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Mamaku On-Site Effluent Treatment System Study

for

Bay of Plenty Regional Council

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1 Executive Summary

Mamaku Village is located mostly within the Lake Rotorua groundwater catchment and is identified as a Maintenance Zone and as a Future Reticulation Zone in the Bay of Plenty Regional Council's OSET Plan 2006. BOPRC are going to review the OSET Plan and will need to make specific provision for Mamaku in the reviewed Rules. This document reports on the first phase of a programme of work directed by Bay of Plenty Regional Council, to both understand what regional plan rules would be appropriate for Mamaku and identify the best long-term wastewater solution.

The project comprised the following:

1. Drilling of 14 hand auger boreholes across Mamaku village, within the road reserve, to investigate the soil profile, determine the depth to shallow groundwater and the depth to a known impermeable ignimbrite layer during May 2019.
2. Visiting 30 individual OSET (on-site effluent treatment) systems (6 groups of 5 houses), to determine the current type of systems installed and their operation and maintenance.

The presence of an impermeable Ignimbrite layer at depths of 850mm to 2,750mm below ground surface in Mamaku presents a significant environmental constraint to effective and sustainable OSET discharges in the village. During winter shallow groundwater perches on the hard Ignimbrite layer and rises towards the ground surface. Wastewater discharged into the shallow surface ash layers above the ignimbrite may be only partially treated before merging with groundwater. This poses an environmental and public health risk as the groundwater may become contaminated. Nutrients and pathogens within the wastewater will potentially impact regional groundwater quality and eventually contribute to the Rotorua Lakes. Groundwater sampling and analysis was outside the scope of this first phase assessment.

The difficult and poorly draining soils appear to have contributed to a high rate of OSET system failure/ issues of concern observed during the site visits. Fifty percent of sites visited fell into this category which is comparatively high. Development of available vacant land in Mamaku will only worsen the cumulative adverse effects of OSET discharges. If Mamaku is not reticulated, then the current rules would require existing on-site wastewater systems to be upgraded. It is expected that most existing systems would need to be upgraded, based on the site visit findings.

2 Background

2.1 Regulatory Requirements

Section 15 of the Resource Management Act, 1991 states that no person may discharge any contaminant to water or into or onto land in circumstances which may result in that contaminant entering water unless the discharge of the contaminant is expressly allowed by a rule in a regional plan [and in any relevant proposed regional plan] or by a resource consent.

<u>On-site Effluent Treatment Regional Plan</u>

The Bay of Plenty Regional Council On-Site Effluent Treatment Regional Plan 2006 (OSET Plan) is operative. Mamaku Village is located mostly within the Lake Rotorua Lakes groundwater catchment, is identified as a Maintenance Zone on Map 18 (Figure 1) and is identified as a Future Reticulation Zone on Map 38 (Figure 2). However, we understand that Mamaku is not listed in the text of Rule 2(c) and Rule 2(d) of the OSET Plan as a Maintenance Zone, and because of the lack of an explicit provision the zone requirements have not been implemented.

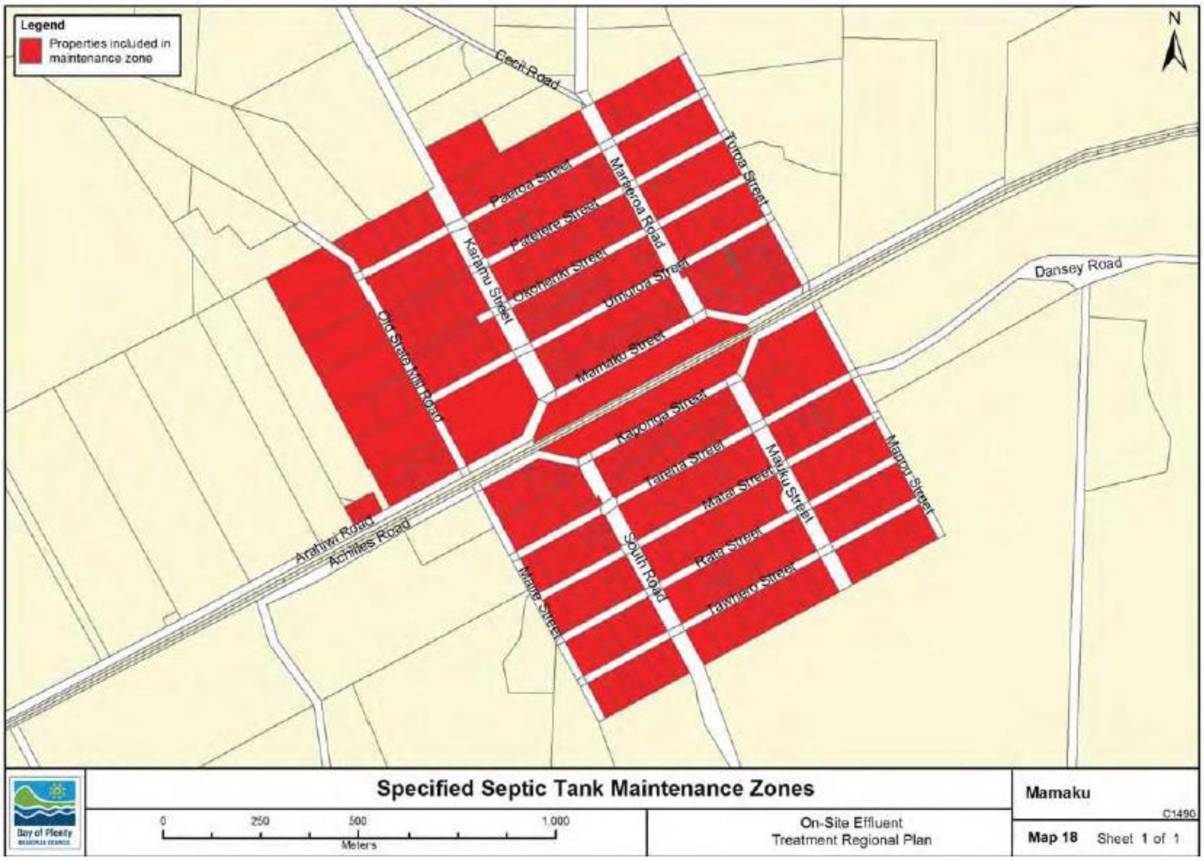


Figure 1: Map 18 Mamaku Maintenance Zone

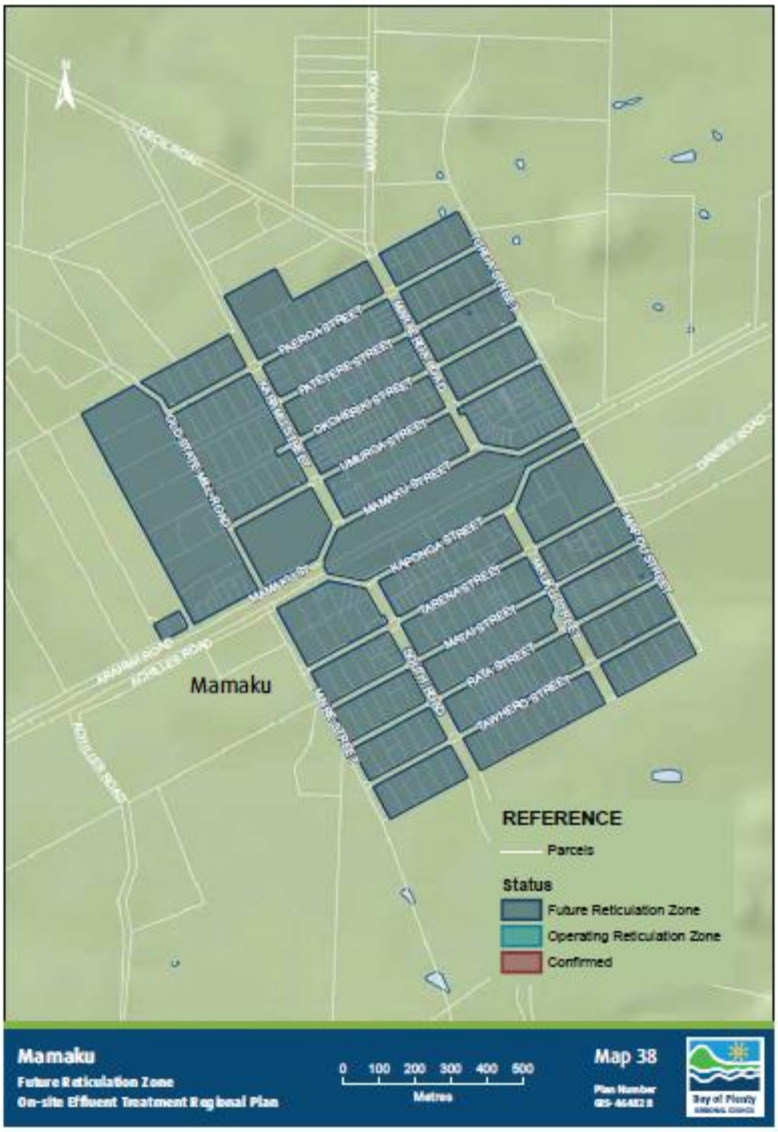


Figure 2: Map 38 Mamaku Future Reticulation Zone

<u>Draft Plan Change 14 (OSET) to the Regional Natural Resources Plan</u>

Draft Plan Change 14 includes policies and rules to manage the safe treatment and disposal of domestic wastewater to go into the Regional Natural Resources Plan. The plan change covers septic tanks, greywater, composting toilets and aerated wastewater systems. The new provisions will eventually replace the existing On-Site Effluent Treatment Regional Plan and will be incorporated into the Regional Natural Resources Plan. The On-Site Effluent Treatment Regional Plan will be withdrawn when Plan Change 14 is operative.

Draft Plan Change 14 (OSET) retains Mamaku in the list of communities to be reticulated -OSET P2 (c). It is also included as a Maintenance Zone.

2.2 Background

On Sunday 4th November 2018 there was a public information session/meeting at the Mamaku Hall regarding wastewater in the Mamaku Village. Staff from Bay of Plenty Regional Council (BOPRC) and Rotorua Lakes Council (RLC) presented at the meeting. This meeting was held in response to the Maintenance Zone requirements in Draft Plan Change 14 and wastewater issues in Mamaku Village. Mamaku Village is identified as a Maintenance Zone in maps in the current Operative On-site Effluent Treatment Plan (2006), but the rules do not specify the Village and therefore have not been enforced.

The following information outlines a programme of work that will be delivered to both understand what regional plan rules would be appropriate for Mamaku and identify the best long-term wastewater solution. Components in overall work programme included:

- Assessment of existing individual wastewater treatment and disposal systems - led by BOPRC
- Determine whether current wastewater treatment and disposal is causing public health risk and environmental effects – led by BOPRC (a Stage 2 project dependant on the outcomes of the first bullet point)
- Identification of potential sewerage reticulation options for Mamaku – led by RLC
- Develop appropriate rules for Mamaku to be included in PC14 - BOPRC

This project addresses the first bullet point above, with two main components investigated as identified by BOPRC:

1. Environmental constraints: Soil texture/geology and groundwater table.
2. Site visits to check existing OSET systems focusing on:
    a. Effluent discharge check for effluent ponding and overflow, odour, discharge to surface water (drains).
    b. Presence (or not) of an effluent outlet filter on septic tanks
    c. Shallow discharge field versus deep soak hole.

3 Project Tasks/Methodology

Initially the project tasks concentrated on site visits to individual OSET systems, with a staged approach of one day of initial visits to be followed by a public meeting and communication with Mamaku residents and then further site visits. Limited soil investigations were to be undertaken concurrently.

Over a number of years, wastewater system designers had commented on the presence of an impermeable rock layer in the Mamaku soils. This was seen as an impediment to the effective operation of OSET systems. BOPRC revisited the available geological/soil information and considered the possibility that a key limiting factor to effective and sustainable OSET systems in Mamaku was the likely presence of an impermeable ignimbrite/rhyolite layer. The focus of the project then shifted to undertaking additional boreholes to check soil conditions, with a smaller programme of site visits. Site visits were still considered necessary.

The project then comprised the following:

1. Drilling of 14 hand auger boreholes across Mamaku, within the road reserve, to describe the soil profile, determine the depth to groundwater and the depth to the impermeable layer. Borehole locations are shown in Figure 3.

   Boreholes were drilled using a 70mm diameter hand auger with the soil profile described by an engineering geologist. All boreholes were drilled until the ignimbrite layer was intersected. The locations of the boreholes were selected to gain a good geographical spread across the township, taking into consideration where BOPRC had existing information from well drilling records.

2. Visiting 30 individual OSET systems (6 groups of 5 houses), to determine the current type of systems installed and their operation and maintenance. A brochure outlining the site visit programme was delivered to all Mamaku residents and this included a survey to be placed in the residents' letter boxes for pick up during the inspections. Unfortunately, as the delivery company was unable to target the 30 sites proposed to be visited, some residents filled in their forms and these were not picked up. Sites visited are shown in Figure 3.

   The selection of the 30 systems to be inspected was based on seeking to visit systems within a range of different lot sizes, along with good geographical spread across the township. The number of systems visited, at approximately 10 percent of the township, is in line with the recommendations of the Auckland Health Board assessment methodology -'Proposed Protocol for Assessing On-site Wastewater Systems and the need for Reticulation' (1998). It is reiterated that the main constraint to effective and sustainable on-site wastewater disposal was considered to be the presence of the impermeable rhyolite layer, and the site visit programme was undertaken to provide a 'snapshot' of current system performance.

3. Formulate a report describing the findings of the project and recommendations.

Figure 3: Borehole and site visit locations

<u>Mamaku Village Setting:</u>

Mamaku is a small village in the Bay of Plenty Region. It lies on the Mamaku Plateau at an elevation of approximately 560 metres above sea level. Situated at the highest point of the now-mothballed Rotorua Branch railway line, the town is 4 kilometres south of State Highway 5. The village is approximately 20km from Rotorua and 90km from Hamilton. As of the 2006 census, the normally-resident population of Mamaku was 726, of whom 37.4% identified their ethnicity as Māori. There are approximately 260 houses.

4 Summary of Information Gathered

On Tuesday 7th and Wednesday 8th May 2019 the field investigation programme was completed by Trisha Simonson of Ormiston Associates Ltd and Jacqui Mackle of BOPRC.

4.1 <u>Soil Investigation Results</u>

Fourteen boreholes were drilled within the settlement at locations as shown in Figure 3. The soil texture was described and categorised in accordance with AS/NZS 1547:2012[1] by an engineering geologist experienced in soil assessment. Photographs of the soil columns are included in Appendix 1.

4.1.1 Geological/Soil Units

The boreholes encountered a remarkably consistent soil sequence across Mamaku, which varied in depth below the ground surface. That is, each borehole drilled through the same units, but the units varied in thicknesses within the study area. Groundwater was not encountered in any borehole.

The geological sequence encountered is comprised as follows and shown in Appendix 2:

1. Topsoil (average thickness 400mm): silty, friable, dark brown, organic, dry (Soil Category 4)
2. Weathered Volcanic Ash (average thickness 850mm): slightly clayey, sticky, slightly plastic, dark orange brown to dark red-brown, moist (Soil Category 5).
3. Ash/Gravelly Silt in clay matrix (average thickness 750mm): orange-brown with light orange fragments, non-plastic, wet (Soil Category 6)
4. Weathered Ignimbrite (average thickness 200mm): Silt, stiff, non-plastic, dry-moist, grey.
5. Ignimbrite – unable to auger, fragments in the weathered unit and road exposures confirm a light grey, welded ignimbrite with visible pumice inclusions. This was intercepted in all boreholes at an average depth of 2.1m, but as shallow as 850mm.

Thickness and depth to each unit in the fourteen boreholes are summarised in Table 1 below:

Table 1: Mamaku Borehole Summary:

BH No.	Topsoil (mm)	Red-Brown Silt/Ash (mm)	Orange Ash/Gravelly Silt (mm)	Silt/weathered ignimbrite (mm)	EOH = unweathered ignimbrite (mm)
1	0-500	500-1400	1,400-1,900	1,900-2,150	2,150
2	0-300	300-850	Not present	Inclusions	850
3	0-300	300-900	900-1,500	1,500-1,550	1,550
4	0-400	400-1,600	1,600-2,300	2,300-2,650	2,650
5	0-300	300-1,200	1,200-1,650	1,650-1,700	1,700
6	0-300	300-1,600	1,600-2,400	2,400-2,500	2,500
7	0-500	500-1,100	1,100-1,750	1,750-2,100	2,100
8	0-300	300-1,200	1,200-2,150	2,150-2,300	2,300
9	0-500 (F)	500-1,350	1,350-2,100	2,100-2,150	2,150

[1] Australian/New Zealand Standard 1547:2012 On-site domestic wastewater management

BH No.	Topsoil (mm)	Red-Brown Silt/Ash (mm)	Orange Ash/Gravelly Silt (mm)	Silt/weathered ignimbrite (mm)	EOH = unweathered ignimbrite (mm)
10	0-500 (F)	500-1,650	1,650-2,200	2,200-2,700	2,700
11	0-400	400-900	900-1,950	1,950-2,000	2,000
12	0-500	500-1,050	1,050-1,350	1,350-1,550	1,550
13	0-300	300-1,100	1,100-2,300	2,300-2,500	2,500
14	0-100	100-1,400	1,400-2,550	2,550-2,750	2,750
Average Unit Thickness Rounded to 50mm	400	850	750	200	2,100

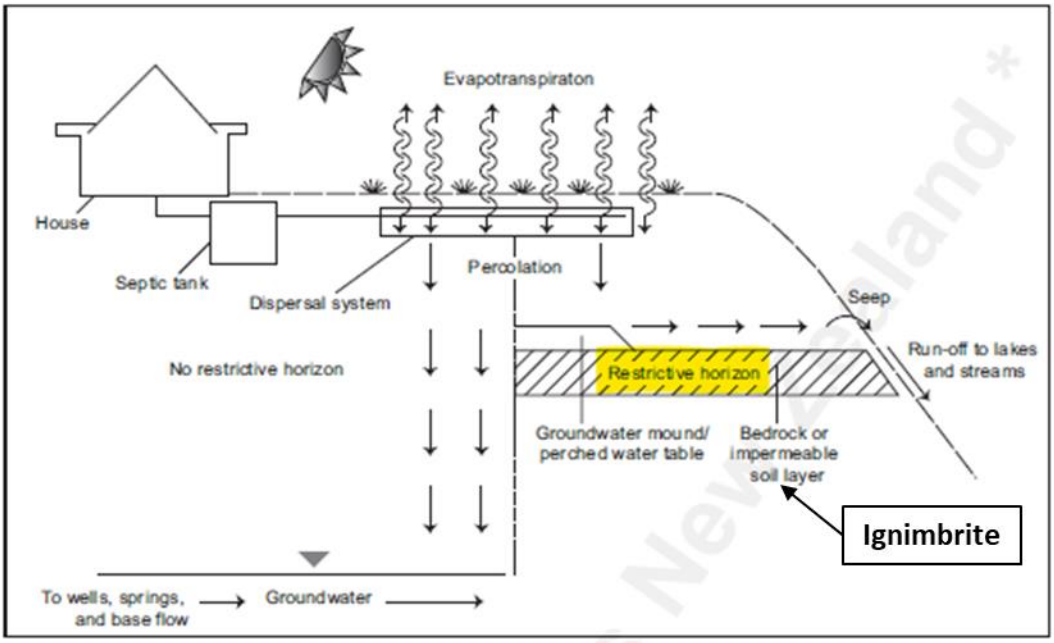
4.1.2 Implications of Findings

Presence of Impermeable Ignimbrite Layer:

The geological sequence has implications regarding the effectiveness and sustainability of OSET systems operation in Mamaku. The main concern is the presence of the unweathered ignimbrite at around 2 metres depth across the village. This unit will impede the progress of discharged wastewater into the ground, as it will not be able to soak through the rock layer and perch on this low permeability surface. The orange gravelly silt/ash layer overlying ignimbrite was always noted as wet, even after a long dry summer season. This confirms that water in the soil, both natural groundwater and wastewater, perches on the top of the low permeability ignimbrite potentially saturating overlying soils and resulting in surface breakout.

As winter groundwater levels rise towards the ground surface, this limits the thickness of dry soil available to provide further treatment of pathogens and removal of nutrients such as phosphorus, which binds to clay particles and nitrate which is highly mobile in water. When these contaminants enter groundwater, there is the potential for adverse effects to occur when the groundwater surfaces as springs, streams or lakes, or is intercepted by a water bore.

This is shown pictorially in Figure 4, from AS/NZS 1547:2012. The Standard also notes in Table R1, that the vertical setback distance between a land application system and a hardpan or bedrock should be 0.5 to 1.5m.



(Adapted from Venhuizen 1995)

FIGURE R2 EXAMPLE OF WASTEWATER PATHWAYS AND SITE CONSTRAINTS FOR APPLICATION OF SETBACK DISTANCES FOR A SOIL ABSORPTION SYSTEM

Figure 4: Figure R2 AS/NZS1547:2012

<u>Soil categories with regards to on-site wastewater disposal system design:</u>
The soil textures identified have different associated soil categories. Soil categories are a method of determining the suitability of a soil to accept on-site wastewater discharges, and the best methods of disposal to use. The borehole investigation identified a good depth of topsoil generally exists (400mm) which is a category 4 soil. The units below the topsoil show gradually less permeable/ slowly draining soils, of category 5 and 6.

In terms of wastewater disposal system design:

- To utilise conventional soakage trenches or beds, the depth of these (500mm) would require that they were constructed within the Red-brown Ash unit, which is category 5, however this unit had weak structure, and hence this is not an acceptable design solution (see Figure 4).
- To utilise pressure compensating dripper irrigation, the base of the PCDI lines would be placed at a depth of 150mm to 200mm and hence be located within the category 4 topsoil – this is an acceptable design solution. It should be noted that PCDI use requires a secondary wastewater treatment system (AWTS or rtPBR) and <u>cannot</u> be used for irrigation of primary septic tank effluent.
- New soak holes are not permitted by the Rules of the current OSET Plan. If installed they would;
    - likely extend to the orange Ash unit which is category 6 and has very limited soakage, or
    - discharge to the top of the ignimbrite allowing discharge directly into the perched groundwater.

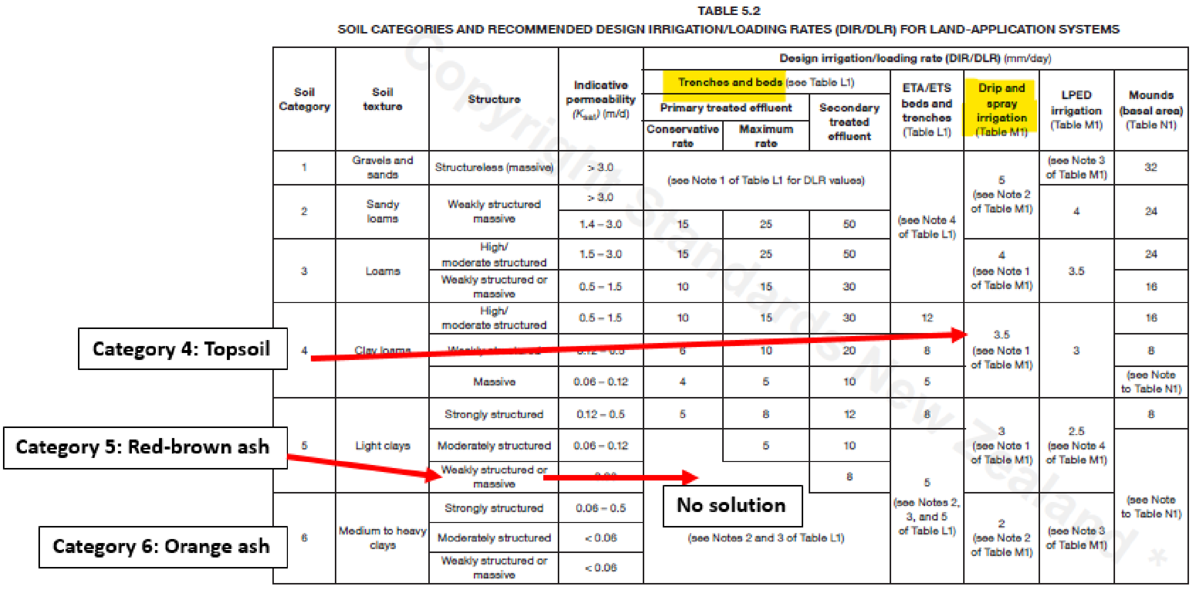


TABLE 5.2
SOIL CATEGORIES AND RECOMMENDED DESIGN IRRIGATION/LOADING RATES (DIR/DLR) FOR LAND-APPLICATION SYSTEMS

Soil Category	Soil texture	Structure	Indicative permeability (K_{sat}) (m/d)	Design irrigation/loading rate (DIR/DLR) (mm/day) — Trenches and beds (see Table L1) — Primary treated effluent — Conservative rate	Maximum rate	Secondary treated effluent	ETA/ETS beds and trenches (Table L1)	Drip and spray irrigation (Table M1)	LPED irrigation (Table M1)	Mounds (basal area) (Table N1)
1	Gravels and sands	Structureless (massive)	> 3.0	(see Note 1 of Table L1 for DLR values)			(see Note 4 of Table L1)	5 (see Note 2 of Table M1)	(see Note 3 of Table M1)	32
2	Sandy loams	Weakly structured massive	> 3.0						4	24
			1.4 – 3.0	15	25	50				
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50		4 (see Note 1 of Table M1)	3.5	24
		Weakly structured or massive	0.5 – 1.5	10	15	30				16
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	15	30	12	3.5 (see Note 1 of Table M1)	3	16
		Weakly structured	0.12 – 0.5	6	10	20	8			8
		Massive	0.06 – 0.12	4	5	10	5			(see Note to Table N1)
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	8	3 (see Note 1 of Table M1)	2.5 (see Note 4 of Table M1)	8
		Moderately structured	0.06 – 0.12		5	10	5 (see Notes 2, 3, and 5 of Table L1)			(see Note to Table N1)
		Weakly structured or massive	[illegible]			8				
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	(see Notes 2 and 3 of Table L1)				2 (see Note 2 of Table M1)	(see Note 3 of Table M1)	
		Moderately structured	< 0.06							
		Weakly structured or massive	< 0.06							

Figure 5: Table 5.2 AS/NZS 1547:2012

<u>Available separation distances:</u>
The distance between the base of an on-site wastewater disposal system and the highest winter groundwater level, is restricted to ensure that there is sufficient unsaturated soil to allow pathogens to die-off before they reach the water table and also to reduce nutrient concentrations. The commonly accepted minimum separation distance for a conventional trench or bed system and winter groundwater is 600mm. In some circumstances the separation distance should be greater – up to 1.5m according to AS/NZS 1547:2012 Table R1. While groundwater was not encountered at the time of drilling hand auger boreholes, the wet nature of the orange ash unit was indicative of a likely groundwater table within this unit and particularly during winter. The overlying red-brown ash did not exhibit any typical evidence of seasonal saturation. Using the 600mm clearance below a trench or bed, which are in the order of 500mm in depth, the minimum depth of unsaturated soil to groundwater required is 1,100mm. The top of the unit expected to be saturated in winter (the orange ash) is at 1,100mm depth or less in 5 of the 14 boreholes drilled. Therefore, in some instances there will be insufficient clearance to groundwater.

<u>Available site area:</u>
A further limiting factor to effective and sustainable on-site wastewater land application is the area on each property which is available for use as primary and reserve application areas. As noted above, the use of PCDI disposal may be an acceptable solution – however PCDI disposal systems require a reasonable amount of site area, as summarised in Table 3:

Table 3: Site areas required for PCDI

Soil Category	Primary Disposal Area (m^2)	Reserve Disposal Area (50%) (m^2)	Total Area Required (m^2)
4	286	143	430
5	333	167	500
6	500	250	750
Based on: **Design daily flow of 1,000 litres per day: 3-bedroom dwelling @ 5 people @ 200 litres/person/day (municipal water supply) as per Schedule 6 of the OSET Plan and AS/NZS 1547:2012 Table H3.** **Design Irrigation Loading Rates as per AS/NZS Table M1 (category 4 = 3.5mm/day, category 5 = 3 mm/day, category 6 = 2 mm/day).**			

Property areas in Mamaku range from 810m^2 to over 4,000m^2. Lots with less than 1,000m^2 area are likely to have difficulty accommodating a PCDI primary disposal area and reserve area along with a dwelling, garage, driveways and boundary setbacks.

4.1.3 Soil Investigation Summary

The soil investigation has confirmed that the impermeable ignimbrite layer exists in all locations drilled across Mamaku Village, with depths between 850 mm and 2,700mm, with an average depth of 2,100m. Groundwater was not encountered however the unit overlying the ignimbrite was wet, signifying a likely perched water table. The soil categories as described are such that conventional trench or bed disposal is not appropriate from a design point of view, and also may not provide sufficient groundwater clearance. Dripper irrigation systems requiring a secondary treatment system may provide appropriate environmental protection, however some sites may not be able to accommodate the required disposal areas.

4.2 <u>Site Visit Findings:</u>

The programme comprised visiting 30 houses (6 groups of 5 neighbouring houses) which were selected to cover a range of different lot sizes, and provide a good geographical spread across Mamaku Village (see Figure 3). A total of 26 sites were visited on Wednesday 8th May 2019 as some of the selected houses were unable to be accessed due to fences or animals on the properties. Four of the properties visited were abandoned/burnt out or contained no habitable buildings.

Of the 22 dwellings which could be visited, and had OSET systems, 17 had septic tank systems and 5 had secondary aerated treatment systems (AWTS). This is quite a high proportion (23%) of AWTS, however it is not known whether this is a function of septic systems needing to be replaced due to failure. Two of the AWTS were nitrogen-reducing systems. All properties inspected were permanently occupied residential homes. Of the 22 OSET systems visited, 11 were noted to either have had previous problems, such as system failure/ tank surfacing due to hydrostatic uplift, or current concerns, such as broken septic tank lids and collapsed soak holes. This is a high proportion of 50 percent.

Where possible information was collected regarding maintenance of the OSET systems. Of the 12 properties where a response was provided, 8 indicated their OSET systems had been serviced in the last year, with a further 2 serviced in the last 2-5 year period and 2 properties serviced in the last 5-10 years. This is a positive response.

Anecdotally, feedback from the community indicated that it was generally known that groundwater levels could be high and that some properties in Mamaku had difficulty with OSET systems. Additional observations from the site visits include that there appeared to be a notable proportion of new residents to Mamaku (<5 years), and several potentially unlawful and less than ideal OSET situations were observed.

4.2.1 Issues of Concern

System Failures/Installations Not to Standard:

- Septic tank system failure replaced with pumped tank system.
- Fibreglass septic tank floating due to hydrostatic pressure and high groundwater, replaced with concrete tank.
- Older AWTS system with alarm light activated.
- Disposal system for AWTS located in paddock with livestock – system could be damaged by stock movement.
- Collapsed soak holes (2 sites).
- Dangerous and insecure/open septic tank lids (2 sites).
- Septic tanks located under driveways (2 sites).
- Disposal area looked potentially like a trench to soakhole - depression and lush growth - possible failure.
- AWTS installed due to problems with old system.
- Septic tank vent located very close to house – possibly tank within required setback.
- Anecdotally another resident noted that their system was struggling and needed emptying every 6 months.

Deprivation/affordability of maintenance:

Through observation it was apparent that some parts of the Mamaku community are experiencing reasonably high levels of deprivation. This is expected to impact on their ability to undertake maintenance and address issues with their OSET systems should they arise.

Available vacant land/cumulative effects:

It is also apparent that there are a significant number of vacant lots in Mamaku, particularly south of the railway line. Should these lots become developed with OSET systems this would likely increase the cumulative effects on the environment of wastewater discharges in Mamaku, to a significant degree.

4.2.2 Comparison with Other Investigations

The project was not intended to complete; and did not collate the required information to complete the Auckland Health Board assessment methodology for determining the need for reticulation 'Proposed Protocol for Assessing On-site Wastewater Systems and the need for Reticulation' (1998). However, basic data from the Mamaku project can be compared with other population centres, as shown in Table 3:

Table 3: Comparison with similar studies.

Location	Sites Visited	%Septic Tanks	%AWTS	%Issues
Tarawera	108	93.52	6.48	16.6
Waitoa	91	96.7	3.3	19.7
Port Waikato	103	91.3	8.7	5.8
Whatawhata	107	94.4	5.6	0.0
Mamaku	22*	77.3	22.7	50.0
***Does not include sites unable to be accessed**				

It can be noted that Mamaku has a significantly higher proportion of AWTS systems and a high proportion of failures/installation concerns than the other data sets.

4.2.3 Site Visit Summary

The site visits to 31 properties indicated that:

- 6 properties were unable to be accessed (19%),
- 6 properties had treatment and/or disposal systems which could not be located (19%),
- 11 sites had current or past problems (35%),
- 8 properties had no signs of concern (25%).
- Maintenance was regularly undertaken where we could gather that information.

5 Conclusions

The presence of an impermeable ignimbrite layer at depths of 850mm to 2,750mm below ground level in Mamaku presents a significant environmental constraint to effective and sustainable OSET discharges in the village. The hard layer of ignimbrite is concluded to cause perched winter groundwater and contribute to groundwater rising towards the ground surface. Wastewater discharged into the surficial ash layers overlying the ignimbrite may not be fully treated before merging with groundwater. This poses an environmental and public health risk as the groundwater may become contaminated. Nutrients from the wastewater will impact regional groundwater quality and eventually contribute to the Rotorua Lakes.

The difficult and poorly draining soils appear to have contributed to a high rate of OSET system failure/ issues of concern observed during the site visits. Fifty percent of sites visited fell into this category which is comparatively high. Development of available vacant land in Mamaku will only worsen the cumulative adverse effects of OSET discharges. If Mamaku is not reticulated, then the current rules would require existing on-site wastewater systems to be upgraded. It is expected that most existing systems would need to be upgraded, based on the site visit findings.

Appendix One: Boreholes:

BH1

BH2

BH3

BH4

BH5

BH6

BH7

BH8

BH9

BH10

BH11

BH12

BH14

The augering process:

APPENDIX TWO:

Geological Units/Soil Units: Mamaku

Exposed profile in Road Cut

Close up of Mamaku Ignimbrite

Topsoil and Red-Brown Silty Ash (Dark or-br and red-br, moist, very sticky)

Red Brown Silty Ash transitioning to Orange Gravelly Silt Ash (Orange-brown, wet)

Close up of Orange Gravelly Silt Ash

Transition between Gravelly Silt Ash and Weathered Ignimbrite (Silt, light grey, stiff, moist)

Close up of Weathered Ignimbrite with fragments of unweathered rock (light grey-white) at left