preservatives, colourings, synthetic fragrances, etc. are all suspect in terms of ecological impact in production and final disposal

5. Zeolite:

- possibly a more benign replacement for phosphate, it is an inert mineral, but it can encourage algae problems in seawater

6. Sodium:

- common salt (sodium chloride) is used as a thickener in washing-up liquid, and soaps and detergents contain sodium ions, which break down the structure of clay soils and so reduce their permeability. This can be a problem for leach fields and greywater irrigation

Table 6.1 Cleaning agent elements

Source: Reference: N Grant, M Moodie, C Weedon. *Sewage Solutions*. Centre for Alternative Technology, Machynlleth, Powys, 1996, p. 125.

While Patterson urges that *re-use initiatives start in the supermarket*, it is also an option for communities to support education and awareness programmes to encourage good household practices that will result in a healthier and more sustainable wastewater cycle, which will be more integrated with the local ecosystem.

¹⁴ RA Patterson. *Reuse Initiatives start in the Supermarket*. In Proceedings, NSW Country Convention, Institution of Engineers, Australia. 6-8 August. Northern Group, Institution of Engineers, Australia, Armidale.

¹⁵ Note: NTA (nitrilotriacetic acid) and EDTA (ethylenediamine tetraacetic acid) are both chelating agents that help to control water hardness ions that can interfere with the performance of household, industrial, and institutional cleaning products.



Ingredient	Use	Impact
Alkyl benzene sulfonates (ABS)	Common surfactant in laundry detergents, cleaners	Very slow to biodegrade; the manufacturing process can release carcinogens and toxins to environment
Alkyl phenoxy polyethoxy ethanols (also nonyl phenols)	Used as surfactant in laundry detergents, cleaners	Slow to biodegrade in the environment; linked with chronic health problems
Butyl cellosolve (also, butyl oxitol, ethylene glycol monbutyl, butoxyethanol, ethylene glycol)	Used as solvent in spray cleaners, all-purpose cleaners	A toxic synthetic – can irritate mucous membranes and cause liver and kidney damage
Chlorine – also as hypochlorite, sodium hypochlorite, sodium dichloroisocyanurate, hydrogen chloride and hydrochloric acid	Household bleaching agent	Most frequently involved in household and industrial poisonings. Reacts with organics in the environment to form carcinogenic toxins, the most well known being dioxin. Serious impact on small wastewater treatment plants
EDTA: ethylene-diamino-tetra-acetate	A builder used as a phosphate substitute in detergents	Slow to biodegrade
Formaldehyde	Not a common ingredient these days, but may be found in deodorisers, disinfectant, germicides, chemical toilet additives, particle board	Extremely potent; carcinogenic and respiratory irritant; serious impact on small wastewater treatment plants
Methanol	Used as solvent in glass cleaners	Acutely toxic and can cause blindness
Phosphates	Used in detergents and cleaners as a builder and deflocculating agent	Non-toxic but a major cause of eutrophication in receiving aquatic ecosystem, causing serious ecological imbalance
Polycarboxylates	Laundry and dishwasher detergents as an anti-redeposition agent	Not much known; non-biodegradable and petroleum based

Table 6.2 Some examples of ingredients used in household products and their potential downstream impacts

6.3 Source technologies

This is a growing area for home-plumbing systems and the design of appliances. Some of these are listed in the tables in the next column.

The advantages and disadvantages of various toilet designs are given in Table 6.4.

Aim	Technology
Reduce the amount of water used in toilets – reduces amount of black water	<ul style="list-style-type: none"> low-volume flush toilets vacuum toilets urine-separating toilets composting toilets waterless urinals
Reduce the amount of water that becomes grey water	<ul style="list-style-type: none"> low-flow shower heads low-volume washing machines aerated tap faucets controlled-flow tap valves pressure-reducing valves
Recycle and re-use water before it becomes wastewater	<ul style="list-style-type: none"> greywater recycling (eg, washing machine water) rainwater collection and stormwater recovery

Table 6.3 Technologies to reduce wastewater at source

Toilet	Litres/flush	Technical features	Benefits/constraints
Conventional flush	6–15	Single flush	Low cost; high water use; good range of systems available
Dual flush	0.5–6	Two flush options	Low cost; medium water use; good range of systems available
Vacuum toilets (discharge to vacuum sewer)	0.5–1.5	Separate vacuum unit required	Low water use; expensive; would have to import systems into NZ; limited range (can only be used in conjunction with a vacuum sewerage collection system)
Urine-separating (discharge to urine-holding tank)	0.2–4	Separate plumbing for urine and for faeces	Enable recovery of nutrients; not common in NZ; requires separate urine-handling system
Hybrid or micro-flush (toilet pedestal located on top of pre-treatment tank)	<0.3	Very small quantity of water used to flush	Very low water use; available only from Australia; separate greywater system required
Composting	0–0.1	No water used	Not flushed after use; cleaning instructions are manufacturer specific, requires on-site management of compost and separate greywater system
Dehydrating	0	No water used	No water used; requires on-site management of removed solids and separate greywater system
Incineration	0	No water used	No water used; requires on-site management of removed ash and separate greywater system

Table 6.4 Characteristics of different toilet designs

COLLECTION SYSTEMS



Changing to water-saving appliances or components can also result in significant reduction in wastewater output (Table 6.5 gives examples).

Appliance	Volume of water used
Washing machines:	Litres/load
• front-loading washers	55–90
• top-loading washers	120–190
Taps:	Litres/minute
• aerated attachments	2–6
• conventional	15–23
Shower heads:	Litres/minute
• aerated heads	6–10
• conventional	15–23

Table 6.5 Water use by other domestic components

In 1997 the *NZ Consumer* (No. 356) stated that compared to top-loading washing machines, front-loading machines used less water, energy and detergent.

For more information on water-saving technology and management, see *Appendix 3*.

Composting toilets

There is increasing interest in composting toilets in some sectors of our community. Available commercial composting toilets range from simple to sophisticated designs. From an environmental viewpoint there are clear advantages with these systems: the water use is substantially reduced, and nutrients and organic matter can be recovered to re-enter the natural nutrient cycle. However, a well-designed and easy-to-maintain composting toilet may be more expensive than conventional flushing toilet systems. Composting toilets also generally require regular management, and a greywater servicing system will be required in addition to the composting toilet.

Composting toilet experience in New Zealand has led the Ministry of Health to conclude they are not appropriate for full-time household use on residential-sized lots. The most successful systems are those in holiday recreational areas where controlled management can be provided. The Ministry also points out that once reticulated sewerage is provided, then composting toilets cannot be used under the Building Act.

See *Appendix 4* for more information on composting toilets.

Where all wastewater servicing is provided on-site (within the property boundaries of the facility generating the wastewater flow), the collection system will consist of internal sewers carrying wastewater to the treatment and land-application system. For example, household drains from the dwelling to the septic tank, and then effluent lines from the tank to soakage trenches. Sometimes pumps or siphons are used to dose the trenches with the septic tank effluent.

Where wastewater treatment is off-site, the wastewater needs to be collected and transported to the treatment plant. This is done by a pipeline or network of pipelines (sewers) that collect wastewater flows from all dwellings in the community. Energy to transport the wastewater may be by gravity, pumping or a combination of pumping and gravity, depending on topography, layout and economics. For systems involving some on-site pre-treatment (such as a septic tank or grinder pump), reticulation is often done by pumped small-bore pressurised pipeline systems. This usually reduces the capital cost of the collection system, but will mean higher on-site costs. Other options include vacuum collection and transport systems.

7.1 Conventional collection technologies

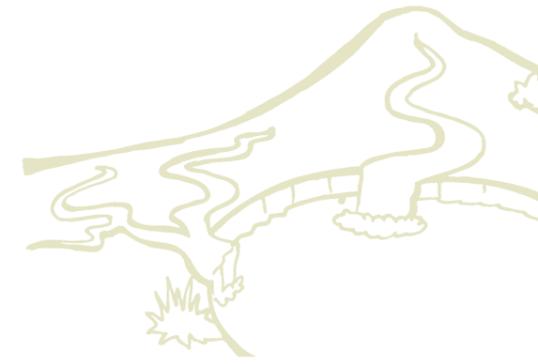
Conventional sewerage (CS)

In the conventional system, household on-property sewer-lines (100 mm diameter) connect to street sewer-lines (minimum 150 mm diameter), which are reticulated in straight lines between manholes that provide access at all changes in direction. Manholes are used at all street reticulation connections to main collecting sewers, and again where trunk sewer connections are made. The minimum sewer sizes are based on design rules for use of traditional clay and concrete sewer pipes, and on the self-cleansing gradients necessary to scour out any sand and sediment entering the sewerage system.

The maximum distance between manholes historically has been determined by the need to mechanically clear obstructions using rods, which becomes difficult for distances over 90–100 metres. Manholes are a significant proportion (15–20%) of the total sewerage costs. They are also a point of weakness in conventional reticulation systems, as the manhole sewer connections often crack as the result of ground settlement and traffic impact, with groundwater infiltration then entering the sewer lines. Infiltration flows dilute the untreated wastewater flow, and result in diminished treatment process performance.

Modified conventional sewerage (MCS)

The availability of smooth-bore long-length ‘plastic’ pipe drainage lines has led to the development of MCS systems, which are particularly suitable for smaller communities converting from on-site to cluster or central sewerage and treatment. Manhole numbers can be reduced significantly through the use of rodding ‘eyes’ (inlets), and pipeline gradients and alignment can be varied to better fit the topography, thereby reducing construction costs. Minimum line diameters can be reduced from 150 to 100 mm depending on connection numbers, and self-cleansing gradients can be reduced due to the smoother pipe material, again producing construction economies. Infiltration opportunities are reduced, thus decreasing the wet-weather flow in the sewer and the hydraulic impact on the treatment plant processes. Flexibility in sewer line location in existing communities can be provided, such that the gravity sewer bypasses properties in low-lying areas, which are then connected to the sewer through a grinder pump unit and on-property rising main.



7.2 Alternative collection technologies

Effluent drainage servicing (EDS)

EDS was introduced into New Zealand in the late 1970s as a local version of the Australian CED (common effluent drainage) and the US STEP (septic tank effluent pumping) systems for reticulating septic tank effluent from each property, and conveying it off-site for cluster or central treatment. EDS can be a wholly gravity system (GEDS) or wholly pumped (PEDS), or a combination of both. The EDS approach can offer significant economies in reticulation costs and overall scheme costs compared to conventional sewerage, particularly in retrofitting sewer lines into unsewered smaller communities in difficult topography.

The components of an EDS scheme include:

- retention of existing (or provision of new) septic tanks on each lot
- low-diameter modified sewer lines (75 mm) for collection of septic tank effluent, special odour-venting controls on the lines, and pump units designed for septic effluent handling
- a modified cluster or central wastewater treatment plant designed to handle inflow of septic effluent, of reduced size due to the input of partially treated wastewater (the primary effluent from the septic tanks)
- a centralised operation and management system that oversees septic tank maintenance as well as treatment plant and final effluent land disposal.

Several EDS schemes are operating in New Zealand, producing significant economies in initial construction cost when sewerage existing communities with on-site effluent management problems. However, when total maintenance costs based on a nominal septic tank pump-out frequency of three years are factored into a 20-year capitalisation of costs, in many cases this gives an economic advantage to MCS. Where the condition of existing septic tanks in a community requires substantial upgrade or renewal, the costs of the EDS scheme swings preference to the MCS. EDS has significant saving in terms of the community component of scheme costs when septic tank upgrade costs are left to lie where they fall (with each property owner). In this case, only the EDS system (including GEDS and PEDS elements) plus the scaled-down cluster or central treatment plant(s) comprise the publicly funded scheme. This benefits property owners with newer septic tanks, and disadvantages those with older tanks.

Some local authorities have difficulty envisaging an appropriate management process when some parts of the scheme are on private property (the primary treatment in septic tanks) and the rest is in community sewer lines and treatment plant. However, this can be readily overcome with co-operation from the community in allowing access rights for maintenance personnel. An important advantage of EDS is provided by a significant reduction in infiltration flows.

Modified effluent drainage servicing (MEDS)

This is a small-bore version of EDS for carrying filtered septic tank effluent from each property to cluster or central treatment. It is based on VGS (variable-grade sewer) technology out of the US. Each on-lot septic tank is an improved septic tank with a large-capacity single chamber and fitted with an effluent outlet filter. The solids control provided by the effluent outlet filter enables 30 mm on-property collection lines to pick up the septic tank effluent and transfer it to 50 mm public sewer lines, which increase to 75 mm as more properties connect. The lines can be installed by continuous-shallow-trenching machines at constant depth and following the natural lie of the land, thus substantially reducing construction costs.

Special design precautions are needed to deal with odour control, and pump-station and sewer-line maintenance. Sewer lines can flow uphill as required, as long as properties connected in the vicinity of uphill sections are elevated above the *hydraulic grade line* (HGL). Where properties are below the HGL, an effluent pump can be installed.

The MEDS approach to decentralised wastewater management for smaller communities can benefit both existing communities and new development. To deal with infiltration impacts on the treatment process, MEDS eliminates infiltration by providing a totally sealed system from the on-property improved septic tanks to the treatment plant.

Alternative sewerage experience in New Zealand

During 1995 a New Zealand-wide survey of city and district councils was carried out as part of a research project at the University of Auckland to obtain information on alternative sewerage schemes. This identified 14 operating schemes, encompassing three collection alternatives:

- EDS (effluent drainage servicing), where septic tank effluent is reticulated via 75 mm sewer lines for off-site treatment and disposal
- MEDS (modified EDS), where 50 mm variable-gradient sewer lines are used
- PEDS (pumped EDS), where everything is pumped into a pressurised reticulation system.

The carriage of anaerobic septic tank effluent off-site via sewers immediately suggests the possibility of odours. However, these were evident at only one scheme, a holiday settlement served by a PEDS system, where at the beginning of a holiday period odours were released from the on-property pump sumps if the lids were lifted for maintenance. Generally all operators were satisfied that odour and corrosion were not a concern. Maintenance problems in the sewer lines were a feature of some schemes where the homeowner was responsible for septic tank maintenance. In all cases where the local councils managed the total system, including on-property septic tanks, such problems did not occur.

Treatment of the reticulated septic tank effluent was best achieved by oxidation ponds or wetlands. These could be purpose-built as a cluster treatment plant, or the effluent could be transferred to an existing community treatment plant. Mechanical aeration plants based on the activated sludge principle were not entirely satisfactory, because the lower organic strength of septic tank effluent resulted in operating problems and poor performance.

Overall, scheme costs showed variable savings relative to conventional sewerage schemes, with PEDS systems showing greater savings (35–45%) compared to EDS (12–40%). However, costings were very site-specific, with alternative sewerage offering particular advantages in locations where very difficult topography and soil (such as rock) conditions make conventional sewers expensive. Some councils saved money on the community portion of the scheme by leaving the costs of septic tank upgrades on each property to lie where they fell – with the home owner.

7.3 Pressure and vacuum collection technologies

Pressure sewerage

Pressure sewers provide full off-site transfer of all household wastewaters by injection of grinder-pumped wastewater flows into a pressurised reticulation network (rather like water reticulation in reverse). The reticulation system can readily follow the natural ground profile at a shallow depth, including undulating and steep terrain, and can be directed around or over topographical obstacles. Effluent is anaerobic (no air surface is present as in a gravity sewer system), and special venting controls are required at the treatment plant discharge point. Maintenance oversight requires ready access to on-property pump units. Infiltration is eliminated.

Vacuum sewerage

Vacuum sewers can operate in conjunction with vacuum toilets (with very low flush) or normal low-flush toilets, and can pick up all other household wastewater flows for vacuum conveyance. They are most suited to flat topography, and are very useful in high-water-table locations such as around lake edges or along coastal strips. Vacuum lines have to be provided with regular low points (or transportation pockets) to facilitate plug flow between dwelling vacuum holding tanks and central collecting tanks. Because flow is continuously mixed with air it does not remain anaerobic. Infiltration is eliminated.



TREATMENT SYSTEMS

St Arnaud Village, Nelson Lakes, Tasman District

St Arnaud village is a holiday settlement on the shores of Lake Rotoiti, in Nelson Lakes National Park. Houses are located on rocky sub-soils, which not only creates problems for disposing of septic tank effluent but also makes construction of a sewerage system for off-site treatment of wastewater very costly. A joint working party was set up by Tasman District Council and the St Arnaud Community Association in 1994 to investigate alternatives for improved servicing.

Eight technical options and two management options were identified. The technical options were (1) the status quo, but with 'failed' systems replaced; (2) localised upgrades; (3) upgrade all systems to modern standards; and (4) use MEDS (modified effluent drainage servicing with 50 mm sewer lines and effluent outlet filters on septic tanks) in three clusters to collect septic tank effluent from problem areas. Each cluster treatment system consisted of sand-filter units, the resulting high-quality effluent to be drip-irrigated at low loading rates into natural forest. Satisfactorily performing on-site systems could connect to the MEDS lines in the future. Option (5) was to require all properties to connect into the three cluster systems.

Options (6) and (7) retained upgraded septic tanks on each property, but reticulated the effluent to centralised treatment via either MEDS 50 mm lines or EDS 75 mm sewer lines. Option (8) was for MCS (modified conventional sewerage) to centralised treatment and land application. The two management options were either council operation and maintenance oversight, or a community management district approach under body corporate control.

Initial cost comparisons showed an advantage to the full MEDS and cluster treatment approach. However, this relied on portions of the forest in the National Park being made available for low-rate drip irrigation of high-quality effluent. Because this did not prove to be acceptable, centralised treatment outside the National Park was required. At this point the cost comparisons favoured MCS and centralised oxidation pond treatment, which also had the advantage of being able to handle future subdivision growth near the village. The resulting scheme is under council operational management.

7.4 Comparing collection technologies

Conventional sewers versus alternative sewerage

One of the major problems with conventional sewer systems is the level of infiltration that occurs due to groundwater and surface water flows leaking into the sewer system during wet weather. It is almost impossible to eliminate this problem as manholes used for maintenance create points of potential leakage in the sewerage system unless the lids are sealed and bolted to the frame. On the other hand, many of the alternative collection systems referred to above for use in small-scale servicing systems enable fully sealed pipes with secure access and inspection points to be constructed so as to eliminate infiltration.

Section 6 looked at managing your wastewater at source, in terms of reducing both its quantity and polluting content. However successful you are at achieving this, you will still need to collect wastewater and treat it before it can be returned to the ecosystem. Section 7 looked at the collection alternatives for conveying the wastewater to the treatment process. This section now looks at the systems and technologies for providing that treatment.

8.1 Treatment: what does it do?

Wastewater treatment processes are used to:

- remove possible contaminants from the water used to transport the wastes – the end product of this process is treated water and sludge/ biosolids
- reduce the amount of water in the remaining sludge/ biosolids so that they can either be landfilled or re-used more easily.

Different stages of wastewater treatment can be used to reduce pollutants. The options used will depend on:

- the kinds of pollutants present in the waste
- decisions about the cultural effects
- the ability of the receiving environment to absorb the waste
- the total effect – not just of your community's wastes, but of possible wastes from elsewhere.

Treatment stage	Waste constituents treated*				Remaining Waste
	Organic material (BOD)	Suspended solids (organic)	Bacteria and viruses	Salts: nitrates and phosphates	
Primary (settling)	Up to 35% captured	Up to 65% captured		Not removed	'Raw' sludge and primary effluent
Secondary (aerobic bacteria growths)	Can be reduced to 20 g/m ³	Can be reduced to 30 g/m ³	Some removed	Not removed	Biological sludge; secondary effluent with some salts, metals, bacteria, etc.
Tertiary (various techniques)	Can be reduced to 15 g/m ³ <small>Sometimes better tertiary quality than this can be achieved</small>	Can be reduced to 10 g/m ³	Can be disinfected to remove	Can be treated to reduce salts	Tertiary effluent and solid residues with metals, etc.
Land (septic tanks and soil soakage)	Will reduce total amounts of organic material, salts, bacteria and viruses – levels depending on system design				Remaining scum and sludge (septage) with metals, etc.
Treatment of sludge	Takes primary and secondary treatment sludges and uses anaerobic digestion to convert them to 'humus solids', known as biosolids, plus methane gas				Methane gas; biosolids with metals, etc.
Treatment to produce reclaimed water	Further treatment for non-potable purposes				

Table 8.1 The stages of wastewater treatment

* Other waste constituents (see Section 2.3) that are not removed by standard treatment processes will need to be assessed to determine whether there is a tertiary technique(s) that can be used to treat them. If there is no applicable process available, the method of ecosystem re-entry used will have to address the environmental risks associated with those substances not managed through the treatment technologies.



The main point to note here is that each stage removes only certain kinds and levels of pollutants, as summarised in *Table 8.1*.

Sludge from primary treatment is smelly, grey-black, semi-solid – stuff! It contains high concentrations of bacteria and other micro-organisms, many of them carrying the risk of disease, as well as large amounts of biodegradable material. It will mean dissolved oxygen in water will be used up very quickly.

Secondary treatment will produce secondary sludge. This is made up of the micro-organisms that have eaten the original wastes. It is not quite as nasty as primary sludge, but does contain high levels of pathogens (disease-causing) and material that will decay and cause odour.

You will need to understand what is in your waste and what your receiving environments can ‘take’ or absorb as a first step in choosing your technical treatment systems. This is the heart of the natural systems approach.

8.2 Types of treatment systems

The treatment component can be located either on-site or off-site. Off-site treatment may be one large treatment plant for the whole village, town or city. This is referred to as centralised treatment. Some off-site systems only do primary treatment and they rely on discharge through long outfalls to the sea. This is becoming less common, especially as the Department of Conservation and regional councils move to improve the quality of the coastal environment. A wide range of different technologies is now available and used at centralised sewage treatment plants, ranging from simple oxidation ponds to high-tech physical, biological and chemical treatment processes.

At the other end of the scale is on-site treatment. Once again a range of treatment options is available. The conventional systems include septic tanks (these may be multi-chamber with filters), and more advanced systems such as aerated wastewater treatment systems (AWTS), recirculating sand filters, or sand-mound systems. Other, less common systems include constructed wetlands, sphagnum peat mounds, and separated grey- and blackwater systems (eg, waterless composting toilets and vacuum toilets). If waterless toilets are used, on-site greywater treatment will also be required.

Cluster treatment systems serve a small number of wastewater suppliers. For example, a common treatment plant may serve a housing development with several houses. In populated areas cluster treatment plants tend to be compact, low-maintenance, odour-free systems. If the cluster treatment plant can be located some distance from the built-up area, treatment may be by oxidation ponds and/or treatment wetlands.

There are variations to both the centralised and cluster treatment configurations. For example, it may be more economical to provide some on-site pre-treatment, such as a septic tank or grinder pump, which would allow the use of a lower-cost small-bore collection pipe network to the cluster or centralised treatment unit.

To sum up, there are four general kinds of treatment systems that deliver these different treatment processes:

- individual (on-site) treatment systems
- central treatment
- cluster treatment
- a combination of on-site and centralised treatment.

Each of these is dealt with below in turn.

Individual (on-site) treatment systems

These service individual sections or lots where all waste produced on-site is treated on-site. Generally the treated waste re-enters the ecosystem on site. This means the ability of the soils to absorb the treated waste will determine whether this kind of system can be used.

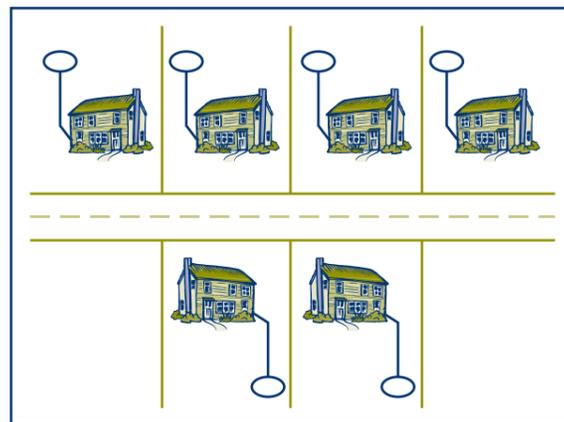


Figure 8.1 On-site treatment systems

The nature of your local groundwater systems, including the level of the water table in different seasons, will be important. Sometimes underground water (aquifers) can be affected by wastewater trickling through the soils and polluting the water. This water may find its way into a local stream, or bores may bring it to the surface for household use.

Some soils will not be suitable. Others may require a larger area for absorption. In many ways the absorption ability of these soils will have been a major factor in originally deciding the density of your community’s settled areas. Deciding whether or not to stick with on-site systems will be a ‘crunch’ issue for your community. The ability of the soils to absorb wastes at all, or to absorb increased amounts, will be a deciding factor for the system you choose. This handbook will give some guidance on the general kinds of issues with soils, but expert advice will be needed.

On-site systems use biological processes that need to be carefully managed and protected. People can find this tiresome, and some visitors to beach communities may know little about how to deal with them. There are ways the community can come together to manage the separate on-site systems. In other words, individual systems do not have to mean private management. The modern approach to managing on-site systems involving system monitoring and operation and maintenance inspections (see *Section 11*) can ensure the long life of the system while protecting the investment in the system hardware. The cost of this managed approach can, when spread out on an annual basis, equate to the sort of charge that councils levy as sewerage charges in urban residential areas.

Treatment systems can also be designed to deal with different kinds of wastewater. For example, on-site systems can deal with a combination of greywater and blackwater, just greywater, or just blackwater. Details of on-site technologies are provided in *Section 8.3*.

Central treatment

This is almost the exact opposite of on-site systems. All waste is collected and transported to a central treatment site, and then re-enters the ecosystem. This kind of system can deal with household waste and tradewaste if certain concentrations of chemicals and other substances are controlled. This protects the pipes and the treatment plant and reduces the amounts that might remain in the sludge. If the sludge is to be re-used for such things as compost, then the issue of concentrations becomes very important.

Types of wastewater	Treatment system
Combined greywater and blackwater	<ul style="list-style-type: none"> • septic tank • septic tank with filter • septic tank with constructed subsurface flow wetland • septic tank followed by a sand filter • aerated wastewater treatment package plant (AWTS)
Blackwater only	<ul style="list-style-type: none"> • all of the above, provided a flush system is used • composting toilet • transportation by tanker to a treatment site
Greywater only	<ul style="list-style-type: none"> • septic tank • grease trap plus a subsurface wetland • some commercial greywater systems

Table 8.2 On-site treatment systems

Centralised systems are designed to service a complete town or settlement. The size and complexity of the system is dependent on the size of the community. They tend to involve an extensive pipe network: usually the system is fed by gravity but it often involves pumping stations as well.

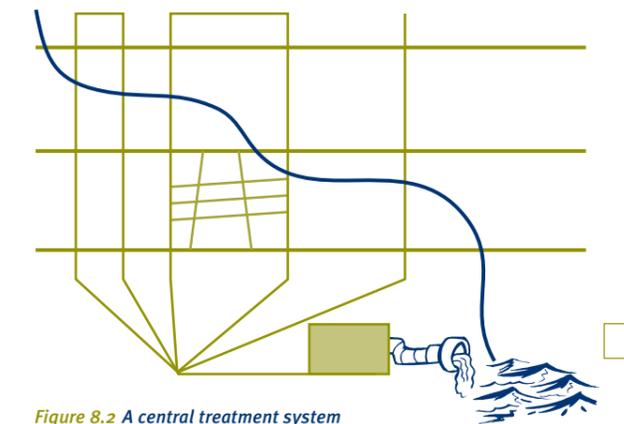


Figure 8.2 A central treatment system



The costs of setting up a centralised system can often be cheaper than on-site solutions because the costs are spread across many households and businesses. But the maintenance costs for the complete system can be high and often make up 15–20% of a council’s annual budget. Therefore you need to think about the ongoing costs as well as the initial set-up costs.

Other considerations also need to be taken into account, such as the increased volumes of sludge produced by centralised systems, not to mention the increased need to rely on chemicals to stabilise the biological treatment that takes place. All of these issues need to be given a full advantage/disadvantage analysis that is beyond the scope of this handbook.

Cluster treatment

The focus here is on relatively small treatment plants designed to service a group of houses or businesses. More than one plant may be needed to service the whole community. They provide considerable flexibility. For example, your community may decide that it wants to continue with on-site treatment and the densities of settlement that this brings. At the same time, it may be prepared to allow a one-off development of a certain size that cannot be serviced by on-site systems. Provided the development has its own cluster system, it can proceed.

On the other hand, it may be that your community is on a centralised system. To allow more growth would require a bigger system – not just the treatment plant but the pipes as well. This can be expensive. More development might be possible if a small cluster system is used. It is therefore a useful tool for allowing some growth and change to occur without shifting to a centralised system that might bring pressure for even more growth. Often a cluster treatment system utilises land disposal. The area of land needed will be determined by the number of dwellings serviced by the cluster system. At the same time, a cluster system can allow a more managed land-based ecosystem re-entry because the volumes of waste treated will be relatively small.

Cluster treatment can also be linked to a centralised system. For example, some technologies allow the ‘mining’ of wastewater, by hooking up to wastewater mains pipes and removing some of the wastewater for processing. This mining can provide reclaimed water for re-use and contribute to reducing the amount of wastewater going to a centralised plant.

Combination of on-site and centralised treatment

A combination system means that:

- wastewater can be collected at source before it is piped off-site
- some basic pre-treatment occurs on-site
- many variations are available
- communities can ‘mix and match’.

On-site systems such as septic tanks are sometimes seen as ‘old-fashioned’ systems that should be replaced where possible. Fully centralised systems are sometimes seen as something that a community should aspire to. This is changing as the possibilities of cluster systems become better known. On-site systems can seem a bother for land owners because they require a lot more direct care. Sometimes communities will choose a more centralised system to avoid these day-to-day problems – even if the local soils can still deal with on-site systems.

It is important that these four categories are not seen as inevitably moving from the primitive to the modern. Each one is equally important and capable of delivering a safe, efficient treatment. The real issue is what system best fits your particular physical environment (especially soils and water quality) and social circumstances.

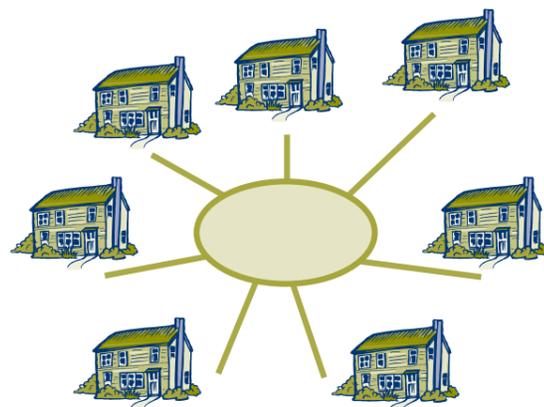


Figure 8.3 Cluster treatment systems

8.3 Types of treatment technologies

Where wastewater is collected for off-site treatment in a central or cluster wastewater treatment plant, a number of conventional treatment units are available, either single-process or a combination of primary/secondary/tertiary treatment processes. For combined on-site/off-site treatment the on-site component is usually a septic tank or improved septic tank, and the resulting effluent is conveyed to the cluster or central plant for secondary treatment.

On-site treatment option	Comments
Combined blackwater and greywater systems (all waste)	
<i>Conventional septic tank</i>	<i>Septic tanks can be single-chamber or multi-chamber. They must be constructed to meet required standards (eg, AS/NZS 1546.1-1998). Septic tanks require de-sludging every few years depending on loading rate, composition of wastewater and temperature</i>
<i>Improved septic tank (equipped with an effluent outlet filter)</i>	<i>There are various types of septic tank filters available to reduce carry-over of suspended solids. These require routine cleaning</i>
<i>Improved septic tank with subsurface flow wetland</i>	<i>The wetland size and dimensions need to be designed for the wastewater loading. Wetland plants are grown in aggregate, with the effluent water level maintained just below the aggregate surface. They need to be designed and installed by qualified and experienced persons</i>
<i>Improved septic tank with intermittent or recirculating sand filter</i>	<i>These produce very high-quality effluent suitable for drip-line irrigation into or onto land within landscaped areas, or for providing a source of reclaimed water for recycle uses. They need to be designed and installed by qualified and experienced persons</i>
<i>Aerated wastewater treatment package plant (AWTS)</i>	<i>These are small domestic wastewater treatment package plants capable of treating the wastewater to a high standard suitable for drip-line irrigation into or onto land within landscaped areas</i>
Separated blackwater and greywater system – blackwater components	
<i>Dry-vault blackwater systems:</i>	<i>These require informed on-site management procedures to ensure safe handling and subsequent disposal of solids. Composting toilets in particular must have informed and dedicated users in order to achieve effective performance</i>
<ul style="list-style-type: none"> • compost toilets • dehydrating toilets • incineration toilets 	
<i>Wet-vault blackwater systems:</i>	<i>Pump-out vaults and chemical storage units require routine road tanker collections. The hybrid toilet system has been designed to use zero or very small volumes of flush water (about 0.3 L/flush). Such a system provides treatment of the low volume of blackwater to a high standard by anaerobic fermentation</i>
<ul style="list-style-type: none"> • pump-out vaults • hybrid toilet • chemical toilet low-flush systems 	
Separated blackwater and greywater system – greywater components	
<i>Conventional greywater septic tank system (outflows from hybrid and chemical toilet systems can be transferred to greywater treatment tanks for further treatment)</i>	<i>Must be constructed to meet required standards (eg, AS/NZS 1546.1-1998). Tanks require desludging periodically</i>
<i>Improved (large-volume) grease trap preceding a constructed subsurface wetland</i>	<i>The wetland size and dimensions need to be designed and installed by qualified and experienced persons for the greywater loading. The grease trap will require regular (up to weekly) maintenance</i>
<i>Greywater reclamation units</i>	<i>Use for recovery of bathroom and laundry waters for recycle for toilet flushing</i>

Table 8.3 Examples of on-site treatment technologies



On-site treatment technologies

Our discussion will focus on domestic on-site wastewater treatment technologies. The treatment component follows wastewater collection, and precedes the technology for returning the treated wastewater to the immediate local ecosystem (re-entry).

Treatment does not significantly reduce the volume of the incoming wastewater, so an unchanged volume has to be returned to the land within the site. It does, however, reduce or transform the dissolved and suspended constituents of the wastewater, mostly by physical processes (such as settling or filtering suspended material), or by biological degradation by bacteria of both suspended and dissolved material in the wastewater.

Treatment plant performance is usually given in terms of measures such as the total concentration of suspended solids (TSS); the five-day biochemical oxygen demand (BOD⁵), which provides an indication of the concentration of dissolved and suspended organic material); a particular nutrient concentration (eg, total nitrogen or total Kjeldahl nitrogen); and the concentration of faecal indicator bacteria (faecal coliform *E. coli*). (See Section 2.3 for further explanation.)

Figure 8.4 illustrates the performance of three different on-site treatment systems: septic tanks (ST), an aerated wastewater treatment system (AWTS) and the sand filter. Their performance is expressed in terms of the five-day BOD and suspended solids (SS). These can be compared to the quality of the raw (RAW) incoming domestic influent.

The figure shows that the standard septic tank does not produce a high-quality effluent, whereas the AWTS and sand filter produce a better-quality effluent. This is why sub-surface irrigation (with drippers with small holes) of septic tank effluent will fail, because even if the drippers don't block up with the carry-over of suspended solids, they are likely to become blocked by the growth of bio-films in the dripper line due to the poor quality of the effluent.

Centralised and cluster treatment technologies

Table 8.4 summarises the various treatment processes commonly used for cluster and small centralised systems.

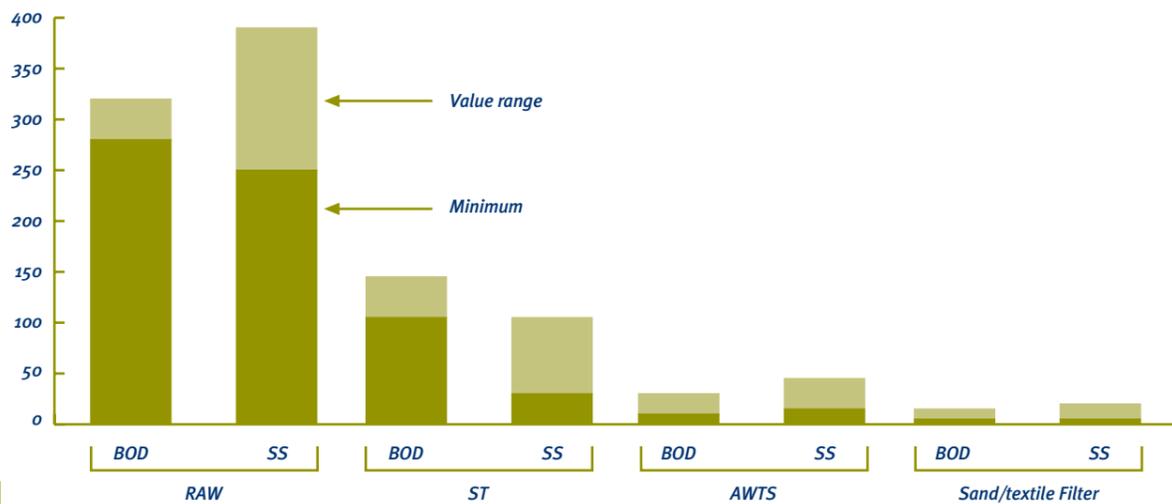


Figure 8.4 Performance of selected on-site treatment systems

Primary versus secondary treatment

Primary treatment can be best accomplished in a large communal septic tank equipped with effluent outlet filters, or an Imhoff tank. Although the Imhoff tank is more expensive to construct due to its two-tiered design, it provides a better and more reliable effluent quality than a large septic tank, and is more economical to operate because of its capacity to hold sludge and decrease its bulk via digestion. The septic tank requires more frequent de-sludging and produces an offensive watery sludge compared to the consolidated and stabilised solids removed from the lower digestion compartment of the Imhoff tank.

Secondary treatment of the dissolved and suspended organic waste matter in the settled effluent from the primary treatment process can be provided via a range of treatment options (see Table 8.4). These are discussed below.

Biofilter systems

These provide suitable secondary treatment for communities with a relatively constant population to maintain uniform loading and reliable treated effluent quality. All biofilter systems incorporate a 'secondary' settling tank to capture the biological sludges that accumulate in the system.

Media trickling filters are tanks of uniform-size gravel or crushed rock, or plastic-spoked wheels (or other plastic shapes, including corrugated sheets), on which grow the aerobic bacterial slimes responsible for cleansing the settled wastewater, and through which air circulates continuously as settled effluent trickles slowly down through stone or plastic media. The slime growths slough from the system continuously, forming a biological sludge for collection and removal from the secondary settling tank.

Wastewater conditioning	Primary treatment	Secondary treatment	Tertiary treatment	Advanced treatment	Sludge treatment
Screening and grit removal	Imhoff tank	Activated sludge: <ul style="list-style-type: none"> • standard aeration • extended aeration • oxidation ditches • sequencing batch reactors 	Sand filters (following activated sludge, biofilter or pond systems)	Nitrogen removal: <ul style="list-style-type: none"> • denitrifying sequencing batch reactors • denitrifying sand filters • zeolite filters 	Septage: <ul style="list-style-type: none"> • burial • chemical treatment and landfilling
	Clarigester				
	Sedimentation (large-capacity septic tank)	Biofilters: <ul style="list-style-type: none"> • trickling filter (biological filter) • rotating biological contactor 	Disinfection (pathogen removal): <ul style="list-style-type: none"> • chlorination • UV • ozone 	Phosphate removal: <ul style="list-style-type: none"> • chemical stripping • biological stripping • amended soil absorption 	Raw sludges: <ul style="list-style-type: none"> • anaerobic digestion • digestion and compost treatment • other treatment technologies
	Sedimentation with chemical addition				
Oxidation ponds (primary treatment)	Sand filters: <ul style="list-style-type: none"> • intermittent sand filter • recirculating sand filter 	Oxidation ponds (maturation treatment)	Membrane filtration	Biosolids: <ul style="list-style-type: none"> • aerobic digestion • digestion and compost treatment 	
	Oxidation ponds (secondary treatment)	Overland flow			

Table 8.4 Central and cluster treatment options



Rotating biological contactors (RBC) consist of 2–3-metre-diameter thin plastic discs 80–100 mm spaced on a rotating axle and turned slowly through a ‘trough’ of settled wastewater, so that the bottom third is continually being submerged. The intermittent submergence in wastewater and then exposure to the air creates aerobic bacterial slime growth on the plastic surfaces in the same way as the media filter described above.

Rotating drum biological contactors provide for biosolids growth on the internal media surfaces of the drum unit.

Activated sludge systems

Suspended growths of aerobic bacterial slimes are maintained by aerating the wastewater and suspended solids mixture by either bubble aeration or mechanical mix aeration. The wash-out of active suspended solids is captured in a ‘secondary’ settling tank and recycled back into the activated sludge tank to continue cleansing the incoming wastewater. Activated sludge variations can provide either ‘secondary’ treatment to pre-settled ‘primary’ wastewater flows, or full treatment of raw wastewater by what is termed ‘extended aeration’.

‘*Package*’ plants are factory-assembled activated sludge-treatment units, ranging from single household size up to village size, which generally operate on the extended aeration basis. They can be readily transported from factory to site, set up on a concrete slab, and, after connection to an inlet sewer and power supply, can be operating within hours of arrival.

Sequencing batch reactors (SBRs) are a fill-and-draw system, which provides a simplified and economical alternative to the conventional extended-aeration activated-sludge approach. They can be operated to strip nitrogen nutrients from waste flows and hence are well suited to residential areas in sensitive environments. The Lake Taupo basin was the first application of SBRs for a small community in New Zealand.

Oxidation ditches are an extended-aeration activated-sludge system which uses a shallow oval, race-track-shaped aeration basin aerated by a surface mechanical aerator, which also maintains a steady circulation of mixed flow in the channel. Overflows are settled to produce a final effluent and sludge, which is recycled to the plant inlet. Excess sludge biosolids are removed periodically.

Aerated lagoons are a low-cost alternative to the extended-aeration activated-sludge system suitable for larger small communities. In some cases they can provide pre-treatment prior to oxidation pond systems. They have particular application in New Zealand holiday area communities, where during winter they operate as a simple oxidation pond followed by ‘polishing’ treatment in the accompanying oxidation pond. In summer the system is changed back to an aerated lagoon/oxidation pond configuration by activating the aerators.

Sand-filter systems

Packed bed biological reactors, or sand-filter systems, use sand or packed media (eg, crushed glass) to provide surfaces for bacterial growth, and voids for air circulation, bacterial storage, and physical straining. These systems can cope well with variable population loading rates.

Intermittent sand filters are used as secondary treatment following community septic tank or *Imhoff tank* pre-treatment. They can cope with fluctuating loadings more effectively than biofilter and activated-sludge systems, and produce a much better effluent quality. They also reduce human intestinal bacteria numbers (measured by coliform indicator organisms), as well as significantly reducing organic matter and suspended solids. They must always be preceded by primary treatment.

Recirculating sand filters are more economical to construct than the intermittent types because of their reduced size, but pumping costs for dose loading are higher due to the recirculation process. *Recirculating textile filters* replace the sand by a synthetic woven fabric, resulting in a very compact treatment unit with high performance in organic matter and suspended solids removal, but are not as effective at bacterial removal.

Oxidation ponds

Facultative ponds are the most common full-treatment system in use in New Zealand. The aerobic liquid depth fosters waste stabilisation via an algal–bacterial symbiosis, which matures incoming flow during a four- to six-week retention period. The anaerobic sludge layer on the floor of the shallow pond stabilises and consolidates settled sludges and algal cells. Pond systems can accept widely varying input loadings due to the buffering action of their considerable storage volume and detention time.

‘*Polishing*’ ponds (tertiary treatment systems) are usually sized on a 21-day retention time at average daily flow to allow algal solids from facultative ponds to settle, and human intestinal bacteria to die off before discharge of effluent. Some polishing or ‘maturation’ ponds consist of several cells in parallel, each cell with 5 to 10 days’ retention capacity. The cells-in-series configuration improves the efficiency of bacterial removal. Maturation ponds can provide tertiary treatment for effluent from any type of secondary treatment system.

Constructed wetland treatment

Wetland systems are of two types: surface flow and sub-surface flow. Because the sub-surface flow units involve effluent treatment via flow through a porous ‘soil’ granular medium, some (but not all) Māori iwi accept that this meets their cultural objectives in handling human waste via ‘soil’ treatment before the resulting water flow enters natural water. The treatment performance of wetland systems is nowhere near as predictable as other treatment systems discussed above, and many wetlands are used as an environmental buffer treatment stage placed between the main treatment system and a receiving water into which a point discharge is made.

Surface-flow wetlands provide either secondary or tertiary treatment over a 5 to 10-day flow-through (retention) period. Emergent wetland plants that are rooted in the soil on the base of the shallow pond in which they have been planted work well, through settling and bacterial growth on plant stems, as well as aeration of the water by oxygen transfer processes. Septic tank effluent, oxidation pond effluent or effluent from secondary treatment processes can be treated.

Sub-surface flow gravel-bed wetlands are increasingly being used to provide a further tertiary treatment stage for facultative oxidation pond effluent flows. They are also used for combined secondary and tertiary treatment of septic tank or other primary effluent in smaller communities.

Overland flow

Overland flow offers both a treatment function and an ecosystem re-entry role. Treatment occurs within the topsoil mantle. To ensure that the aerobic renovation capacity of the soil is maintained, alternating cycles of load and rest are required (as is the case for ‘rapid infiltration’). Effluent to be treated is spread over the upper surface of a sloping, grassed plot and is treated via sheet flow as it moves down to a collection system at the lower edge of the plot. As the wastewater flows over the land, some will be infiltrated into the soil, achieving re-entry to the ecosystem. Flow that does not soak in is collected as ‘polished’ effluent for appropriate disposal.

Having collected and treated your wastewater (see Sections 7 and 8) you need to look at systems and technologies for its re-entry to the ecosystem. In some cases, water and biosolids can be reclaimed for re-use, and the options for this are briefly discussed below.

9.1 Re-entry of treated waste into the ecosystem

Sixty to seventy years ago the way wastewater re-entered the environment was not a major focus for communities or technicians. For on-site systems the main concern was to ensure that septic tank fields were able to absorb the wastes: periodically the tank would need to be cleaned out and the wastes buried. Various levels of treated waste from centralised systems would be discharged directly into streams, rivers or the sea. Untreated waste, especially sewage, would often be discharged via 'sewer outfalls' onto coastal areas. This, of course, has changed and significant levels of treatment now occur.

Treated wastewater may be returned to the ecosystem through direct point discharge to a water body such as a river, lake, wetland or estuary, or to sea. In this case the RMA will require high discharge standards, and Māori values often prohibit direct discharge to natural waters. Alternatively, the treated wastewater may be returned to land by various irrigation methods, such as flood irrigation, overhead sprinklers or sub-surface drippers.

Towns and cities close to the coastline tend to return the treated wastewater to the coastal ecosystem. Inland treatment plants may discharge their treated wastewater to a lake, a river, or to land via irrigation. The other waste product from a treatment plant is the processed sludge (biosolids). This may be disposed to a landfill site, spread on to land, composted, pelletised or treated for use as a soil conditioner.

Options for returning the treated wastewater to the ecosystem within the site boundaries (often referred to as on-site disposal) depend very much on the site's characteristics, such as soil types, area and slope of land available, location of groundwater, and local climate. Options include seepage into the soil sub-surface, irrigation (surface or sub-surface) and evapo-transpiration.

ECOSYSTEM RE-ENTRY OR RE-USE



Types of wastewater residuals

There are four kinds of wastewater residuals that must re-enter the natural environment after treatment.

Gases

These include gases such as ammonia, methane and hydrogen sulphide, and odorous organic gases such as mercaptans, indole and skatole. These can re-enter at various points, such as if water turns septic from an overload of organic material, or at the point sludge is landfilled. Methane can build up within a site and will need to be managed to reduce risks to surrounding properties. Risk management and site management plans for landfills to manage combustible gases and odour will be an important part of the re-entry process. Often communities do not factor in the costs of landfill management into wastewater management costs when choosing options.

Wastewater aerosols

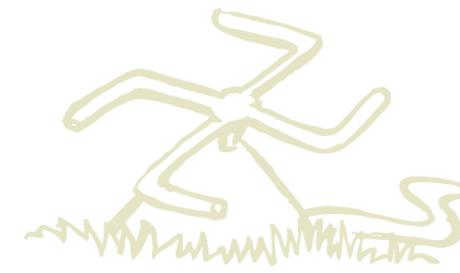
These are very small airborne droplets that can carry pathogens and other contaminants. Aerosols are created by mixers and aerators, which disturb the surface of wastewater tanks and ponds, or by overhead sprinklers. The distance these aerosols can carry in winds and the survival time of pathogens is variable and will depend on the site. A risk management plan and regulation of where and how any treatment plant or land irrigation area is to be located will be important.

Liquids

The characteristics of treated wastewater to be returned to the environment will depend on the level of treatment it has received (see Section 7).

Solids – sludge and biosolids

These can be classified as semi-solids and semi-liquids depending on the amount of water left in them. Unprocessed solids from primary and secondary treatment processes are referred to as sludges. Local authorities invest significant effort into converting sludges to biosolids and reducing the level of water in the processed solids in order to improve handling problems when they are disposed to landfills. The New Zealand Waste Strategy calls, by 2007, for such wastes to be beneficially used or appropriately treated to minimise the production of methane and leachate.



The Ministry for the Environment is placing strong emphasis on improving landfill management, and many smaller landfills have closed. Some landfills will not take biosolids. The Ministry is keen to promote re-use of biosolids, but there are issues with some processes in terms of available markets. The re-use of biosolids that have been composted is not straightforward because of concerns about the impacts of remaining heavy metals and other substances. Reference should be made to the *Biosolids Guidelines*.¹⁶

9.2 Types of re-entry system

There are six main ways in which liquid and solid wastewater residuals re-enter the ecosystem, as shown in *Table 9.1*.

As we saw in *Part One*, ecosystems are dynamic, complex interacting webs of human, biological and physical processes. People are dependent on natural ecosystems for the goods, services and products they provide. Consequently our long-term wellbeing is totally dependent on maintaining healthy ecosystems well into the future. The impact of wastewater re-entry on these systems will not just depend on the quantity and quality of residuals released into them. It will also depend on the sensitivity of the ecosystems and the relative importance of the ecosystem's goods and services.

There are procedures for assessing impacts and managing them. These include assessment of environmental effects (AEE) and hazard identification analysis and monitoring programme (HIAMP). The RMA requires that these impacts be assessed before consents will be issued. The main agency for managing these effects is your regional council. These and other groups with a role in managing impacts are discussed in *Section 4*.

9.3 Solids re-entry technologies

On-site systems

Septage is the pump-out contents from septic tanks, and is a dilute and offensive mixture of sewage, scum and partly digested organic solids. The most effective means of handling this material is to transport it to a centralised community wastewater treatment plant, where it is processed in ad-mixture with the raw sludges produced from primary settlement tanks. Where the community plant is an oxidation pond system, the septage can be added to the facultative pond, but carefully so as not to overload the inlet zone of the pond with solids.

System	Residuals managed
Freshwater ecosystems (streams, lakes and wetlands)	<ul style="list-style-type: none"> treated wastewater effluent (various levels of treatment)
Marine ecosystems (estuaries, harbours and ocean – coastal and offshore)	<ul style="list-style-type: none"> treated wastewater effluent (various levels of treatment)
Land ecosystems (agricultural, horticultural, forestry or landscaped areas)	<ul style="list-style-type: none"> some untreated wastewater (more rare)
Atmosphere	<ul style="list-style-type: none"> treated wastewater effluent (various levels of treatment) odour gases (indirect and flaring of landfill gases) wastewater aerosols (a by-product of treatment processes)
Landfills (closed systems)	<ul style="list-style-type: none"> sludges and biosolids
Waste-to-energy plants (not used in New Zealand at present)	<ul style="list-style-type: none"> dried sludge/biosolids

Table 9.1 Types of re-entry system

Other options for septage include burial in trenches on land set aside as a management area. As the septage degrades under the bacterial action within the soil, stable humus solids are formed, and the older trenches can then be re-excavated for handling fresh septage.

Pump-out contractors are licensed by local authorities to undertake this work, and they use special vacuum-suction tanker vehicles for the purpose. A recent innovation in pump-out tanker design is a unit that dewateres the septage on-site and returns the liquid to the septic tank, while consolidating and storing the scum and sludge solids. This enables efficient long-haul servicing of remoter rural-residential areas.

Cluster and centralised treatment plants

Small community treatment plants using biofilter or activated sludge systems produce a range of sludges from the combination of both primary and secondary treatment processes. The degree of stabilisation of these solids by the anaerobic and aerobic processes in the treatment plant determines the volume of final biosolids to be managed by disposal or utilisation onto land. The wet biosolids may be dried on special sand beds at the treatment plant before being collected as dried 'cake' for trucking to land (or even to a solid waste landfill). Alternatively, the wet biosolids may be spread on land under the 1992 guidelines prepared by the Ministry of Health.

A new set of national guidelines is currently in preparation (2002) under the oversight of the NZ Water & Wastes Association. Agricultural land uses are favoured if the biosolids are digested and are mature (ie, have been aged since digestion), and can be placed by sub-surface injection into the soil. Forest land application provides an opportunity for the nutrients in the solids to enhance tree growth, and is a further beneficial use of biosolids.

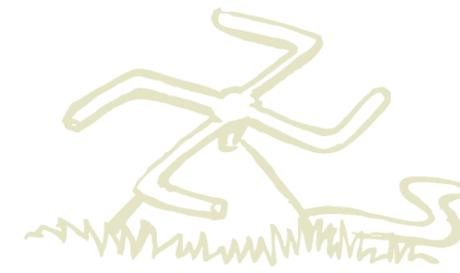
9.4 Wastewater effluent re-entry technologies

On-site systems

On-site wastewater re-entry technologies are summarised in *Table 9.2* below. For all of these systems the dimensions required are determined by the wastewater quantity and quality, and site conditions. Examples are given in *Table 9.3*. Such systems must be designed and approved by a qualified and experienced person.

The system dimensions set out in *Table 9.3* represent only its design size. The site area taken up by the installed system has to include the space between each trench or mound or irrigation line, and a buffer zone around the system footprint. In addition, a reserve area should be set aside nearby for extensions to the system if needed to handle unexpected poor performance due to system overload or misuse.

¹⁶ *Guidelines for the Safe Application of Biosolids to Land in New Zealand* Copyright © New Zealand Water Environment Research Foundation 2003



Type of system	Comments
Sub-surface seepage trenches and beds	This requires sub-soils with appropriate drainage characteristics. Groundwater levels must not be too high
LPED (low-pressure effluent distribution) trenches	Specially designed shallow and narrow trench systems with a nested perforated dosing pipe within a drain-coil line. Used for either deep sandy soils to distribute septic tank effluent for further in-soil treatment, or for deep topsoil conditions overlying clay to distribute effluent for topsoil treatment and evapo-transpiration
Wisconsin mounds	Sand-filled treatment mounds producing treated effluent for seepage to natural ground under the base. Used on sites with high groundwater levels and/or poorly drained soils
ETS (evapo-transpiration seepage) beds	Appropriate where soils have impeded drainage, and used in climates with good evapo-transpiration rates and lower rainfalls. Beds and/or surrounding spaces between beds are planted with high-transpiration shrubs, plants and/or grasses
Surface spray irrigation	For wastewater that has received secondary treatment (AWTS, packed-bed reactors [an upgraded intermittent sand filter], wetland) plus disinfection via ultraviolet light or chlorine tablets. Note: Not used for on-site applications in NZ
Surface drip-line irrigation	For wastewater that has received secondary treatment (AWTS, packed-bed reactors [an upgraded intermittent sand filter], wetland). Drip lines are laid on the soil surface and covered with mulch or bark or compost. Can be designed for incorporation within a landscaped area on the lot
Subsurface drip-line irrigation	For wastewater that has received secondary treatment (AWTS, packed bed reactors [an upgraded intermittent sand filter], wetland). Drip lines are laid within good topsoil to depths of 50 to 100 mm. Can be designed for incorporation within a landscaped area on the lot

Table 9.2 Ecosystem re-entry options for on-site wastewater systems

	Water saving	Sand loam – free draining			Loam – moderate drainage			Light clay – poorly drained		
		Trench length (m)	Mound area (m ²)	Sub-irrigation (m ²)	Trench length (m)	Mound area (m ²)	Sub-irrigation (m ²)	Trench length (m)	Mound area (m ²)	Sub-irrigation (m ²)
Primary effluent	No	120	40	NA	174	45	NA	400	112	NA
	Yes	72	23	NA	106	28	NA	240	70	NA
Secondary effluent	No	40	20	180	50	23	225	200	90	315
	Yes	24	11	180	31	14	138	122	55	190

Table 9.3 Indicative dimensions of on-site ecosystem re-entry options Source: Based on AS/NZS 1547:2000

Centralised and cluster technologies

Water re-entry

Discharge of wastewater effluent to natural water such as streams, rivers, estuaries, harbours and the ocean has traditionally been used by most of New Zealand’s larger communities that have developed alongside or in close proximity to such waters. Early drainage systems were based on the ‘dilute and disperse’ approach to using natural self-purification processes in the water ecosystem to treat the wastes. As communities expanded, treatment plants were provided to reduce the polluting impact on the receiving waters. In addition, rather than use end-of-pipe discharge into natural waters, special diffusers were used to achieve better dispersion and dilution of the treated effluent. For example, ocean outfalls for the larger coastal urban areas have been substantially upgraded by improved treatment and diffuser systems in recent years. The main forms of community wastewater effluent re-entry used in New Zealand are shown in Table 9.4

However, cultural issues associated with Māori spiritual values, together with the recognition that water re-entry systems often do not provide sound environmental performance, have shifted the emphasis for new or upgraded facilities away from water re-entry towards land re-entry. This shift in approach has been particularly significant for smaller communities, as the land areas needed can be more readily found in the adjacent rural areas than can be found for a larger community. For large communities upgrading their treatment and ecosystem re-entry systems, the use of constructed or natural wetlands has been accepted as an appropriate buffer between the treatment plant and the natural water into which the final discharge diffuses.

Land re-entry

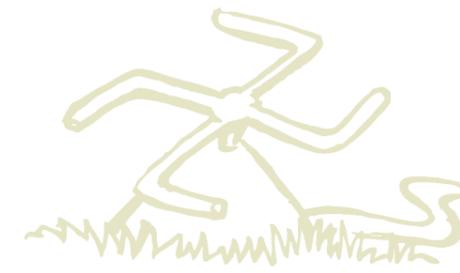
Land options include rapid infiltration, overland flow, and low-rate irrigation by either spray irrigation or drip-line irrigation. Land treatment is the favoured method for achieving the cultural objectives for human waste management by the majority of Māori iwi.

Forms of re-entry	Number of communities	%
Freshwater:		
• stream flow	147	51.9
• lake	4	1.4
	151	53.4
Marine:		
• estuarine	7	2.5
• harbour	13	4.6
• coast	6	2.1
• offshore outfall	29	10.2
	55	19.4
Land and other:		
• to land	59	20.8
• land/ excess flow to water	17	6.0
• pipeline to another treatment plant	1	0.4
	77	27.2
Totals	283	100

Table 9.4 Main forms of wastewater effluent re-entry in New Zealand

Rapid infiltration can be both treatment and ‘disposal’ (via discharge to groundwater some distance below the soil infiltration surface). Partially or fully treated effluent is soaked into the ground at a high rate for further in-soil treatment. Only sandy soils are suitable for long-term use, and the water table must be sufficiently deep so that all human bacteria are trapped in the soil, where they can gradually die off and not contaminate the ground water. You should note that other pathogens may not be removed.

Low-rate irrigation is a land-treatment and disposal system that involves total effluent absorption via soakage and evapo-transpiration through planted crop or vegetation ground cover. Application rates are only a few centimetres per week, so large land areas are required. The higher the level of pre-treatment (secondary treatment being a minimum), the more effective the long-term performance of the irrigated area in coping with the effluent load. For spray irrigation systems, significant buffer distances (planted, non-irrigated borders) are required adjacent to any location where people may be present to avoid human contact with aerosol-carried bacteria in the spray drift.



Forest irrigation is a common method of effluent spray irrigation management, with the advantage that nutrients and water enhance tree growth. Grassland spray irrigation is another method, but unfortunately the dairy industry is not interested in using the harvested crop for fodder as they say that overseas consumers are likely to reject dairy product from cows fed on human effluent-irrigated pasture. Where drip-line systems are used, buffer distances can be very small, and horticultural use of the treated effluent nutrients and water becomes feasible.

In-land treatment via surface application and under-drainage lines for collecting filtrate that is subsequently disposed to a receiving water or to a reclaimed water use is a variation on rapid infiltration. It can provide the advantages of irrigation for crop or pasture growth where water table depths may restrict application rates unless lowered by artificial drainage.

9.4 Re-use of water and biosolids reclaimed from wastewater

Traditionally wastewater has been managed as a product that is a threat to both human and ecosystem health. Consequently, the infrastructure design for handling such a material will reflect this.

Domestic wastewater contains essential resources such as water, nutrients and organic material. Treated wastewater produces liquid wastewater and primary and secondary sludge, which is the material that remains once the original water-borne waste is 'dewatered'. Both these wastes can be processed to recover reusable water and composted biosolids for horticultural application as a soil conditioner.

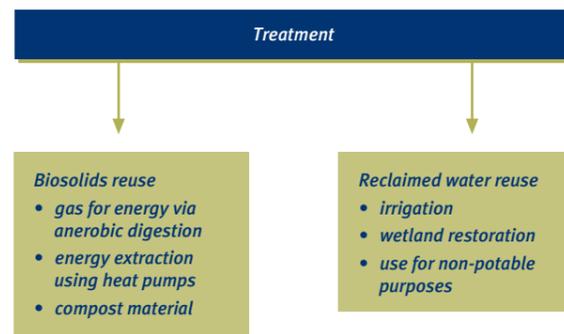


Figure 9.1 Alternative reuse strategies

Re-use of biosolids requires a higher level of treatment beyond what is achieved with the normal treatment of primary and secondary sludges.

A number of technologies are commonly used that utilise the resource value of wastewater, most commonly with centralised systems, where the volumes of treated wastes are likely to be large enough to encourage investment. It is also possible with the smaller cluster systems, although this is a fairly new area. Re-uses include biogas production for energy (a process that converts the organic component of primary and secondary sludges to methane), irrigation of water and wastewater nutrients for biomass production, and the use of the treated wastewater for wetland restoration. Other practices overseas include aquaculture, energy extraction (from the wastewater) by heat pumps, urine separation, and nutrient stripping for the production of nutrients.

It is rare for an on-site system to involve re-use, although some of the options include recycling treated wastewater or greywater for non-potable uses such as toilet flushing and irrigation, or feeding landscaped wetlands, and the use of composting toilets and production of humus.

Reclaimed water has non-potable uses for garden irrigation or industrial processes. Wetland restoration involves artificially putting water back into a wetland to offset the loss of water from drainage of surrounding areas and the lowering of the water table.

Re-use of reclaimed water is a new part of wastewater management in New Zealand. It is also where Māori have concerns about the re-entry of wastes. There are concerns about irrigation direct on to food crops, and uncertainty about compost as an end use. Non-potable use is acceptable if it is not used for food production, and where it must pass through soils first. There is also wider community concern about some of these processes (eg, heavy metals in composts).

Health authorities also have concerns regarding the use of reclaimed water sourced from wastewater because of the possibility of direct contact with pathogens if something goes wrong with the treatment process, or if the system is not adequately maintained.

A wide range of technologies can be explored, even if the area is relatively new. Like managing water use at source, biosolids and reclaimed water re-use have the potential to reduce the overall cost of the wastewater system. For a smaller community it may be worth looking at how the waste streams, especially sludges to be converted to biosolids, might be combined with other communities in a centralised process. Re-use is well worth exploring as part of your wastewater thinking.

Golden Valley subdivision, Kuaotunu, Coromandel Peninsula

A new subdivision of 40 residential lots has been designed and constructed (2000) with a pumped MEDS (modified effluent drainage servicing) collection system. Filtered septic tank effluent is conveyed in 50 mm pressure sewer lines from a pump within each septic tank to a central recirculating sand-filter treatment plant located in an enlarged and landscaped central median strip on the access road serving the development. The very high-quality effluent produced is in part disinfected and returned to each lot as non-potable reclaimed water for toilet flushing. The remaining effluent flow is not disinfected, but pumped to an area of steep terrain where it is to be irrigated by driplines into eucalyptus planted plots. A portion of treated effluent will be held in storage for firefighting purposes.

The advantage of the recirculating sand media filter treatment system for this type of development is that it can be commissioned to run on a modular basis. Treatment capacity can be extended to match housing numbers as constructed over time. On a seasonal basis, modules can be started up and then shut down to fit the expansion and contraction of holiday occupancy. All this can be accommodated while maintaining a consistently high treatment performance.

Because of the use of a fully sealed reticulation system, there will be no infiltration into the system, thus protecting the treatment plant from excess flows. The treatment plant performance, including the operational status of all mechanical units and effluent quality readings from treatment stages, is remote monitored by sensors, with the resulting information transferred to computer surveillance at the operating company's headquarters in Auckland. This is a design-build-operate (DBO) project where the performance of the overall treatment system is remote monitored by offsite specialists, but with locally trained service people on standby callout to deal with any operational events that need attention.



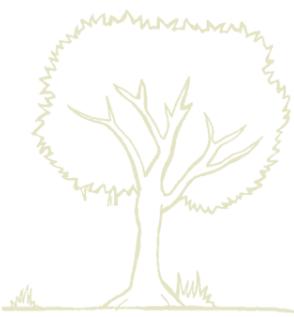
SYSTEM CONFIGURATION, PERFORMANCE AND FAILURE ISSUES

In Sections 6 to 9 different parts of the wastewater management system were described, from managing wastewater at source, through collection and treatment, to its re-entry into the ecosystem or re-use for various purposes. In this section we will be looking at options for how some of the overall systems come together, and how they perform.

Many smaller communities will have on-site systems, and your decision-making will centre around how these work, can they work better, and what your options are for moving to cluster or centralised systems. For this reason the section has a strong focus on on-site system configurations, their advantages and disadvantages. However, we also compare the performance of cluster systems and on-site systems, and conclude by running through the typical reasons for on-site system failure and how to avoid it.

System	Source control	Wastewater	Treatment	Disinfection	Loading	Ecosystem re-entry
1	No water saving	All waste (black and grey)	Conventional septic tank (ST)	NA	Trickle loading	Conventional seepage trench
2	No water saving	All waste (black and grey)	Multi-chamber ST (MST) or improved single-chamber large ST with effluent outlet filter (IST)	NA	Dose loading	Conventional seepage trench or LPED trench system
3	No water saving	All waste (black and grey)	MST or IST	NA	Dose loading	Wisconsin mound
4	Water saving	All waste (black and grey)	MST or IST	NA	Dose loaded	Seepage trench or LPED trench system
5	No water saving	All waste (black and grey)	MST or IST plus intermittent (ISF) or recirculating sand filter (RSF)	NA	Dose loading	Sub-surface irrigation
6	No water saving	All waste (black and grey)	MST or IST plus constructed wetland	None	Dose loading	Sub-surface irrigation
7	No water saving	All waste (black and grey)	AWTS	None	Dose loading	Sub-surface irrigation
8	No water saving	All waste (black and grey)	AWTS	UV or chlorine tablet	Dose loading	Surface irrigation
9	No water saving	All waste (black and grey)	MST or IST	Storage of compost for 12 months	Spray loading Dose loading	Evapo-transpiration seepage (ETS) bed
10	Composting toilet and water saving	Blackwater	Composting	None	Manual	Returned to topsoil as humus
		Greywater	Grease trap and constructed wetland		Dose loading	Subsurface irrigation

Table 10.1 On-site wastewater system options



10.1 On-site wastewater system configurations

The on-site technologies described so far in *Part Three* can be combined in a variety of different ways to provide an on-site wastewater servicing system. *Table 10.1* presents some of the combinations that have been used.

Each of these is described in more detail in a series of key features diagrams in *Appendix 6*. The detail in *Appendix 6* is provided so that you can see how each system works, and to help you make informed judgements about the kind of system that best suits your community. (Note: combinations other than the 10 listed in *Table 10.1* may be possible.)

10.2 System performance

Table 10.2 provides a summary of some of the effluent qualities provided by various on-site and cluster treatment plants. Regional council rules will often set the discharge quality requirement for a range of treatment technologies relative to the council's oversight of environmental effects

from discharges. Councils have responsibility for managing the potential cumulative effects of wastewater servicing (either on-site, cluster or centralised) on the natural land and water environment. On-site systems come under the permitted activity rules of councils, but all cluster and centralised treatment plant discharges will need to be processed via council consents procedures, and issued with a discharge permit to which conditions will be attached (including the effluent quality to be met).

10.3 On-site system failure

Table 10.3 provides a selection of potential 'failure modes' (things that can go wrong) for on-site wastewater servicing. Failure in this context is defined as the inability of the system to perform as intended by the design. Either poor soil assessment during the design phase, incorrect design, inadequate attention to installation, or lack of operation and maintenance servicing can initiate such failure. Improper use by overloading the system with more people than it was designed for, or the discharge of substances such as fats or paints or chemicals down the inlet sewer line, will all contribute to failure.

	On-site systems				Cluster			
	Raw domestic wastewater	Septic tank	AWTS	Sand filter	SBR	Extended aeration	Constructed wetlands	Packed bed sand or textile filter
BOD ₅ g/m ³	200-300	120-150	15-40	5-15	3-9	< 30	5-15	< 5
Suspended Solids g/m ³	260-400	40-120	20-60	5-20	2-19	< 30	5-20	< 5
Total nitrogen g/m ³	30-80	40-60 ¹⁸	25-50		2-9	< 7	5-30	
Total Kjeldahl nitrogen (TKN) g/m ³	30-80	40-60	25-50	30-50			5-30	
Total phosphorus g/m ³	10-20	10-15	7-12	5-10	1-10	< 8	5-10	
Faecal coliform cfu/100ml	10 ⁶ -10 ⁸	10 ³ -10 ⁵	10-10 ³	10-10 ³		< 10 ⁴	300-1000	1000

Table 10.2 Performance of different treatment technologies¹⁷

Note: Some of the systems shown are able to treat raw effluent directly (septic tank, AWTS, SBR, extended aeration); others are secondary and/or tertiary systems requiring some sort of preceding treatment (sand filter, constructed wetlands, packed beds).

¹⁷ Many of these systems can also be designed in different ways and built with different sizes to achieve different treatment objectives (eg, a large, constructed wetland will generally work better than a small one treating the same flow).

¹⁸ T Gardner, P Geary, I Gordon. Ecological sustainability and on-site effluent treatment systems. *Australian Journal of Environmental Management* 1997, 4: 144-156.

Treatment failure	
Failure mode <i>Sludge buildup</i> on septic tanks or AWTS will reduce treatment performance	Avoiding failure Regular checking of levels of both settled and floating sludge in the various chambers with de-sludging when necessary
Filter blockage – for treatment systems with proprietary filters (septic tank filters, or filters pre-sub-surface irrigation)	Regular checking and cleaning of filters
Sand-filter clogging – where septic tank effluent is treated further before discharge to re-entry system	The system should be designed by a competent wastewater engineer. It is important that the sand-dosing arrangement ensures regular and uniform distribution of the septic tank effluent over the surface of the sand filter
Biological failure – most on-site wastewater systems rely on small micro-organisms, such as bacteria, to breakdown and purify the wastewater. If these living organisms are poisoned by chemicals flushed down the kitchen sink, toilet or other drains, the treatment system will fail	Take care with what chemicals are flushed down drains and toilets. Do not flush disinfectants, oils, thinners, paints, bactericides, fungicides, pesticides or chlorine-based cleaners. Use biodegradable cleaners and detergents as much as possible
Leakage – from or into a below-ground tank and pipe-work can cause failure. High groundwater table and stormwater infiltration can cause hydraulic overloading	Ensure the subsurface tanks, gully traps, and pipes are well sealed from surface stormwater and groundwater flow
Eco-system re-entry failure Blocked drainage field – this may occur due to one or more of the following factors: inadequate pre-treatment, poorly draining soils, or overloading of the field drainage system	Ensure that the total system is designed by a competent wastewater engineer who carries out a thorough site investigation. It is important that systems are installed by experienced and competent tradespeople
Flooding due to high groundwater – groundwater levels will vary throughout the year. A flooded field drainage system will cause system failure	Design and install a system that can cope with high groundwater conditions
Blockage of irrigation distributors – sprinklers and drippers. Most NZ wastewater irrigation systems use subsurface drippers. These may block after some time in operation. Emitters with small apertures can block due to the lodging of suspended particles in the treated wastewater and/or growth of bacterial slimes and other micro-organisms in the pipeline. Fine roots may also penetrate drifter apertures	A high-standard pre-treatment is essential for an irrigation system (AWTS or better). Suitable upstream filters must be installed. Some dripper lines come impregnated with biological growth inhibitors to prevent biological growth and root penetration Regular checking is advised and dripper line replacement recommended when blockage occurs
Mechanical failure – pump failure or electrical outage	Regular maintenance is advised where effects on the environment and human health have been identified Back-up systems should be designed as part of the system
Surface ponding – a poorly designed and managed system may result in the treated wastewater ponding on the ground surface. This can be a serious health risk	The reason for surface ponding must be determined and corrective measures taken. It can be due to a high groundwater table, overloading, blocked drains and impermeable soils
Overloaded system – extra flow over and above the design allowance floods the soakage system and results in breakout of wastewater and ponding on the ground surface. This can be a serious health risk	This could occur if water-saving devices are no longer operable or used, or if an extra water-using fixture such as a garbage grinder is installed when not allowed for in the design

Table 10.3 Failure in on-site systems

4 PART

MANAGEMENT, FUNDING AND SELECTION OF WASTEWATER OPTIONS

The fact that management is as important to the success of your wastewater venture as choosing the technical systems themselves has already been stressed. Indeed, a key question your community should ask itself is: what is the capacity of individual households or the community to manage a wastewater system in the long term? The answer to this question will be a significant factor in deciding whether you want a system that can be managed by an external agency – such as a local council – or whether you will stay with local responsibility. Section 11 discusses this management issue.

By this stage, if you have made your way through the manual, you may feel rather overwhelmed with all the information you have been presented with. Section 12 tries to help by providing a framework for decision-making, in which various criteria can be applied to assess the various options you now face.



MANAGEMENT AND FUNDING OF WASTEWATER SYSTEMS

Obviously cost will be a significant factor in choosing a technical solution. There will be ongoing maintenance and operating costs that will need to be paid for. The relative costs of different on-site systems are discussed in Appendix 6. The more general issues of funding are discussed here.

On-site systems

The individual household management of on-site systems has come under increasing scrutiny by agencies concerned about public health. It is common to find that septic tanks and other on-site systems are poorly maintained and operated. There are often consequent problems with discharges on to land and waterways, and contamination of the water supply. Sometimes the cause of failure is lack of information about how to operate and maintain the systems. Sometimes it is an issue of cost.

Another problem is that failure to maintain the on-site system can mean that its 'life' is drastically reduced. The homeowner may save money in the short term, but the system may have to be replaced earlier than normal. The value of the asset is lost. This recent scrutiny is likely to force communities who are otherwise comfortable with their on-site systems to review the situation.

One of the problems with this on-site system failure is that it can push a community into choosing off-site cluster or centralised systems. This physical technical system may not be necessary if the on-site systems are well managed.

There are two types of management solution you can consider when you explore technical solutions.

11.1 Management of wastewater systems

Traditionally, wastewater systems have been managed in two ways. The first is where on-site or individual systems have been managed by the householder or stand-alone business. The construction, maintenance and operation of the system lie with the individual. In contrast, centralised collection and treatment systems are managed by a central agency, usually the local authority, which undertakes all management activities in a co-ordinated approach to wastewater servicing. This has normally been the practice on a regional or district or cluster approach to management of community-wide wastewater schemes. Occasionally, responsibility would be transferred to a separate agency, which would be governed in some way by the local authorities concerned. Auckland region's Watercare is an example of this.

However, there is an international trend towards placing on-site wastewater systems under integrated management programmes, particularly with respect to their operation, maintenance and monitoring. This trend is becoming evident in some areas of New Zealand, and is the recommended approach in the joint Australian/New Zealand Standard (2000) for on-site domestic wastewater management.

The newer cluster systems can be managed by a local authority (if they constructed them) or by a corporate entity. The latter would be set up by the property owners to manage the system on their behalf. This 'centralising' of management reflects both the need to have a clear line of responsibility and the complexity of the systems being managed.

So a more comprehensive picture of wastewater systems management can look something like that outlined in Figure 11.1.

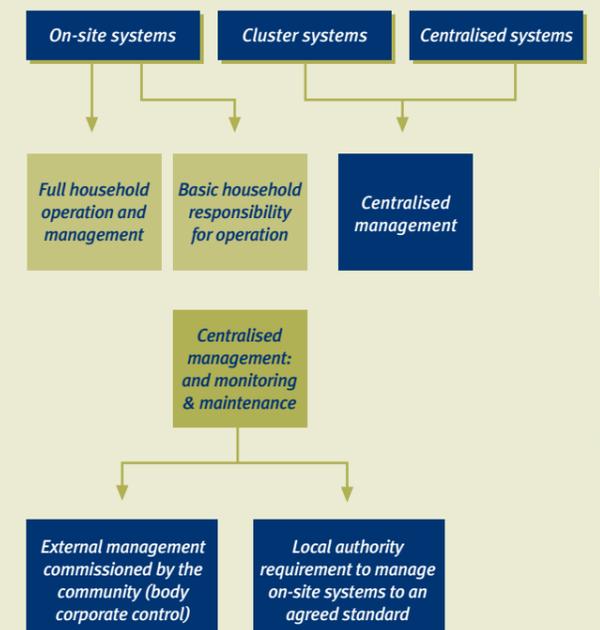


Figure 11.1 Wastewater systems management



A collective approach to maintaining systems

For example, your bach settlement might consist of 100 houses, all with septic tanks. Fifty of these houses have permanent residents and 50 have summer visitors, who have limited knowledge of septic tank systems. One solution may be for the owners to get together and pay a third person to monitor and maintain these systems for a set price. Capital costs to upgrade and repair a particular septic tank would still be the responsibility of the individual land owner.

A collective approach to improved management of septic tanks

The majority of the community may feel that some regulation to require management of the on-site systems is necessary. Or your community may want to clearly indicate the expected standard for any new people settling in the area. A simple way to do this is to require everyone to perform to a certain level. This two-pronged approach may reduce pressure to move to a centralised technical system because the management of the on-site systems is faulty.

Such integration can:

- provide for the involvement of professional operation and maintenance servicing (O&M), which removes the direct responsibility from the homeowner
- protect the investment in the on-site system hardware and soil treatment capacity by maintaining long-life performance
- bring better environmental and public health results.

This concept of integrating the management of on-site systems is referred to overseas as ‘decentralised wastewater management’ (DWM). The objective of DWM is to provide centralised management of decentralised facilities, such as on-site septic tank and soakage trench systems on individual properties. This means that a level of management service equivalent to that of centralised and cluster wastewater systems can be accomplished. Sometimes overseas this DWM can include investigation and design of the system.

This approach to operating and maintaining on-site systems would still need the householder to take some responsibility; for example, making sure that toxic substances do not enter the system.

Environment Bay of Plenty (BOP) Maintenance Certification Scheme

In 1999 Environment BOP introduced a system of on-site wastewater system inspections for properties at 14 coastal communities in the Tauranga Harbour and Rotorua Lakes areas. There was concern that the high density of residential development and un-maintained septic tank effluent soakage systems were contributing to environmental effects on natural water quality. To initiate the programme, Environment BOP ran training courses for prospective certifiers, who were recruited from the drainlaying and tank-servicing industry. All homeowners in the community areas were given ample information on the reasons for and the method of carrying out the inspections, and advised that following a satisfactory inspection, a compliance certificate would be issued. Those systems that required remedial work to bring them up to a satisfactory standard would be certified following completion of the work. A deadline was set for homeowners to engage a certifier and have the inspections completed, whereupon certificates would be issued by Environment BOP.

The on-site system inspection process involved lifting the lid of the septic tank, pumping the tank out, inspecting its size and structural condition, and checking out the condition of the soakage field. In addition, the location of the system in relation to environmental features on the site (such as groundwater level, nearness to streams, water courses, lake and harbour sides, as well as site boundary conditions) were noted and reported on. A scoring system based on demerit points associated with non-compliance with regional rules for on-site system installation was used to rank the suitability and performance of each system. Payment for the inspection and septic tank pump-out was arranged directly by the owner through the certifier who arranged all the work. A fee was recovered by the certifier to pay Environment BOP for the issue of the compliance certificate, as well as administration costs, including auditing of inspections.

The inspection programme indicated that several settlements needed to change to a community sewerage scheme. For the remaining localities, inspections are to continue at three-yearly intervals.

Levels of management

There are different levels of management associated with the use, operation and maintenance of on-site systems involving householders, owner body corporate agencies, or local authority agency. Examples are as follows.¹⁹

Level 1: leave all responsibility for O&M management in the hands of householders, but the local authority develops an inventory of systems, and provides information to owners and users on a regular basis.

Level 2: inspection and maintenance certification – agree a standard of maintenance, which would be carried out by an external operator engaged by the householder. This would require the council to set a consistent standard across all the systems in an area, which might involve upgrades to an agreed level first. All mechanical treatment systems would be subject to maintenance contracts. The council would keep records of all maintenance certificates and contract reports.

Level 3: a utility operator takes over the monitoring and maintenance. A council may take on the maintenance programme and charge back the cost via rates or a direct charge. Alternatively, a private organisation (body corporate) could manage the O&M activity with reporting back to the council.

Level 4: the assets are actually vested in the agency, which manages them directly. This might be a council or a body corporate-type approach.

Levels of inspection

Clearly, with large lot sizes and low density of development, on-site systems are likely to have limited potential for creating environmental effects beyond the site boundary. Hence, the frequency and detail of monitoring inspections could be modified to accommodate the intensity of development and the likely performance of on-site systems.

Table 11.1 provides a model for the levels of inspection and procedures involved for various types of facility.

Assessing whether it is a management or a technical system problem

The previous discussion identifies some approaches to management options, which, if adopted, might mean that your community continues with on-site systems. How then do you balance this kind of management approach against other factors that might be pointing you to technical solutions? How can you be sure that it is a fixable management issue and not a technical problem?

First, you need to know:

- the scale of the problem – this may involve working with your local council to do a full review of on-site systems
- the extent that people do actually maintain their on-site systems
- whether the systems are suitable for the physical environment, the soils, the water table, the topography and other physical attributes of the site.
- the cost of an upgrade.

In the end it may come down to a decision about how far your community’s on-site systems have declined in quality, and how much it will cost to haul them back to an acceptable level.

Make sure you factor in information about how your community manages its on-site systems and match that with the scale of any problems and with the condition of the systems. Remember that there are a variety of choices, including continuing with well-managed on-site systems for parts of the community. (The choices are covered in *Part Three*.)

¹⁹ Concepts are derived from the US Environmental Protection Agency model for requiring integrated decentralised wastewater management.



Inspection level	Application	Inspection procedures
Class 1 (low level, 5–10 year intervals)	<ul style="list-style-type: none"> remote area recreational facilities farmhouses lifestyle blocks (on large lots >2 ha) rural/residential dwellings (>4000 m²) where significant clearances are available to property boundaries (50 m or more) where an established history of good environmental performance exists where environmental, public health and economic consequences of poor performances are considered insignificant. 	Class I low-level inspections may involve a check on the septic tank and/or other pre-treatment unit sludge and scum levels, and a visual inspection of the general location of the land application area and on-site system environment.
Class II (intermediate level, 3–5 years)	<ul style="list-style-type: none"> rural/residential subdivisions of fewer than 5 lots rural/residential subdivisions on medium-sized lots (>1000 m²) urban dwellings on medium-sized lots (>1000 m²) isolated rural dwellings on lots >800 m² where the site coverage allows ample room for providing a replacement system to modern design standards where seasonal occupancy is the norm (ie, holiday resort areas) where overall performance of local systems is judged satisfactory. 	Class II intermediate-level inspections may involve (in addition to the low-level assessment) the search of building consent records, distribution system inspections, probing to locate soakage field elements, full sketch plans of site and on-site system elements, general soil assessment, and an overall environmental performance review.
Class III (high level, 1–3 years)	<ul style="list-style-type: none"> rural/residential subdivisions of more than 5 lots rural/residential subdivisions on smaller lots (<1000 m²) isolated rural residential dwellings on smaller size lots (less than 800 m²) urban area dwellings in smaller lot sizes (<1000 m²) where site coverage results in restricted room for a replacement system to modern design standards where permanent occupancy is the norm in rural/residential areas where overall performance of local systems is judged unsatisfactory where a high level of failures of existing systems is evident (>than 20% of systems are affected) where potential environmental and public health effects are judged to be significant. 	Class III high-level inspections may involve (in addition to intermediate assessment): emptying pre-treatment units via pump-outs of septage and then evaluating the physical condition of the unit; excavating elements of the land application system/area to assess liquid retention and current operational capability; undertaking detailed solid profile determination and soil category assessment to confirm design suitability; sampling and analysing pre-treatment effluent quality; and undertaking environmental effects assessment (including groundwater and surface water monitoring within and beyond the site, as well as checking soil condition and plant health in the vicinity).

Table 11.1 A New Zealand model for on-site inspection

What are the operational and maintenance issues that need management?

Operational issues

‘Operations’ usually applies to the day-to-day actions that need to take place to run a system. For example, to run a central wastewater treatment system, electricity is needed, as well as someone to monitor and oversee the system. These are operating costs.

In choosing an option the costs of operating any system need to be factored in. Interestingly, the operating costs of on-site systems tend not to be factored into decisions. Costs are generally absorbed directly by the homeowner or businessperson – in terms of time and effort to monitor and look after the system. This is very misleading because it is the willingness of the owner to operate and maintain the system that is such a big factor in its long-term success.

At the very least, the time needed by an owner to run a system should be estimated and converted to some sort of hourly rate. If the community decides to commission external operations and maintenance, the costs will then be comparable.

For on-site systems, the operational issues are probably relatively small but will include monitoring and inspections.

Monitoring technologies

The development of new technologies for monitoring on-site system treatment units and transferring monitoring data by phone lines to a central management and servicing agency now provides high-level, economical support to inspection programmes. Remote monitoring of a large number of systems on individual properties can be accommodated by computer data processing, with fault detection and alarm call-out procedures initiating maintenance responses to deal with emergency situations. Such monitoring technologies enable labour cost savings associated with operation and maintenance inspections (see Golden Valley subdivision example, Section 9.4).

Maintenance

This includes all the activities needed to keep the physical system at a high quality. Time and money spent on maintenance will extend the ‘design life’ of the asset and mean that you don’t have to replace the system earlier than is needed. Maintenance can include routine cleaning of any pipes and screens, pump-outs of septic tanks, and associated testing. Monitoring of the physical state of a system will also be necessary.

Replacement

Any system will have a life, beyond which it will be ‘worn out’. It will need replacing at some stage and an important management concern will be to ensure that it is replaced at the best possible time. As much as possible, this needs to be right at the point where the system is still functioning well (so service levels are maintained) but just before it might fail. This involves expert judgement, and puts an onus on the homeowners to make that judgement, or to know when to seek expert advice. More often than not that advice is sought when the system fails. Commissioned management assistance may avoid this problem.

New assets and upgrades

Building a new system, improving the quality of an existing system, or increasing its capacity may all be needed from time to time.



Centralised and cluster systems

The management regimes for cluster and centralised servicing are well established, and may be administered by one of the following agencies:

- local authority
- regional authority
- council controlled organisation (previously called a LATE – local authority trading enterprise)
- private enterprise servicing company.

The resources and procedures for operation and maintenance and monitoring of both the sewerage system and the treatment plant and ecosystem re-entry facilities will have been developed and refined over many years, with trained and experienced staff providing oversight of this full service approach.

In the case of a small subdivision in a rural area, sometimes a ‘sewage package plant’ is an acceptable solution to the local authority. This requires some form of legal agreement between the benefiting parties to provide for maintenance and management. This can be supplied under a turn-key contract and there are a number of suppliers of such systems operating in New Zealand. Speak with the New Zealand Water and Waste Association for an up-to-date list.

In urban communities a communal system of wastewater service is the most efficient and effective delivery mechanism. Typically in New Zealand the system has been provided and maintained by the local council, but in recent times arrangements have evolved to include other options, including:

- transfer of the activity to a council-controlled organisation (previously called a LATE – local authority trading enterprise), so the activity is managed on a more business-like basis
- maintenance of the system by contractors – usually on a relatively short-term basis (eg, 3–10 years)
- franchising of wastewater services under a long-term contract (eg, Papakura District Council).

Since the enactment of the Local Government Act 2002, franchising (in the Papakura form) is no longer an option and the general provisions relating to the ownership and operation of ‘water services’ by local authorities (water supply, sewerage treatment and disposal and stormwater drainage) are much more constrained.

Every territorial authority that provided water services at the commencement of the Act is required to maintain that capacity, the transfer of ownership or control to a person that is not a “council-controlled organisation” is prohibited, and contracts for the operation of water services cannot exceed 15 years.

The principal legislative requirements that have to be complied with are:

- the Local Government (Rating) Act 2002 – especially the provisions in *Section 16* and *Schedule 3* relating to targeted rates
- *Sections 108 & 407* of the Resource Management Act 1991, and *Sub-parts 1 and 2 of Part 7*, and *Sub-part 5 of Part 8* of the Local Government Act 2002 regarding water services and development contributions, respectively
- *Section 148* in the Local Government Act 2002 (being the power to make a new by-law for tradewastes).

(For more information on the implications of the Local Government Act 2002, see *Appendix 2*.)

11.2 Funding

Whatever the system, be it public or private, it will have to be paid for somehow. This will include the:

- capital cost – the cost of building a new system, or of upgrading or extending an existing system
- annual cost of operating and maintaining the system
- cost of making provision for future replacement (depreciation).

For on-site systems, the owner will have to cover all costs, including capital, operating, monitoring and maintenance costs. Most owners of on-site systems make no provision for replacement costs, by setting aside money for depreciation of the asset. This would be like setting aside a sum each week to replace your washing machine when it wears out; the amount set aside would be an estimate of the replacement costs divided by the number of years of the life of the machine.

The following discussion deals with the funding of cluster or centralised wastewater systems managed by a body corporate, local authority trading enterprise, or council agency.

Capital cost

The capital cost of providing a proposed new system is of course very important – but it is not as important as the cost that is going to have to be paid annually over subsequent years. In *Appendix 6* some alternative systems arrangements are described with suggestions of possible ranges of capital costs. It may sometimes be better to select a system that is more expensive to build but cheaper to operate and maintain, than one that is cheaper initially but expensive to operate. However, the cost of loan servicing and the amount that is going to have to be put aside for depreciation are other important matters that will influence this decision.

In terms of a public system, there are three main ways of funding this capital cost.

- If the system is small, or there are many properties to share the cost, the property-owners involved might agree to contribute a single lump sum, or to pay a capital contribution by instalments.
- If sub-dividers and developers are likely to benefit in future, as well as requiring them to reticulate their own subdivisions and developments, contributions may be sought from them.
- The most common way is for the local authority concerned to raise a loan – usually for a term of 25–30 years.

Annual cost

The annual cost will be made up of direct maintenance and operating charges, loan interest and repayments, provision for depreciation, and, in the case of a council system, an amount for management and general overheads.

There are many ways these costs can be shared, and the first thing that needs to be done is to agree how much should be paid by the users and how much by the community at large. The answer to this question will vary from area to area, but normally the full cost (or almost all of it) will be required to be met by those whose properties are connected, or able to be connected, to the new system.

While rating according to the land, the capital or rateable value of properties is permitted, this is not often used for funding wastewater costs these days – except in some rural districts where a targeted rate may be levied over an ‘area of benefit’. The disadvantage of land-value rating is that the individual amounts charged often do not bear any resemblance to the use being made of the system, and this raises questions of funding equity.

Ideally, the method for collecting the annual charges should be one that encourages water conservation, but (except in certain industrial situations, where the tradewaste provisions mentioned later apply) in reality charging according to the quantity of water discharged is not legally allowed.

The most common method used is to levy charges ‘per pan or urinal connected’, subject to the provision that every separately occupied household is deemed to have only one pan. The charge may be uniform or according to a scale that reduces in price the greater the number of pans.

Another de facto user pays method is to levy a uniform annual charge per rating unit, or per separately rateable portion of every rating unit, that is able to be connected to the system. This option is particularly useful in the early years of the system’s life, until the number of properties connected makes the pan charging approach viable.

It should be noted too that the availability of the system also benefits properties that are capable of being, but are not presently, connected, in that the ability to connect increases the value of the land. The usual practice is for the owners of non-connected properties to be required to pay a reduced fee – usually 50% or 60% of the basic charge.



Some specific issues to be aware of

School charges

There have been long-running arguments about what schools should be required to pay. However, you should note that the former Rating Powers (Special Provision for Certain Rates for Education Establishments) Amendment Act 2001, commonly known as ‘the Donnelly Act’, now no longer applies and councils are free to decide what the charges for schools should be.

Tradewastes

Ensure that tradewastes (wastes discharged from a trade premises in the course of any trade or industrial process or operation) are adequately controlled. In order to be able to levy tradewaste charges, a bylaw will be required. The usual approach is for the council to recover the reasonable costs for treating discharges of such strength and volume in excess of sewage of a domestic nature that would be discharged from a property of ‘substantially similar rateable value’.

Financial contributions

Ensure there is a process in place for requiring the payment of financial contributions to public wastewater systems by sub-dividers and developers. Before sub-dividers and developers can be required to contribute, unless the council is still able to use the provisions of the Local Government Act 1974 as a transitional measure it has to have an ‘operative rule’ in its district plan. Getting such a rule operative can be a long and difficult process. Another option in future is to use the new development contribution provisions in the new Local Government Act 2002.

Public consultation

Whatever the funding system proposed, if it is a local authority wastewater system there will have to be plenty of public discussion and consultation. The matter will have to be canvassed through the annual plan, and in future the proposed long-term council community plan. The provision of a new sewerage system is often very contentious, and anyone who makes a written submission about it has to be given the opportunity to be personally heard.

Another matter you may have to decide is how the proposed new system is to be accounted for in future. Often rural councils manage quite a few separate, relatively small schemes and there will be the question of whether there should be different charges for each or whether they should be managed and funded as one. Because of the impact of depreciation and of future capital renewal needs, the latter system has some distinct advantages.

Other sources of funding

A new and significant source of assistance for smaller communities is the Government’s subsidy scheme for wastewater systems. It provides small and isolated communities with the ability to develop systems they might not otherwise be able to afford. The scheme is outlined below.

It is important to note that the assistance is for the *capital costs* of a project. If your community is considering the scheme, you need to make sure you have determined whether the operating, maintenance and replacement costs will be affordable. Note also that the subsidy is focused on off-site systems.

Sanitary Works Subsidy Scheme (SWSS)

The following are the main criteria the Government has decided on for a Sanitary Works Subsidy Scheme (SWSS). The scheme is primarily aimed at improving sewage treatment and disposal for small, largely rural communities that are unable to fund the necessary upgrades to meet public health and RMA requirements. More detailed criteria will be developed prior to the scheme starting on 1 July 2003. Applications have been possible since 1 January 2003.

The main criteria are:

- the health risks posed by each community’s existing treatment/disposal system and discharge (priority criterion)
- the environmental and cultural needs will be covered by the scheme to the extent required to obtain relevant resource consents under the RMA
- the size and definition of eligible community to be communities between 100 and 10,000 people
- the maximum subsidy for eligible capital works to be 50% for communities up to 2,000, reducing in a straight line to 10% for communities of 10,000

- the socioeconomic conditions of the community in question to be considered in reviewing applications
- the size of subsidy to a community sanitary works to be at least matched by an equivalent contribution from the relevant territorial authority, and an undertaking to ensure adequate maintenance and operating arrangements
- the responsible territorial authority to agree that constraints may be introduced as part of the grant agreement to ensure that the benefits of the subsidy are passed on to ratepayers.

Any SWSS would *not* apply to:

- industrial discharges
- new or future subdivisions
- domestic wastewater discharges within the property boundary
- maintenance costs
- city councils
- upgrading existing reticulation systems.

Administrative arrangements will be developed around the following criteria.

- The application will be reported on and approved by the medical officer of health as meeting public health objectives.
- Eligibility of applications (including the report of the medical officer of health) will be considered by a technical advisory committee convened by the Ministry of Health, which will make recommendations to the Minister of Health for approval after consultation with the Minister for the Environment.
- Priority for funding will be given to those communities with:
 - a high health risk (first priority)
 - high measured rates of water-borne communicable disease
 - significant environmental risk
 - a poor score in the deprivation index
 - a low rating ability and limited debt finance levels
 - a significant Māori population, or inequalities
 - no previous funding subsidy from any SWSS scheme.

For further information on the SWSS, please contact your local public health service.

Purchasing options

On-site systems

In this case the property owner is the purchaser of the on-site system, and engages an engineer or a drainage contractor to:

- carry out site and soil investigations and detailed design
- arrange council consents
- organise construction
- provide as-built plans
- draw up operation and maintenance guidelines
- make recommendations for ongoing monitoring and inspection of the system.

The owner will have to engage O&M services, either through a maintenance contract or on a casual basis as demand requires. Where council maintenance certification schemes are in place to ensure sound operation and management practice across a locality or a district, owners will have to pay for the inspection and certification services as and when required under the terms of the council scheme. Where a body corporate structure is formed by a group of owners, such as in a rural-residential subdivision, the body corporate will levy a uniform annual charge for operation and maintenance, and engage a servicing company to undertake the work.

CRITERIA FOR SELECTING A WASTEWATER SERVICING OPTION

Lake Hayes Wastewater Scheme, Queenstown Lakes District Council

In December 2001 the Queenstown Lakes District Council (QLDC) tendered a 'design-build-operate' (DBO) contract for the Lake Hayes Water Supply and Sewage Disposal Scheme. The wastewater management component of the scheme included several kilometres of gravity sewer and four wastewater transfer pumping stations. The project required the contractor to:

- obtain all resource consents
- obtain all land easements
- obtain designations for the pump-station sites
- undertake public consultation
- design the entire scheme
- construct the works
- operate the scheme for an initial period of 10 years, with a right of renewal of a further two five-year periods.

The QLDC selected Transfund's 'Brookes Law' procedure as the tender evaluation method. This method is not common in DBO tender evaluations. Council believed this method provided the best selection method for the potentially difficult consent, easement and public consultation aspects of the project. In addition, the method allowed for the inclusion of high-quality engineering within the works – an important consideration for a location such as Lake Hayes.

A joint venture between a civil engineering construction company and a consulting company was selected as the contractor with the highest attributes relating to experience, technical and management skills, and proposed methodology. The final contract price, including management, consultation, design and construction, and future operating costs, was negotiated within the council's budget, providing a win-win result for both parties.

The tendering method identified the contractor's attributes in a manner that allowed the council to select the best possible team to undertake the project. Construction was completed at the end of 2002.

Cluster and centralised systems

Local councils have traditionally provided wastewater schemes through their works division or department. This can be via direct labour, or (more often) via council engagement of consultants to design the work, arrange tendering of the construction contract, and supervise the construction. The council processes the relevant planning and environmental consents; arranges funding via loans, or direct charges against budgeted capital works funds, and on completion of the work; and funds monitoring, inspection, and operation and maintenance services against its operational budget.

Two methods of purchasing wastewater schemes have been employed by some councils in recent years, although the Local Government Act 2002 may have made these alternatives less likely to be utilised. These are design-build-operate (DBO), and build-own-operate-transfer (BOOT) contracts.

In DBO the client, which may be a council or body corporate, engages a contractor to design and build the wastewater scheme and carry out the operation and maintenance for a defined period. The contract price includes purchase of all services leading to the construction of the scheme, and then operation and maintenance costs over the agreed period.

A BOOT project is a totally private venture in which the client pays annual fees to the BOOT company over a defined period, during which the company recoups its capital investment and operating costs. At the end of the defined period the BOOT company transfers ownership to the client, who then takes over responsibility for ongoing operation and maintenance costs. The advantage of BOOT to a council is they do not have to raise a loan to cover the capital costs. The BOOT company handles all financing.

BOOT contracts are more applicable for large projects, but DBO contracts are suitable for small community wastewater schemes. The Lake Hayes wastewater scheme undertaken by Queenstown Lakes District Council in 2002 is an example of DBO in action.

This handbook aims to provide sufficient information to enable communities and individuals to participate in making decisions about the best wastewater servicing option for their community. The options vary from a larger centralised wastewater servicing system to individual on-site wastewater systems. There are a variety of options for both the individual technological components of such systems and for the ways these different individual technologies can be fitted together to provide a total wastewater servicing system. There are also several options for the way these systems might be managed. All these factors can influence the decision on which is the best system to install.

This handbook emphasises that a wastewater servicing system can be linked to ecosystem services such as water supply, stormwater, and food and fibre production (via the nutrient cycles), as well as social and cultural services such as education and research. These factors are discussed in *Section 1*.

These various interrelated issues can make the process of selecting the best option very complex. To enable more holistic decision-making, and a better integration of services within these human and natural ecosystems, we have provided a framework for decision-making in this section. The basis of this framework is illustrated in *Figure 12.1*. From this is derived a series of criteria for evaluating the various options. The information required for these criteria has been provided in earlier sections of this handbook.

Scoping the options

Two levels of option assessment are offered to help you with your decision. Each site will have certain characteristics that will eliminate particular options.

The first level of evaluation, given in *Tables 12.1* and *12.2*, is an initial scoping exercise to eliminate the options that are clearly not suitable. The second level of evaluation, given in *Table 12.3*, provides more detailed criteria against which a reduced number of options can be assessed.

The detail of the criteria for evaluating the different options for wastewater technologies and wastewater system is extensive, complex and site-specific. As a result, it is strongly recommended that as a community you:

- *identify your own goals* in relation to your need for wastewater systems
- *set your own criteria* for evaluating the different wastewater system options
- *identify indicators* that would enable ongoing monitoring of the chosen system.



A systems approach is about selecting the option that best fits the total natural and human ecosystem within which it is embedded

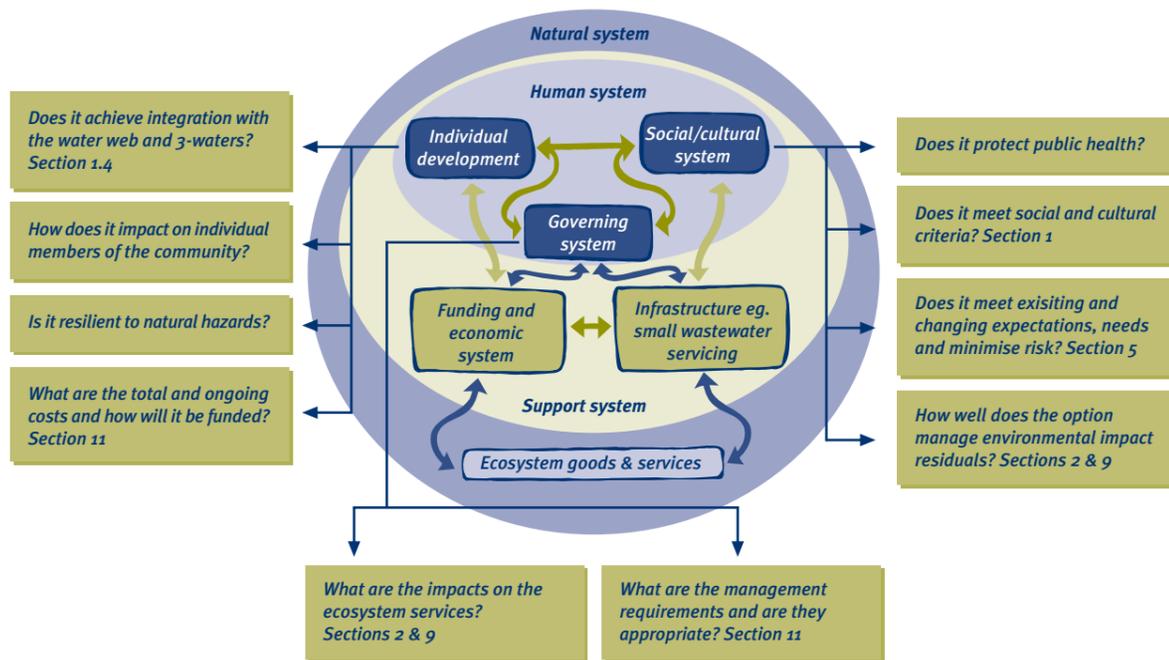


Figure 12.1 Criteria for selecting options

Type of system	Brief description and possible benefits	System and site limitations
On-site: basic treatment system	Wastewater is treated and then discharged within the property boundaries. Treatment is usually by a simple septic tank system followed by some dispersal system, such as sub-surface trenches or a mound. This is the lowest-cost on-site option. If well designed, it can be reliable with minimal maintenance and operational requirements.	These systems are likely to be inappropriate on properties with the following limiting factors: <ul style="list-style-type: none"> • very small section • steep sloping section • high ground-water table at any time during the year • very poorly draining soils or rocky section. It can be an expensive option in urban areas, with costs of \$4,000–\$7,000 per standard home, and \$50 to \$100 annual maintenance costs.
On-site: high-quality treatment	Wastewater is treated and then discharged within the property boundaries. Treatment may be by an active aerated system or multi-chamber septic tank, followed by a sand-filter system. The treated wastewater is of higher quality and can be dispersed by sub-surface irrigation, and is therefore better suited to sites with poorly draining soils. Irrigation effects can be beneficial.	These systems are likely to be inappropriate on properties with the following limiting factors: <ul style="list-style-type: none"> • very small section • steep sloping section • poor surface drainage. It may cost \$8,000–\$13,000 per standard home and up to \$150/year operating and annual costs.
Cluster	The wastewater from a collection of local houses, or other activities, is reticulated to a nearby treatment plant, where it is treated and then returned to land, usually within the site area set aside for treatment and ecosystem re-entry. Cost sharing can mean lower cost per connection while maintaining a high quality of treatment. Water recycling is made easier; loading to the centralised system is reduced.	This is best suited for a housing development specifically designed for a cluster system. It requires a local area of suitable land for the treatment plant and re-entry of the treated effluent to the ecosystem. Adequate soil types, groundwater conditions and topography are required. An appropriate management and servicing structure is required. Costs are variable, and will depend on the design, site and number of connections.
Centralised	All wastewater is collected at the source and then transported (through sewer pipes) to a central site for treatment and final return to the ecosystem. This may be the lowest-cost option (although full environmental costs are often not factored in). Management and control are very easily centralised.	This is not appropriate in sparsely populated areas (eg, rural areas) due to cost. Because such systems can involve very large wastewater volumes, there may be site limitations in providing a sustainable ecosystem re-entry technique. Costs per property are usually less than on-site options.

Table 12.1 Scoping the options: conventional systems – benefits and limitations



Type of system	Brief description and possible benefits	System and site limitations
Reclaimed water recycling	Reclaimed water sourced from treated wastewater effluent can be recycled for non-potable water uses, although this requires a high standard of treatment. Such systems include multi-stage treatment, recirculating sand filters and disinfection. Recycling of reclaimed water for on-site toilet flushing, laundry and car washing and irrigation is possible. This is an appropriate option to consider if potable water is expensive or in short supply.	Careful consideration must be given to potential health risks. Such systems require a high standard of treatment, disinfection and management. Separate and clearly labelled plumbing and outlets are necessary. No NZ guidelines are yet in place to cover such on-site recycling uses, so local authorities are unlikely to grant approval until the Ministry of Health has assessed risks and devised appropriate guidelines for risk elimination.
Composting toilets	Composting toilets are waterless (dry) or minimal water use (wet) toilets that use aerobic bacteria and other micro-organisms to biodegrade the faeces and other organics. There are various designs suitable for outdoor installations (eg, forest parks) and domestic installations. Modern composting toilets are designed for domestic use as clean, odourless facilities. Benefits include low water use, and recycling of organic matter and nutrients.	Well-designed domestic composting toilets can be expensive and require competent, consistent and dedicated management. Some require sufficient under-floor clearance for the composting chamber. The composted solids require handling and appropriate safe burial. Most composting toilets will not accept greywater, so a separate and approved greywater system will be required. Many councils are reticent about approval because of perceived health risks if compost toilet systems are not properly operated and maintained. Compost removal must be undertaken to strict hygiene standards, so regulatory obstacles often face people seeking to use this type of system.
Vacuum toilets	Vacuum toilets for domestic applications are not common in NZ (the only system is at Turoa Skifield, Mt Ruapehu). They have been used in countries where water is expensive or in short supply. These toilets use very low water volumes (0.5–1.5 L/flush). Benefits include low water use and wastewater volumes. Concentrated blackwater offers better technological opportunities for nutrient recovery (eg, liquid composting).	The vacuum unit, toilets and vacuum pipes are expensive and require skilled installation and design. For some people the noise of the vacuum can be off-putting, although recent designs have eliminated this problem. Technology and expertise are not common in NZ.
Separated systems: greywater, blackwater, faeces and urine	Separation of the various wastewater components enables separate management and recovery of the water and the wastewater nutrients. Most nutrients are contained in the urine, while most of the water is in the greywater. Urine-separating toilets are available and plumbing can be installed to separate these streams.	Separate plumbing is required and will increase building costs. No cost benefits are gained if connected to a centralised system. On-site systems require suitable treatment systems for each component, and land area and soils for ecosystem re-entry. Many councils are not familiar with these options.

Table 12.2 Scoping the options: less common systems – benefits and limitations

<p>Physical characteristics of the site:</p> <ul style="list-style-type: none"> • limitation of site or area (eg, soils) • resilience to natural hazards.
<p>Ecological:</p> <ul style="list-style-type: none"> • effect on habitat • effect on ecosystem services • effect on waterways • effect on marine ecosystems • effect on overall natural systems • ecological restoration opportunities • resource efficiency – closing of ecological cycles.
<p>Compatibility with Māori perspectives:</p> <ul style="list-style-type: none"> • issue of passage onto land • protection of mauri.
<p>Other cultural concerns:</p> <ul style="list-style-type: none"> • sensitivity to other cultures • local stewardship/responsibility • potable re-use of treated water • inter-generational issues.
<p>Public health:</p> <ul style="list-style-type: none"> • operational safety • effects of failure on community health • residue and human proximity.
<p>The technical system:</p> <ul style="list-style-type: none"> • reliability • serviceability • engineering life of the system • resilience to acts of vandalism • linkages with other opportunities and services (eg, water supply).
<p>Ability to be changed:</p> <ul style="list-style-type: none"> • extendability • flexibility • adaptability.
<p>Management:</p> <ul style="list-style-type: none"> • convenience • operation and maintenance implications.
<p>Economic factors:</p> <ul style="list-style-type: none"> • capital costs • ongoing annual costs.
<p>Community effects:</p> <ul style="list-style-type: none"> • level of local control • need for external expertise/management.

- Community change:**
- pressure for future growth
 - capacity to absorb growth
 - declining population
 - ageing population
 - visual and noise effects.

- Other potential benefits:**
- leisure and recreation
 - education
 - research.

- Formal processes:**
- familiarity to decision-makers
 - technical demands
 - differing demands
 - ease of the consent process.

Table 12.3 Examples of detailed criteria for assessment

An example of a matrix showing some of the above criteria evaluated against the broad wastewater services categories is given in Appendix 7.

5

PART

GLOSSARIES, ABBREVIATIONS, APPENDICES AND INFORMATION SOURCES

Term	Definition	For more details see
<i>Aerated wastewater treatment system (AWTS)</i>	Small domestic wastewater treatment package plants commonly used for on-site treatment of household wastewater. The process typically involves: <ul style="list-style-type: none"> • 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
<i>Aerobic</i>	Conditions in which free oxygen (including dissolved oxygen in water) is readily available to micro-organisms such as bacteria	
<i>Anaerobic</i>	Conditions in which there is an absence of free oxygen (including dissolved oxygen in water) for micro-organisms such as bacteria	
<i>Bioaccumulation</i>	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
<i>Biogas</i>	Principally methane and carbon dioxide produced by bacterial fermentation of organic matter	
<i>Biological treatment</i>	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	
<i>Biosolids</i>	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
<i>Blackwater</i>	Human body waste discharged either direct to a vault toilet, or through a flush toilet and/or urinal	
<i>BOD</i>	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	
<i>BOD₅</i>	The oxygen demand associated with biochemical oxidation, under specified conditions, over 5 days	
<i>Centralised wastewater system</i>	An urban wastewater infrastructure that takes wastewater from the source and reticulates it through 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	
<i>Chemical treatment</i>	A wastewater treatment process designed around the chemical qualities of the wastewater and its constituents	
<i>Chlorination</i>	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	

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 <i>Nitrosomonas</i> oxidise ammonia (NH_3) to nitrites (NO_2), then bacteria of the genus <i>Nitrobacter</i> 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: <ul style="list-style-type: none"> 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 through 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'	

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	

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



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 – cemetery; burial ground

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

Wairua – spirit

Whānau – family

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

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 Nitritotriacetic 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

Appendix 1 *Examples of ecosystem goods and services*

System	Goods	Services
<i>Agricultural ecosystems</i>	<ul style="list-style-type: none"> • food crops • fibre crops • crop genetic resources • flowers 	<ul style="list-style-type: none"> • 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
<i>Coastal ecosystems</i>	<ul style="list-style-type: none"> • fish and shellfish • fish-meal (animal feed) • seaweeds (for food and industrial use) • salt • genetic resources 	<ul style="list-style-type: none"> • 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
<i>Forest ecosystems</i>	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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
<i>Freshwater ecosystems</i>	<ul style="list-style-type: none"> • drinking and irrigation water • fish • hydro-electricity • watercress • genetic resources • recreation 	<ul style="list-style-type: none"> • 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
<i>Grassland ecosystems</i>	<ul style="list-style-type: none"> • livestock (food, game, hides, fibre) • drinking and irrigation water • genetic resources 	<ul style="list-style-type: none"> • 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 be 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 EDU²² (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 Control²³ 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.

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. Occurrence 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

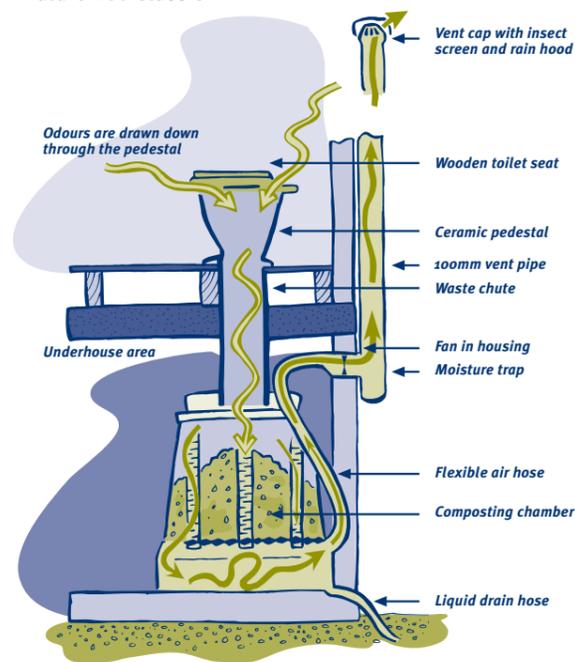


Figure A1 Typical composting toilet

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 m³. The water level variation is about 50 to 100 m³. 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).

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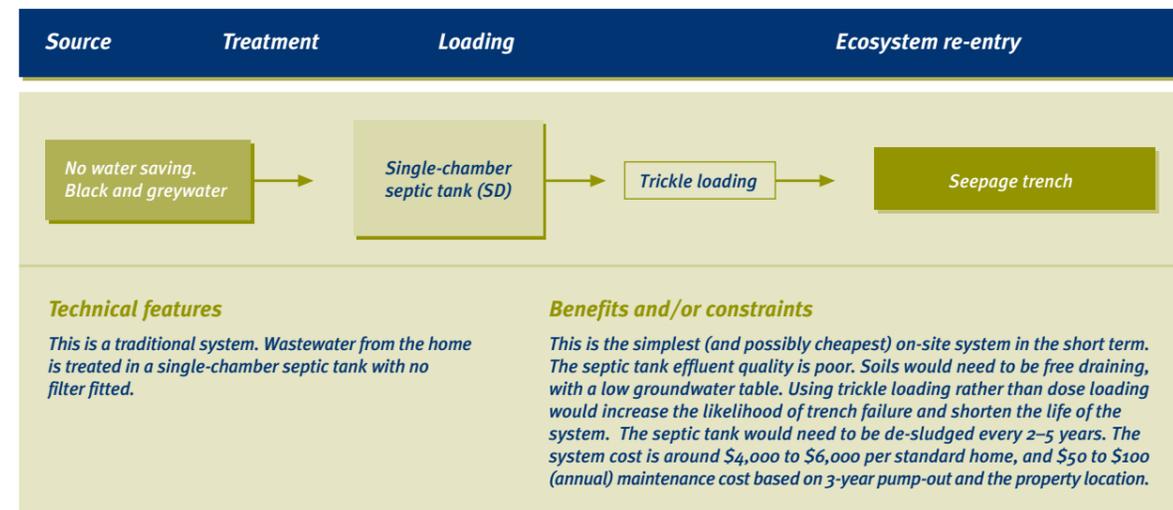
Wild U, Kamp T, Lenz A, Heinz S, Pfadenhauer J. 2000. Cultivation of *Typha* spp. in constructed wetlands for peatland restoration. *Ecological Engineering*, 17(1): 49–54.



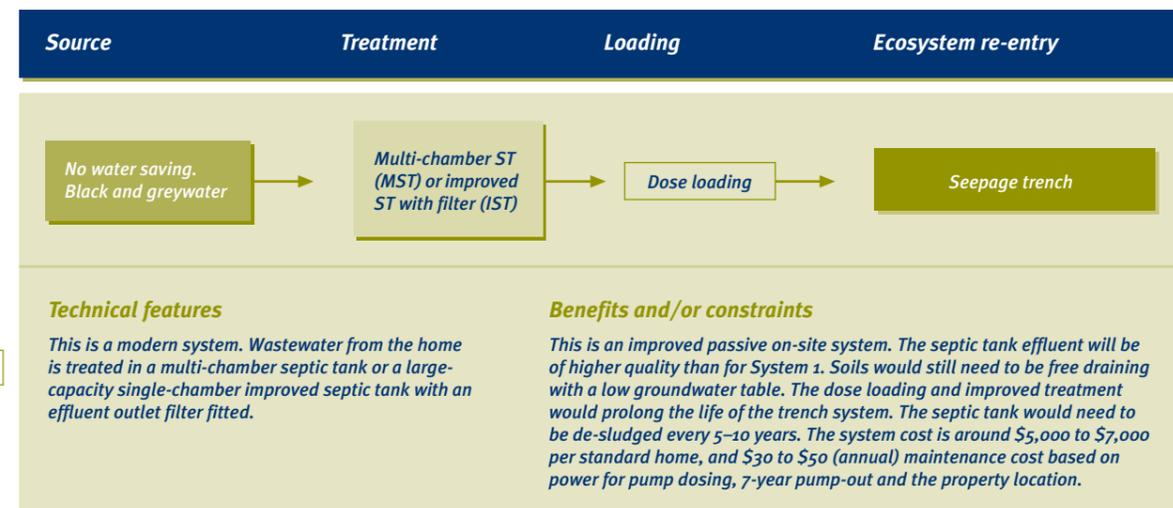
Appendix 6 On-site systems – key features

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

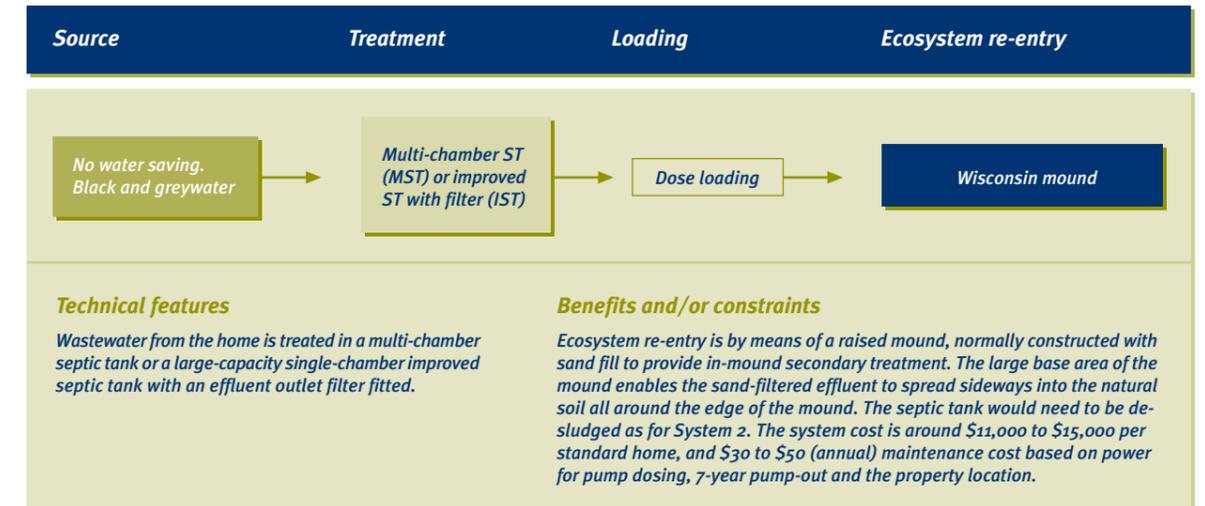
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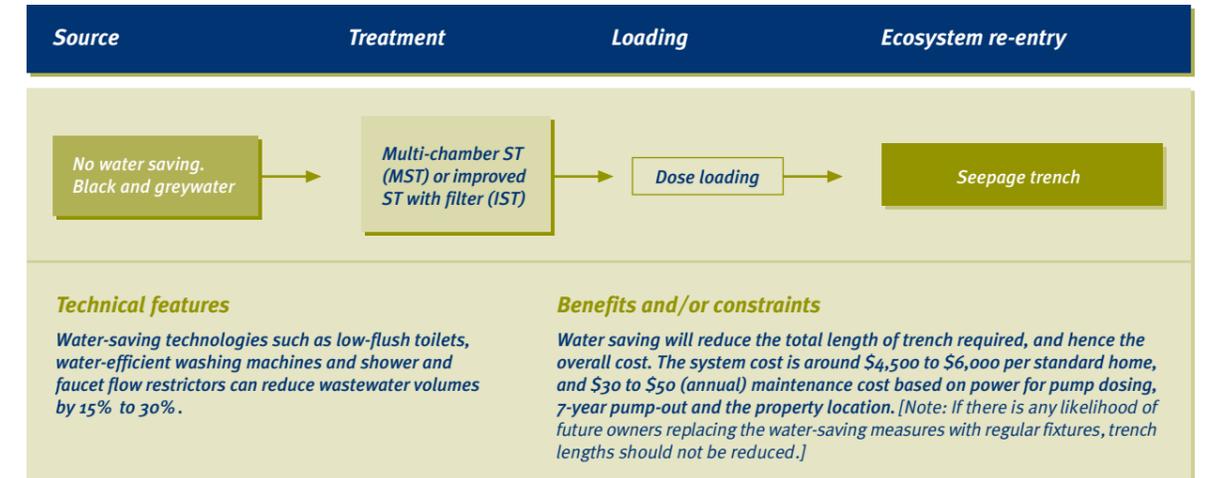
System 2



System 3

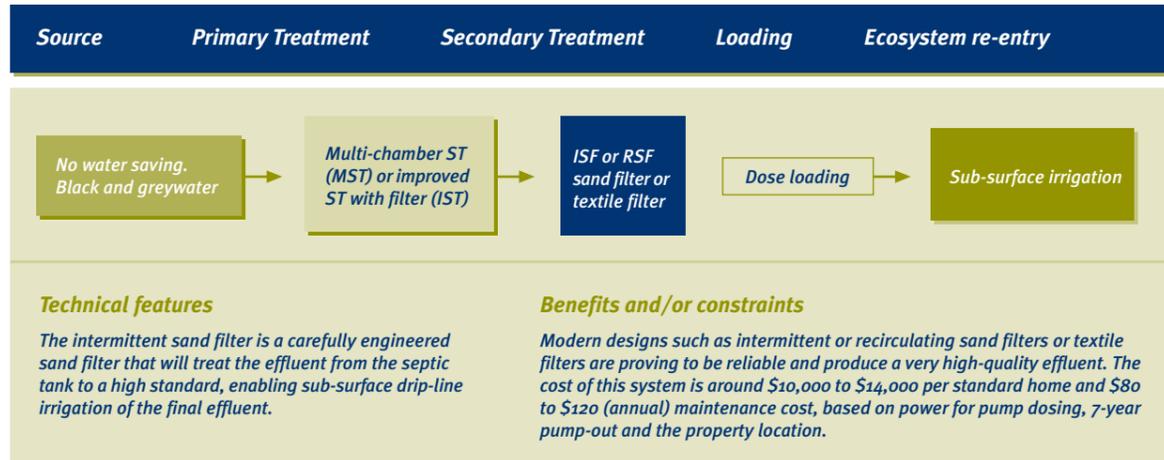


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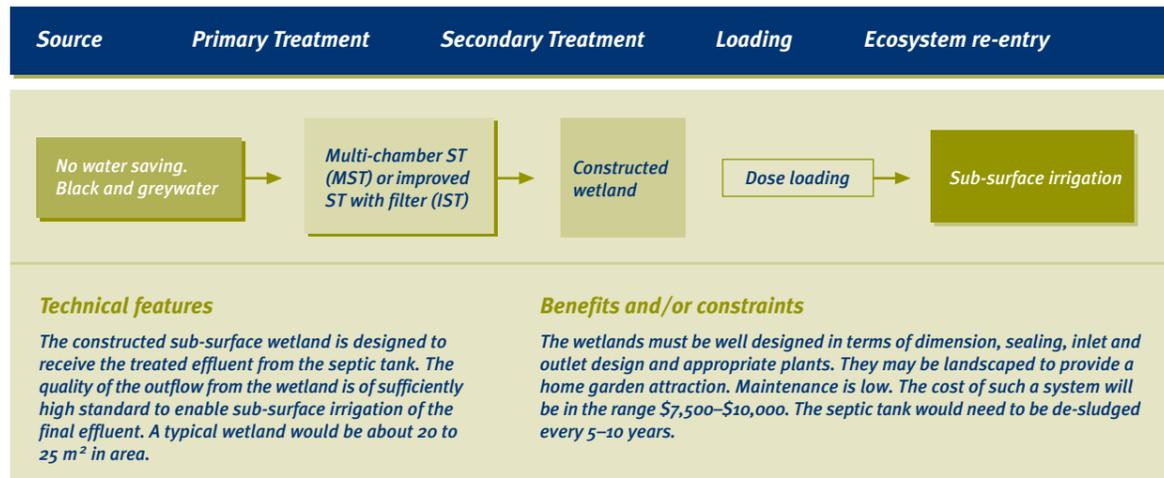




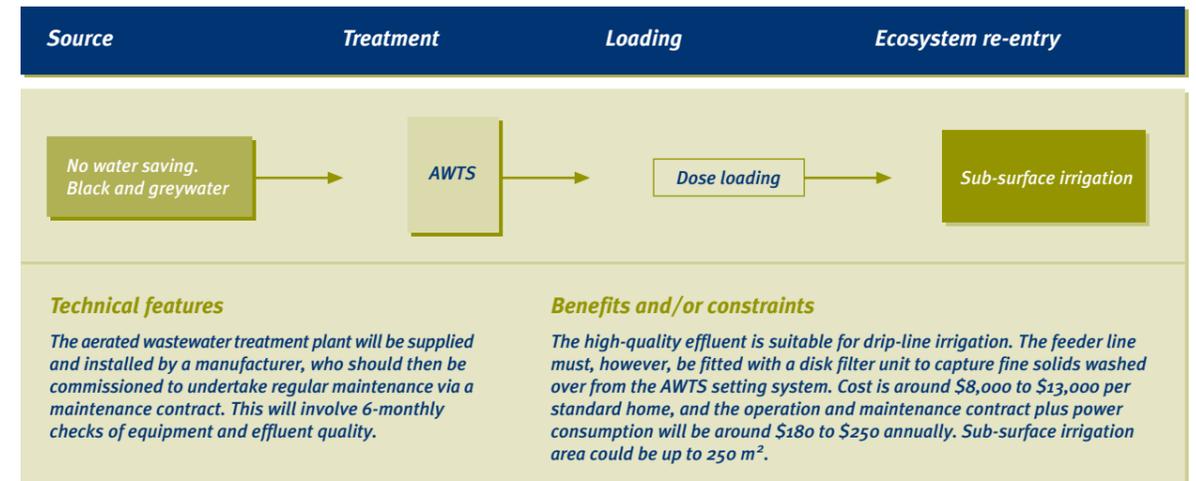
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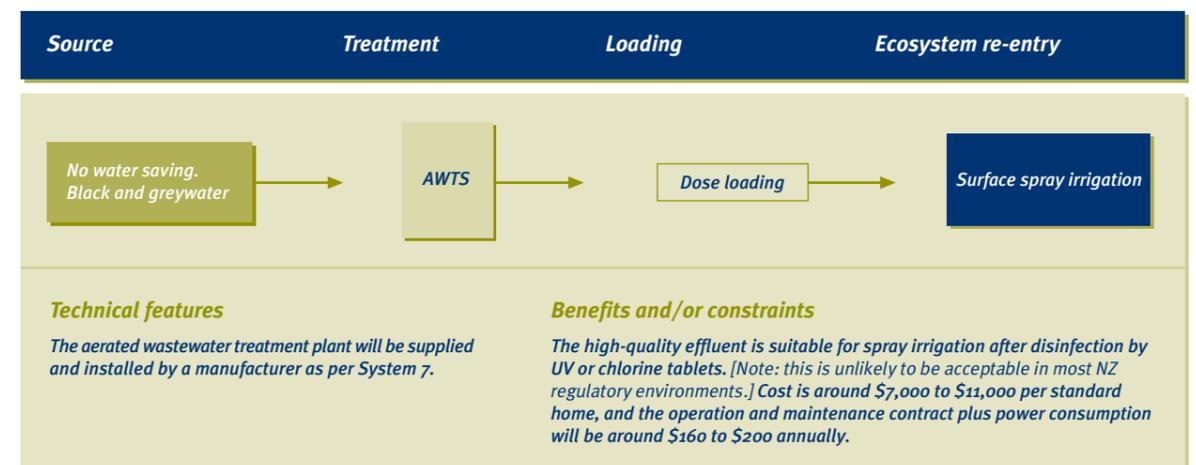
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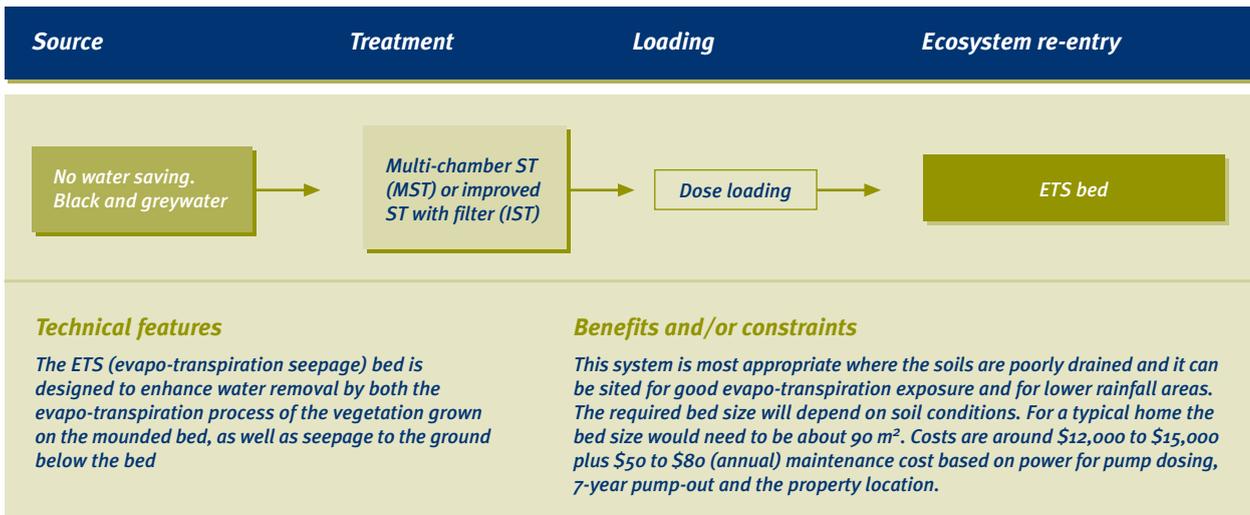
System 7



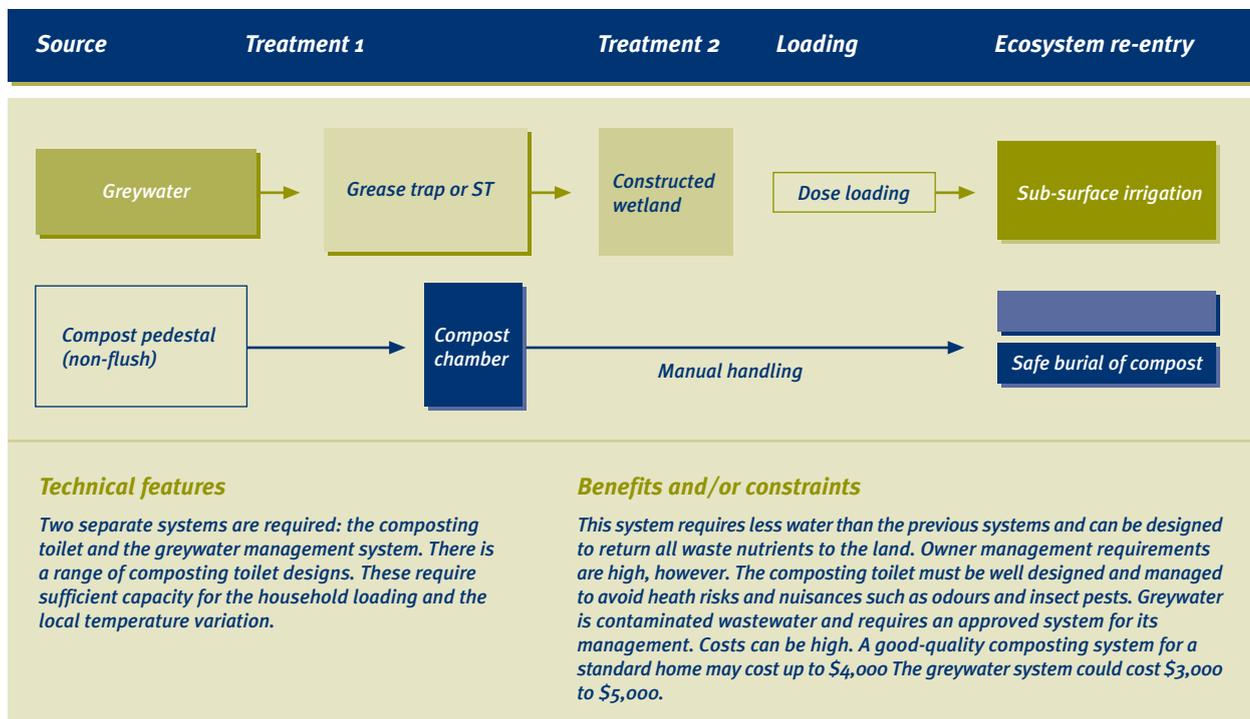
System 8



System 9



System 10

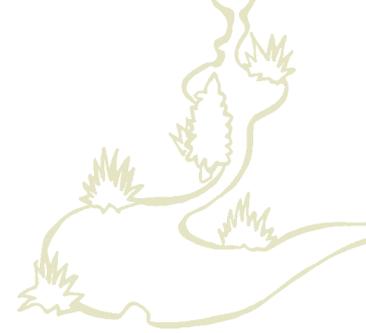




Appendix 7 System Matrix

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 sensitivity 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 management 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

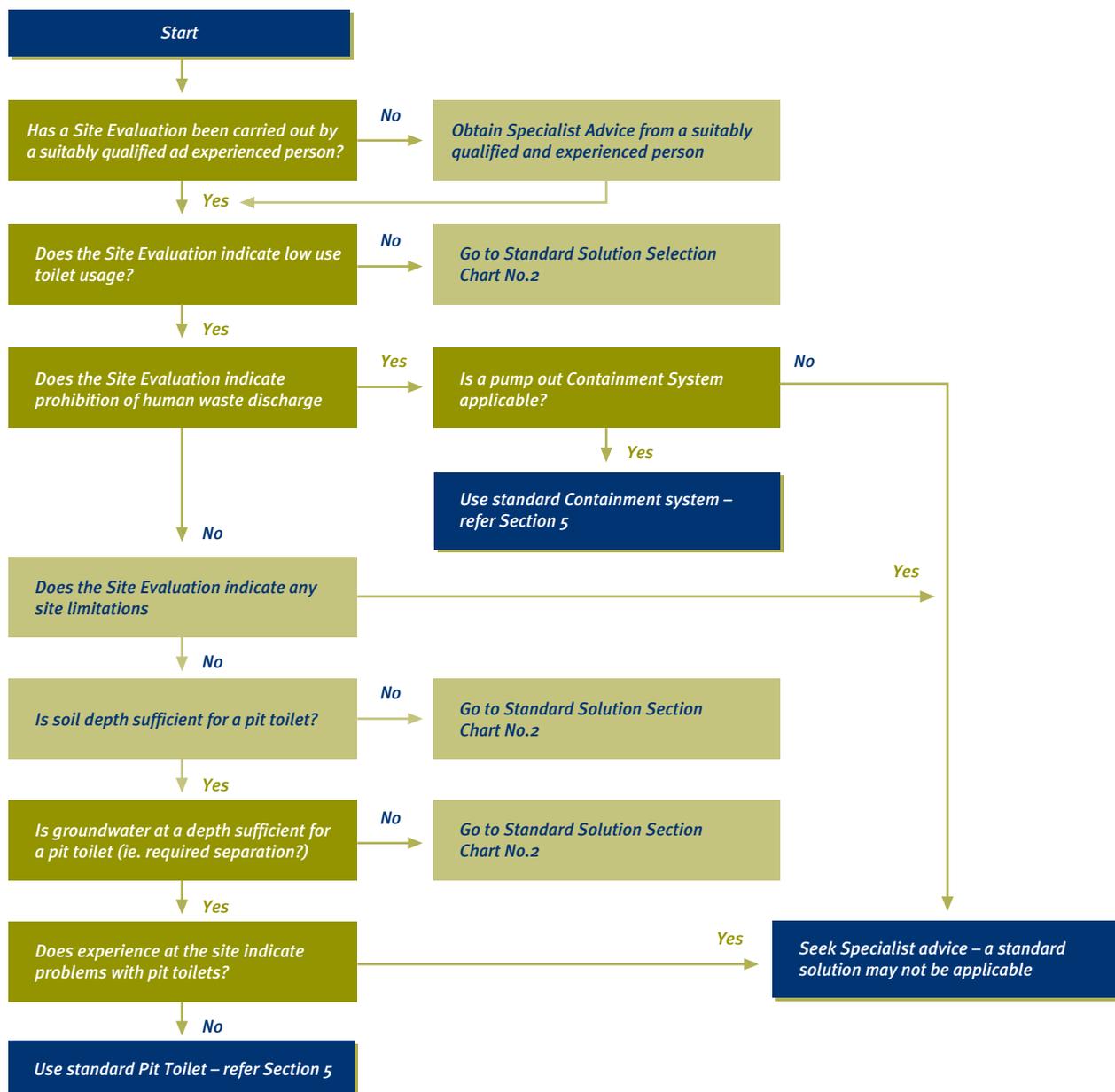
Possible criteria	Fully centralised system	Combination of on-site and centralised system	Cluster system	Fully on-site systems
Ability to be changed				
<i>Extendability</i>	<i>Depending on design, most of the older, centralised systems are not so extendable or adaptable to changing requirements. Sewer 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</i>	<i>Depending on design, these system tend to be more recent and therefore extendibility may have been included in the design</i>	<i>Depends on design, but more likely to be adaptable due to being a smaller system. Funding may limit extendibility and adaptability</i>	<i>It is the individual property owner's responsibility to build in extendability and adaptability. 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</i>
<i>Adaptability/flexibility</i>		<i>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</i>		
Management				
<i>Ownership</i>	<i>Normally owned and managed by city/district council</i>	<i>Normally owned and managed by city/district council</i>	<i>Can be owned and managed by city/district council or by corporate body</i>	<i>Owned by property owner. Normally managed by property owner, although owners can form a body corporate to oversee O&M</i>
<i>Convenience</i>	<i>Having all the operation at a central location simpifies management requirements</i>	<i>With some components on-site and most central, management will be less convenient</i>	<i>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</i>	<i>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</i>
<i>Operation and maintenance implications</i>	<i>The centralised nature of this system makes operation and management uncomplicated</i>	<i>The operation and maintenace programme will need to be designed for a combination of on-site and centralised requirements</i>		<i>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</i>
Economic factors				
<i>Capital and operating costs</i>	<i>City/district council responsibility. Capital and annual operating costs are normally evenly spread across the community served. User-pays possible with water metering</i>	<i>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</i>	<i>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</i>	<i>Capital and operating costs are the responsibility of the property owner. Where a council or body corpotate management programme is in place, annual charges will be levied for O&M</i>
<i>Funding</i>	<i>Rates</i>	<i>Rates</i>	<i>Rates, or built into purchase price</i>	<i>Individual capital funding, and individual or body corporate or management agency fees for O&M</i>
Local community impacts				
<i>Level of local control</i>	<i>Community generally has minimal input into the design, operation and management of these systems</i>	<i>Community generally has minimal input into the design, operation and management of these systems</i>	<i>More opportunity for community input into the design, operation and management of these systems</i>	<i>Greater degree of control lies with individual property owners</i>
<i>Need for external expertise/management</i>	<i>Usually a significant external input into the design, operation and management of these systems</i>	<i>Usually a significant external input into the design, operation and management of these systems</i>	<i>External expertise for the design is normally required. Management can be local or centralised</i>	<i>External expertise for technology selection and design is normally appropriate. Management can be on-site or centralised</i>
Community change				
<i>Pressure for future growth</i>	<i>Stimulates urban growth, including commercial and industrial growth</i>	<i>Stimulates urban growth, including commercial and industrial growth</i>	<i>The cluster system will enable domestic localised growth. Less conducive to commercial and industrial growth</i>	<i>Local geophysical and hydrological conditions can restrict urban growth. Recent systems can overcome some of these constraints</i>
<i>Capacity to absorb growth</i>	<i>Depends on both total system design capacity and individual capacity for each component. Modern systems can be designed to accommodate future growth</i>	<i>Depends on both total system design capacity and individual capacity for each component. Modern systems can be designed to accommodate future growth</i>	<i>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</i>	<i>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</i>
Other potential benefits				
<i>Leisure and recreation</i>	<i>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</i>	<i>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</i>	<i>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</i>	<i>NA</i>
<i>Education</i>	<i>Opportunities to develop community education activities centred on wastewater, and social and ecological issues</i>	<i>Opportunities to develop community education activities centred on wastewater and social and ecological issues</i>	<i>Opportunities to involve local community in educational activities centred on wastewater and social and ecological issues</i>	<i>Opportunities to educate community to take greater responsibility for their waste</i>
<i>Research</i>	<i>Many research opportunities to study the resource value of wastewater</i>	<i>Many research opportunities at the centralised level to study the resource value of wastewater</i>	<i>Many research opportunities at the local level to study the resource values of wastewater</i>	<i>Many research opportunities at the individual level to study the resource values of wastewater</i>
Formal processes				
<i>Familiarity to decision-makers</i>	<i>Decision-makers are familiar with these types of systems and traditionally place confidence in them</i>	<i>Decision-makers are less familiar with these types of systems but normally have confidence in them because of the final centralised management</i>	<i>Decision-makers are less familiar with these types of systems and subject such systems to greater scrutiny</i>	<i>Decision-makers are familiar with on-site systems, but often very unfamiliar with recent innovations and the benefits of inspection and management programmes</i>
<i>Technical demands</i>	<i>Requires expert engineering input for design. Requires skilled operators</i>	<i>Requires expert engineering input for design. Requires skilled operators</i>	<i>Requires expert engineering input for design. Requires skilled operators</i>	<i>Requires expert engineering input for design. Requires trained inspection, operation and maintenance personnel</i>
<i>Public health service</i>	<i>Strict health standards</i>	<i>Strict health standards</i>	<i>Strict health standards</i>	<i>Strict health standards</i>
<i>Ease of the consent process</i>	<i>Site and system dependent. Consenting process usually well resourced</i>	<i>Site and system dependent. Consenting process usually well resourced</i>	<i>Site and system dependent. Consenting process usually less well resourced</i>	<i>Consent under council building controls</i>



Appendix 8 Examples of Decision Trees for Wastewater Systems

(a) Pit toilets

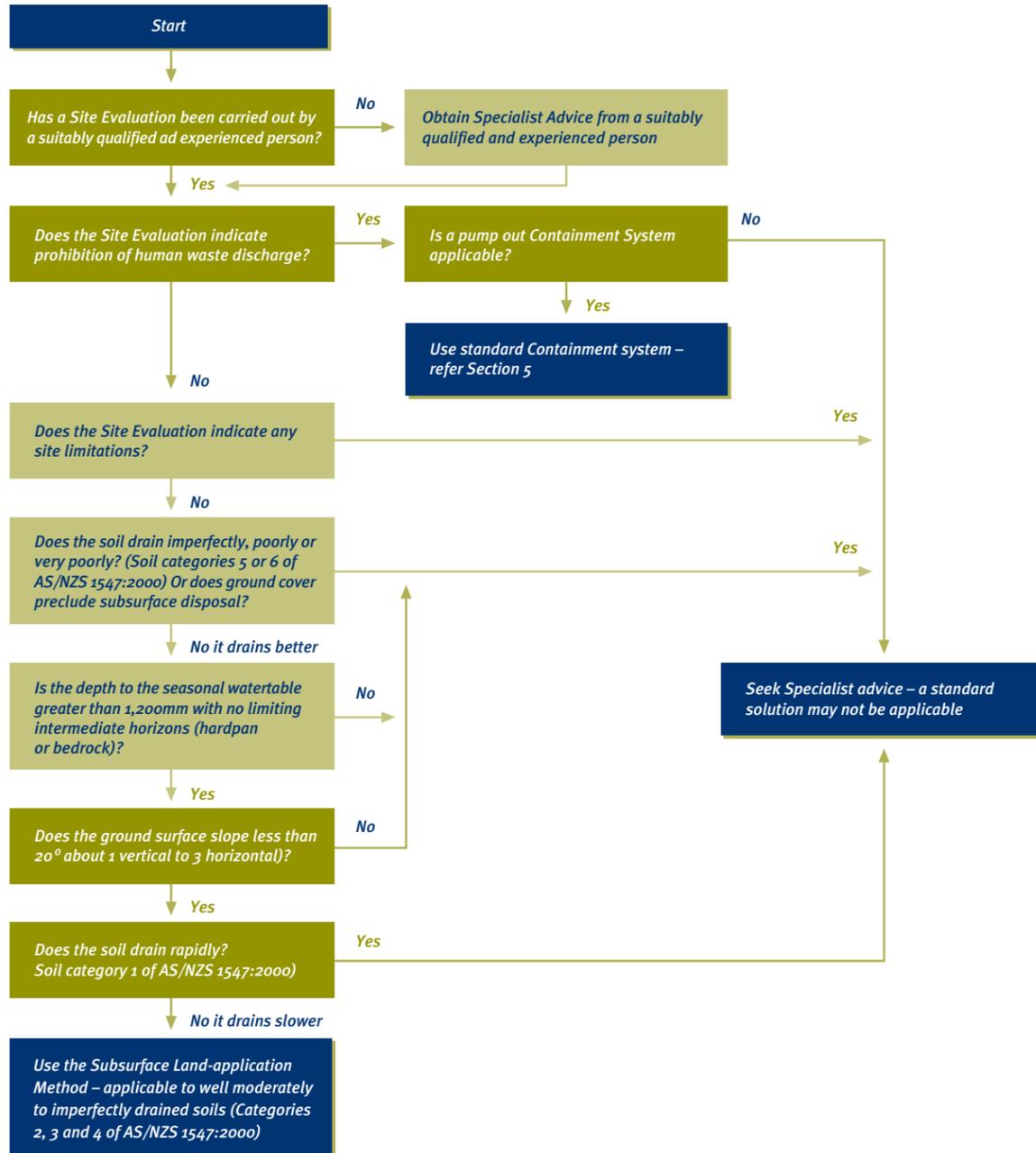
(Courtesy of Department of Conservation from: Standard of Practice for Backcountry Hut Toilets (draft))





(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>

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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

