Audit of Rarotonga's Domestic Sanitation Systems

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Executive Summary

Lagoon water quality monitoring studies by the Ministry of Marine Resources show that coastal lagoon water quality is gradually deteriorating. Whilst there are several sources of lagoon pollution including livestock wastewater, sediment from excavated building sites and road cuttings, horticultural fertilizers and laundry wastewater, failed on-site sanitation systems such as septic tank and secondary/advanced treatment systems are a contributing factor.

The Ministry of Health randomly selected 101 sanitation systems to audit for 26 parameters including system design, age, structural integrity, soil type and maintenance issues. 90% of sanitation systems failed the sanitation audit. Of the tanks that were accessible to assess for leakage 50% are leaking. 86% of land application systems are soak pits. These findings indicate poorly constructed and incompetently installed septic tank systems.

90% of sanitation systems failed the sanitation audit

Low awareness about how sanitation systems function is widespread. Little consideration is given by some installers, builders and home-owners about the effects of storm water on sanitation systems. Some home-owners are also unaware of the importance of gaining access to the septic tank for regular desludging and maintenance. These issues highlight the importance of raising community awareness on good on-site wastewater management practices.

The sanitation industry and inspectors are inadequately trained. Most septic tanks are undersized and with current development densities, soak pits are no longer an acceptable system for applying septic tank effluent to land. Trade training and the registration of expertise under the Public Health (Sewage) Regulations 2008 is imperative.

Fixing or replacing a failed septic tank on its own will not significantly reduce the risk to public health or the lagoon.

Improving on site sanitation systems is not just a case of replacing septic tanks. Fixing or replacing a failed septic tank on its own will not significantly reduce the risk to public health or the lagoon. For on-site sanitation systems, dosing the effluent to a well designed land application system is the only engineering solution to reduce these risks.

A sanitation system upgrade programme will only be successful in the long term if the knowledge and skill of the industry and regulators is significantly improved and if there is a co-ordinated, integrated and co-operative effort by key players: government agencies, sewage system designers, suppliers, installers and servicing agents, training institutions and private consultants. At present, many individuals are working to their own standards and with little technical knowledge. It is recommended that the industry start by agreeing to a programme that will achieve an effective and sustainable on-site wastewater service.

Acknowledgements

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Introduction

There has been a growing recognition of the need to improve sewage treatment to protect the coastal lagoons of Rarotonga and Aitutaki. Lagoon and stream water quality monitoring studies from 2007-2009 by the Ministry of Marine Resources have concluded that:

1. Nutrient levels are above maximum levels recommended for healthy coral reefs in coastal embayments

2. While faecal coliform counts in the lagoon show that swimming is safe there, the counts in the streams that empty into the lagoon are well above maximum levels recommended by WHO for recreational water

3. Water quality in the coastal lagoon is gradually worsening (CIMRIS, 2010)

Whilst there are several sources of this pollution including livestock wastewater, sediment from excavated building sites and road cuttings, horticultural fertilizers and laundry wastewater, the results of the water quality studies demonstrated the need to examine sanitation systems and determine their effectiveness.

Most properties in the Cook Islands treat their sewage on-site. Three components of an on-site sewage system must be operational for it to be effective at treating sewage. These are:

1. The wastewater source (taps, toilets, shower heads etc)

2. The treatment unit (septic tank, secondary/advanced treatment unit)

3. The land application system (soak pit, absorption trench/bed, mound, sub-surface irrigation including pumps/siphons/flouts)

If there is a failure in any of these components, the system becomes a risk to public health and/or the environment, polluting the groundwater, nearby streams, wetlands and the coastal lagoon.

In early 2010 the New Zealand Aid Programme funded the design of a project that would address waste management issues on Rarotonga and Aitutaki. This project, called the Waste Management Initiative Design Project was guided by a steering committee comprising representatives of the government, private sector and NGO's. On 22 January 2010, the steering committee adopted a motion to carry out a thorough technical audit on domestic sanitation systems on these two islands. The Ministry of Health compiled a proposal to enable an audit to be completed. The approved project had the following objectives:

1. Determine the scale of the problem of failed sanitation systems
2. Identify the specific areas within the sanitation system that are failing
3. Collect data that can be used to plan improvements in sanitation

The survey was completed by two independent auditors who are registered sewage system installers and was assisted by Public Health staff of the Ministry of Health. Because Aitutaki was rebuilding after Cyclone Pat, the survey was eventually only done in Rarotonga.

Methods

Households were randomly selected from across the island of Rarotonga using a random numbers table and the telephone directory. All home-owners were required to sign an agreement allowing the auditor to inspect their system and protecting the home-owner from damage to their sanitation system during inspection. The agreement was explained by the Health Inspector prior to signing. Once signed, an appointment was made for the auditor to do the sanitation system audit.

If the home-owner was not home at the first visit, the Health Inspector visited neighbours until someone was found at home and that home was selected for the survey. If the septic tank was over 500mm underground, the auditor would move to the next selected house to avoid excessive digging on-site. If the homeowner didn't know who installed the septic tank (seven out of ten homeowners knew), then the auditor would examine the tank and determine who constructed it based on building materials and drainage type.

101 sanitation systems were surveyed for 26 parameters including greywater separation, setback breaches, treatment unit age, type, design and integrity, land application system type, soil type and whether the treatment unit requires desludging. In some situations the Health Inspector was unable to obtain data on household occupancy because the homeowner is unavailable and/or did not wish to provide that information. For this reason only 33 households were assessed for occupancy and 51 for the number of bedrooms. 69 sanitation systems were assessed for effects from stormwater. Some tanks were not accessible to assess for leaking. The survey sheet is attached in Appendix A.

Results

101 sanitation systems were surveyed and 91 septic tank systems (90%) failed overall.

Household Occupancy

Based on a survey of 33 properties, the most common number of people in a household was 4. The average occupancy of each house was 5 people but this figure was skewed up by a very high maximum occupancy (30). Of the large households three had 6 people, one had 8 people and three had 10 people. The next highest number of people in a household was 30 which included five families living together with many children. This was also the maximum number of people in a household. Based on a survey of 51 properties, the average house is a three-bedroom house and the largest house audited had six bedrooms.

Condition of Septic Tanks

A large proportion of septic tanks (42%) need urgent repair or replacement. Of the accessible tanks (78 tanks) 49% require desludging. Of the tanks that were accessible to assess for leaking (91 tanks) 50% were leaking. Of the accessible tanks for which information on the number of bedrooms was available (45 tanks) 55% were undersized. Other results were:

- 97% of treatment units are septic tanks and 3% are secondary treatment units
- 86% of septic tanks were installed before 1980
- Only 5.2% of septic tanks have an effluent outlet filter
- 72% of septic tanks have a single chamber, 18% have a double chamber, and 5.2% have three chambers
- 93% of septic tanks were built by the owner or supplied by someone who is not a registered septic tank manufacturer.
- 25% of tanks and tank lids were not structurally sound
- Several tank inlets, outlets and openings were not to standard.
- Of 45 septic tanks for which all information is available, 86% need replacing either because they are leaking, undersized and/or suffer from structural failure.

Sanitation System Design

- 86% of land application systems are soak pits
- 38% of houses have greywater separation
- Of 69 properties for which related data were collected 26% had storm water affecting the sanitation system
- Of 93 properties for which related data were collected, 51% of sanitation systems are on sandy soils, 42% are on loamy soils, 8% are on clay soils.

A summary of the data is attached in Appendix B. Additional comments made by the auditors are in Appendix C.

Discussion

The quality of sanitation is very poor on Rarotonga. Almost all sanitation systems fail to meet current standards under the Public Health (Sewage) Regulations 2008. A large number of septic tanks are leaking and many need urgent repair or replacement.

The majority of land application systems are soak pits. With current development densities, soak pits are no longer an acceptable system for applying septic tank effluent to land. The land application system is an important part of sewage treatment. While some treatment happens in the treatment unit (septic tank or secondary/advanced treatment unit tank), the effluent that comes out of the tank is still highly contaminated. This partially treated effluent must be further treated in the soil around the land application system. Soak pits don't disperse effluent over a large enough area for the soil to adequately treat it. Trenches, beds, mounds and sub-surface drip irrigation systems are more effective than soak

pits because they apply the effluent over a larger and shallower area. Below and around these land application systems, bacteria in the soil can treat the effluent further. It is important that there is at least 900mm of soil between the effluent drainage pipes/irrigation hoses and the groundwater table or the groundwater will become contaminated.

Little consideration is given by some installers, builders and home-owners about the effects of storm water on sanitation systems. More than a quarter of sanitation systems surveyed for this were at risk of being flooded by storm water. Some sanitation systems were sited directly under the edge of roofing or even under rainwater downpipe drainage. Some were also located where the groundwater or lagoon water can easily flood into the tank through the outlet. There needs to be an awareness of the requirement to divert water away using spouting on nearby roofing, correct siting and storm water drainage. This issue highlights the importance of competent design of on-site wastewater systems by qualified and experienced people. A well designed system (including the land application system) can minimise problems such as stormwater inundation, undersized septic tanks and undersized land application areas.

Some home-owners are also unaware of the importance of gaining access to the septic tank for regular desludging and maintenance. One house was built over and around the septic tank. This would make it difficult, if not impossible to fix blockages and remove sludge. Other septic tanks were located in gardens and were at risk of being damaged by tree roots, resulting in untreated sewage seeping into the groundwater.

The size of a section or property in the Cook Islands is determined by landowning families and not by local government. Land is divided and allocated to Cook Islanders by their extended families. The nature of Cook Islands land tenure is such that blocks of land are subdivided into ever decreasing sizes of sections while families increase in size over successive generations. There are now a minority of instances where ¼ acre sections are being subdivided into 1/8 acre sections.

Depending on the type of sanitation system used, existing houses on properties this size with clay soil could face enormous difficulties with upgrading to an effective on-site sanitation system. Such properties may be too small to install an effective land application system. For example, a household of five people will need a trench ranging from 125 to 500m^2 in size. If a secondary/advanced treatment unit is installed the land application area needed is reduced to 83m^2. Although the survey indicated that only 8% of properties have clay soil the importance of making landowning families aware of keeping sections to a minimum size of ¼ acre is evident.

These issues highlight the importance of raising community awareness on good practices with respect to on-site wastewater management.

The audit showed many cases of inadequate septic tank inlet and outlet designs, poor access for servicing and inappropriate venting or no venting. The use of effluent outlet filters to prevent solids from reaching the land application system is rare. These filters have been proven to protect the land application system and prevent blockage. They are a requirement under the new Public Health (Sewage) Regulations and their use needs to be promoted.

These findings and many of the observations recorded by the auditors (Appendix C) indicate poorly constructed and incompetently installed septic tanks. This highlights the importance of trade training and registering septic tank manufacturers and installers of on-site wastewater systems. It also highlights

the importance of regular servicing of the on-site wastewater system by trained and qualified servicing agents.

Conclusion

The results of this survey indicate that 90% of sanitation systems on Rarotonga will need to be upgraded. Based on the latest census in 2006 there were 2,899 private dwellings on Rarotonga and 515 private dwellings on Aitutaki. Therefore 2,609 sanitation systems on Rarotonga will need to be upgraded. Of these 2,493 septic tanks will need replacing because they are either leaking, undersized and/or suffer from structural failure.

Improving on site sanitation systems is not just a case of replacing septic tanks. Fixing a failed septic tank on its own will not significantly reduce the risk to public health or the lagoon. Dose loading to a well designed land application system to receive the septic effluent is the only way to reduce these risks in septic tank systems. Each site requires assessment as to soil conditions, depth of groundwater table, effects of stormwater runoff, flooding and other site specific aspects. Land application systems must be designed to meet site conditions. It is also important that the key players (installers, inspectors, owners) are well educated about this.

A significant problem with sanitation systems in Rarotonga is the lack of knowledge held by many who are designing, installing and servicing them. Installers are typically owners or builders and the survey has shown that they are unaware of the function of the various components of septic tank systems. The survey discovered some very unusual arrangements and fittings for inlet T's, outlet T's, vents and inspection ports. Some tanks are also not level, creating problems with flow. Others are poorly located and are vulnerable to flooding, presenting a significant health risk. Few people are aware of the importance of adequate design including where the tank should be situated, what type of land application system should be installed and how large the land application system needs to be.

Some inspectors of sanitation systems are also very inadequately trained. Inspection of installations is currently the responsibility of the Public Health department under the Public Health (Sewage) Regulations 2008. Most health inspectors are employed as they leave high school or if they have commenced or completed a public health qualification. Their drain laying training is by senior health inspectors who have not received formal drain laying training. Health inspectors responsible for inspecting sanitation systems have traditionally been expected to work in other public health areas including food safety, vector control, port health and occupational safety. They are now attending a new drain laying course at the Department of National Human Resources Development. However they will need to have at least six months work experience enforcing the regulations full time to begin to understand technical aspects of sanitation as well as the technical detail of the regulations.

The registration process established under the Public Health (Sewage) Regulations 2008 is designed to bring designers, installers, inspectors and septic tanks up to standard. Under the regulations, septic tanks built only by registered septic tank manufacturers are permitted to be installed. Installers and inspectors must have a National Certificate in Drain-laying. Designers and inspectors must have passed a recognised sewage system design course outlined in the Public Health Sewage Code.

In addition to the low level of skill, poor public education and limited experience with enforcing the new regulations, a threat to the success of any sewage treatment improvement program is the subdivision of

land blocks into sections less than ¼ acre in size. Good sanitation, protection of public health and a reversal of lagoon pollution cannot be achieved if property owners have insufficient land area for applying treated effluent. A policy that encourages families to divide their blocks into no less than ¼ acre sections is needed unless a reticulated community wastewater service is provided to the site.

An upgrade of existing sanitation systems, along with improvements in other land use practices such as livestock wastewater management, horticulture, earth-moving, wetland protection, storm water management and laundry wastewater management should improve lagoon water quality in Rarotonga and Aitutaki. However, a sanitation system upgrade programme will only be successful in the long term if the knowledge and skill of designers, installers, servicing agents, septic tank manufacturers and inspectors is significantly improved.

To achieve an effective and sustainable on-site wastewater service there must be a co-ordinated, integrated and co-operative effort by key players: government agencies, sewage system designers, suppliers, installers and servicing agents, training institutions and private consultants. At present, many individuals are working to their own standards and with little technical knowledge. Senior managers in government (Directors and Heads of Ministry) need to be well briefed about the technical aspects of sanitation to understand the reasons for the significant additional resources their staff need to enforce the new standards.

Recommendation

Government agencies and the sanitation industry should meet to develop a programme that will address sanitation issues on Rarotonga and Aitutaki. Such a discussion could include:

1. Suggestions for the review of the Public Health (Sewage) Regulations 2008 and Public Health Sewage Code
2. Training needs for registration
3. Ways to build immediate capacity
4. Coordination and mechanisms of communication between and within industry and government
5. Public education
6. Work plan, timeline, indicators and means of verification
7. Budget (including the establishment of a revolving fund or some other financial support mechanism for upgrades)

Possible participants at such a meeting might be:

Government Agencies: BTIB, MOIP, NES, MOH, NHRD, Trade Training School, Tourism Accreditation, CIIC
Industry: Sewage System Designers, Suppliers, Installers, Servicing Agents
Private Sector: Tourism Industry Council and active individuals
Community: Muri Environment Care and other active community groups

Through such a process, a work plan to address sanitation issues can be owned and implemented by the key stakeholders involved.

References

CIMRIS. 2010. Takitumu Lagoon Health 2010 Report. Report Card 2010. CIMRIS/NZAID, Rarotonga

Public Health (Sewage) Regulations 2008. Cook Islands Parliament Services, Rarotonga

Public Health Sewage (Code) Regulations 2008. Cook Islands Parliament Services, Rarotonga

Appendix A: Survey Sheet

Septic Tank Audit 2010.

7 Feb 2010

Project Advisor: Andrew Dakers, Technical Advisor, NZ Aid

Please Read.

- **It may not be possible to obtain some of the information sought below, or it may not be relevant. In such cases just enter "NA" for Not Applicable.**
- **The audit is of septic tanks only – NOT secondary treatment systems and package plants.**
- **If the on site audit is likely to cause too much damage to the site or create concerns for the land-owner or occupier, please do not do the audit and move on to the next site.**
- **If, as auditor, you consider it necessary to pump out the septic tank to complete the audit, please contact the MoH who will make these arrangements.**

Note: Shaded cells in the form below are to be completed (if the information is available) by the MoH Officer appointed to make initial contact with the property owner. All other cells are to be completed by the on site auditor . Items in shaded cells not completed by the MoH officer may be able to be completed by the auditor at the time of the site inspection.

Septic Tank Audit: Standard Form

Septic Tank Audit			
Date of first contact by MoH		MoH Staff name	
Date of inspection		Auditor's Name	
Site Details			

Tapere			
Village			
Name of property owner/occupier		Ph. No.	
Area of property (if known)		Way Point as per GPS.(if avail)	
Other details of site location (attach sketch map if necessary)			
Source details			
1. Number of residents		2. Number of bedrooms	
3. Is greywater separated?	Y/N. If **yes,** describe grey and blackwater management methods.		
4. Describe any unusual circumstances that will affect wastewater volume and quality	e.g. water saving devices, spa bath, actvities that affect wastewater volume and quality		

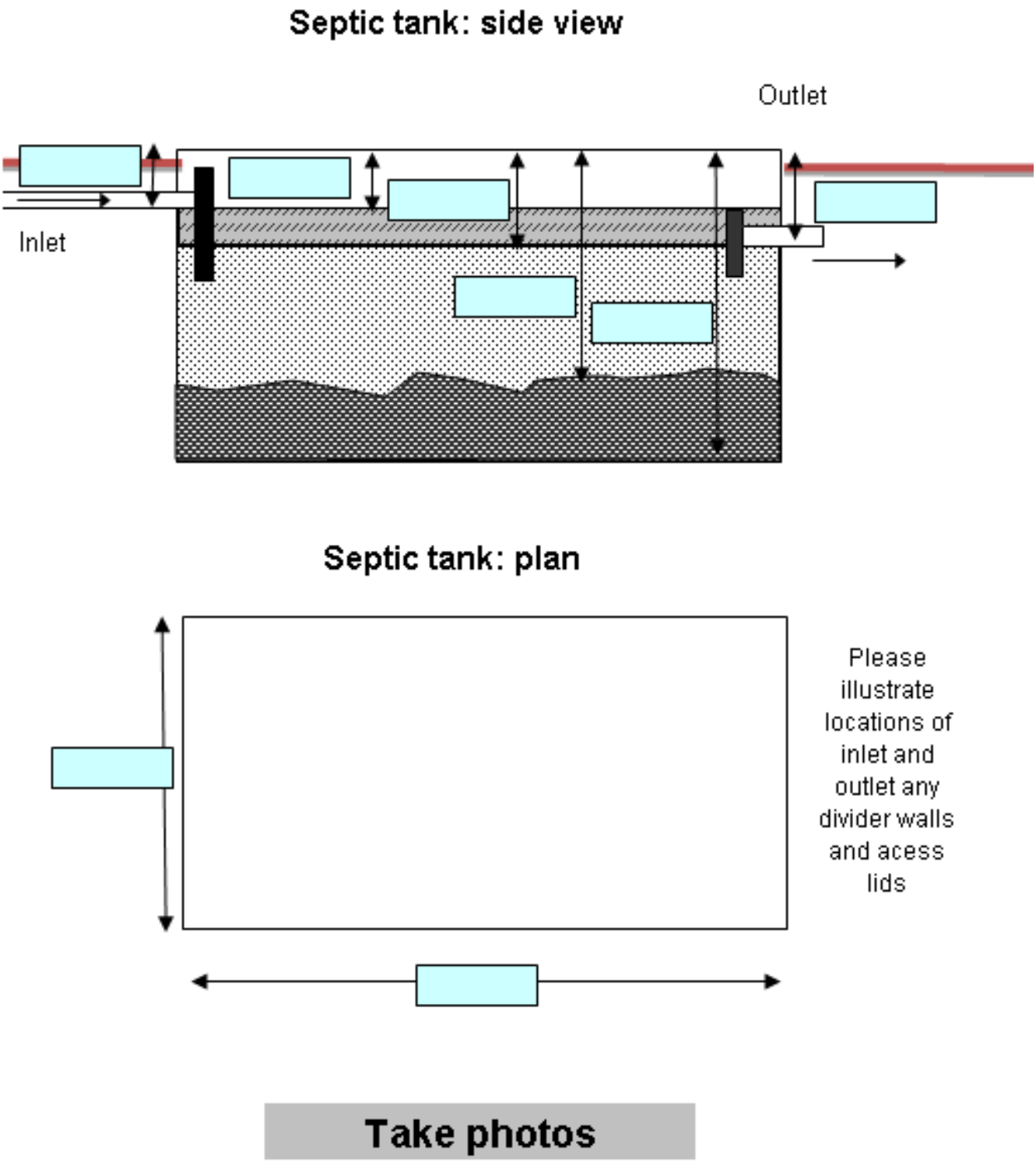
Septic tank system			
5. Sketch and attach site plan showing location of: house, septic tank, land application system, boundaries, watercourses, wells, and any other key features.			
6. Age of system (yrs) – date installed.			
Septic tank inspection			
7. ST manufacturer		8. ST Filter? type	Y / N
9. No. of chambers		10. Concrete/Plastic/other (circle)	
11. Airvent/access comments			
12. Date of last pump out.			
13. Stormwater issues			
14..Septic Tank Dimensions	**Sketch septic tank dimension on Figure 1 below**		

		Comments
15. Are the tanks and tank lids structurally sound?	Y / N	
16. Are there suitable inspection caps fitted?	Y / N	
17. Is the tank adequately sealed to	Y / N	

prevent insect/vermin access?		
18. Is the air vent in a functional state?	Y / N	
19. Are both T-pieces attached and operational?	Y / N	
20. Is the area flood prone or is there any evidence of stormwater inundation?	Y / N	
21. Are the tanks accessible for 1maintenance purposes?	Y / N	
22. Does the primary tank/chamber require desludging?	Y / N	
23. Do any tanks require urgent repair or replacement?	Y / N	
24. Is there a dosing pump or siphon fitted method	Y / N. If yes - pump, siphon, other	
25. Other comments		

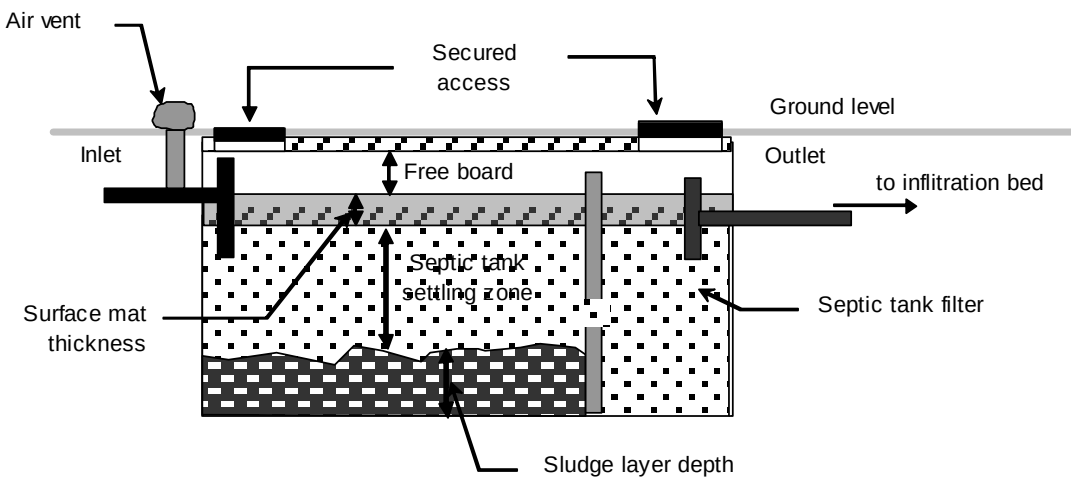
Discharge Field/Land Application System	
26 Type of system, (circle)	Soakhole Trench Mound Surface irrigation Subsurface irrigation Other (specify in 30)
27. Dimensions	
28. Soil type	Free draining sand soil Moderate drainage loam Poorly draining clay
29. Stormwater issues	
30. Other issues	

Figure 1 . Septic tank – enter the dimensions



Sketch layout. Also show wells, watercourses, boundaries and buildings and distances to the ST. See example Fig 3

Figure 2. Typical septic tank design



Examples

Example of site plan deatils

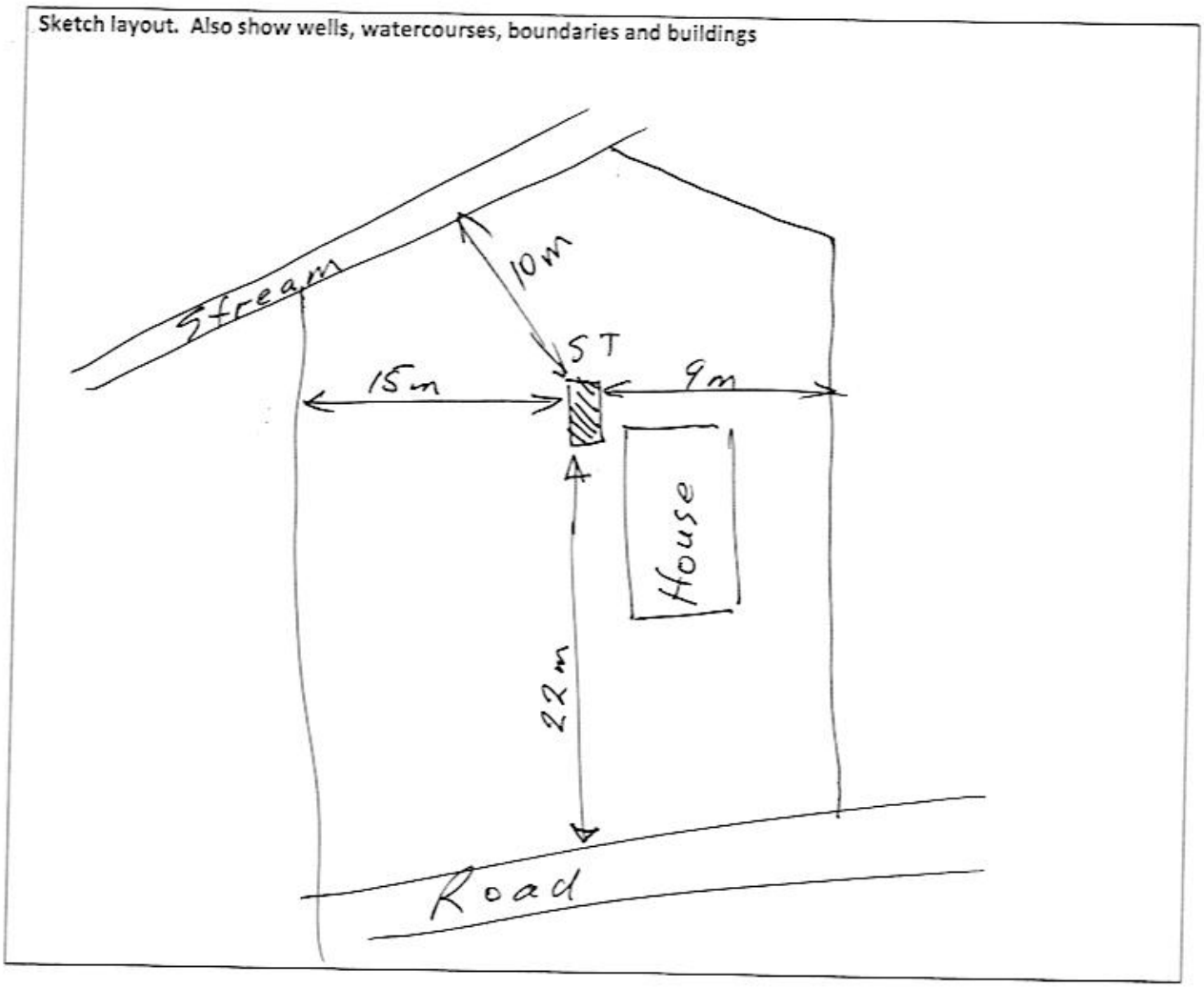


Figure 2. Typical septic tank design

Appendix B: Summary of data

No. of properties audited	101			
	No. of data sets	**Average per hse**	**Max per hse**	**Min per hse**
Occupancy of dwelling	33	5.0	30	1
Number of bedrooms	51	3.1	6	1
Properties with greywater separation	96	**Number**	**%**	
		36	38%	
Treatment units		**Number**	**%**	
Septic tanks	100	97	97%	
No. of secondary treatment unit	100	3	3%	
ST with filters	96	5	5.2%	
Single chamber ST	97	70	72%	
Dual chamber ST		17	18%	
Three chambers ST		5	5.2%	
Septic suplier/builder		**Number**	**%**	
T & M Heather	98	10	10.2%	
Builder		22	22.4%	
Owner		45	45.9%	
Culvert		14	14.3%	
Other		7	7.1%	
Stomwater Issues	69	**Yes**	**No**	
		18	50	
	Percent	26%	72%	
Are the tanks and tank lids structurally sound?	97	72	24	
	Percent	74%	25%	
Are there suitable inspection caps fitted?	97	67	30	
	Percent	69%	31%	
Is the tank adequately sealed to prevent insect/vermin access?	100	50	49	
	Percent	50%	49%	
Are air vents in a functional state?	99	72	24	
	Percent	73%	24%	
Are both T-pieces attached and operational?	98	68	28	
	Percent	69%	29%	
Does the primary tank/chamber require desludging	93	49	42	
	Percent	53%	45%	
Tanks require urgent repair or replacement?	92	39	50	
	Percent	42%	54%	
Is a dosing mechanism fitted	97	1	93	
	Percent	1%	96%	
General structural failure	101	58	42	**Not enough**

	Percent	57%	42%	**information**
Is the ST undersized ?	101	25	20	55
	Percent	25%	20%	54%
Is th ST leaking?	101	45	46	9
	Percent	45%	46%	9%
Does the ST require desludging	101	49	29	22
	Percent	49%	29%	22%

ST Age (yrs)	**No. of data sets**	**Number**	**Percentage**
Pre 1980	101	87	86%
1981 – 1990		2	2%
1991 – 2000		5	5%
2001 – 2008		6	6%
Land Application			
Number of soakholes	101	87	86%
Number of mounds		1	1%
Number of trenches		3	3%
Number of irrigation fields		1	1%
Sites on sandy soils	49	26	53%
Sites on moderatley draining soils		16	33%
Sites on clay soils		7	14%
No of soakholes sited on clays or moderate drainage soils	101	21	21%
Set-back breaches: No. of trtmt and land application areas less than:			
2m from boundary?	101	16	16%
3m from building?	101	21	21%
15m from surface water/well?	101	12	12%
No of properties with one or more set-back breach	101	43	43%
Overall rating			
System OK	102	9	9%
Systems failed (exluding set back breach)		91	89%
Systems failed (including set back breach)		92	90%

Appendix C: Additional Comments by the auditors

Interesting Comments
Tank full of sand
Tank not level
Roof overhang direct fall over tank causing surface water
Septic tank on driveway
Roof runoff onto septic and soak pit
Tank is broken and leaking
Need to replace broken slab(lid). Tank seems to be leaking
No access to tank possible
Unplastered tank. Affected by king/high tide
Septic tank never been emptied
Tank not plastered, inlet/outlet needs repiping, need new soaker
Tank overfull
Roof has no spouting. Rain onto tank area
Not enough land available for normal soakage land application area.
Soakage has failed
Two houses on one undersized septic tank
Soak hole under the building and inaccessible
Run-off from the roof likely to flow around the tank
The surface of the run-off is likely to inflow to the soakage area and the septic tank
Needs to be replaced, appears to be no septic tank floor
Sand collapsing into the pit
Tank overflowing
No land area available for new ST and land application
Structurally strong, but leaking
Soak hole undersized and exposed
Septic tank is full of solids - needs urgent desludging
Downpipe discharge close to tank and stormwater entering ST
Failed system- overflowing. No land area for disposal. Inundation during heavy rain.
Tank leaking, no water inside
Undersized and unsafe
Collapsed soakhole side next to tank
Looked like a septic tank until lid is removed. Is pit built with coral rocks