ENCLOSURE J

Whirinaki Housing Development:

Soil Assessment for Land Treatment of Wastewater

Freeman Cook & Associates Pty Ltd and NexGen Water Limited

Whirinaki Housing Development: Soil Assessment for Land Treatment of Wastewater.

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Peter Gearing, NexGen Water Limited

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REFERENCE Whirinaki Housing Development: Soil Assessment for Land Treatment of Wastewater

STATUS Final report

1 Background

A new housing development is proposed at Whirinaki, Hawkes Bay, see figure 1. The wastewater treatment system for this development will need to be developed with onsite disposal. The size of the lots means that this will necessitate a community system and reticulation of the wastewater from individual lots to the community system. The final stage will require a polishing of the wastewater through the soil. The ultimate destination of the polished wastewater will be the Pacific Ocean.

In order to determine the best soil treatment for the wastewater Development Nous contracted Freeman Cook & Associates to give an assessment of the site with regard to the soils for land treatment of the wastewater as a final treatment step.

Peter Gearing from NexGen Water was contracted via Freeman Cook and Associates to provide advice and to provide a preliminary report on a reticulation and community system for treatment of the wastewater.

1.1 Site

There are two proposed areas that are being considered for housing development either side of a drain. Area 1 is approximately 9.2 ha and Area 2 is 17.6 ha. The site is between 175 and 475 m from the Pacific Ocean coastline. A drain runs diagonally through the site and joins the Esk River estuary to the south of the site.

Figure 1. Google Earth map showing: location of the Housing development areas either side of the drain, soil pit locations and proximity to the Esk river and Pacific Ocean.

1. Soil Survey

The soil in the development areas was examined by Freeman Cook on 17th August 2021. A total of eight pits were dug to a depth of greater than 1.5 m across the site. Description of the soil texture and estimated permeability are given below.

2.1 Soil Pits

A total of 8 soil pits were dug and descriptions of the soil properties with emphasis on their permeability are given in Table 1 below. Photos of soils in the pits are shown in Appendix 1.

Pit No.	Depth (mm)	Texture	Estimated Permeability	Pit No.	Depth (mm)	Texture	Estimated Permeability
1	0-200	Sandy loam	Rapid	5	0-250	Sandy silt	Rapid
	200-1000+	Sand	Rapid		250-600	Silt loam	Slow
2	0-200	Sandy loam	Rapid		600-1000	Silty clay	Slow
	200-1100	Sand	Rapid		1000+	Sand	Rapid
	1100+	Sandy loam	Moderate	6	0-250	Sandy loam	Rapid
3	0-200	Sandy loam	Rapid		250-500	Sand	Rapid
	200-700	Sandy loam	Moderate to Rapid		500-1100	Sandy silt	Moderate to Rapid
	700+	Silty sand	Moderate to slow	7	0-220	Silty sand	Moderate
4	0-200	Sandy loam	Rapid		220-600	Sandy loam	Rapid
	200-500	Silty sand	Moderate to low		600+	Sandy silt	Moderate to low
	500-1300	Sand	Rapid	8	0-250	Sandy loam	Rapid
					250-450	Sandy loam	Moderate to rapid
					450-900	Sandy clay	Moderate to slow
					900+	Sand	Moderate to rapid

The soils are similar to the soils shown on S-Maps (https://smap.landcareresearch.co.nz/), Hinds_25a.1 and Oreonoko_5a.1 with the report for these soils listed in Appendix 2. The soils found would be similar to the Hinds_25a.1 in pits 1,2 and 6 and more like the Oronoko_5a.1 soil in the other pits.

The second area has been cropped and there has also been some addition of soil material and leveling in area 2. This means that especially at pit 6 the topsoil is relatively undeveloped with little organic matter.

The area around pit 3 used to waterlog and drains have been installed in this area (pers comm. S Evans, landowner). The road beside the Area 1 (Pohutukawa Drive) required drainage consideration within the construction to prevent slumping (pers comm. K Carew, Development Nous). High water tables could be expected in these areas of the site.

The best areas for land treatment of the treated wastewater would be in the region of soil pits 1 and 6 at the northern end of the site.

2. Options for Wastewater Treatment.

The average minimum lot size for the indicative proposed development is > 1000 m^2 ((9.2 - 0.92-1.8)*10000/60 = 1008 m^2) and maximum 1200 m^2 so individual septic system are feasible with secondary or tertiary treatment. However, to meet Hawke's Bay Regional Resource Management Plan expectations, the site area must be greater than 1.5 m^2/L of discharge, so the minimum area per lot would need to be greater than 1080 m^2 for a 4 person house with water tanks and greater than 1800 m^2 for a 6 person house with reticulated water. Obviously, this makes the latter not viable for a lot size of less than 1800 m^2.

The constraint of discharge to area ratio means that a reticulated sewage system to a community treatment facility would be preferable to enable the proposed form of residential development. Possible reticulation systems and community treatment systems are outlined in section 3.1 and 3.2.

2.1 Reticulation System

While there are many options to provide a reticulation system for a standalone decentralised small community wastewater system (such as proposed), in general the options fall into three (3) generic types (or concepts) being:

(i) *Gravity*

In general, these types of systems have a direct wastewater pipe from each residence to a reticulation network, with no treatment at each dwelling. The reticulation system typically has a gravity fall from each home via a lateral to a pipe network. The common gravity pipe network then falls to a pump station. From there, it is pumped to the central treatment plant, often by a series of "rising" or pumped mainlines (typically getting larger in capacity at each pump station).

Key Advantages

- Tried and proven system;
- Typically involves larger conveyance pipelines, which can be "rodded" to clean;
- No infrastructure of significance on each individual property;
- Typically has all key infrastructure in "common" land;
- Ownership resides with the service provider (i.e. Council, or Body Corporate etc);

Key Disadvantages

- Apart from the lateral (on each residential property), it typically all needs to be built at the time of other common infrastructure construction (i.e. roads etc);

- It can be prone to infiltration of stormwater (as pumpstations are typically at low points);
- It can have piping at depths (to allow for gravity fall) which can be inundated by groundwater, hence may leak from outside to inside i.e. be prone to ingress;
- Infiltration and Ingress (i.e. I&I) can significantly increase the overall volumes requiring treatment and disposal in wet weather;

(ii) *Small Bore*

While there can be many variations of this theme, in general there are two (2) basic types of small-bore sewerage systems, being:

(a) Pressure Sewers

These generally have a lateral from the home to a small buried pump station at each individual residence, and these operate on level switches and literally pump the macerated sewerage from the residence down a herringbone (or similar) conveyance network, to the central wastewater treatment plant. Larger systems may also have communal pumpstations and rising mains in the network as well.

(b) Septic Tank Pumped (or Gravity)

These generally have a gravity system from the home to a septic tank on each individual property; then either pump (or gravitate) from the septic tank via a herringbone (or similar) conveyance network, to the central wastewater treatment plant. Gravity (or larger pumped) systems may also have communal pumpstations and rising mains in the network as well.

Potentially key disadvantages of these septic-tank based systems vs the small-bore pressure systems are often considered as:

(i) the quality of the system (particularly wet weather volumes) is very dependent upon the quality of both the septic tank and the condition of the gravity pipe from the house to it;

(ii) the septic tank holds a large percentage of the carbon (solids) at each residence, which may impact the central wastewater treatment plant processes (which often require carbon);

(iii) these systems also provide the home owner most of the disadvantages of having a septic tank on their property, such as: potential odour; unsightly vents; and the need for regular desludging;

Key Advantages of small-bore systems

- Often the home builder pays for the onsite infrastructure;
- The onsite infrastructure is only added as each residence is connected, spreading cash-flow for the overall system;
- Often less capital expensive, as much of the piping is typically of a small diameter / polyethene type and may be installed by directionally drilling (rather than large open trenches);
- May often pump directly from each home to the central treatment plant, rather than require pump stations and rising mains (or potentially reduce the quantum of pump stations and rising mains);
- If of a pumped type, may be better sealed reducing I&I wet weather volumes;

Key Disadvantages of small-bore systems

- Key system assets are located on both private property and public land, this can cause problems with servicing, or poor performing assets on private land, affecting the overall system performance (contractual formats have been developed to help minimise these effects);

- Effective standards need to be maintained, in terms of both on-site system specification and maintenance etc;
- The systems need to be designed appropriately, in order to allow for factors such as power cuts, with both sufficient onsite storage, and provision for how the overall system then restarts with each pump trying to come on at the same time etc;
- The effluent quality needs to be compatible with the central wastewater treatment plant requirements.

2.2 Small Community Treatment System

There are a multitude of different wastewater treatment plant types, processes and suppliers, but in general, there are probably two (2) main generic types of standalone decentralised small community wastewater treatment options, being; (a) aerated; or (b) some type of membrane.

(i) *Aerated*

These can take many forms, such as:

- Rotating biological contactors;
- Some form of hanging sheet, or textile;
- Some form of submerged media with blowers;
- Some form of sequential: aerate / settle / decant, based reactors

All have various advantages and disadvantages – but the key will be:

- Finding a proven reliable supplier, to stand by the system;
- Determining power requirements;
- Maintenance and ease of operation;
- Ability to withstand shocks (i.e. peak wet weather inflows / or periods of lower flows / higher summer or holiday loadings / resistance chemical shocks (i.e. cancer medicines) etc;

(ii) *Membranes*

In general, these involve tubes (or straws), with small diameters and very small apertures from outside to inside, or sheets. Depending upon straw type, water can flow from outside the straws to inside, or inside the straw to outside. In the case of sheets, the water tends to flow from one side to the other. Typically, membranes:

- Provide a higher quality of treated effluent;

BUT

- Are more capital intensive;
- Are more complex and expensive to operate;
- More prone to blockage, or other operational difficulties;

In summary – the treatment plant should:

- Be suited to the type of reticulation inflow and effluent quality, appropriate to achieving the Resource Consent discharge conditions;
- Be of a proven type, that can be easily maintained and reliably operated;
- May be modulated, so can expand as the scheme expands.

Where consideration may be given to who may own and operate it as reliability and consistently within Consent Conditions, as these may be key factors ultimately determining plant selection.

Disinfection of the wastewater with ultraviolet light and/or chlorination derivative should be used to treat the wastewater to the standard required for resource consent. If subsurface drip irrigation is used as a further stage of treatment, then a chlorination system that results in a residual chloride (or derivative) in the wastewater is required to prevent the development of slimes in the pipes transporting the wastewater to the irrigation system.

2.3 Subsurface Drip Irrigation option

The wastewater from the community treatment system would be sent to a subsurface drip irrigation (SDI) system for final polishing.

To be reliable over the long-term, SDI with municipal effluent is not simply agricultural drip irrigation installed below the ground. Specialist technologies should be incorporated for this application, including:

- Specialist system design provisions allowing for both effective vacuum relief upon system shutdown (to avoid particulate ingress), and effective dripline flush velocities;
- Root intrusion inhibition, of a type compliant with local legislative requirements.

Inbuilt antimicrobial provision, to reduce risk of blockage via internal bacterial slime growth.

Area of development

The number of houses indicatively proposed for Area 1 is approximately 60. With an occupancy of 4-6 people per house this would give a range of wastewater volume of 720-1080 L/day/per house for on-site roof water tank supply and 800-1200 L/day/per house for reticulated community /bore water supply (HMRC chapter 6, p. 164). The volume from 60 houses would be between 43.2 and 72 m^3/day.

Assuming the wastewater receives tertiary treatment, the soil properties have moderate permeability (4-72 mm/hr). Using the Criters and Tchobangoglous (1998) estimation of the hydraulic loading rate this would allow an application rate of up 29 mm/day. However, further soil investigations should be undertaken to confirm this. The required area would be between 0.15 and 0.25 ha for this loading rate depending on the daily flows. A larger area is likely to be required depending on nutrient loading rates, and requirement for extra area for when repairs and maintenance are required.

To determine if this hydraulic loading rate is feasible the climate for this area needs to be considered. This site has had surface water on it during high intensity storms in recent years, so this will need to be considered in siting the SDI area. An advance of SDI is the wastewater is applied at some depth below the surface. When surface water ponding occurs the direction of flow is downward, so it is highly unlikely any wastewater would reach the surface. Also, under such conditions the soil water content will be close to saturation which will produce conditions for denitrification and nitrogen loss due to leaching will be reduced.

The area shown as area 2 in figure 1 could be used for the SDI system especially around pit 6 where the soils are most suitable. The SDI dispersal area could be used for amenity purposes and would require implementation of cut and carry for the vegetation in order to reduce nutrient build up.

3 Climate and Water Balance

The climate data for Napier airport was the closest climate station to Whirinaki. The data was obtained from the NIWA Climate Database (https://cliflo.niwa.co.nz/pls/niwp). The reference evapotranspiration (ETo) for a short grass crop was calculated using the Penman-Monteith equation as implemented in (Allen et al., 1998). Frequency distribution of the rainfall, ETo and daily water balance (rainfall – ETo) are provided in figure 2.

What this shows is that the rainfall is dominated by a few large events with 89% of the rainfall days having less than 2.5 mm and 99% of the rainfall days having rainfall less than 27.5 mm. The evaporation has a more even distribution with a minimum ETo of 0.1 mm/day maximum of 13 mm/day and average of 3 mm/day. The daily water balance has a minimum of -13 mm/day, maximum of 124.5 mm/day and average of -0.8 mm/day. This means that on average there is a water deficit each day.

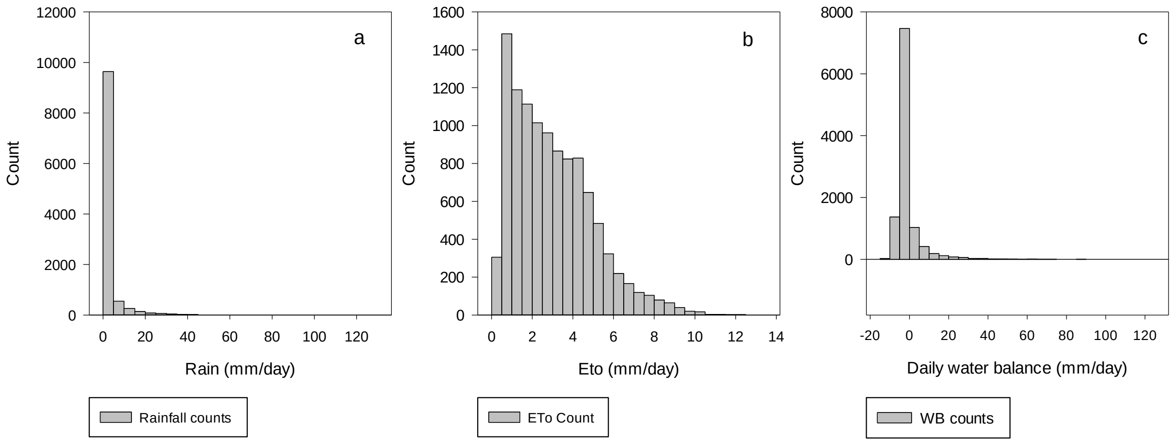

Figure 2. Distribution of a) rainfall, b) ETo and c) daily water balance for the period from 28/10/1991 to 14/8/2021.

The minimum permeability estimated for the soils in S-Map (Appendix 2) is 96 mm/day (4 mm/hr x24). The proposed daily application would be 29 mm/day which means that only days that exceed 100 mm/day of combined rainfall and wastewater application are likely to be of concern for saturating the soil. During the 10884 days in this analysis, only 4 days exceeded a daily water balance of 92.5 mm/day. All except one large rainfall event (125.2 mm on 26/4/2011) occurred in summer when ETo is highest, and the soil is likely to have a soil water deficit prior to rainfall. Thus, the risk associated with a subsurface drip system of overloading the soil is low.

5 Conclusion and Recommendations

Following an investigation of the soils at the site of development the following conclusions and recommendations can be made:

- The soils are suitable for land treatment of the wastewater;
- The lot size means that a communal treatment system is required. and options are provided for both the reticulation system and treatment plants;
- The land treatment option should be subsurface drip irrigation (SDI) using specialised technologies that are appropriate;
- The best soils for SDI are at the northern end of the site, adjacent to the state highway frontage;
- Testing of the soils in the area where the SDI system is to be installed should be undertaken prior to detailed design of the system;
- Modelling of the SDI to determine leaching/accumulation of nitrogen and phosphorus in the soil and to the groundwater should be undertaken.

5. References

Allen RG Pereira LS, Rae D and Smith M (1998). Crop evapotranspiration: Guidelines for computing crop requirements. Irrigation and Drainage Paper No. 56, FAO, Rome, Itay, 300p.

Crites, R., & Tchobanoglous, G. 1998. 'Small and Decentralized Wastewater Management Systems.' McGraw-Hill, New York.

Appendix 1. Photos of the soils.

Phots were taken at all of the pits except pit 4.

Figure A1. Soil pit 1. This shows the three layers with a sandy loam topsoil, sand layer with some structure and dark colours and a single grained sand subsoil.

Figure A2. Soil pit 2. This shows the sandy loam topsoil which is similar to pit 1.

Figure A3. Soil pit 2. This shows the sand subsoil which is similar to pit 1 until 1100 mm depth where blue reduced iron colours suggest high water content.

Figure A4. Soil pit 3. This shows the three layers with a sandy loam topsoil, sand layer reddish colour and third layer with finer texture and blue reduced iron colour.

Figure A5. Soil pit 5. This shows a darker coloured up section consisting of three layers with a sandy silt topsoil, finer silt loam layer with some pea sized gravel and dark intrusions of possibly charcoal and third layer with finer texture of a silty clay and blue reduced iron colour. The lower horizon is sand but has iron mottles indicating that this site gets wet.

Figure A6. Soil pit 6. This has three indistinct layers with a sandy loam topsoil, sand layer with some silt intrusions of approximately 10 mm in diameter and a single grained sand subsoil with iron mottles. This pit is similar to pit 1 with a less developed topsoil and signs of wetness/impeded drainage in the subsoil.

Figure A7. Soil pit 7. This has three layers with a sandy silt topsoil, sand layer with pea sized gravel and a sandy silt subsoil with iron mottles. This pit shows signs of wetness/impeded drainage in the subsoil within 600 mm depth.

Figure A7. Soil pit 8. This has four layers with a sandy loam topsoil, sandy loam layer with pea sized gravel, a sandy clay with iron mottles and sand in the final layer also with iron mottles. This pit shows signs of wetness/impeded drainage in the subsoil within 450 mm depth.

Appendix 2: S-Map soil reports

Manaaki Whenua
Landcare Research

S O I L   R E P O R T

Hawkes Bay Regional Council

Hinds_25a.1

Report generated: 11-Aug-2021 from https://smap.landcareresearch.co.nz

Hind_25a.1 (80% of the mapunit at location (1934797, 5632766), Confidence: Medium)

This information sheet describes the typical average properties of the specified soil to a depth of 1 metre, and should not be the primary source of data when making land use decisions on individual farms and paddocks. S-map correlates soils across New Zealand. Both the old soil name and the new correlated (soil family) name are listed below.

Capture of the base soil information in this region was funded by Hawkes Bay Regional Council and Manaaki Whenua.

Soil Classification

Soil Classification:
Mottled Fluvial Recent Soils (RFM)

Family Name:
Hinds (Hind)

Sibling Name:
Hinds_25a.1 (Hind_25a.1)

Soil profile material
Soil with stones (non contra:

Depth class (diggability)
Deep (> 1 m)

Profile texture
loam

Parent Material

Stones/rocks
hard sandstone rock

Soil material
hard sandstone rock

Origin
Alluvium

Soil Sibling Concept

This soil belongs to the Recent soil order of the New Zealand soil classification. Recent Soils are weakly developed, showing limited signs of soil-forming processes although a distinct topsoil is present, a B horizon is either absent or only weakly expressed. It is formed in alluvial sand silt or gravel deposited by running water, from hard sandstone parent material.

The topsoil typically has loam texture and is stoneless. The subsoil has dominantly loam textures, with gravel content of more than 3% but below 35% for most part of the soil. The plant rooting depth extends beyond 1m.

Generally the soil is imperfectly drained with low vulnerability of water logging in non-irrigated conditions, and has moderate to high soil water holding capacity. Inherently these soils have a high structural vulnerability and a moderate N leaching potential, which should be accounted for when making land management decisions.

About this publication

- This information sheet describes the *typical average properties* of the specified soil.
- For further information on individual soils, contact Landcare Research New Zealand Ltd: www.landcareresearch.co.nz
- Advice should be sought from soil and land use experts before making decisions on individual farms and paddocks.
- The information has been derived from numerous sources. It may not be complete, correct or up to date.
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- Landcare Research shall not be liable on any legal basis (including without limitation negligence) and expressly excludes all liability for loss or damage howsoever and whenever caused to a user of this factsheet.

Manaaki Whenua
Landcare Research

HAWKE'S BAY
REGIONAL COUNCIL

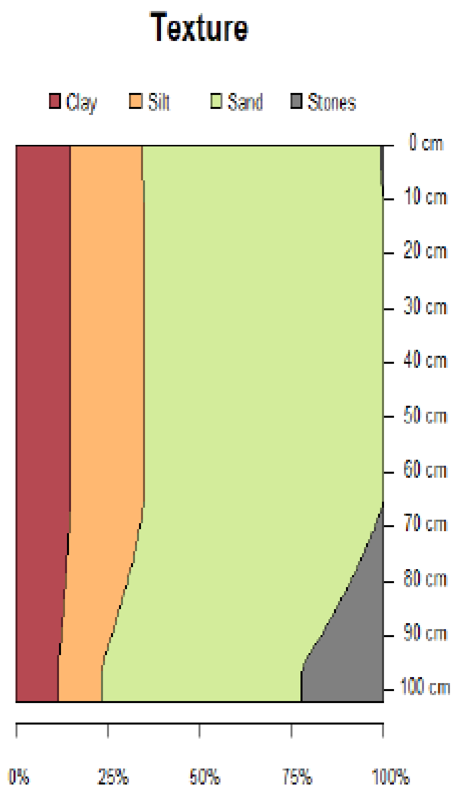
Hinds_25a.1

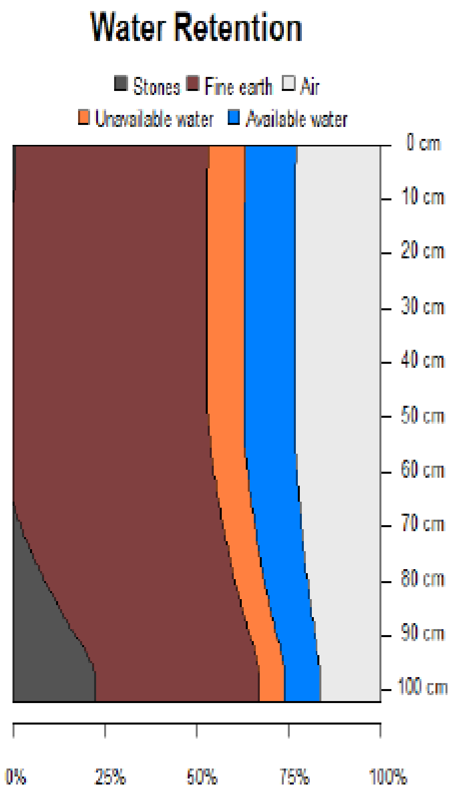
Soil horizons

Characteristics of functional horizons in order from top to base of profile:

Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Weak	15 - 25 cm	0 %	10 - 20 %	50 - 80 %	rapid
Loamy Weak	65 - 80 cm	0 %	10 - 20 %	50 - 80 %	moderate
Stony Loamy Weak	0 - 20 cm	15 - 30 %	10 - 20 %	60 - 80 %	moderate

* clay and sand percent values are for the mineral fines (excludes stones). Silt = 100 - (clay + sand)





The values for the graphs above have been generated from horizon and pedotransfer data. These values have then been splined to create continuous estimates of soil water holding capacity and particle size distribution the soil profile. These curves express the particle size distribution and water retention of the soil however there may be barriers to rooting depth that are not necessarily represented in these properties directly. It is advisable to check the potential rooting depth and rooting barrier fields in the soil physical properties section on page three of this factsheet.

Hinds_25a.1

Soil physical properties

Depth class (diggability)
Deep (> 1 m)

Potential rooting depth
Unlimited

Rooting barrier
No significant barrier within 1 m

Depth to hard rock
No hard rock within 1 m

Depth to soft rock
No soft rock within 1 m

Depth to stony layer class
Moderately deep

Texture profile
Loam

Topsoil stoniness
Stoneless

Topsoil clay range
10 - 20 %

Drainage class
Imperfectly drained

Permeability profile
Moderate over rapid

Depth to slowly permeable horizon
No slowly permeable horizon

Permeability of slowest horizon
Moderate (4 - 72 mm/h)

Aeration in root zone
Moderately limited

Profile available water

(0 - 30cm or root barrier)	(0 - 60cm or root barrier)	(0 - 100cm or root barrier)
Moderate (40 mm)	Moderate (79 mm)	Moderate to high (130 mm)

Dry bulk density

topsoil	subsoil
1.09 g/cm³	1.30 g/cm³

Soil chemical properties

Topsoil P retention
Medium (33%)

Soil management factors

Vulnerability classes relate to soil properties only and do not take into account climate or management

Soil structure integrity

Structural vulnerability
High (0.69)

Pugging vulnerability
not available yet

Septic tank installation category
A1 if slope > 15 deg otherwise B3

Contaminant management

N leaching vulnerability
Medium

P leaching vulnerability
not available yet

Dairy effluent (FDE) risk category
B

Water management

Water logging vulnerability
Moderate

Drought vulnerability - if not irrigated
Low

Bypass flow
Low

Hydrological soil group
B

Relative Runoff Potential

Slope	0-3°	4-7°	8-15°	16-25°	>25°
Risk	VL	VL	L	L	M

SINDI - Soil quality Indicators

SINDI - Soil Quality Indicators

A suite of soil quality indicators is available from http://sindi.landcareresearch.co.nz/

- Compare your soil with information from our soils databases.
- Assess the intrinsic resources and biological, chemical and physical quality of your soil
- See how your soil measures up against current understanding of optimal values.
- Learn about the effect each indicator has on soil quality and some general management practices that could be implemented to improve soil quality.

Hinds_25a.1

Soil information for OVERSEER

The following information can be entered in the OVERSEER® Nutrient Budget model. This information is derived from the S-map soil properties which are matched to the most appropriate OVERSEER categories. Please read the notes below for further information.

Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Hind_25a.1**

Considerations when using Smap soil properties in OVERSEER

- The soil water values are estimated using a regression model based on soil order, parent rock, soil functional horizon information (stone content, soil density class), as well as texture (field estimates of sand, silt and clay percentages). The model is based on laboratory - measured water content data held in the National Soils Database and other Manaaki Whenua datasets. Most of this data comes from soils under long-term pasture and may vary from land under arable use, irrigation, etc.

- Each value is an estimate of the water content of the whole soil within the target depth range or to the depth of the root barrier (if this occurs above the base of the target depth). Where soil layers contain stones, the soil water content has been decreased according to the stone content.

- S-map only contains information on soils to a depth of 100 cm. The soil water estimates in the > 60 cm depth category assume that the bottom functional horizon that extends to 100 cm, continues down to a depth of 150cm. Where it is known by the user that there is an impermeable layer or non-fractured bedrock between 100 and 150 cm, this depth should be entered into OVERSEER. Where there is a change in the soil profile characteristics below 100 cm, the user should be aware that the values provided on this factsheet for the > 60 cm depth category will not reflect this change. For example, the presence of gravels at 120 cm would usually result in lower soil water estimates in the > 60 cm depth category. Note though that this assumption only impacts on a cropping block, as OVERSEER uses soil data from just the top 60 cm in pastoral blocks.

- OVERSEER requires the soil water values to be non-zero integers (even though zero is a valid value below a root barrier), and the wilting point value must be less than the field capacity value which must be less than the saturation value. The S-map water content estimates supplied by the S-map web service have been rounded to integers and may be assigned minimal values to meet these OVERSEER requirements. These modifications will result in a slightly less accurate estimate of Available Water to 60 cm (labelled PAW in OVERSEER) than that provided on the first page of this factsheet, but this is not expected to lead to any significant difference in outputs from OVERSEER.

SOIL REPORT

Hawkes Bay Regional Council

Oronoko_5a.1

Report generated: 11-Aug-2021 from https://smap.landcareresearch.co.nz

Orono_5a.1 (35% of the mapunit at location (1934346, 5632326), Confidence: Low)

This information sheet describes the typical average properties of the specified soil to a depth of 1 metre, and should not be the primary source of data when making land use decisions on individual farms and paddocks. S-map correlates soils across New Zealand. Both the old soil name and the new correlated (soil family) name are listed below.

Capture of the base soil information in this region was funded by Hawkes Bay Regional Council and Manaaki Whenua.

Soil Classification

Soil Classification:
Typic Orthic Brown Soils (BOT)

Family Name:
Oronoko (Orono)

Sibling Name:
Oronoko_5a.1 (Orono_5a.1)

Soil profile material
Stoneless soil

Depth class (diggability)
Deep (> 1 m)

Profile texture
silt

Parent Material

Stones/rocks
not applicable

Soil material
hard sandstone rock

Origin
Alluvium

Soil Sibling Concept

This soil belongs to the Brown soil order of the New Zealand soil classification. Brown Soils have a brown or yellow-brown subsoil below a dark grey-brown topsoil. The brown colour is caused by thin coatings of iron oxides weathered from the parent material. It is formed in alluvial sand silt or gravel deposited by running water, from hard sandstone parent material.

The topsoil typically has silt texture and is stoneless. The subsoil has dominantly silt textures, with gravel content of less than 3%. The plant rooting depth extends beyond 1m.

Generally the soil is moderately well drained with very low vulnerability of water logging in non-irrigated conditions, and has moderate to high soil water holding capacity. Inherently these soils have a high structural vulnerability and a moderate N leaching potential, which should be accounted for when making land management decisions.

Orthic Brown

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Oronoko_5a.1

Soil horizons

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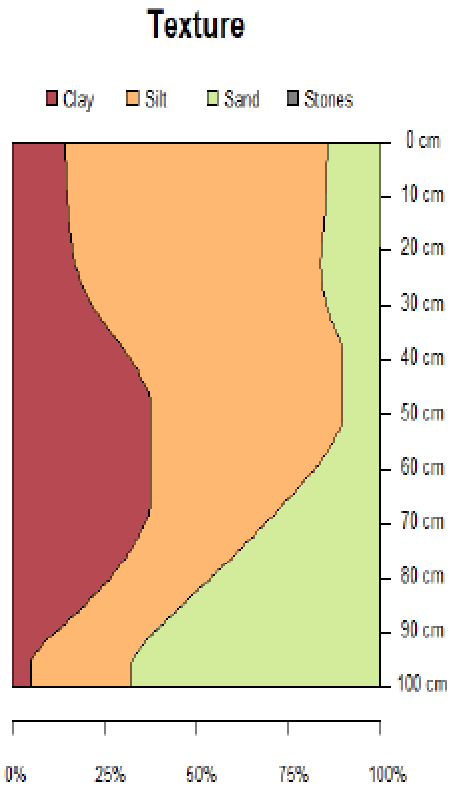
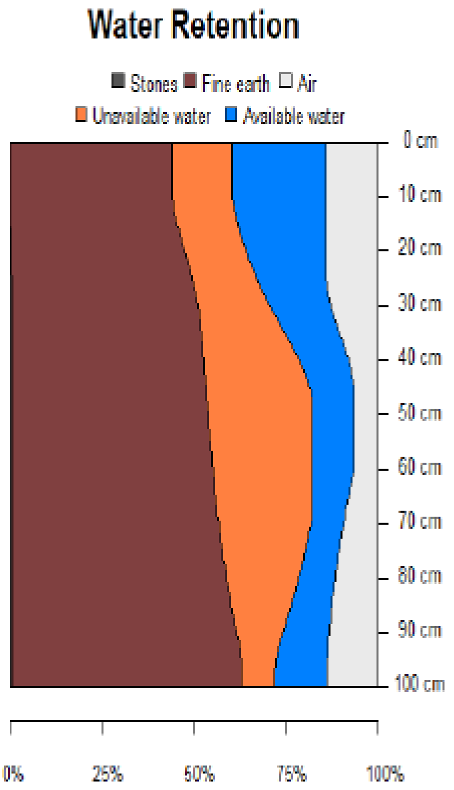
Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Weak	15 - 25 cm	0 %	12 - 18 %	10 - 20 %	rapid
Loamy Weak	12 - 18 cm	0 - 1 %	15 - 25 %	10 - 20 %	moderate
Clayey Fine Firm	20 - 35 cm	0 - 1 %	35 - 40 %	5 - 15 %	moderately slow
Loamy Fine Slightly Firm	20 - 35 cm	0 - 1 %	25 - 35 %	30 - 50 %	moderate
Sandy Weak	0 - 20 cm	0 - 1 %	2 - 8 %	55 - 80 %	rapid

* clay and sand percent values are for the mineral fines (excludes stones). Silt = 100 - (clay + sand)





The values for the graphs above have been generated from horizon and pedotransfer data. These values have then been splined to create continuous estimates of soil water holding capacity and particle size distribution the soil profile. These curves express the particle size distribution and water retention of the soil however there may be barriers to rooting depth that are not necessarily represented in these properties directly. It is advisable to check the potential rooting depth and rooting barrier fields in the soil physical properties section on page three of this factsheet.

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Soil physical properties

Depth class (diggability)
Deep (> 1 m)

Potential rooting depth
Unlimited

Rooting barrier
No significant barrier within 1 m

Depth to hard rock
No hard rock within 1 m

Depth to soft rock
No soft rock within 1 m

Depth to stony layer class
No significant stony layer within

Texture profile
Silt

Topsoil stoniness
Stoneless

Topsoil clay range
12 - 18 %

Drainage class
Moderately well drained

Permeability profile
Moderate

Depth to slowly permeable horizon
No slowly permeable horizon

Permeability of slowest horizon
Moderate (4 - 72 mm/h)

Aeration in root zone
Unlimited

Profile available water

(0 - 30cm or root barrier)	(0 - 60cm or root barrier)	(0 - 100cm or root barrier)
High (69 mm)	High (106 mm)	Moderate to high (150 mm)

Dry bulk density

topsoil	subsoil
1.09 g/cm³	1.42 g/cm³

Soil chemical properties

Topsoil P retention
Medium (36%)

Soil management factors

Vulnerability classes relate to soil properties only and do not take into account climate or management

Soil structure integrity

Structural vulnerability
High (0.63)

Pugging vulnerability
not available yet

Septic tank installation category
A1 if slope > 15 deg otherwise B3

Contaminant management

N leaching vulnerability
Medium

P leaching vulnerability
not available yet

Dairy effluent (FDE) risk category
D

Water management

Water logging vulnerability
Very low

Drought vulnerability - if not irrigated
Low

Bypass flow
Medium

Hydrological soil group
B

Relative Runoff Potential

Slope	0-3°	4-7°	8-15°	16-25°	>25°
Risk	VL	VL	VL	VL	L

SINDI - Soil quality Indicators

SINDI - Soil Quality Indicators

A suite of soil quality indicators is available from http://sindi.landcareresearch.co.nz/

- Compare your soil with information from our soils databases.
- Assess the intrinsic resources and biological, chemical and physical quality of your soil
- See how your soil measures up against current understanding of optimal values.
- Learn about the effect each indicator has on soil quality and some general management practices that could be implemented to improve soil quality.

Oronoko_5a.1

Soil information for OVERSEER

The following information can be entered in the OVERSEER® Nutrient Budget model. This information is derived from the S-map soil properties which are matched to the most appropriate OVERSEER categories. Please read the notes below for further information.

Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Orono_5a.1**

Considerations when using Smap soil properties in OVERSEER

- The soil water values are estimated using a regression model based on soil order, parent rock, soil functional horizon information (stone content, soil density class), as well as texture (field estimates of sand, silt and clay percentages). The model is based on laboratory - measured water content data held in the National Soils Database and other Manaaki Whenua datasets. Most of this data comes from soils under long-term pasture and may vary from land under arable use, irrigation, etc.

- Each value is an estimate of the water content of the whole soil within the target depth range or to the depth of the root barrier (if this occurs above the base of the target depth). Where soil layers contain stones, the soil water content has been decreased according to the stone content.

- S-map only contains information on soils to a depth of 100 cm. The soil water estimates in the > 60 cm depth category assume that the bottom functional horizon that extends to 100 cm, continues down to a depth of 150cm. Where it is known by the user that there is an impermeable layer or non-fractured bedrock between 100 and 150 cm, this depth should be entered into OVERSEER. Where there is a change in the soil profile characteristics below 100 cm, the user should be aware that the values provided on this factsheet for the > 60 cm depth category will not reflect this change. For example, the presence of gravels at 120 cm would usually result in lower soil water estimates in the > 60 cm depth category. Note though that this assumption only impacts on a cropping block, as OVERSEER uses soil data from just the top 60 cm in pastoral blocks.

- OVERSEER requires the soil water values to be non-zero integers (even though zero is a valid value below a root barrier), and the wilting point value must be less than the field capacity value which must be less than the saturation value. The S-map water content estimates supplied by the S-map web service have been rounded to integers and may be assigned minimal values to meet these OVERSEER requirements. These modifications will result in a slightly less accurate estimate of Available Water to 60 cm (labelled PAW in OVERSEER) than that provided on the first page of this factsheet, but this is not expected to lead to any significant difference in outputs from OVERSEER .

Manaaki Whenua
Landcare Research

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