From: 7(2)(a) [redacted]
To: Consents Applications
Cc: Simon Spark; Analese Fon
Subject: Consent application - S J Allen - Discharge to Land
Date: Thursday, 21 August 2025 12:24:44 p.m.
Attachments: image003.png
RE_SJ Allen_ 250820-FINAL.pdf
Consent Application Form - signed.pdf

Kia ora,

Please see attached resource consent application on behalf of S J Allen, to discharge waste to land at Brown Road, Lauder.

We had a pre-application meeting with Alexa Harrington, Mat Bell and Mark Crawford. We've also engaged with Aukaha from the early stages of the project and have obtained their written approval, as well as landowner written approval.

Analese Fon (cc'd) and I will be the key contacts for this application as the Applicants Consultant.

Please invoice for the deposit payment and any other processing costs directly to the Applicant 7(2)(a) [redacted] and reference 'Muddy Creek'.

Kind regards,

7(2)(a) [redacted]

LOWE Environmental Impact

| T | 7(2)(a) [redacted]
| E | | W | www.lei.co.nz

Form 1 – Application for Resource Consent

This application is made under Section 88 of the Resource Management Act 1991 (RMA).

The purpose of this Form 1 and the relevant activity form(s) is to provide applicants with guidance on information that is required under the Resource Management Act 1991. Please note that these forms are a guide only, and Otago Regional Council reserves the right to request additional information or to reject the application as incomplete under Section 88 of the RMA if the provisions of the fourth schedule of the RMA are not provided (refer to page 6 of this form, which details these requirements).

1(a). Applicant's details:

- The full legal names (including any middle names) or Company name or Trust (including full legal names of all Trustees) of the consent holder who will be responsible for the consent and any associated costs.
- A resource consent can only be held by a legal organisation or fully named individual(s). A legal organisation includes a registered limited company, incorporated group or registered trust. If the application is for a Trust, the full legal names of all Trustees are required. If the application is not for a limited company, incorporated group or trust, then you must use the full legal names of the individual(s).
- All invoices will be made out to and sent to the applicant.

Full legal name(s), **or** Registered company **or** Trust:

S J Allen Holdings Limited

If a Trust what are the full legal names of all Trustees:

Postal address: 34 Margaret Place, Frankton

Post code: 9300

and

Address for service[1]: Level 2, 77 Centennial Avenue, Alexandra

Post code: 9320

7(2)(a)

Mobile: [redacted]

Work Phone:

Email address:

Please provide a valid and clear email address. Otago Regional Council has adopted a paperless consenting process – therefore any correspondence including decision documents and consent (if granted) will be sent via email, unless you request a paper copy.

[1] This is the address where any official legal documents are to be sent to. PO Boxes are not accepted.

1(b). Key contact for applicant details (if applicable):

Only complete if the applicant consists of multiple parties (for example, multiple consent holders, Trust etc.). Please outline who the key contact for the consent will be, if granted:

Full legal name: Simon Spark

7(2)(a)

Mobile: [redacted]

Work Phone:

Email address:

2. Consultant details (if applicable):

Contact person: Analese Fon

Company: Lowe Environmental Impact

7(2)(a)

Mobile: [redacted]

Work Phone:

Email address:

3. Consents required in relation to this proposal:

Select the type of resource consent/s that you are applying for in your application.

☐ **Coastal**
For activities that are within the coastal marine area (CMA), for example, mooring, boat shed

☑ **Discharge**
For activities outside the CMA that may discharge contaminants into the air, water and onto or into land

☐ **Land Use**
For activities and structures outside the CMA for example, a bore, Earthworks, disturbance of contaminated land, dairy effluent systems, or activities in or on beds of lakes or rivers or flood-bank

☐ **Water**
For activities outside the CMA that involve the abstraction, damming, diversion and/or use of ground or surface water

☐ **Change to an existing consent**
For applications to change conditions or lapse date of a current consent/s

Where you have indicated the type of consent that is required, you must complete the appropriate application form before your application can be processed. Application forms can be found on the Council's website: www.orc.govt.nz/consents/ready-to-apply-for-a-consent

4. For what purpose is/are the consent(s) required (e.g. gravel extraction, water for irrigation etc.):

To discharge waste and wastewater to land

5. Location of proposed activity:

Address: Brown Road, Lauder

Legal description(s): Section 25 and Section 47 Block V Lauder SD, section 20 Block V Lauder SD

Map reference(s) (NZTM 2000)

Easting: E1336545

Northing: N 5011220

Please include location details on separate documentation if there are multiple sites or activities.

Note: Certificate(s) of Title less than three months old for the site to which this application relates are required.

6. Are there any current or expired Resource Consents relating to this proposal:

☐ Yes ☑ No

If yes, give consent number(s), description, and expiry date(s):

(a) Do you agree to the above consent/s automatically being surrendered should a replacement consent be issued?

☐ Yes ☐ No

(b) Has there been a previous application for this activity that was returned as incomplete?

☐ Yes ☑ No

If yes, please state the consent application number:

(c) Have you lodged a pre-application with Council for this activity?

☑ Yes ☐ No

If yes, please state the pre-application number: RM24.503

(d) Have you spoken to a Council staff member about this application prior to lodging this application?

☑ Yes ☐ No

If yes, please state name of staff member: Alexa Harrington, Mark Crawford, Mat Bell

7. Review of consent conditions:

Do you wish to review a draft of the Council officer's report and consent conditions before any consent is issued?[2]

☑ Yes ☐ No

If *Yes* an extension of timeframes under s37A of the Resource Management Act 1991 will be required to provide time for this review, any discussions with Council staff and for a decision to be made. Do you agree to this extension?

☑ Yes ☐ No

[2] Please note that we do not typically send out drafts of land use consents for bores or the drilling over an aquifer as these only have standard conditions added to them and they are minor activities. If you are seeking one of these consents, please tick no to question 7 above.

8. What is the term of consent you are seeking and reason for this term:

35 years. See section 11 of AEE

9. Territorial Local Authority in which activity is situated:

☑ Central Otago District Council
☐ Clutha District Council
☐ Dunedin City Council
☐ Queenstown Lakes District Council
☐ Waitaki District Council

10. Do you require any other resource consent from any local authority for this activity:

☐ Yes ☑ No

If yes, please give the date applied for or issued: ______________

11. For the land on which the activity occurs, is the applicant (tick one):
If the applicant does not own the land to which this application relates, unconditional written approval from the land owner/affected party will be required.

☐ The owner
☐ The lease holder
☐ The occupier
☑ Prospective purchaser

If the applicant is not the landowner, who is the owner of the land on which the activity occurs/is to occur:

Name of landowner: Moran Pastoral Limited

Mobile: 7(2)(a) [redacted] (mike Moran)

Work Phone: ______________

Email address: 7(2)(a) [redacted]

12. Site visit from the Consents Team:

Consents staff are able to meet with you, visit your site and see what you are proposing to do. We find that this is beneficial to everyone involved. The cost of the visit will be included in the total cost of processing your consent. However, we find that applications that have an on-site visit are processed with less congestion and at a similar or lesser overall cost. Please let us know below if you would like us to come and see your site.

I would like a member of the Consents Team to visit my site: If required.

☑ Yes ☐ No

13. Processing Officer:

Due to high workloads or the complex nature of your application, it could be assigned to a consultant processing officer. Having your application assigned to an external officer should not greatly affect the processing costs. However, if you would like your application to be assigned to an internal officer then please advise. This may mean that your application enters a waiting line to be allocated and may not be processed straight away. If this is the case, we will ask for a timeframe extension to cover the waiting time. There may be situations where we cannot accommodate this request but will let you know why this is.

I would like my application to only be processed by an internal staff member:

☐ Yes ☑ No

14. How to pay:

A deposit **must** accompany this application (see **page 9** for amounts and ways to pay). The applicant will be invoiced for all costs incurred in processing this application that exceed the deposit.

If the required deposit does not accompany your application, staff will contact you on the email address provided on this form to request payment, and after 5 working days your application will returned as incomplete if no payment is made for the required deposit.

When paying online, please use the word '**Consent**' followed by the name of the applicant as a reference.

Method of payment:

☐ Online bank transfer ☐ In person ☐ Credit card ☑ Invoice required

If an invoice is required is there a purchase order/ reference number that needs to be added to it?

Is so please provide this: ______________________________

Date of payment: ____________________

Amount paid: ____________________

Payment reference: ____________________

Please note: Your deposit may not cover the entire cost of processing your application. At the end of the application process you will be invoiced for any costs that exceed the deposit. Interim invoices may be sent out for applications, where appropriate. We will communicate processing costs to you at key stages through the process. If you would like this, then please let us know and we can see if this is an option for you.

If your application is returned to you, you will still be charged for the cost of processing the application up to the point it was returned or withdrawn. **Therefore, it is recommended that you have your application checked before it is lodged. This can be done as part of a pre-application. Further information regarding pre-applications can be found via the following link:**

https://www.orc.govt.nz/consents-and-compliance/before-applying-for-a-consent

Information regarding costs can be found via the following link: www.orc.govt.nz/consents/ready-to-apply-for-a-consent/fees-and-charges

Checklist

Before signing the declaration below, in order to provide a complete application have you remembered to fully complete:

- ☑ This Form 1, including signed declaration.
- ☑ Completed the necessary application forms relating to the activity. Application forms can be found on Council's website via the following link: www.orc.govt.nz/consents/ready-to-apply-for-a-consent
- ☐ Payment of the required deposit. Information on fees and charges can be found on Council's website via the following link https://www.orc.govt.nz/consents-and-compliance/apply-for-a-consent/fees-and-charges/
- ☑ Written approvals from all potentially affected parties.
  "Written Approval of Affected Persons" forms are available from Councils website
  https://www.orc.govt.nz/consents-and-compliance/apply-for-a-consent/#consents-application-forms
- ☑ An assessment of effects on the environment
- ☑ An assessment against the relevant objectives, policies and rules from Regional Council Plans, Regional Policy Statement (including proposed and partially operative versions), and relevant Regulations, National Policy Statements, National Environmental Standards and iwi management plans
- ☑ Site and location plans
- ☑ Certificate(s) of Title less than three months old for the site to which this application relates
  Certificates of Title can be obtained via the Land Information New Zealand website: www.linz.govt.nz

Declaration

I/we hereby certify that to the best of my/our knowledge and belief, the information given in this application is true and correct.

I/we undertake to pay all actual and reasonable application processing costs incurred by the Otago Regional Council.

Name(s): Simon Sparkle

Signature(s): 7(2)(a) [redacted]

(or person authorised to sign on behalf of applicant)

*Ensure you use the "fill and sign" function of Adobe Acrobat when signing this form. Either draw your signature or add an image. Council cannot accept typed signatures.

Designation: Managing Director
(e.g. owner, manager, consultant)

Date: 18 | 8 | 25

Council can accept electronic lodgment of applications if sent to consents.applications@orc.govt.nz
Alternatively, applications can be posted to:

Otago Regional Council
Private Bag 1954
Dunedin 9054
New Zealand

Consultation
(Consultation is not compulsory, but it can make a process easier and reduce costs)

Under Section 95E of the Resource Management Act 1991 (the Act), the Council will identify affected parties to an application and if the application is to be processed on a non-notified basis the unconditional written approval of affected parties will be required. Consultation with potentially affected parties and interested parties can be commenced prior to lodging the application.

Consultation may be required with the appropriate Tangata Whenua for the area. The address of the local Iwi office is: *Aukaha, 258 Stuart Street, P O Box 446, Dunedin, Fax (03) 477-0072, Phone (03) 477-0071, Email info@aukaha.co.nz.* If you are in the Clutha River area you may need to talk to Te Ao Marama Inc, Phone (03) 931 1242. If you require further advice, please contact the Otago Regional Council.

Good consultation practices include:
- Giving people sufficient information to understand your proposal and the likely effects it may have on them.
- Allowing sufficient time for them to assess and respond to the information.
- Considering and taking into account their responses Written approval forms are available from Councils website https://www.orc.govt.nz/consents-and-compliance/apply-for-a-consent/#consents-application-forms

Information Requirements
In order for any consent application to be processed efficiently in the minimum time and at minimum cost, it is critical that as much relevant information as possible is included with the application.

Resource Management Act 1991
FOURTH SCHEDULE – ASSESSMENT OF EFFECTS ON THE ENVIRONMENT
(Below are the provisions of the fourth schedule of the Act, which describes what must be in an application for resource consent, as amended in 2015)

1. **Information must be specified in sufficient detail.**
   Any information required by this schedule, including an assessment under clause 2(1)(f) or (g), must be specified in sufficient detail to satisfy the purpose for which it is required.

2. **Information required in all applications.**
   1. An application for a resource consent for an activity (the **activity**) must include the following:
      (a) a description of the activity; and
      (b) a description of the site at which the activity is to occur; and
      (c) the full name and address of each owner or occupier of the site; and
      (d) a description of any other activities that are part of the proposal to which the application relates; and
      (e) a description of any other resource consents required for the proposal to which the application relates; and
      (f) an assessment of the activity against the matters set out in Part 2; and
      (g) an assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b) *("document" includes regional and district plans, regulations, national policy statements, iwi plans)*.
   2. The assessment under subclause (1)(g) must include an assessment of the activity against:
      (a) any relevant objectives, policies, or rules in a document; and
      (b) any relevant requirements, conditions, or permissions in any rules in a document; and
      (c) any other relevant requirements in a document (for example, in a national environmental standard or other regulations).
   3. An application must also include an assessment of the activity's effects on the environment that:
      (a) includes the information required by clause 6; and
      (b) addresses the matters specified in clause 7; and

(c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

3. Additional information required in some applications.
An application must also include any of the following that apply:

(a) if any permitted activity is part of the proposal to which the application relates, a description of the permitted activity that demonstrates that it complies with the requirements, conditions, and permissions for the permitted activity (so that a resource consent is not required for that activity under section 87A(1))

(b) if the application is affected by section 124 or 165ZH(1)(c) (which relate to existing resource consents), an assessment of the value of the investment of the existing consent holder (for the purposes of section 104(2A))

(c) if the activity is to occur in an area within the scope of a planning document prepared by a customary marine title group under section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011, an assessment of the activity against any resource management matters set out in that planning document (for the purposes of section 104(2B).

4. (relates to subdivisions – *not included here as subdivisions are not within ORC's jurisdiction)*

5. Additional information required in application for reclamation.
An application for a resource consent for reclamation must also include information to show the area to be reclaimed, including the following:

(1) the location of the area; and
(2) if practicable, the position of all new boundaries; and
(3) any part of the area to be set aside as an esplanade reserve or esplanade strip.

Assessment of environmental effects

6. Information required in assessment of environmental effects.

(1) An assessment of the activity's effects on the environment must include the following information:

(a) if it is likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity.

(b) an assessment of the actual or potential effect on the environment of the activity

(c) if the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment that are likely to arise from such use.

(d) if the activity includes the discharge of any contaminant, a description of:

(i) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(ii) any possible alternative methods of discharge, including discharge into any other receiving environment.

(e) a description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect.

(f) identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted.

(g) if the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved.

(h) if the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).

(2) A requirement to include information in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

(3) To avoid doubt, subclause (1)(f) obliges an applicant to report as to the persons identified as being affected by the proposal, but does not:
(a) oblige the applicant to consult any person; or
(b) create any ground for expecting that the applicant will consult any person.

7. Matters that must be addressed by assessment of environmental effects.

(1) An assessment of the activity's effects on the environment must address the following matters:
(a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects
(b) any physical effect on the locality, including any landscape and visual effects.
(c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity.
(d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations.
(e) any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants
(f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

(2) The requirement to address a matter in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

Set out below are details of the amounts payable for those activities to be funded by fees and charges, as authorised by s36(1) of the Resource Management Act 1991.

Resource Consent Application Fees (from 1 July 2024)

Note that the fees shown below are a deposit to be paid on lodgment of a consent application and applications for exemptions in respect of water measuring devices. The deposit will not usually cover the full cost of processing. the application, and further actual and reasonable costs are incurred at the rate shown in the scale of charges. GST is included in all fees and charges. Costs for applications are typically invoiced at the end of process.

If you wish to make a payment via internet banking, or online, the details are below. Please note the applicants name and 'consent application' should be used as reference when paying the deposit.

For ways to pay, visit: www.orc.govt.nz/consents/ready-to-apply-for-a-consent

Pre-Application Work

We offer a pre-application service to help customers. The costs related to this service include administration, research, meeting time, taking minutes, distribution of meeting notes, and follow up advice. Pre-applications typically require 2-4 hours to complete the above actions. 30 minutes of work carried out by the Consents Planner is free of charge. The remaining work is charged at the relevant staff member's hourly rate in accordance with the fees and charges schedule.

For deposit fee amounts and scale of charges these can be found via Council's website at: https://www.orc.govt.nz/feesandcharges. Alternatively, you can contact us via phone on 03 474 0827, or 0800 474 082 Monday to Friday, 8am to 5pm.

Review of consent conditions

Following the granting of a consent, a subsequent review of consent conditions may be carried out at either the request of the consent holder, or as authorised under Section 128, as a requirement of Council. Costs incurred in undertaking reviews requested by the consent holder will be payable by the consent holder at the rates shown in the Scale of Charges above.

Reviews initiated by Council will not be charged to consent holders.

Compliance Monitoring Charges

Compliance charges may also be applied to any granted consent(s). These can be found via Council's website at: https://www.orc.govt.nz/consents-and-compliance/apply-for-a-consent/fees-and-charges/

6 Application To Discharge Contaminants to Land

Otago Regional Council

(For Office Use Only)

Consent No.: ______________

Show the location of the discharge and adjoining properties on your map on Form 1.

Part A: General

1. What is the source of the contaminant (e.g., sewage, treatment, industry, water treatment, rural activity, solid waste, etc)?

   Community Wastewater treatment plant waste activated sludge, grease trap waste, mud tank/ sump waste and winery wastewater.

2. Describe the contaminant, including, where appropriate, the physical and chemical content and their toxicity to the receiving environment.

   See AEE

3. Is the contaminant treated in any way before being discharged? Yes ☐ No ☑

   If yes, describe treatment ______________

3. What is the location of the discharge, including map reference in NZTM 2000?

   NZTM 2000: E 1336545 N 5011220

5. For liquid contaminants, what method of discharge will be used (e.g., spray irrigation, soakage, etc)

   See section 3.7 of AEE

6. Describe the soils, topography and vegetation cover of the land onto which the discharge will be made:

   See AEE

7. What is the total area of land onto which the discharge is to be made? 178.57 hectares

   What is the area of land over which the discharge is made each day? ______ hectares

Part A: General (continued)

8. **Discharge Rate Information:** See section 3.2 of AEE

Maximum flow rate:	______	litres per second
Maximum discharge rate:	______	cubic metres per day
or	______	cubic metres per week

Is the discharge: continuous ☐ or intermittent ☐

What will be the maximum discharging period?	______	hours per day
	______	days per week
	______	weeks per month
	______	months per year

9. For animal manure, what is the source of the manure?

Cows ☐ Pigs ☐ Poultry ☐ Other, specify, ______________

How many animals in your herd:	______
What maximum herd size are you planning?	______
What is the volume of waste produced daily:	______
If you have treatment ponds, how many do you have:	______

What are their dimensions?

________ metres long, ________ metres wide ________ metres deep

10. For septic tanks, what is the source of waste?

Multiple dwelling ☐ Motel/Restaurant ☐ Park/Recreation facility ☐

Other, specify ______________________________

Is the waste: Toilet and hand washing ☐ Toilet, bathroom and kitchen waste? ☐

Other, specify ______________________________

What is the estimated number of people using the facility per day? ______________

Please provide details of your design, design calculations, soils, percolation tests and site plan which justify your choice of septic tank size, type and layout.

11. Does the discharge also involve		Yes	No
	Outlet structure?	☐	☐
	Diversion?	☐	☐
	Discharge to air?	☐	☐
	Discharge to water?	☐	☐

If you have answered "Yes" to any of 11. above, another schedule to this consent application may be required.

Part B: Assessment of Effects on the Environment

1. Comment on the possible effects the discharge may have on the drainage capacity, fertility, ground or surface water of or near the site:

See AEE

2. Within the vicinity of the discharge are there any:

	Yes	No	Not Known
(a) Waterbodies, groundwater or groundwater bore(s)?	☑	☐	☐
(b) Water abstractions?	☐	☑	☐
(c) Obvious signs of fish, eels, insect life, aquatic plants, etc?	☑	☐	☐
(d) Wetlands (e.g., swamp areas)?	☑	☐	☐
(e) Recreational activities carried out (eg., swimming, fishing, canoeing)?	☐	☑	☐
(f) Areas of particular aesthetic or scientific value (eg., scenic waterfall, rapids, archaeological sites)?	☐	☑	☐
(g) Areas or aspects of significance to Iwi?	☐	☑	☐

If you have answered "Yes" to any of the above, describe what effects your operation may have and the steps you propose to take to mitigate these.

See AEE

(Continue on a separate page if necessary)

3. What alternative methods of disposal or discharge locations have you considered?

See section 6 of AEE

4. Why did you choose the proposed method of disposal and location point?

See AEE

Part B: Assessment of Effects on the Environment (Contd.)

5. How will the equipment controlling the discharge be operated and maintained to prevent equipment failure, and what measures will be implemented to ensure that the effects of any malfunction are remedied?

The discharge is manually applied on a daily basis. The operator will be present for any discharge and thus any mechanical issue can be addressed immediately. if the equipment failure or malfunction cannot be remedied within a day, the discharge would be transported to landfill.

6. What, if any, monitoring do you propose to carry out to ensure that the discharges does not have any adverse effect?

See Section 9 of AEE.

Resource Consent Application and Assessment of Environmental Effects

Land Application of Waste Activated Sludge, Winery Wastewater, Grease Trap Waste and Mud Tank/Sump Waste at Brown Road, Lauder

Prepared for

S J Allen Holdings Limited

Prepared by

Lowe Environmental Impact

August 2025

Lowe Environmental Impact

office@lei.co.nz | www.lei.co.nz | 06 359 3099

Resource Consent Application and Assessment of Environmental Effects for the Discharge of Waste Activated Sludge, Winery Wastewater, Grease Trap and Mud Tank/Sump Waste on Land

S J Allen Holdings Limited

Quality Assurance Statement		
Task	Responsibility	Signature
Project Manager:	Brian Ellwood	
Prepared by:	[redacted], Analese Fon	
Reviewed by:	[redacted], Brian Ellwood	
Approved for Issue by:	Brian Ellwood	[redacted]
Status:	Final	

Prepared by:

Lowe Environmental Impact
P O Box 29288
Christchurch 8440

| T | [+64] 3 359 3059
| E | office@lei.co.nz
| W| www.lei.co.nz

Ref: RE_SJ Allen_

Job No.: 11013

Date: 20 August 2025

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Form 9

APPLICATION FOR RESOURCE CONSENT
UNDER SECTION 88 OF THE
RESOURCE MANAGEMENT ACT 1991

To: Otago Regional Council

1. **We, SJ Allen Holdings Limited,**

   C/- Project Manager Infrastructure
   SJ Allen Holdings Limited

   Mailing Address:
   34 Margaret Place,
   Frankton, Queenstown 9300

   Physical Address:
   Level 2, 77 Centennial Avenue,
   Alexandra 9320

   Mob: [redacted]; Ph: [redacted]
   Email: [redacted]

   Apply for the following types of resource consent:

   A Discharge Permit to discharge contaminants into and onto land.

2. **The Activity** to which the application relates (the **proposed activity**) is as follows:

   To discharge waste and wastewater which includes waste activated sludge, grease trap waste, mud tank/sump waste and winery wastewater into and onto land.

3. **The site** at which the proposed activity is to occur is as follows:

   Physical Location: Brown Road, Lauder, 9377
   Legal Description: Section 25 and Section 47 Block V Lauder Survey District. Section 20 Block V Lauder Survey District
   Title Identifier: ID: OT10B/341 and OT392/70.
   Map Reference: NZTM2000 E1336545, N5011220

4. Owner/Occupier: Moran Pastoral Limited

5. There are **no other activities** that are part of the proposal to which this application relates.

6. No **Additional resource consents** are required from Otago Regional Council for the proposal to which this application relates.

7. We attach an assessment of the proposed activity's effect on the environment that:

(a) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and

(b) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and

(c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

8. We attach an **assessment of the proposed activity against the matters set out in Part 2** of the Resource Management Act 1991.

9. We attach an **assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b)** of the Resource Management Act 1991, including information required by clause 2(2) of Schedule 4 of that Act.

10 The **value of the investment** of the existing consent holder is: n/a, no existing consent.

11 Omitted.

12 Omitted.

13 Omitted.

14 We attach the further information required to be included in this application by the District Plan, the Regional Plan, the Resource Management Act 1991, or any regulations made under that Act.

Dated August 2025.

7(2)(a) [redacted]______________________ ______________________________

Consultant's Signature	Applicant's Signature
Brian Ellwood	Simon Spark
Senior Environmental Engineer	Director
Lowe Environmental Impact Limited	**SJ Allen Holdings Limited**

Contact Details
Level 2, 77 Centennial Avenue,
Alexandra 9320

Otago Regional Council
C/- Lowe Environmental Impact
P O Box 29288
CHRISTCHURCH, 8540

Phone: (03) 359 3059
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1 INTRODUCTION

1.1 Overview

This application for Resource Consent is made pursuant to Section 88 of the Resource Management Act 1991 (the Act). The purpose of this report is to accompany a Resource Consent application for the discharge to land of four waste types:

1) waste activated sludge (WAS);
2) grease trap waste;
3) mud tank/sump waste; and
4) winery wastewater.

SJ Allen Holdings Limited (SJA) is a commercial waste disposal firm that services grease traps, mud tanks/sumps, winery wastewater, portaloos and septic tanks throughout Central Otago, and has been in operation since the 4th of April 2016. The waste is generally collected using a vacuum tanker (sucker truck) and is currently discharged at District Council operated facilities or to land at McArthur Road and Springvale Road in Alexandra as per Discharge Permit RM20.287.01.

SJA also manages WAS from community wastewater treatment plants (WWTPs) within the Otago Region. The WAS is currently disposed of to landfill, which is a significant expense each year. SJA wishes to develop a sustainable WAS management system which provides beneficial reuse of the material.

Currently, for example there is up to 2,000 tonnes of WAS per year from the Wanaka Wastewater Treatment Plant requiring management. There are also other WWTPs in Central Otago which produce WAS, which requires management.

SJA is working with a local property owner near Lauder (Figure 2.1) to purchase land or enter a joint venture for the application of WAS, grease trap waste, mud tank/sump waste and winery wastewater onto the property which is approximately 230 ha.

1.2 Project Scope

Lowe Environmental Impact (LEI) has been engaged by SJ Allen Limited (SJA) to prepare an Assessment of Environmental Effects (AEE) for the discharge of waste activated sludge, grease trap type waste, mud tank/sump type waste, and winery wastewater on land in accordance with Section 88 and the Fourth Schedule of the Resource Management Act 1991 (RMA).

This AEE will cover the following:

- Description of receiving environment;
- Description of proposed activity including discharge methods;
- Site suitability assessment;
- Consideration of alternatives;
- An assessment of the actual and potential effects of the activity on the environment to satisfy Section 88 of the RMA; and
- An assessment against the objectives and policies of the relevant regional plans.

The scope of this application is for the discharge of WAS, winery wastewater, grease trap type waste and mud tank/sump type waste onto land which have been assessed as discretionary activities in Section 7 of this report.

2 SITE CHARACTERISTICS

2.1 Location

The site for the proposed activity is located in Lauder, approximately 35 km northeast of Alexandra (Figure 2.1). The property is bounded by Drybread Road, Brown Road and Muddy Creek Road, and is legally described as Section 25 and Section 47 Block V Lauder Survey District and Section 20 Block V Lauder Survey District. The GPS coordinates for the site are (NZTM2000) E1336545, N5011220.

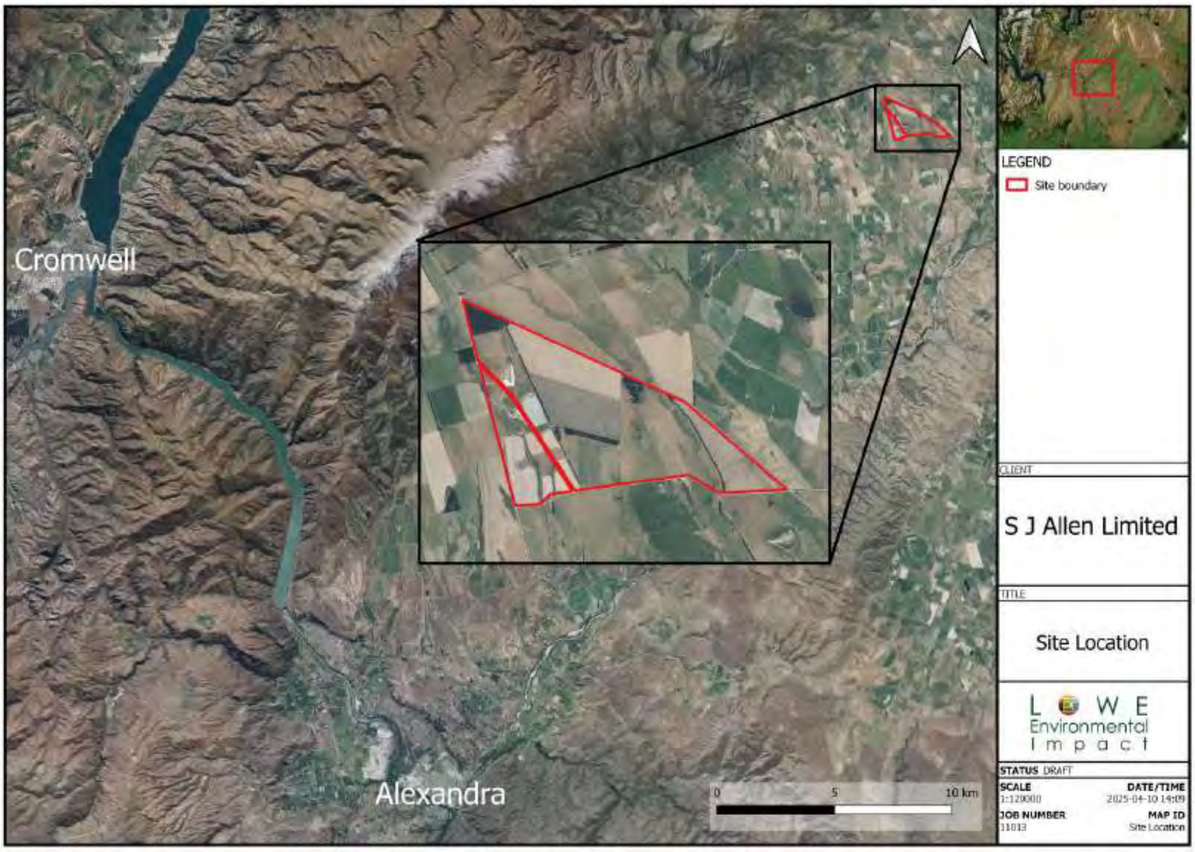

Figure 2.1: Site Location (Image not to scale.)

2.1.1 Current Land Use

The site 228.6 ha, owned and operated by Moran Pastoral Limited (Table 2.1 and Table 2.2). The block is divided into 12 paddocks and has good road access surrounding the property.

The current land use is for dairy support and sheep and beef farming. The land has in the past been partially irrigated to support pasture and grow lucerne and stock feed for winter.

Irrigation water is applied using flood/border dyke irrigation methods. The total area irrigated is approximately 200 ha. The main dam used for flood irrigation has a storage capacity of approximately 100,000 m^3 (McKeague Consultancy Ltd, 2020) and is located on the western side of the site. There is a stock water pond to the north of this dam. Additionally, there is a smaller storage pond than can be configured to use for irrigation near the centre of the site, supplied by the main storage dam via irrigation races.

LEI staff carried out a site investigation from the 2nd – 4th of April 2025 to assess site characteristics, existing land use, and soils. A memo summarising observations from the site walkover, along with photos taken during the visit is included in Appendix B.

2.1.2 Historical Mining Activities

Mining activity has previously occurred on the property, in the northwestern part of the site. Aerial imagery sourced from LINZ (2013-2014) shows the extent of the mining area in Figure 2.2 below.

Figure 2.2: Extent of Mining Operations (Source: LINZ Southland & Central Otago 0.4 m Rural Aerial Photos 2013-2014)

2.1.3 Surrounding Land Use

The land use surrounding the site is predominantly sheep and beef farming, with some dairy and dairy support. The nearest residential dwelling is located on the adjacent property to the south of the site, legal description Section 26 Block V Lauder SD. Residential dwellings in the wider area are sparsely located and limited to farm/rural housing. The nearest main town is Alexandra, approximately 35 km southwest of the site.

Table 2.1: Site Location Details

Owner	Moran Pastoral Limited
Site Adress	Brown Road, Lauder, 9377
Map Reference (NZTM2000)	NZTM2000 E1336545, N5011220
Legal Description	Section 25 and Section 47 Block V Lauder Survey District. Section 20 Block V Lauder Survey District
Total Site Area	228.6 ha
Site Use	Current use -Sheep and beef, and dairy support. Proposed use – mixed use with continued farming and land application of WAS, grease trap and mud tank/sump waste and winery wastewater
Regional Council Area	Otago Regional Council (ORC)
District Council Area	Central Otago District Council (CODC)

Table 2.2: Site Summary Details

Surrounding Land Use	Rural, primarily sheep and beef, mixed livestock, and dairy. Sparsely located residential dwellings.
Ground Cover	Grazed pasture, lucerne, and crop
Slope	Generally flat, with steeper areas along Lauder Creek Tributary and Clear Creek

2.2 Surface Water

2.2.1 Catchment Overview and Surrounding Surface Watercourses

The site is located within the Clutha/Mata-Au Freshwater Management Unit (FMU), specifically in the Manuherikia Rohe, and a Schedule 16B Water Quality Area (Otago Regional Council, 2020).

Main surface watercourses surrounding the site are shown in (Figure 2.3). Lauder Creek is the nearest to the property and flows roughly parallel to the northern boundary with its closest point around 2 km north of the property. The creek curves around the eastern side of the property and joins the Manuherika River approximately 5 km south. The nearest point of the Manuherikia River to the property is approximately 4.3 km southeast. Thomsons Creek is located approximately 3.5 km to the west.

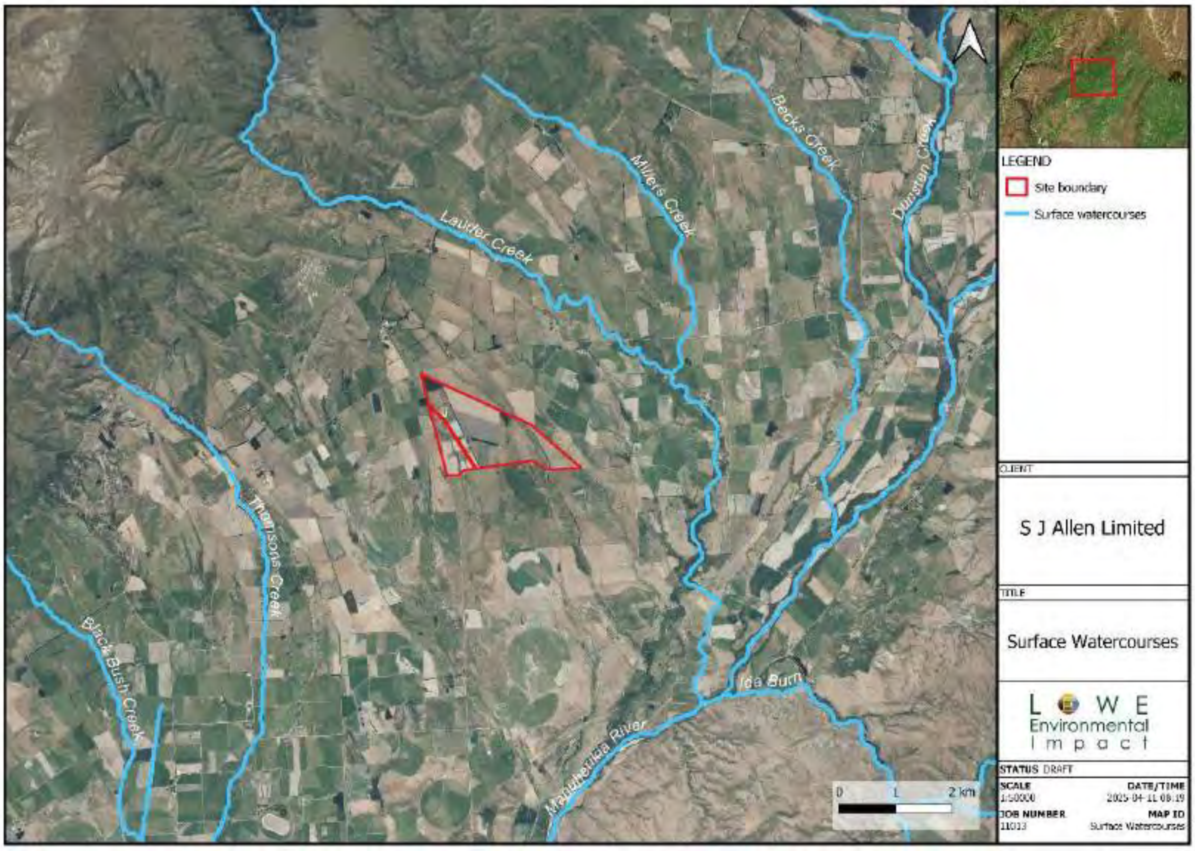

Figure 2.3: Surrounding Surface Watercourses

Lauder Creek

Lauder Creek is a tributary of the Manuherikia River, with a total catchment area of approximately 164.5 km^2 and headwaters in the Dunstan Mountains (Stewart, 2021). Within the upland basin of Lauder Creek, both permanent and ephemeral watercourses contribute to its flow (LINZ, 2006). As the creek flows from the mountainous region, it loses water to shallow groundwater and regains as it approaches the Manuherikia River (Stewart, 2021).

Lauder Creek experiences annual drying during the irrigation season over an approximate 2 km stretch between the floodplain and Glassford Road Bridge.

Water quality in the lower Lauder Creek is influenced by flood irrigation methods within the wider catchment, with elevated phosphorus, sediment and microbial contaminants (McKeague Consultancy, 2020)

In September 2009 to 2010, Otago Regional Council (ORC) investigated the water quality and ecological health in the Manuherikia River catchment. Lauder Creek was identified to have a degraded habitat and water quality with poor macroinvertebrate communities; however, it still supports trout and several native fish species.

Table 2.3 below presents Lauder Creek records from the NIWA Freshwater Fish database. Electric fishing records within 3 km of the site have recorded Upland Bully, Brown Trout and Longfin Eel.

Additionally, two eDNA records from 2022 by DOC Otago approximately 2.2 km northeast from the site and 5 km southeast from the site, detected the presence of Upland Bully, Unidentified Bully, Brown Trout, Rainbow trout, Longfin Eel, Perch, Roundhead Galaxiids, Unidentified Galaxias, Lamprey and Unidentified Bully.

eDNA sequencing counts were highest for Upland Bully, Brown Trout and Longfin Eel. These species were also observed in electric fishing records, indicating they are most prevalent in reaches of Lauder Creek nearest to the property. In contrast, other species may be less prevalent or located in higher reaches further upstream.

Table 2.3: Lauder Creek NIWA Freshwater Fish Database Records

Group	Date	Method	Species Recorded	Species Count	Direction to Site	Distance to Site
Ross Dungey Consulting Ltd	15-05-2018	Electric Fishing	Upland Bully	9	North	3 km
			Brown Trout	22		
Fish and Game	12-0-2011	Electric Fishing	Upland Bully	22	Northeast	2.2 km
			Longfin Eel	1		
DOC Otago	15-02-2022	eDNA	Brown Trout Longfin Eel Upland Bully Unidentified Bully Unidentified Eel Lamprey Roundhead Galaxias Unidentified Galaxias	N/A	Northeast	2.2 km
DOC Otago	15-13-2001	Electric fishing	Brown Trout	N/A	Northeast	2.2 km
Fish and Game	18-12-2013	Electric fishing	Upland Bully	N/A	Northeast	2.1 km
			Brown Trout	2		
Fish and Game	12-12-2013	Electric fishing	Longfin Eel	2	East	2.5 km
			Upland Bully	N/A		
			Brown Trout	10		
Ross Dungey Consulting Ltd	10-05-2018	Electric Fishing	Upland Bully	13	East	2.5 km
Fish and Game	12-12-2013	Electric Fishing	Upland bully	N/A	East	2.5 km
			Longfin Eel	1		
Otago University	09-04-2003	Electric fishing	Brown trout Upland Bully	N/A	Southeast	2.7 km
ORC	04-09-2003	Electric fishing	Brown Trout	14	Southeast	2.9 km
Fish and Game	13-12-013	Electric Fishing	Longfin Eel	4	Southeast	2.9 km
			Brown Trout	7		
			Upland Bully	1		
DOC Otago	16-02-2017	Electric Fishing	Brown Trout	4	Southeast	3 km
			Upland Bully	13		
			Longfin Eel	2		

Group	Date	Method	Species Recorded	Species Count	Direction to Site	Distance to Site
DOC Otago	20-05-2001	Electric fishing	Brown Trout	4	Southeast	3.1 km
			Upland Bully	N/A		
DOC Otago	15-02-2022	eDNA	Upland Bully Rainbow Trout Longfin Eel Lamprey Brown Trout Perch	N/A	Southeast	5 km

Manuherikia River

The 2009-2010 ORC water quality and ecological health investigation indicated that the mainstem of the Manuherikira River generally exhibited 'excellent' habitat conditions and 'good to excellent' water quality. Macroinvertebrate communities ranged from good to poor, with lower scores reflecting the presence of larger substrate rather than degraded water quality. The river supports Brown Trout, Rainbow Trout, Brook char, Perch and several native fish species.

While the upper reaches of the Manuherikia catchment generally exhibited excellent water quality, many tributaries showed signs of degradation. Elevated concentrations of Dissolved Reactive Phosphorus (DRP) were found in most rivers within the catchment, particularly in areas receiving flood/border-dyke irrigation runoff. Water quality parameters were also more often elevated during low-flow periods when rivers receive inputs from irrigation runoff (ORC, 2009-2010). With improved irrigation practices and a move to spray irrigation the impact of irrigation runoff and border dyke bywash will diminish.

2.2.2 Site-Specific Surface Watercourses

Figure 2.4 shows the surface watercourses, irrigation races and storage ponds at the site. There are two main surface water courses: Clear Creek and a tributary of Lauder Creek. The NIWA Freshwater Fish Database shows no recorded fish species in either creek.

On the western side of the site, two ponds are present. One is a dam used for irrigation water storage, and the other is a stock water pond. There is also a smaller storage pond near the centre of the site, supplied via irrigation races from the main storage dam. Several other irrigation races cross the site for flood and border dyke irrigation; these will likely be replaced with pipelines in the future. Where there are active irrigation races, a setback of 5 m will be maintained.

During LEI's site visit, an area approximately 250 m east of the smaller storage pond exhibited a different vegetation pattern compared to the surrounding pasture, potentially including sedge or rush species. The area also featured a slight depression in the landscape, which may indicate the presence of an ephemeral wetland, although it was dry at the time of the visit. LEI is conservatively treating this as a potential wetland. There are no Regionally Significant Wetlands near the property.

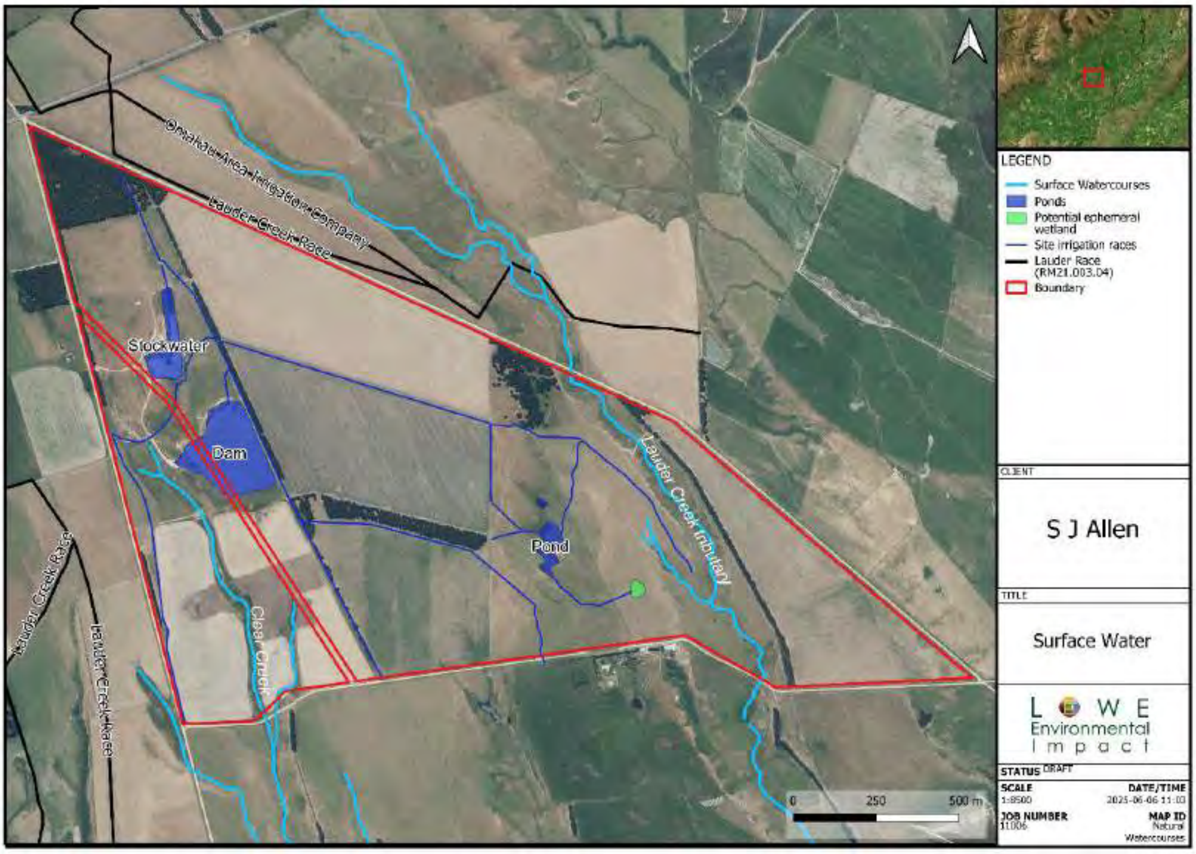

Figure 2.4: Site-Specific Surface Water

Clear Creek

Clear Creek is a small tributary of Muddy Creek, located at the southwestern part of the site (Figure 2.5 and Figure 2.6).

The tributary of Clear Creek is primarily fed by run off from contour and border dyke irrigation on the properties upstream, or by water deliberately released into the creek for abstraction by Moran Pastoral Limited. Without additional flow from irrigation runoff, Clear Creek is naturally intermittent (Matt Hickey, 2020).

During LEI's site visit, Clear Creek was observed to contain water, with a low flow rate.

Clear Creek was surveyed in 2018 at the existing point of take as part of an ORC initiative to gather fisheries information in the vicinity of a number of water takes across Otago, which found no species present (Matt Hickey, 2020).

Figure 2.5: Clear Creek looking South from the Fenceline at its Northern End

Figure 2.6: Northern End of Clear Creek Looking Northwest

Lauder Creek Tributary

Lauder Creek tributary flows through the eastern part of the site (Figure 2.7 and Figure 2.8). A vehicle access track crosses the tributary at the northern end of the site (Figure 2.9). The direction of flow is from north to south.

The tributary's banks are notably steep, with the channel width from bank to bank approximately 20 m. During LEI's site visit, the tributary was observed to contain water, with a channel width of approximately 1.5 m. The presence of vegetation within the creek bed suggests the tributary typically experiences low flow. Discussions with the landowner indicate that water is present in the tributary year-round. The landowner also mentioned that during spring the Creek has a higher flow rate, and the average flow of the Creek is approximately 20 L/s.

Figure 2.7: Lauder Creek Tributary Looking South from Drybread Road

Figure 2.8: Lauder Creek Tributary Looking North from Brown Road

Figure 2.9: Lauder Creek Tributary at Road Track Crossing Looking North

2.3 Site Irrigation Systems

The property is irrigated to support pasture and grow lucerne and stock feed for winter. Irrigation water is applied using flood/border dyke methods The total area irrigated is approximately 200 ha.

Water is sourced from Lauder Creek under Consent No. RM21.003.04, held by Omakau Area Irrigation Company Limited. The surface water take is located approximately 3.4 km north of the site at the mouth of the Lauder gorge.

Storage dams are used to ensure pasture and crop can be irrigated as required, not only when water is available. The main storage dam is located at the western side of the site (Figure 2.10) and has a capacity of approximately 100,000 m^3 (McKeague Consultancy Ltd, 2020). To the north of the storage dam is a stock water pond (Figure 2.11). Additionally, there is a smaller storage pond near the centre of the site (Figure 2.12) which is supplied via irrigation races from the main storage dam (Figure 2.13).

As discussed in Section 2.2.2 above, LEI is conservatively treating an area approximately 250 m east of the smaller storage pond as a potential ephemeral wetland (Figure 2.14).

Figure 2.10: Main Storage Dam for Irrigation Looking East

Figure 2.11: Stock Water Pond Looking South

Figure 2.12: Smaller Irrigation Storage Pond Looking South

Figure 2.13: Irrigation Race Leading to the Irrigation Pond Looking West

Figure 2.14: Potential Ephemeral Wetland

2.4 Groundwater

The site is located within the Manuherikia Groundwater Management aquifer which has been mentioned as confined/unconfined in the Otago Regional Council Map.

There are no nearby Groundwater Protection Zones as defined in the Otago Regional Plan C series Maps.

The nearest bore to the site is G41/0296, approximately 0.9 km north of the property boundary and is used for irrigation.

The nearest consented groundwater take is RM16.042.01.V1 held by Satinburn Dairy Limited to take and use groundwater for the purpose of dairy shed supply and domestic supply. This is approximately 5 km south of the site. The next closest consented groundwater take is RM15.242.01.V1 held by Wildon Dairy Limited to take and use groundwater for the purpose of dairy shed, stock water and domestic use. This is approximately 5.3 km southwest of the site.

A summary of the well/bore characteristics within 3.5 km of the site is provided in Table 2.4Table 2.. Available static groundwater levels are as follows: H41/0140 at 4.9 m, CC14/0134 at 3.4 m, G41/0277-G3 at 1.3 m, and G41/0277-G2 at 1.0 m. These bores are located between 2.6 km and 3.6 km from the site.

During LEIs site visit, no groundwater was observed in any of the nine test pits, which were dug to around 2 m below ground level. The soil profiles were dry throughout, indicating that the groundwater table is likely deeper than 2 m.

Table 2.4: Surrounding Well/Bore Characteristics (Source: ORC Maps)

Well Number	G41/0296	G41/0310	H41/0140	G41/0297	CC14/0116	CC14/0115	CC14/0114	CR2007	CC14/0134	G41/0277-G3	G41/0277-G2
Well Status	Existing	Existing	Existing	Existing	Proposed	Proposed	Proposed	Decommissioned	Existing	Existing	Existing
Well Type	Well/Bore	Well/Bore	Unknown	Unknown	Unknown	Unknown	Unknown	Well/Bore	Well/Bore	Well/Bore	Well/Bore
Aquifer	Manuherikia Gw Manag	Manuherikia Gw Manag	Manuherikia Gw Manag	Manuherikia Gw Manag	–	–	–	Manuherikia Gw Manag		Manuherikia Gw Manag	Manuherikia Gw Manag
Depth (m)	160.0	5.0	5.0	160.0	–	–	–	270.0	115.0	12.0	12.0
Drill Date	7-Jan-2003	1-Feb-2004	18-Dec-1996	7-Jan-2003	–	–	–	14-Oct-1978	4-Jun-2024	19-Sep-2001	19-Sep-2001
Owner	7(2)(a) [redacted]	7(2)(a) [redacted]	Central Otago District Council	7(2)(a) [redacted]	7(2)(a) [redacted]	7(2)(a) [redacted]	7(2)(a) [redacted]	Lime and Marble Limited	Tarnhill Farms Limited	7(2)(a) [redacted]	7(2)(a) [redacted]
Northing	5012793	5010990	5010597	5014293	5008828	5008728	5008596	5007746	5007962	5008089	5008089
Easting	1334672	1333073	1340778	1334671	1339924	1339832	1339906	1336117	1340076	1333407	1333253
Use	Agriculture Irrigation	Domestic	Geotechnical / Geological Investigation	Agriculture Irrigation	Unknown	Unknown	Unknown	Geotechnical / Geological Investigation	Stock water & Domestic	Groundwater Investigation	Groundwater Investigation
Groundwater Basin	Clutha / Mata-Au	Clutha / Mata-Au	Clutha / Mata-Au	Clutha / Mata-Au	–	–	–	Clutha / Mata-Au	–	Clutha / Mata-Au	Clutha / Mata-Au
Consent Number	2003.38	2004.024	97175	2003.382	RM21.324.01	RM21.324.01	RM21.324.01	–	RM24.176.01	–	–
Static Water Level (m)	–	–	4.9	–	–	–	–	–	3.4	1.3	1.0
Distance from Site (km)	0.9	2.5	2.6	2.2	2.4	2.4	2.6	2.7	3.2	3.3	3.5
Direction from Site	Northwest	West	East	North	Southeast	Southeast	Southeast	South	Southeast	Southwest	Southwest

2.5 Topography

Figure 2.15 below illustrates the site's topography with contours, showing the central area is predominantly flat, as is much of the far eastern area.

Figure 2.16 shows the slope percentage across the site, with areas exhibiting slopes greater than 15% highlighted in red. These steeper areas mostly correspond to the banks of the two watercourses: Clear Creek at the southwest and Lauder Creek tributary at the southeast. There are also some steeper areas around the main irrigation dam and stock water pond on the western side, and near the smaller irrigation pond at the central part of the site.

Additionally, the southwestern part of the site has steeper undulating land that follows the contour of a gully. The far southeastern corner also has a steeper gradient, sloping down at the intersection of Drybread Road and Brown Road.

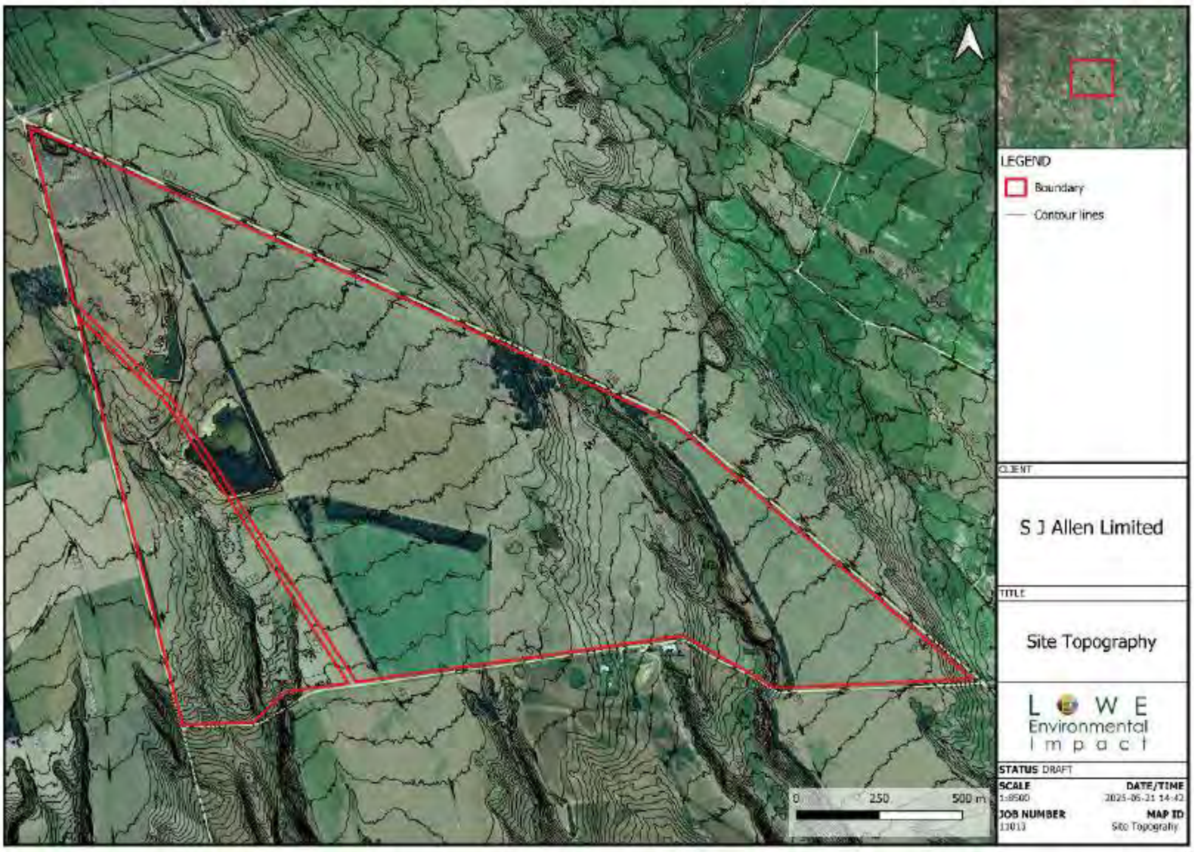

Figure 2.15: Site Topography

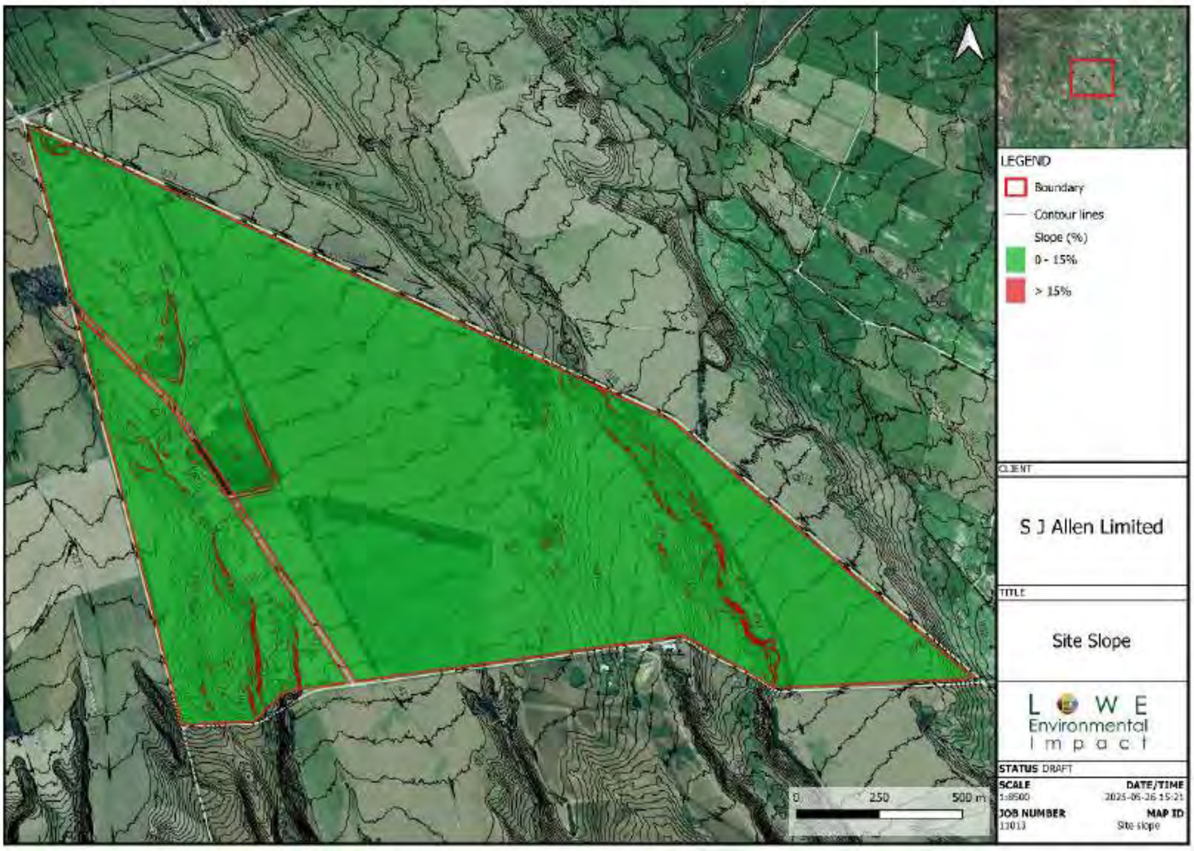

Figure 2.16: Site Slope

2.6 Geology

The proposed SJ Allen land disposal area is located within Early Quaternary alluvium within a terrace that is located above and to the east of the Clutha River (GNS Science – Online GNS Maps). The sites geology and surrounds are presented in Figure 2.17 below. The general area is known as the Alexandra Basin.

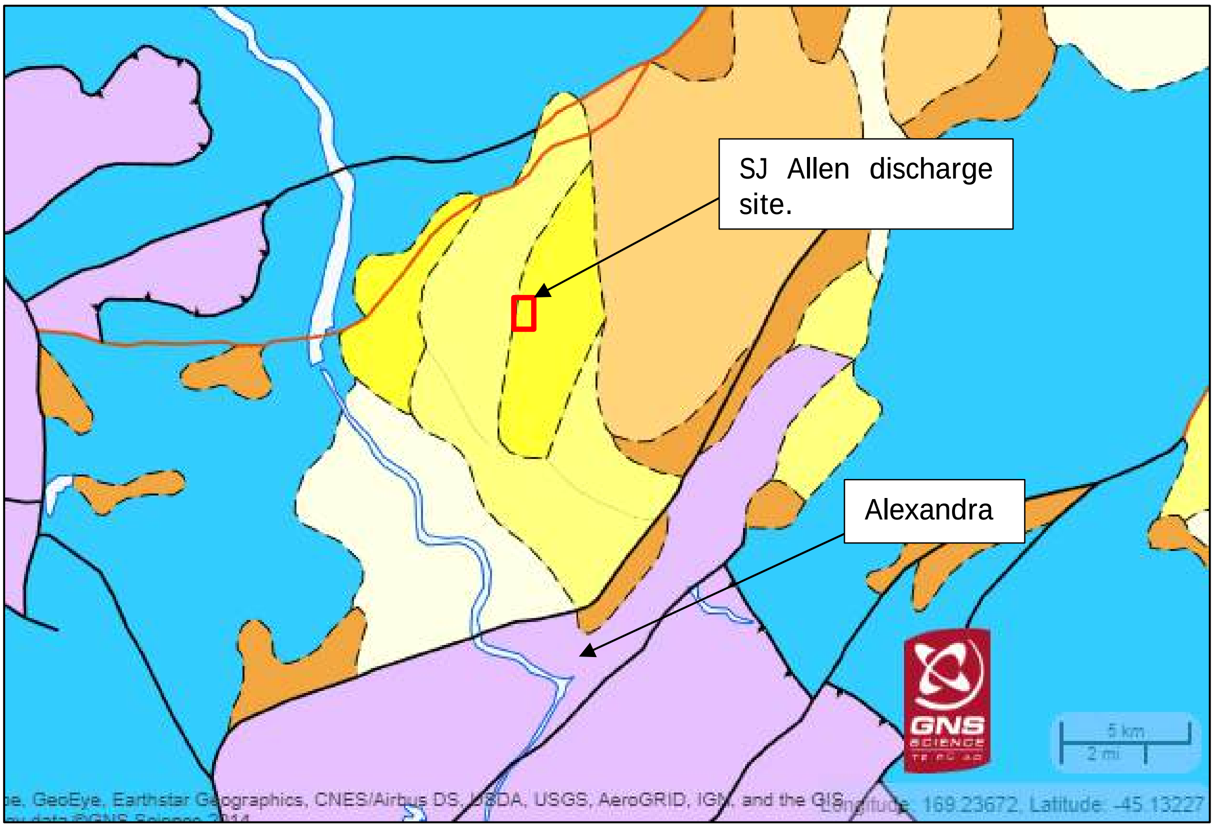

Figure 2.17: Geology of the Alexandra Basin (GNS Online Science Maps). Yellow and Brown Areas are Soil Deposition (Gravel Sand and Silt). Blue and Pink Areas Comprise Basement Schist Rock

The Alexandra Basin is a folded structure of schist rock basement. This basement has been infilled by tertiary sediments (Manuherikia Formation), and due to the structural nature, surrounding geology, and recent quaternary deposition from glacial outwash and some river deposition, it has since been preserved. Overlying the Tertiary deposits are quaternary deposits of glacial advance, mostly comprised of river gravel, sands and silts. The valley is fault bound either side with an active fault present on the northern boundary.

2.7 Soils and Plants

The ground cover at the site comprises approximately 150 ha of lucerne crop and 17 ha of kale, with the remaining paddocks in pasture. Shelterbelts of planted pine trees line some paddock boundaries, and small stands of pine trees are present, consistent with the latest aerial imagery of the site.

During LEI's site visit, a detailed soil investigation was conducted. A memo detailing the soil profiles has been provided in Appendix C. The key findings are summarised below.

2.7.1 Soil Investigation

A soil investigation was undertaken by LEI from 2nd - 4th April 2025. It comprised of 9 machine excavated test pits, to a depth of 1.5 - 2 m below the existing ground surface. The location of the test pits is shown in Figure 2.18.

The soil investigation memo is attached to this application which discusses the sampling methodology, individual profiles and results from different layers at each test pit and transect sampling location (Appendix C).

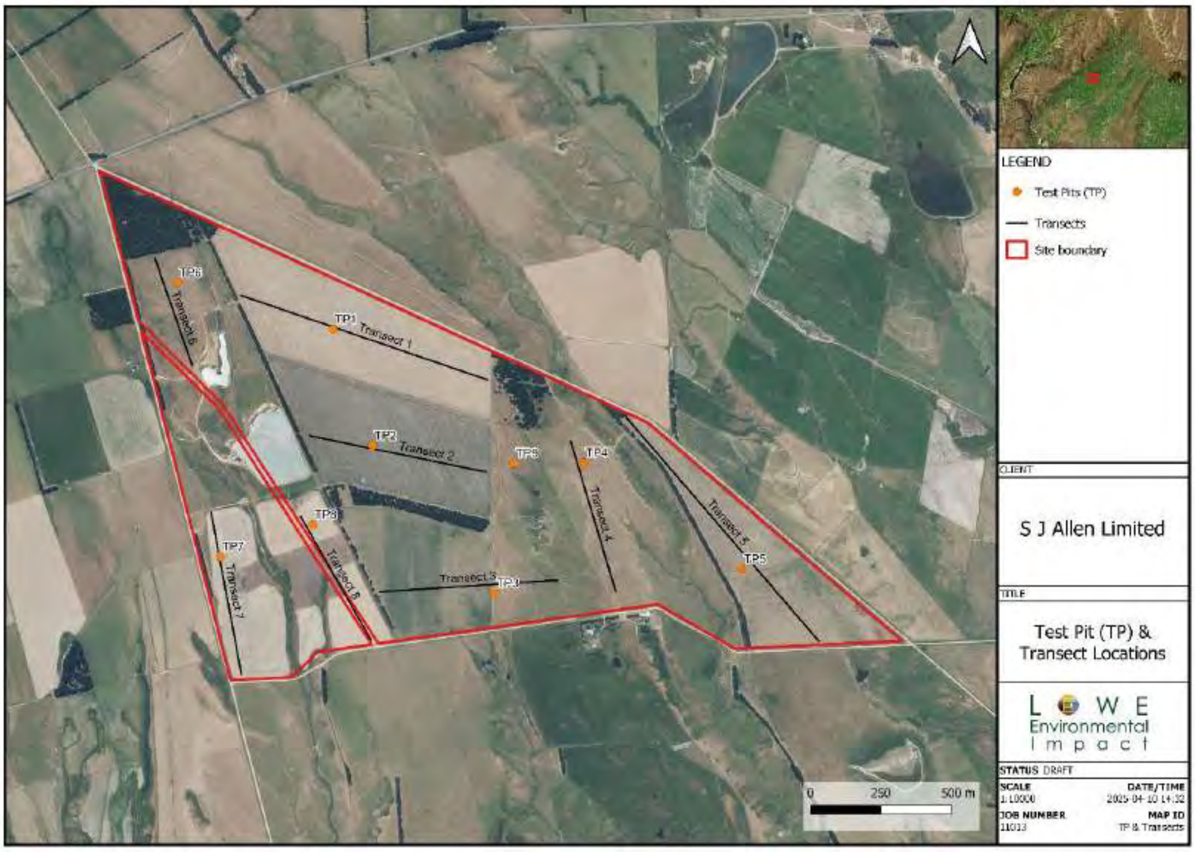

Figure 2.18: Location of Soil Test Pits and Surface Transects

A summary of average soil profiles for pallic soil is supplied in Table 2.5 below. The soil profiles typically comprised of 0.35 m of weathered loamy topsoil with roots throughout up to 60 cm. The soil layers had gravels from 5% to 70% with less sands in the deep layers.

Table 2.5: Averaged LEI Test Pit Logs

Distance from Surface of Soils (below ground) (m)	Pallic Soil	Pallic Soil/Gley Soils, TP 5
0 - 0.4	Dry, 10YR 5/6 Yellowish Brown Coloured Soil, roots up to 60 cm, common abundance. Slightly Sticky, Slightly Plastic, Medium loam soil texture, slightly gravely (5-15%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	Dry, 5Y 3/3 Dark Olive Grey Coloured Soil, Many root abundance. Slightly Sticky, Slightly Plastic, Silty loam soil texture, Moderately gravely (15-35%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.
0.4-0.8	Dry, 10YR 6/6 Brownish Yellow Coloured Soil, few roots. Slightly Sticky, Slightly Plastic, Medium loam soil texture, Very gravely (36-70%), Apedal, single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	Dry, 5Y 4/2 Olive Grey Coloured Soil, few root abundance. non Sticky, non Plastic, Medium Loam soil texture, Moderately gravely (15-35%), Apedal, single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.
0.8-2.0	Dry, 10YR 4/3 Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clay/Clay loam soil texture, Moderately gravely (5-15%), Apedal, Massive, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	Dry, 5Y 7/2 Light Grey Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clay loam soil texture, Very gravely (35-70%), Apedal, Single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.

2.7.2 Soil Chemistry of the Samples Collected from Different Sites

During the field visit, soil core samples and chemical analysis samples were collected from the A horizon (topsoil) and B horizon (subsoil) of each test pit.

Soil core samples were sent to Landcare Research for analysis of soil pores and bulk density, and soil samples for chemical analysis were sent to Hill Laboratory in Waikato.

The pH of the transect soil samples ranged from 5.4 to 5.9, which is generally within the range that supports the availability of plant nutrients in soluble form (Sparling et al., 2008). Olsen P is lower than the adequate limit, total phosphorus is at the lower end of the medium range (Hill Laboratory result sheet, attached at the end of soil memo), Total carbon and total nitrogen is close to the lower limit, exchangeable cations are generally low in Transect samples (except potassium in Transect T4), all heavy metals (As, Cd, Cu, Cr, Hg, Ni, Pb, and Zn) are much lower than the Soi Eco-Guideline values (Cavanagh, 2016) and CEC are at the lower end of the medium range (Hill Laboratory result sheet, attached at the end of soil memo).

Further details of the soil chemistry results and discussion are provided in the Soil Investigation Memo (Appendix C).

2.7.3 Summary of Soil Assessment

The soil evaluation at the Lauder site indicates that the physical properties—such as bulk density, pore space, moisture retention capacity, and texture (loamy topsoil and clay loam subsoil)—are generally favourable for the land application of WAS, grease trap type waste, mud tank/sump type waste, and winery wastewater. The incorporation of these organic materials is expected to enhance soil structure, improving aeration, water infiltration, and root penetration, particularly through the A horizon.

Chemical analysis shows that the soils are relatively infertile, with low levels of phosphorus, nitrogen, and exchangeable cations. The application of WAS and winery waste will contribute essential plant nutrients and organic matter, which are anticipated to improve plant growth, nutrient availability, and overall soil health. Both Olsen P and total phosphorus levels are below the recommended thresholds for optimal crop productivity, and total nitrogen is deficient across most transects. Organic carbon levels are also low, indicating a need for organic matter inputs to support microbial activity and improve soil vitality. The presence of a clay loam texture in the subsoil, particularly around 100 cm depth, suggests a reduced risk of downward movement of contaminant from applied WAS and winery waste by soil water drainage, thereby minimising potential leaching into deeper soil layers or groundwater.

Cation exchange capacity (CEC) is below ideal ranges in several horizons, limiting the soil's capacity to retain and supply nutrients. However, exchangeable sodium levels are low, which supports soil structural stability and reduces the risk of dispersion. Trace metal concentrations are significantly below the ecological guideline values set by Landcare Research (Cavanagh, 2016), confirming that the risk of heavy metal accumulation from WAS and winery wastewater application is minimum.

In summary, the soils at the Lauder site are suitable for the application of waste materials and wastewater as proposed in this application. These amendments are expected to improve soil fertility, structure, and hydrological performance, thereby enhancing land productivity and resilience over time.

2.8 Natural Hazards

Alluvial Fans

The Otago Natural Hazards Portal indicates there is an inactive portion of a floodwater dominated alluvial fan type at the site. There is also an active floodwater dominated alluvial fan type to the east of the site.

The Otago Alluvial Fans Project (Grindley et al., 2009) defines inactive alluvial fans as:

> *"those where these processes have clearly ceased, or are confined to the extent that erosion no longer takes place and sediment can no longer be deposited on the fan surface."*

And active fans are defined as:

> *"Those where there is evidence of historically recent or ongoing flooding, erosional and/or depositional processes on the fan surface (e.g. bare gravel bars, transported logs, etc), or where there is clear potential for flood activity to occur in future."*

The project further states that:

> *"An active (cf. inactive) classification indicates that flooding, deposition and/or erosion are possible within the next 100 years in the area defined by a particular fan polygon in the GIS dataset."*

Active Faults

The Active Faults layer indicates that the Lauder strand of the Dunstan Fault Zone lies approximately 1 km to the north of the site.

The site is situated within a "low to none" liquefaction potential domain, with the ground type predominantly underlain by rock or firm sediments.

Flood Hazard

The Otago Flood Hazard layer shows the Lauder Creek floodplain lies approximately 1 km to the east of the site.

2.9 Heritage and Archaeology

Lauder is a small settlement in Central Otago, located approximately 8 km northeast of Omakau. Once a railway town station on the former Otago Central Railway, the area now serves as a stop along the Rail Trail for cyclists and supporting vehicles. The trail crosses State Highway 85 at Lauder.

The Kā Huru Manu Atlas identifies Māori Pass (Thompsons Pass in the Dunstan Range) which served as a shortcut across the ranges approximately 3.3 km to the east of the subject site.

There are no known archaeological sites or sites of cultural significance within the subject site.

2.10 Climate

The climate of the Manuherekia Rohe is semi-arid, characterised by cold winters, warm, dry summers and low rainfall.

2.10.1 Rainfall

The average annual rainfall taken from the closest monitoring station (5537) approximately 3 km is shown in Figure 2.19 below. The data has been collected from Cliflo database of NIWA. From 1971-2000, the maximum average monthly rainfall recorded was 60 mm in December, the lowest was in August 29 mm with an average annual rainfall of 510 mm. In the 2000-2021 period, the maximum average monthly rainfall was 70 mm in January, and the minimum was 28 mm in August, and the average annual rainfall was 545 mm.

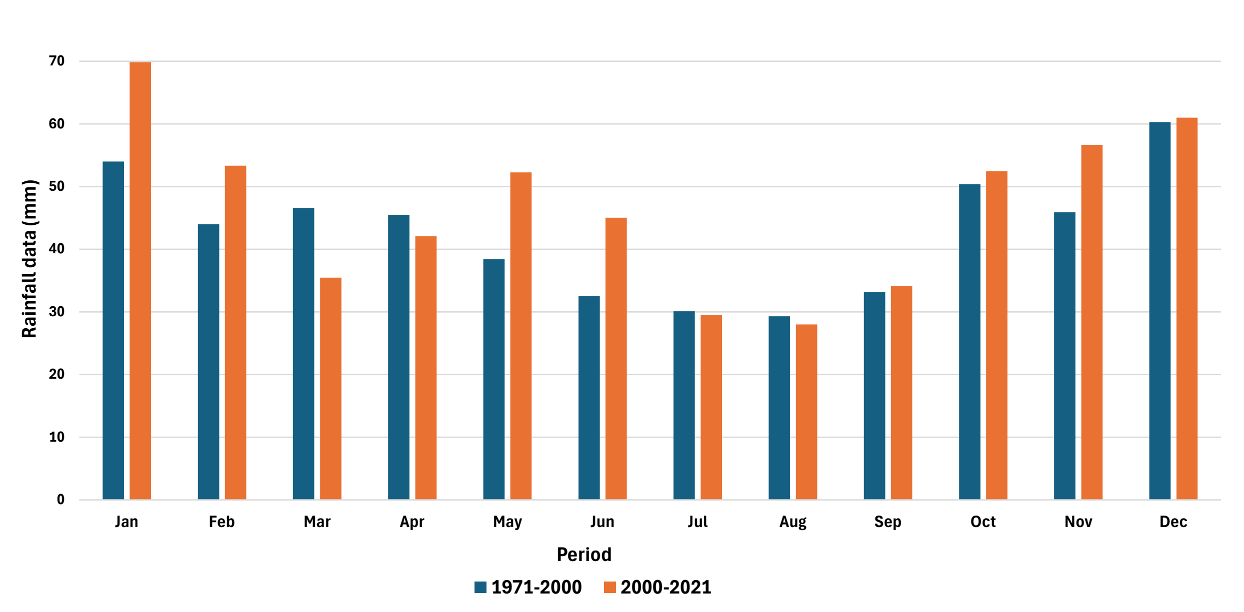

Figure 2.19: The Average Annual Rainfall in 1971 to 2000 and 2000 to 2001. Data source: https://cliflo.niwa.co.nz.

2.10.2 Temperature

The mean air temperature, mean daily maximum air temperature and mean daily minimum air temperature from 1991-2020 of the closest station has been given in Table 2.6 (agent number: 5535). The average air temperature ranges from 2.7 in July to 16.3ºC in January. The mean minimum temperature was negative during the month of June to August. During these months, the degradation of organic matter will be low.

Table 2.6: Air Temperature (1991-2020. Data source: https://cliflo.niwa.co.nz)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Air Temperature	16.3	15.9	13.4	9.8	6.8	3.3	2.7	5.2	8	10.1	12.2	14.8
Mean Daily Maximum Air Temperature	23.3	23.1	20.4	16.2	12.3	8.2	7.7	10.7	13.9	16.3	18.7	21.5
Mean Daily Minimum Air Temperature	9.3	8.7	6.4	3.4	1.3	-1.7	-2.4	-0.3	2.1	3.9	5.7	8

According to the 'Grow Otago' layer in Otago Maps, the annual median 10 cm soil temperature at the site is 8.6 – 9.0 °C.

2.10.3 Evapotranspiration

The average monthly evapotranspiration of the investigation site ranged from 11 to 161 mm from 1998 to 2023. The lowest average monthly evapotranspiration of the investigation site from 1998 to 2023 was in June and the highest was in January.

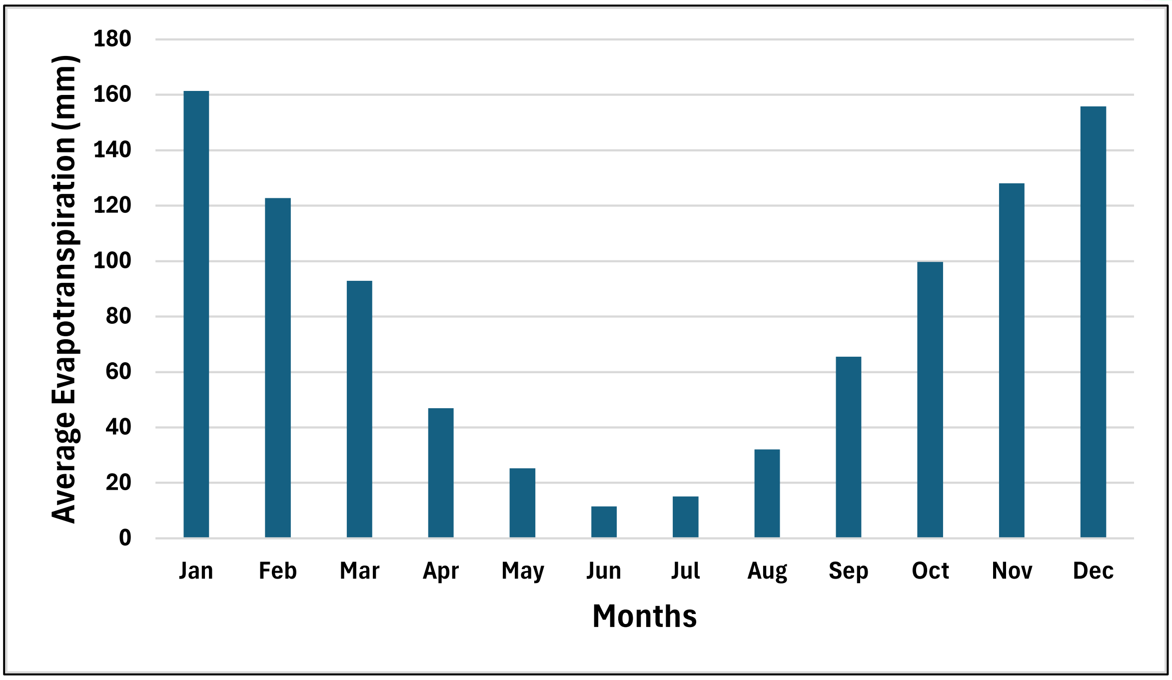

Figure 2.20: Average Monthly evapotranspiration (1998 to 2023. Data source: https://cliflo.niwa.co.nz.)

2.10.4 Wind

Figure 2.21 presents the wind rose of mean annual wind frequencies (%), showing surface wind directions and strengths based on hourly observations at the Lauder EWS station (Macara, 2015).

The Lauder EWS wind rose indicates prevailing north-easterly winds ranging from 1 – 20 km/hr, as well as from the west-southwest within the same speed range. The strongest winds are from the northwest, with speeds occasionally reaching over 40 km/h.

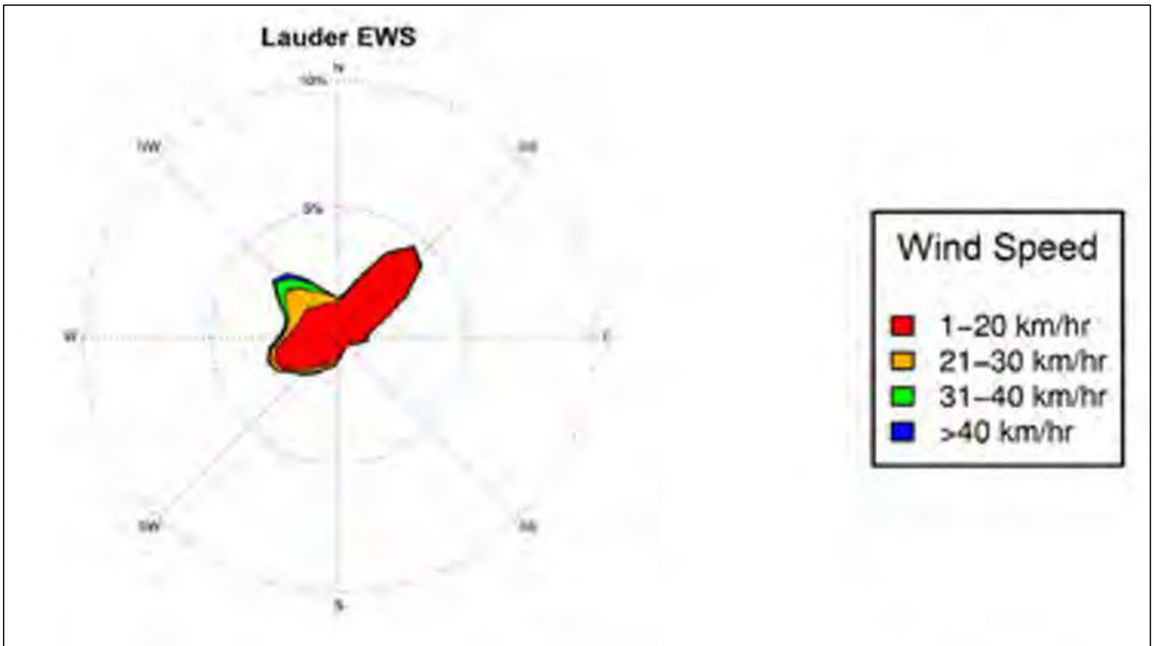

Figure 2.21: Mean Annual Wind Frequencies (%) and Directions at Laudr EWS Station (Macara, 2015)

2.11 Anticipated Climate Change

Otago's climate is undergoing significant changes, and these trends are projected to continue into the foreseeable future, driven primarily by human-induced greenhouse gas emissions. The Otago Regional Council commissioned NIWA to analyse future climate projections for the region, utilizing climate model simulations from the IPCC Fifth Assessment Report and assessing hydrological impacts. Key findings include:

- Projected temperature increases, with annual average warming of 0.5-1.5°C by 2040 and 0.5-3.5°C by 2090, depending on emissions scenarios.

- Extreme hot days (>30°C) are expected to rise significantly, particularly in Central Otago, with an additional 30-40 such days by 2090, while frost days (<0°C) are projected to decline by 10-15 days by 2040 and up to 40 days by 2090 in inland areas.

- Annual rainfall is anticipated to increase slightly (0-10%) by mid-century, with larger increases (10-20%) by 2090, especially in western Otago, accompanied by a rise in extreme rainfall event severity, such as a 35% increase in the intensity of a current 1:100-year event by 2090.

The number of dry days is projected to decrease in some coastal and central areas but increase in others (Macara et al., 2019).

2.12 Existing Consents

Consents currently exercised on the property include:

- Discharge Permit: RM21.003.10: Held by Moran Pastoral Limited to discharge water from a dam for the purpose of operating the dam. Expires September 2029.

- Dam Water Permit: RM21.003.09: Held by Moran Pastoral Limited to dam surface water for the purpose of storing water for irrigation. Expires September 2029.

2.12.1 Surface Water Permits

There are no consented surface water takes within 1 km of the property boundary. Below is a list of consented water takes located within 3 km of the property.

- RM21.003.08 - held by Moran Pastoral Limited to take, retake and use surface water from Clear Creek for the purpose of irrigation and stock water supply. This is the nearest surface water take to the site, located approximately 1.4 km south.

- RM21.003.16 - held by 7(2)(a) [redacted] to take, retake and use surface water as primary allocation from a tributary of Lauder Creek for the purpose of irrigation and stock water supply. This is approximately 2 km east/southeast of the site.

- RM21.003.14 - held by 7(2)(a) [redacted] to take, retake and use surface water from Lauder Creek for the purpose of irrigation and stock water supply. This is approximately 2.1 km northeast of the site.

- RM21.003.15 - held by [redacted] to take, retake and use surface water from Lauder Creek for the purpose of irrigation and stock water supply. This is approximately 2.5 km east/northeast of the site.

- RM21.003.18 - no consent holder listed, to take retake and use surface water from Millers Creek for the purpose of irrigation and stock water supply. This is approximately 2.6 km northeast of the site.

- RM22.337.01 – held by Milkwell Holdings Limited to take retake and use surface water from Lauder Creek as supplementary allocation for the purpose of irrigation and stock water supply. This is approximately 2.8 km southeast of the site.

- RM18.030.01 – held by Milkwell Holdings Limited to take and use surface water as primary allocation from Lauder Creek for the purpose of irrigation and stock water supply. This is approximately 2.8 km southeast of the site.

- RM21.003.19 –no consent holder listed, to take, retake and use surface water from an unnamed tributary of Lauder Creek for the purpose of irrigation and stock water supply. This is approximately 3.3 km east of the site.

2.12.2 Groundwater Permits

There are no groundwater permits within 2 km of the property boundary. The nearest consented groundwater take (Consent Number RM16.042.01.V1) is held by Satinburn Dairy Limited to take and use groundwater for the purpose of dairy shed supply and domestic supply, located approximately 5 km south of the site.

3 DESCRIPTION OF PROPOSED ACTIVITY

3.1 Introduction

SJ Allen Holdings Limited is a commercial waste disposal firm that services grease traps, mud tanks/sumps, winery waste, portaloos and septic tanks throughout Central Otago, and has been in operation since the 4th of April 2016. The waste is generally collected using a vacuum tanker (sucker truck). SJA also manages WAS from QLDC community WWTPs and may extend their services to the wider Otago Region in the future.

SJA wishes to develop a sustainable WAS management system which provides the beneficial reuse of the material and minimises the pressures on landfill and costs associated with landfilling.

Consent is therefore sought to discharge WAS, grease trap waste, mud tank/sump waste and winery wastewater onto land. The discharge of WAS will be the predominant discharge at the subject site; up to 2,000 tonnes (at 20% dry solids) per year of WAS from community WWTP's within the Otago Region. It is likely that WAS will be mostly from the Wanaka WWTP as this is currently sending its WAS to landfill and is increasingly under pressure to find an alternative solution to reduce costs. The subject site is approximately a 1.5-hour drive from the Wanaka WWTP, making it more practical to transport the WAS to Lauder than to the Kings Bend Landfill which is 2.5 hours away.

The scope of this application is for the discharge of WAS from QLDC community WWTPs, grease trap waste, mud tank/sump waste and winery wastewater onto land. The grease trap waste, mud tank/sump waste and winery wastewater are currently discharged at another property controlled by S J Allen (Consent RM20.287.01.V1) who are seeking to consolidate all of their activities to this site.

Further details will be discussed in Section 3.2.

3.2 Consent Sought

Consent is sought for the discharge of WAS and wastewater onto land, including waste-activated sludge from WWTPs, grease trap waste, mud tank/sump waste and winery wastewater (90% moisture). The proposed land application area site has the legal description Section 25 and Section 47 Block V Lauder Survey District, and Section 20 Block V Lauder Survey District at approximately NZTM2000 E1336545, N5011220.

There are four waste types proposed to be managed at the site, including:

1) Equivalent weight of Waste Activated Sludge (WAS) that will have 34.2 tonnes of nitrogen/year or 102.5 tonnes of nitrogen in a 3-year return period (considering 200 kg N/ha/year or 600 kg N/ha/3-year return period;
2) 1,200 cubic metres per year of waste from grease traps discharged into land via soakage trench and/or soil injection;
3) 1,200 cubic metres of waste from mud tanks/sump discharged into land via soakage trench and/or soil injection; and
4) 1,200 cubic metres of winery wastewater surface applied to land.

The WAS will be applied at a rate of 200 kg N/ha/yr or the equivalent of 600 kg N/ha every three years.

The grease trap waste, mud tank/sump waste and winery wastewater will be applied at a rate as currently authorised at McArthur Road under Consent RM20.287.01.V1. According to the consent condition 1, S.J. Allen is allowed to put:

a) The total volume of grease trap and mud tank/sump waste and wastewater discharged must not exceed 20 cubic metres per day.
b) The total volume of winery wastewater discharged must not exceed 20 cubic metres per day.
c) The total volume of grease trap waste and wastewater discharged must not exceed 1,200 cubic metres per year.
d) The total volume of mud sump waste and wastewater discharged must not exceed 1,200 cubic metres per year.
e) The total volume of winery wastewater discharged must not exceed 1,200 cubic metres per year.
f) The application of winery wastewater to land must not exceed 24 mm in any one application in any part of the Land Disposal Area (LDA).
g) The application of winery wastewater to the land disposal area must not occur less than 48 hours after any rain event.
h) The annual nitrogen loading from winery waste/wastewater to the LDA must not exceed 170 kg N/ha/yr.
i) The discharge must comprise of waste sourced only from grease traps, mud tanks/sumps, and wineries; and
j) The discharge must not contain any human waste, animal waste, or offal.

The proposed land application system will comprise the following:

a) Total land application area of 178.57 ha; and
b) Discharge system applying WAS fresh onto the land surface to be incorporated into the soil over a total area when fully exercising the consent of 171 ha.
c) Discharge system for winery wastewater applying to the soil surface.
d) Discharge system for grease trap and mud tank/sump waste via soakage trenches and/or soil injection.
e) Separate areas designated for the land application of different waste streams.

The Applicant proposes the following minimum setbacks from the land application areas:

a) 10 metres of the property boundary;
b) 20 metres of the road;
c) 20 metres of wetlands;
d) 50 metres of any other natural surface watercourses;
e) 20 metres of any storage ponds;
f) 5 metres of any irrigation races; and
g) 200 metres of any residential dwelling.

Additionally, the proposed land application areas will exclude areas with a slope percentage greater than 15%.

3.3 Mud Tank/Sump and Winery Waste Characteristics

To dispose of grease trap waste, mud tank/sump waste and winery wastewater, SJA also holds resource consent RM20.287.01.V1 to discharge to land at another site located on McArthur Road, Alexandra. Therefore, the sample results required by the annual reporting of that consent have been provided below.

3.3.1 Grease Trap and Mud Tank/Sump Waste

The material from grease traps is collected from small takeaway and fast-food outlets and comprises of mostly fats, oils and other waste liquids originating from kitchens similar to domestic households, albeit on a larger scale.

Mud tank waste is collected from light industrial activities including garages, mechanics and roading contractors. There are no heavy or moderate industrial activities whose mud sumps are collected, and most of the liquid waste (two-third) is wash down water or stormwater from grated sumps.

The sample results from the 2023-2024 annual report have been provided in Table 3.1 below.

Table 3.1: Grease Trap and Mud Tank/Sump Waste Results

Date	Type	pH	As g/m³	Cd g/m³	Cr g/m³	Cu g/m³	Pb g/m³	Ni g/m³	Zn g/m³	C7-C9 g/m³	C10-C14 g/m³	C15-C36 g/m³	Total Hydro carbons (C7-C36) g/m³
17/01/2024	Mud sump waste	7.5	<0.021	<0.0011	<0.011	<0.011	0.0029	<0.011	0.048	1	11.7	3	16
8/03/2024	Grease Trap	4.7	<0.021	<0.0011	<0.011	1.08	0.0041	<0.011	0.143	<0.5	<1.0	12	13
20/03/2024	Mud sump waste	11	0.073	0.0077	0.109	0.57	0.26	0.141	1.35	<0.5	<1.0	<2	<4

3.3.2 Winery Wastewater

Winery wastewater is untreated and usually comprises of 90% wash water and 10% raw winery wastes. The raw winery waste is passed through basket screens or sieves prior to collection, and the levels are considered to be low.

Eight wastewater samples were taken in the 2023-2024 period, and the average annual values are presented in Table 3.2 below.

Table 3.2: Summary of Winery Wastewater Monitoring Results 2023-2024

Date	pH	TSS g/m³	Ca g/m³	Mg g/m³	K g/m³	Na g/m³	SAR mmol/L	TN g/m³	NO3 + NO2 g/m³	TKN g/m³	DRP g/m³	cBOD₅ g O₂/m³	E. coli cfu/100ml
Avg. 2023-2024	4.79	1500	43	9.7	354	211	7.8	106	0.92	105	8.039	7229	96157

3.4 WAS from Community WWTP

Given the Wanaka WWTP is likely to be the primary source of WAS (and was the reason for investigating the proposed alternative management method), its data and information will be used to describe the WAS characteristics, volumes produced etc.

The Wanaka WWTP is engineered to handle wastewater from both Wanaka and Albert Town, with a daily treatment capacity of up to 12,860 m³. It is also capable of accommodating a peak instantaneous inflow rate of up to 232 L/s.

The WAS produced at the Wanaka WWTP is primarily of domestic origin, with minimal to no input from industrial trade waste. It is derived from the processing of domestic wastewater, and comprises predominantly organic matter, being the remains of the micro-organisms that have digested the wastewater. The WAS includes no recognisable items of sewage or gross solids, as these are screened or broken down and/or removed at the treatment plant. The WAS is thickened using a polyacrylamide flocculent and dewatered by centrifuge to an approximate 18 - 20% dry solid content.

Currently, there is up to 2,000 m^3 per year of WAS (solid waste) from the Wanaka WWTP requiring management.

At present, the WAS is disposed of at Kings Bend Landfill in Southland, which is a 3+ hour drive away. This disposal method is costly, at several hundred dollars per cubic metre, and results in significant greenhouse gas emissions from large transport distances. Additionally, it consumes valuable landfill space. As such, the current approach is neither environmentally sustainable nor economically feasible for the community to continue with long-term.

Figure 3.1 below demonstrates how WAS can be managed in a more sustainable way by applying to land, and is the proposed management at the subject site.

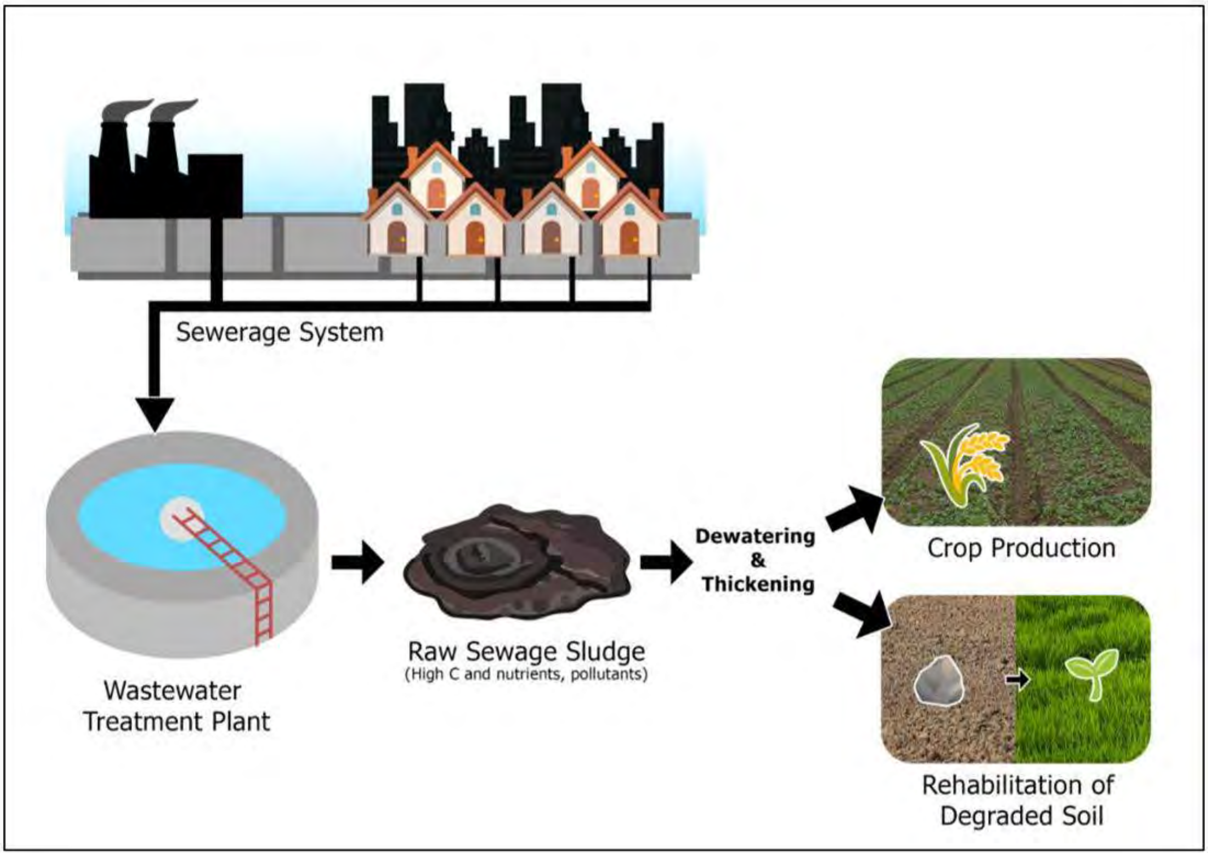

Figure 3.1: Flow Diagram of WAS Source to Discharge

It is proposed that the WAS be applied fresh and directly incorporated into the land with no storage required. Fresh WAS tends to be in an aerobic form, higher in organic matter and nitrogen, and these components appear to dilute the other nutrients.

The WAS is similar to a bio-solid and is the precursor biosolid input product. However, without stabilisation it does not meet the strict definition of a bio-solid as outlined in the Guideline for Beneficial Use of Biosolids on Land (Water NZ, 2025). However, with appropriate handling and soil incorporation, it can be safely and beneficially used as a soil amendment and fertiliser.

WAS from the Wanaka WWTP was analysed from samples taken between March and November 2009, for the purpose of informing a consent application to Otago Regional Council for the then-proposed discharge of WAS to land at Tarras ("Project Pure"). Those analysis results are considered representative of the WAS. The WAS composition is outlined in Table 3.3 below and have been compared to the Water NZ, 2025 Biosolid guideline values. The WAS prior to stabilisation is high in bacteria and historically has had elevated copper and zinc. These elevated contaminants can be managed sustainably with soil incorporation. The appropriate handling and soil incorporation is a well-established way of making the WAS safe. This is the same way "B" grade biosolids have been treated in the past.

It is to be noted that the composition of sludge was tested in 2009 and recently in June 2025 (Appendix D). The AEE has been prepared based on 2009 report before the sludge test results arrived at the end of June 2025. The N concentration is same in two results of sludge samples on which the sludge application rate is calculated. The other elements concentration slightly increased or decreased which is very common for any environmental samples and do not pose any significant variation in AEE. The recent sampling supports that the sludge is relatively stable organically with a reduction in most heavy metals.

Table 3.3: WAS Composition Compared to the Guideline for Beneficial Use of Biosolids on Land 2025

Parameter	WAS Composition 2009	WAS Composition June 2025	Grade 1 Limit (Biosolid Guideline 2025)
Nutrients (% w/w)			
pH	-	6.85	
Nitrogen	6.6	6.6	No criteria to be met
Phosphorus	1.3	1.55	
Sulphur	0.49	0.54	
Calcium	0.97	0.72	
Magnesium	0.6	0.37	
Potassium	0.2	0.58	
Sodium	0.44	0.035	
Pathogens			
E. coli (MPN/100 mL)	650,000	-	<100
Campylobacter	-	-	<1/25 g
Salmonella	-	-	< 2 MPN/g
Human Adenovirus	-	-	<1 PFU/0.25 g
Helminth Ova	-	-	<1/4g
Trace Elements (mg/kg)			
Arsenic	4.5	8	30
Cadmium	1.4	0.73	6.5
Chromium	15	14	1500
Copper	215	122	750
Lead	15	8.5	300
Mercury	1.23	0.31	7.5
Nickel	13	10	135
Zinc	455	280	1250

In comparison to guideline limits for chemical contaminants, the results given in Table 3.3 demonstrate that the WAS generally complies with the "Contaminant Grade 1".

With regard to the stabilisation grade requirements, the results in the table above show that the WAS exceeds the pathogen limit for *E. coli*, therefore does not achieve the "A" grading for biosolids. In addition, WAS direct ex-plant has not undergone a stabilisation process as prescribed in the guidelines and therefore does not achieve the "B" grade for biosolids. For this reason, it is described as sludge rather than as biosolids.

3.5 Land Application Area

The proposed land application area site has the legal description Section 25 and Section 47 Block V Lauder Survey District, and Section 20 Block V Lauder Survey District at approximately NZTM2000 E1336545, N5011220. The land application areas suitable for the application of WAS and waste from grease taps, mud tanks/sumps and winery waste have been shown in Figure 3.2 below.

Separation distances are used to assist with minimising the risks to sensitive receptors. The following minimum setbacks from the application areas will be maintained:

- 200 m from any residential dwelling
- 50 m from any surface water body
- 20 m from any storage pond
- 20 m from the road
- 10 m from the property boundary
- 5 m from irrigation races

Additionally, land areas with steeper slopes have been excluded with setbacks, as these are mostly associated with the banks of the surface watercourses.

The total available land application area (LAA) is 178.57 ha (Table 3.4). As shown in Figure 3.2, separate LAAs will be designated for different waste types. A total area of 170.75 ha has been allocated for WAS, and 7.82 ha for winery wastewater, grease trap waste, and mud tank/sump waste.

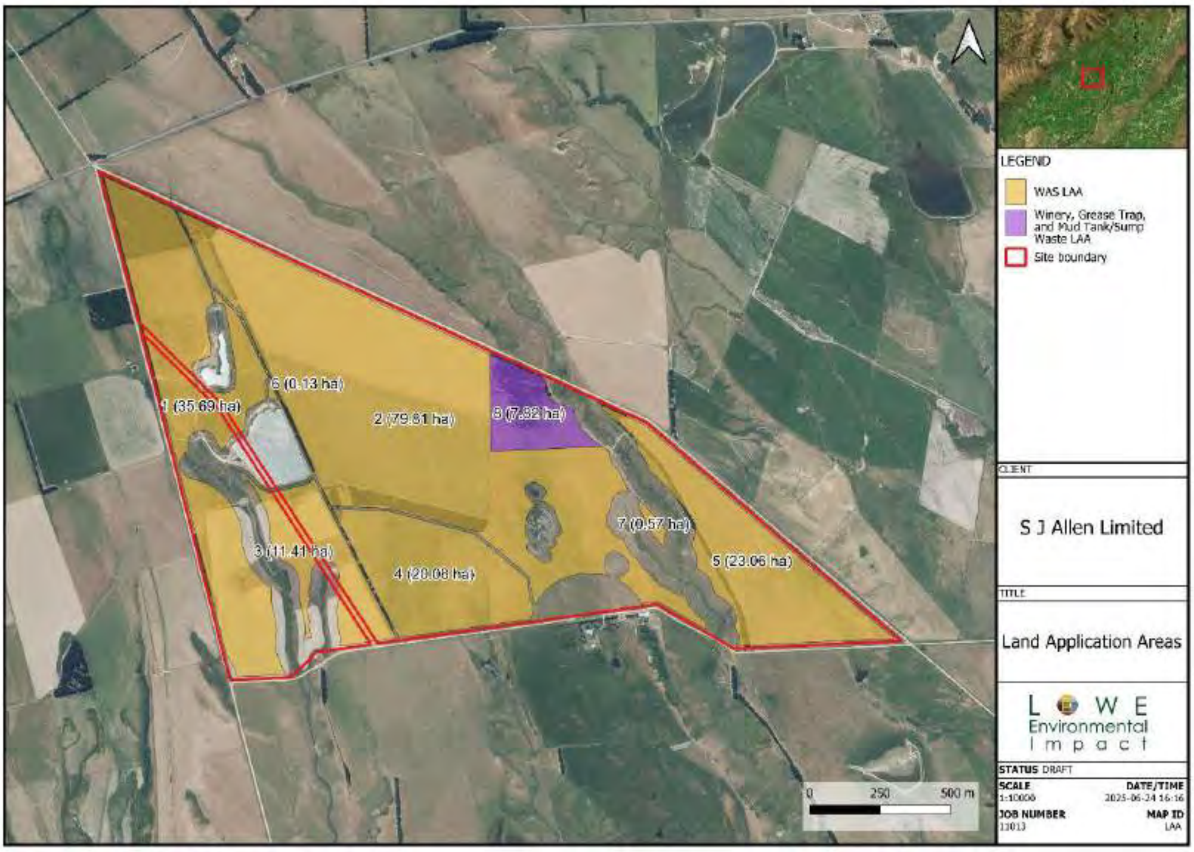

Figure 3.2: Land Application Areas

Table 3.4: Land Application Areas

Application Area Number	Application Area (ha)
1	35.69
2	79.81
3	11.41
4	20.08
5	23.06
6	0.13
7	0.57
8	7.82
Total	**178.57**

Testing of heavy metals at the site confirmed that none of the trace elements/heavy metals exceed the ecological soil guideline values (Table 3.5) for different land uses in NZ soils, as advised by Landcare Research (Cavanagh, 2016).

Table 3.5: Eco-Guideline Soil Limit mg/kg (dry weight) of Trace Elements/Heavy Metals (Cavanagh, 2016)

Contaminant's (Trace Elements/Heavy Metals) Name	Eco-Guidelines Soil Limit, mg/kg (dry weight) (Cavanagh, 2016)
Arsenic (As)	17
Cadmium (Cd)	0.8
Chromium (Cr)	200
Copper (Cu)	95
Lead (Pb)	160
Mercury (Hg)	1
Nickel (Ni)	60
Zinc (Zn)	180

3.6 New Zealand Biosolid Guideline 2025

Guidelines for Beneficial Use of Biosolids on Land, 2025 was published in March 2025. This Guide outlines the decision making and risk management processes that enable practitioners to select and manage the application of biosolids to land.

The Guide supersedes Guidelines for the Safe Application of Biosolids to Land in New Zealand, 2003 and its reference in NZS 4454:2005, Composts, Soil Conditioners and Mulches.

The proposal will be undertaken in general accordance with the new guidelines.

3.6.1 Stabilisation Grade Requirement 1, Vector Attraction Reduction Processes According to 2025 Guide

Vectors such as flies, mosquitoes, birds and rodents are potential carriers of disease. They can transmit pathogens to humans and other living hosts physically, through contact, or biologically, by playing a specific role in the lifecycle of the pathogen. Reduction of the attractiveness of organic products to vectors reduces their potential for transmitting diseases. This process is known as vector attraction reduction (VAR). According to the Guideline the

WAS needs to go through a vector attraction reduction process as mentioned in Table 3.6 below.

Table 3.6: Vector Attraction Reduction Methods (Table 2 in the Guide)

Vector Attraction Reduction Methods	Organic Materials Suited to These Methods
Reduction of the mass of volatile solids by >38%	Anaerobically or aerobically digested sludge
Drying to ≥ 75% dry solids by weight	Aerobically or anaerobically digested sludge
Heating at temperatures greater than 80°C to achieve a minimum dry solid content of 90% by weight	Heat dried unstabilised slurry or sludge
Maintaining >40°C for a minimum of 14 days, with an average minimum temperature of 45°C or greater	Compost products
Not exceeding a maximum SOUR at 20°C of 1.5 g/hr/m³	Liquid sludge from aerobic processes operating at 10–30°C and ≤2% dry solids
Maintain a pH ≥12 at 25°C, >2 hours and without further alkali addition a pH ≥11.5 for an additional 22 hours	Alkali amended product
Drying to ≥75% solids	Stabilised, anaerobically or aerobically digested sludge
Drying to ≥90% solids	Heat dried unstabilised sludge
Soil incorporation is undertaken as soon as practicable and within at least 24 hours of the product discharge	**Partially stabilised or unstabilised slurries or sludges**
On a surface disposal site, covering with soil or other material at the end of each working day	Sludge placed on a surface disposal site

For the proposed on-site WAS management in Lauder, the WAS incorporation will be undertaken within 24 hours following the instruction (Table 3.6) as given in the Guideline for Beneficial Use of Biosolids on Land, 2025 (Table 2 in the Guide).

The total area required at 200, 400 & 600 kg N/ha application rate has been given in Table 3.7 below:

Table 3.7: Area Required at 200, 400 & 600 kg N/ha

Parameters	N Application rate kg N/ha		
	200	**400**	**600**
N (kg)/ dry ton	66	66	66
N (kg)/wet ton	13.2	13.2	13.2
Wet Ton applied per ha	15.2	30.3	45.5
Ha/yr needed for QLDC and CDC (2,500 m³ wet thick WAS)	165	82.5	55
Ha/wk required	3.17	1.6	1.1
Ha/day required	0.45	0.23	0.15
Return period to achieve 200 kg N/ha/yr	1	2	3

The applicant seeks consent to apply WAS at a 600 kg N Loading rate equivalent/ha per three-year period. After three years, the WAS will be applied again at the same rate. The assimilation capability of the soils in the area has been discussed in the Assessments of Environmental Effects, Section 8 of this application.

3.7 Method of Discharge

3.7.1 WAS Application Method

WAS can be applied to land as a beneficial agronomical "fertiliser" substitute. The following factors were taken into account when selecting a suitable discharge area and application method:

- Area (ha) of land available
- Distance from the WWTP site
- Proximity to waterbodies
- Slope
- Accessibility
- Other land use(s)

The WAS will be applied to the land surface using a muck spreader or similar. To minimise effects on the environment, the nitrogen loading rate is expected to be up to 600 kg N/ha, with a return period of 3-years. The aim would be to discharge up to 50 m^3 of WAS each week, requiring approximately 0.5-1 ha of land application area. To allow for this volume, and a return period of 3-years, a land are of 132 ha is required and will to be split up into different management blocks. As detailed in Section 3.5 above, a total area of 170.75 ha has been allocated for WAS.

The proposed management regime of the land application area is to sow a catch crop regularly after applying the WAS (generally within 1 month of the WAS application except during winter when the land would remain cultivated but fallow until spring planting).

The WAS area would be planted with a crop like Oats, Ryecorn or Triticale, given these crops can generally be sown in Autumn, Spring and Summer. These fast-growing catch-crops will uptake nutrients i.e., nitrogen from the WAS, ultimately minimising nutrient loss to waterbodies via leaching.

In years 2 and 3, the areas would be managed as rotational grass with grazing by sheep or silage made, before being suitable to receive the WAS discharge again. This 3-year rotation of each block will minimise effects of the WAS discharge on the environment i.e., water quality. A generic diagram of the intended management is shown in Figure 3.3 below. This diagram will be refined prior to lodgement of the consent application.

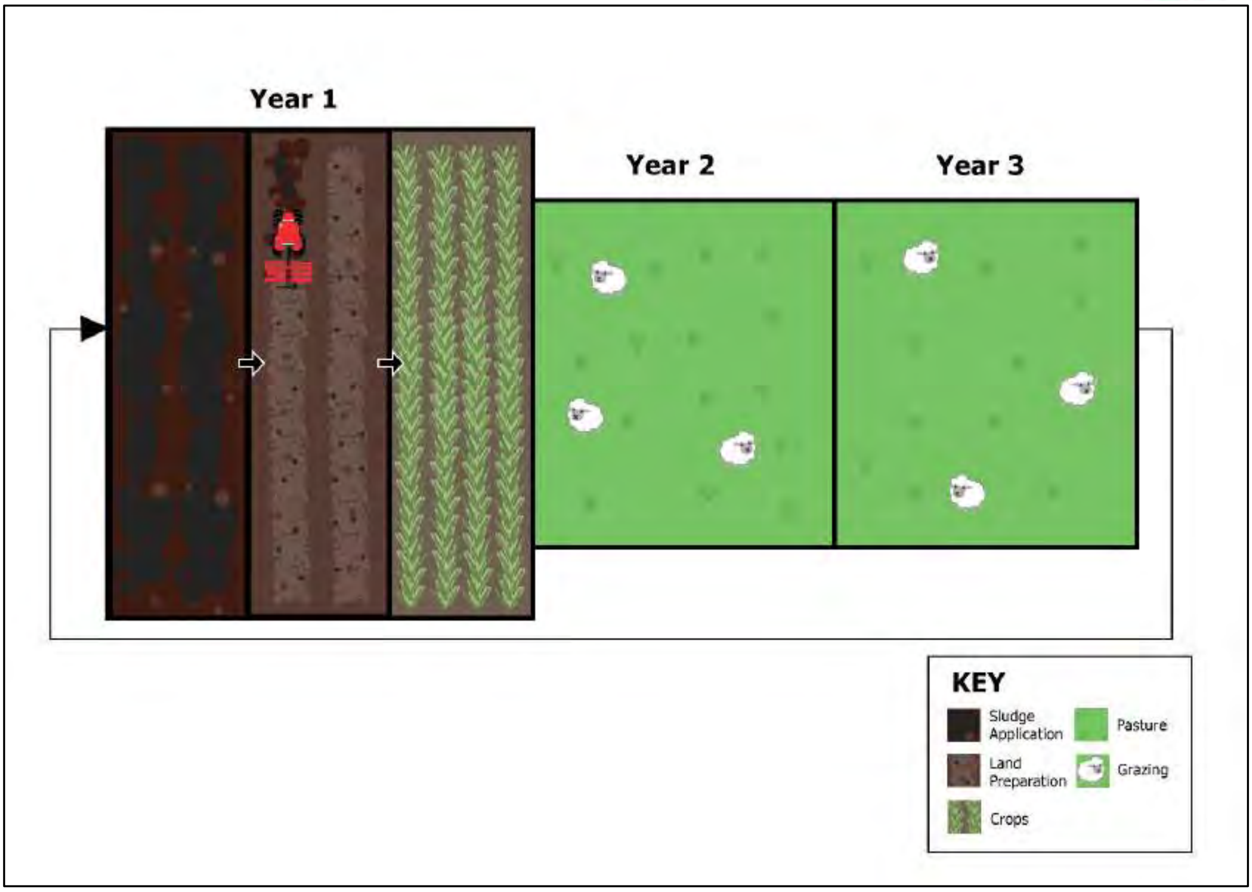

Figure 3.3: 3-year Rotational Management Plan

The WAS would be transported from a WWTP in self-levelling, covered bins containing 20% dry solids. There will not be any uncovered storage on-site, but the covered bins could sometimes remain on-site for a week if conditions aren't suitable for discharge.

The proposed management of WAS is not the sole option. The WAS can continue to be taken to landfill, if necessary, but the aim would be to discharge to land as a preference, and utilise the landfill as back-up only i.e., during periods when application is restricted due to heavy and persistent rainfall. Having multiple options will ensure best practice management of the WAS, increased efficiency and reduced costs.

3.7.2 Winery Wastewater Application Method

Winery wastewater will be applied at a rate as currently authorised at McArthur Road under Consent RM20.287.01.V1. The discharge of winery wastewater will occur directly from the vacuum tanker truck. The truck has a 2.4 m length spreader bar that has a 25 mm continuous slot, 300 mm above the ground which sprays at a rate of 15 litres per second to the soil surface. The wastewater would be applied over approximately 150 m lengths, and 2.4 m width strips (360 m^2) until the land application area is completely covered, then the next set of applications occur at 90 degrees to the earlier zone. The truck drives along the strip, spraying the waste until the truck's tank is empty. For each disposal event, a separate strip is used, and the truck's GPS system ensures this occurs.

As the typical disposal volume is 4,000 L, this results in an 11.1 mm application per disposal event over the 360 m^2 area. A larger tanker load would use multiple 150 m strips.

3.7.3 Mud Tank and Grease Trap Waste

Consent is sought for two different methods of application for the mud tank and grease trap waste: soakage trenches and soil injection.

The most appropriate discharge method for grease trap and mud tank waste is into land through soakage trenches and/or soil injection, as described in Section 6.2. The dimensions of trenches will be in the order of 1 – 2 m wide, 1.5 - 2 m deep and up to 150 m long.

Initially, the operation of the trenches will be to leave them open following the discharge. The general order will be grease trap waste put on the trench bottom, then the next load of mud sump waste will be put over it. This will continue until the trenches are within 200 mm of the surface and then they will be capped with material removed from the trench. Should odour from the grease trap waste be observed and considered a nuisance, (this is not considered likely as it will not be disturbed), then some excavated material will be put over the grease trap waste following discharge.

The Applicant wishes to have flexibility to discharge via soil injection as an alternative method. Soil injection is considered a risk management tool for pastoral land and is useful for soil incorporation of wastes. Soil injection involves directly applying the waste below the soil surface using specialised equipment. It can reduce exposure to pathogens, reduce the uptake of contaminants by grazing animals and transfer to the human food chain, remove vector access to pathogens, maximise dilution and dispersal of contaminants, and enhance immobilisation reaction in soil and minimise losses after application from wind blow or surface run-off and effects on non-target areas.

For soil injection, as the typical disposal volume for grease trap and mud sump waste is up to 20 m^3/day or 2,400 m^3/year, the depth of injection per application will be in the order of 20 mm.

As described in Section 3.5 above, a 7.82 ha land application area has been allocated for the application of winery wastewater, grease trap, and mud tank/sump waste.

4 RESEARCH COLLABORATION WITH UNIVERSITY OF CANTERBURY

A research collaboration has been established between scientists from the University of Canterbury, S J Allen and LEI at this site to monitor the effects of land application of WAS. It is planned that a PhD student could undertake monitoring these effects.

The PhD supervisors will be Dr. Maria J Gutierrez Gines and Professor Brett Robinson.

The Title of the PhD will be "*Attenuation of Pathogens and Nutrients in Sewage WAS-Amended Soil using novel Land Application Techniques*".

5 CONSULTATION

In the pre-application stage, the Applicant acknowledges the importance of considering parties which could be affected by the proposal, or that would have a particular interest in the activities and/or location.

5.1 Aukaha on behalf of kā Rūnaka

The Applicant has been proactive in engaging with iwi early, given the novel nature of the proposed WAS management. LEI first discussed this proposal with Aukaha in September 2024. Aukaha sent a summary of the activities and location to kā Rūnaka in October 2024 and the feedback received was that they were in agreement that the subject site appeared suitable to receive WAS from a cultural perspective. Contact was made again in May 2025 in preparation for consent lodgement.

Aukaha commented that it was a "really promising option from a mana whenua perspective to utilise a site such as the one that was considered earlier for WAS management" and that once the draft application is complete they can share this with kā Rūnaka for their final feedback.

LEI sent the draft consent application to Aukaha on 26 June 2025. The following feedback was received:

- All Rūnaka responses <u>support</u> the project provided that they be granted access to the monitoring data from Year 1 of the consent being exercised, to fully understand the effects and to retain the ability to raise concerns based on impacts on cultural values, and help refine methodology for the following years if required.

- To this effect, they've requested a condition be included on the consent along the following lines: *'that the monitoring results of the trial are shared with Rūnaka for feedback. If after the trial period, the monitoring results show the discharge of waste products has adverse effects on the receiving environment which are greater than predicted, or unforeseen, by the application, the consent holder shall either revise the operations and management plan in consultation with mana whenua and the Otago Regional Council or through another process mutually agreed with mana whenua and the Otago Regional Council in order to remediate these effects. The timeframe for any required remediation will be set during the consultation process'.* This is reflected in proposed condition 19 outlined in Section 9 of this report.

Kā Rūnaka have provided their written approval to the proposed activities, and this is attached as Appendix E.

5.2 Landowner

The Applicant also provided a copy of the draft consent application to the current landowners; Michael James Moran, Abby Kate Moran and Moran Pastoral Ltd. They provided their written approval to the application, and this is attached as Appendix F. It is also worth noting that SJ Allen (the Applicant) is in the process of purchasing this property, subject to this consent being granted.

There is not considered to be any consultation required with any other parties.

6 CONSIDERATION OF ALTERNATIVES

6.1 Assessment of Alternatives for Waste Activate Sludge

The primary alternative option to the proposed WAS management is to continue the status quo of sending the waste to landfill. However, as discussed this is a significant financial investment and does not utilise the potential of WAS for beneficial reuse as a fertiliser and soil conditioner. Other alternative options that were considered with the proposal to discharge to land include the site location and the discharge methods.

6.1.1 Site location

Consideration was given to what site would be considered suitable for the proposed WAS discharge. The requirements included:

- Flat, or at least easy graded land, to ensure no run-off of applied material from the application site;
- A large enough area of suitable land to safely receive a substantial portion of the WAS/biosolids generated; and
- A farming (or other land use) operation that will not be compromised by public or market perceptions of the use of sewage-derived material as fertiliser.

SJA has selected a property that meets all three of these criteria for WAS application to land.

6.1.2 Land Discharge Rate Options

There is a spectrum of possibilities for the rate at which WAS may be most efficaciously applied to productive land.

- The material may be applied very sparsely, thereby having no effect on the environment, and likewise delivering no measurable productive benefit.
- It may be applied thickly, maximising the nutrient application rate to a minimised land area. However, beyond a certain level, the application of further nutrient does not enhance agricultural productivity, and the likelihood of adverse effects on the receiving environment through leaching of nutrients surplus to plant requirements is increased.
- A balance can be found between a high enough WAS application rate to generate worthwhile productive enhancement, and a low enough application rate to limit environmental effects to not greater than minor. Past investigations have shown that about 33% of the Nitrogen is bioavailable in any one year, so the application rate of 600 kg N/ha/yr is designed to ensure no environmental effects.

6.2 Assessment of Alternatives for Grease Trap and Mud Tank/ Sump Waste and Winery Wastewater

The following alternatives have been considered for grease trap and mud tank/sump waste and winery wastewater:

(i) Discharge all wastes into trenches;
(ii) Discharge all wastes onto land via the spreader bar;
(iii) Discharge the grease trap and mud sump waste via soil injection; and
(iv)Truck the winery wastes to district council WWTP facilities.

6.2.1 Discharge all Wastes into Trenches

An option of conventional soakage contour trenches is suitable for all wastes. Soakage contour trenches are either natural material or lined with free draining gravel and are a method of landfilling the three wastes. This kind of system should only be installed in free or moderate draining soils. As wastes are discharged from the tanker, free draining liquids drain through surrounding soils while the solids are filtered and retained.

The discharge method considered most appropriate for grease trap and mud tank/sump waste is into the land through trenches.

However, it is not considered the most suitable option for winery wastewater. In particular, winery wastewater has a higher Nitrogen content which increases leaching potential to groundwater without further treatment. Therefore, winery wastewater is more suitably applied to the land surface (as proposed) and will be beneficial for pasture growth whilst the grease trap and mud tank/sump waste will be managed separately via trenches (and/or soil injection). The dimensions of trenches are estimated as shown in Figure 6.1. In practice, the trench's width can be up to 2.5m wide and 2 m deep, depending on the operator and equipment used.

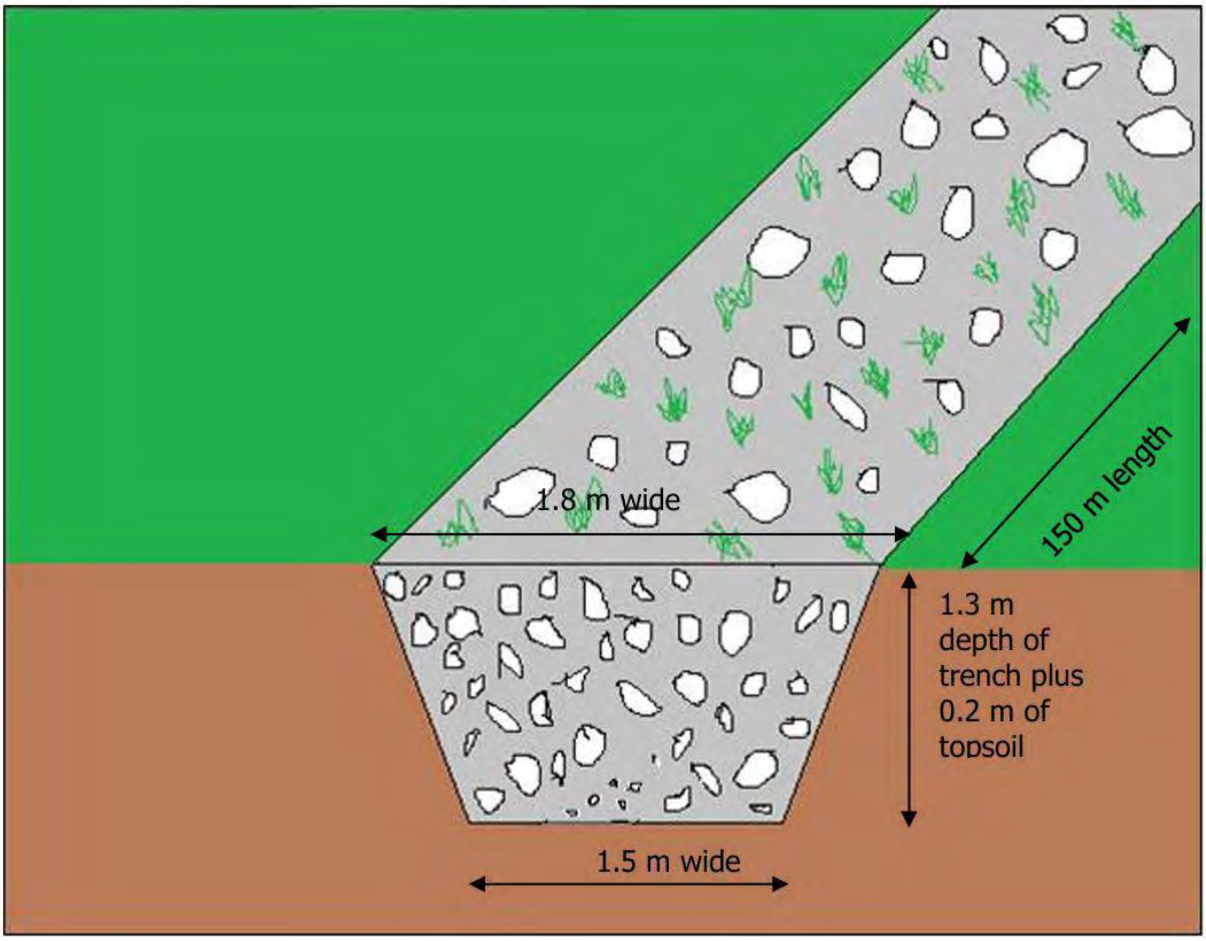

Figure 6.1: Estimated Trench Dimensions

Initially, the operation of the trenches will be to leave them open following the discharge. The general order will be grease trap waste put on the trench bottom, then the next load of mud tank/sump waste will be put over it. This will continue until the trenches are within 200 mm of the surface and then they will be capped with material removed from the trench. Should odour from the grease trap waste be observed, and this is not considered likely as it will not be disturbed, then some excavated material will be put over it following discharge.

6.2.2 Discharge all Wastes via Spreader Bar

All types of waste can be applied to the land by spreader bar. This has been the historical practice at previous sites, direct from the applicant's vacuum tanker truck. The method has been described as for winery waste in sections above.

However, this kind of discharge activity for grease trap/mud tank waste (high concentration of solids) may have a risk of odour as well as a risk of soil pore blockage, resulting in runoff. Due to this, the surface spreader technique is only proposed to discharge winery wastewater on land, as described in sections above.

6.2.3 Discharge all Wastes via Soil Injection

Another method of applying wastes to land is soil injection. Soil injection is an option that the applicant is interested in utilising. This will require purchasing and trialling a tractor and injector system, as well as a loading system. It is possible that all wastes could be soil injected but this would be a waste of the nutrients in the winery wastewater so is proposed to only be used for the grease trap and mud tank/sump waste streams.

6.2.4 Truck Waste/Wastewater to District Council Municipal WWTPs

Another alternative is to truck wastes to the District Council Municipal WWTP. However, Councils are not keen on receiving grease trap waste due to impacts on their WWTP.

6.2.5 Best practicable option(s) for Grease Trap and Mud Tank/Sump Waste and Winery Wastewater

The applicant has adopted land application/treatment for winery waste and two options for the grease trap and mud tank/sump waste - trenches and soil injection.

7 STATUTORY FRAMEWORK

7.1 Introduction

Consent is sought for the discharge of WAS and wastewater onto land to manage WAS from community WWTPs, grease trap waste, mud tank/sump waste and winery wastewater collected throughout the Otago region.

The Resource Management Act (RMA) 1991 sets out a statutory framework for consideration of resource consent applications which includes National Environmental Standards, National Policy Statements, Regional Policy Statements and Regional and District Plans. An assessment of the proposed activity against the RMA and relevant standards, statements, policies and plans are given below.

The Otago Regional Policy Statement (ORPS) is the dominant regional planning policy document for the Otago Region. It became operative on 01 October 1998 and is currently in the process of being reviewed. An assessment of the objectives and policies of the ORPS will be provided later in this application document.

The relevant operative regional plans are the Regional Plan: Water for Otago (ORPW) and the Regional Plan: Air for Otago (ORPA). These two regional plans include the rules governing the discharges of contaminants into water or air and will be discussed further below.

In addition to these regional documents, the National Environmental Standards (NES) for Sources of Human Drinking Water Regulations 2007, the National Environmental Standard for Air Quality Regulations 2004, the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations 2011, and the National Environmental Standards for Freshwater Regulations 2020 have been considered.

7.2 National Environmental Standards

7.2.1 NES for Air Quality

The NES for Air Quality includes standards governing ambient air quality, via the imposition of standards for five priority air pollutants (fine particles (PM10), sulphur dioxide, ozone, carbon monoxide, nitrogen dioxide). The standards apply in open air everywhere where people may be exposed in all regions of New Zealand. They do not apply to sites to which resource consents apply, to indoor air or air in tunnels.

The NES also requires air shed definition. ORC has gazetted defined air sheds within the Otago Region. The land application areas and site lie within Air Zone 3 and is not within an identified air shed.

There is potential for sulphur dioxide and nitrogen dioxide emissions from the WAS, therefore, Regulations 20 and 21 are relevant to the activity.

Regulation 20 (2) states a consent authority must decline an application for a resource consent to discharge oxides of nitrogen or volatile organic compounds into air if the discharge to be expressly allowed by the resource consent –

(a) is likely, at any time, to cause the concentration of nitrogen dioxide or ozone in the airshed to breach its ambient air quality standard; and

(b) is likely to be a principal source of oxides of nitrogen or volatile organic compounds in the airshed.

The proposed application of WAS, winery wastewater, grease trap and mud tank/sump waste will not result in gaseous emissions to air. These materials will be applied directly to soil, where they will be effectively absorbed and integrated into the soil matrix.

Within the soil environment, microbial processes will facilitate the transformation of nitrogen and sulphur compounds into their stable inorganic forms—primarily nitrate (NO_3^-) and sulphate (SO_4^{2-}). A portion of the nitrogen and sulphur will remain in organic forms, contributing to long-term soil fertility.

The generated nitrate and sulphate ions will either be taken up by plants as essential nutrients or retained in the soil through anion exchange mechanisms and adsorption to mineral surfaces and soil organic matter. These natural soil processes ensure minimal risk of volatilisation or gaseous losses.

As such, there will be no appreciable emission of nitrogen oxides or sulphur dioxide associated with this activity. Any trace emissions will be consistent with typical background levels observed in standard agricultural practices where composts or organic fertilisers are applied. Therefore, the proposed application is not expected to contribute to air quality degradation under the NES for Air Quality.

Given that the discharge will not breach the ambient air quality standards, a discharge consent is not precluded from being granted.

7.2.2 NES for Sources of Human Drinking Water

The NES for Sources of Human Drinking Water includes standards governing monitoring of water supplies and protection of abstraction points, water treatment plants and distribution networks. These standards tie in closely with the Drinking Water Standards for New Zealand.

Regulations 7 and 8 apply to an activity that has the potential to affect a registered drinking-water supply that provides no fewer than 501 people with drinking water for not less than 60 days each calendar year.

There are no registered drinking water supplies that provide 501+ people with drinking water within 5 kilometres of the site. There will not be any effects on any registered drinking water supply and therefore regulations 7 and 8 do not apply.

7.2.3 NES for Assessing and Managing Contaminants in Soil to Protect Human Health

The NES for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 applies when a person wants to do an activity described in any of subclauses (2) to (6) on a piece of land described in subclause (7) or (8).

The proposed activity in this application is for the discharge of WAS and wastewater to land, which does not fall within any of the activities described in subclauses (2) to (6).

The site is not listed on the ORC Listed Land Use Register. Notwithstanding that mining operations have previously occurred at the site, which is described in the Hazardous Activities and Industries List (HAIL), the site will remain in production land and the proposed activity in this application is not listed in in subclause (8) (a) to (d). Therefore, the regulations do not apply.

7.2.4 National Environmental Standards for Freshwater 2020 (NES-FW)

Part 2 of the NES-FW regulates farming activities such as feedlots and stockholding areas, as well as use of synthetic nitrogen fertiliser. Part 3 regulates various activities that relate to freshwater including activities that will change the hydrological function or water levels of a natural inland wetland.

The wetland on the subject site is considered ephemeral in nature, but because no formal wetland delineation assessment has been undertaken, we've considered whether the natural inland wetland rules of the NES-FW may apply on a precautionary basis.

Regulation 54 states it is a non-complying activity to discharge water into water within, or within a 100 m setback from a natural inland wetland if-

(i) there is a hydrological connection between the discharge and the wetland; and
(ii) the discharge will enter the wetland; and
(iii) the discharge will change, or is likely to change, the water level range or hydrological function of the wetland.

The proposal is not to discharge water, rather it is to discharge contaminants and/or solid wastes. The proposed discharges will be 20 metres setback from the wetland, any contaminants are unlikely to enter the wetland, but even if they did, they would not have any effect on the water level range or hydrological function of the wetland. Therefore, this regulation does not apply, and there are no other relevant rules in the NES-FW for this activity.

7.3 Otago Regional Plans

The Operative Regional Plan for water quality and air quality in the Otago Region is the Otago Regional Plan: Water (ORPW) and the Regional Plan: Air for Otago (ORPA) respectively.

7.3.1 Regional Plan: Water for Otago

The purpose of the ORPW is to provide a framework for the integrated and sustainable management of Otago's water resources.

The relevant sections are **Section 12.A** – Discharge of human sewage and **Section 12.B** - Discharge from industrial or trade premises.

Rule 12.A.A.1 states:

"The discharge rules in section 12.A apply where a discharge contains human sewage"

The WAS contains human sewage and therefore Section 12.A applies. There are no permitted activity rules which are applicable under 12.A for the discharge of WAS from a community WWTP.

Rule 12.A.2.1 states:

*"Except as provided for by Rules 12.A.1.1 to 12.A.1.4, the discharge of human sewage to water, or onto or into land in circumstances where it may enter water, is a **discretionary** activity."*

The discharge of WAS onto land from community WWTPs is therefore deemed to be a **discretionary** activity.

Rule 12.B.A.2 *also specifies that the discharge rules in section 12.A apply in addition to 12.B where a discharge contains human sewage.*

Rule 12.B.4.1 states:
*"The discharge of water (excluding stormwater) or any contaminant from an industrial or trade premises or a consented dam to water or to land is a **discretionary** activity, unless it is permitted by Rule 12.B.1.6, 12.B.1.7, 12.B.1.10 or 12.B.1.11."*

The proposed discharge of grease trap and mud tank/sump waste and winery wastewater contain contaminants from an industrial or trade premise. It is therefore deemed to be a **discretionary activity** under Rule 12.B.4.1.

Overall, all discharges proposed are **discretionary** activities under Rule 12.A.2.1 and Rule 12.B.4.1.

7.3.2 Regional Plan: Air for Otago

The purpose of the ORPA is to seek the avoidance, remediation, or mitigation of adverse effects resulting from discharges of contaminants into air.

Rule 16.3.7 – Waste Management

Table 7.1 provides an assessment against the relevant rule.

Table 7.1: Assessment of Waste Management Rule 16.3.7.1 (ORPA)

Condition	Description	Assessment
Rule 16.3.7.1	The discharge of contaminants into air from the storage, transfer, treatment or disposal (including land application of treated effluent and sludge, but excluding the burning of sludge and associated solids) of liquid-borne municipal, industrial or trade waste, where the influent liquid waste does not exceed a BOD_5 of 850 kg per day; is a ***permitted activity***, providing:	**Complies.**
(a)	Ponds constructed after 1 January 2002 are located at least 150 metres from the closest part of the boundary of the property; and	**N/a.** No ponds are to be constructed.
(b)	Land application does not occur within:	
(i)	150 metres from any residential dwelling on a neighbouring property or from a building used for employment purposes on a neighbouring property; and	**Complies.** The nearest residential dwelling is > 150 metres from the land application areas.
(ii)	20 metres from a formed public road; and	**Complies.** The land application areas are > 20 metres from public roads.
(iii)	150 metres from any public amenity area or place of public assembly, excluding formed public roads, and	**Complies.** There is no amenity area or public assembly within close proximity.
(c)	Any discharge of odour, particulate matter, droplets or gases is not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.	**Complies.** The application of WAS, wastes and winery wastewater to land will not result in any discharge of odour, particulate matter, droplets or gases that would be noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.

The land application of WAS from community WWTPs, grease trap, mud tank/sump waste and winery wastewater complies with all conditions of Rule 16.3.7.1 and therefore is considered a **permitted activity.**

7.3.3 Conclusion

The discharge of WAS onto land is considered a **discretionary activity** pursuant to the Otago Regional Plan: Water under Rules 12.A.2.1 and 12.B.4.1.

The discharges of grease trap, mud tank/sump waste and winery wastewater are considered a **discretionary activity** pursuant to the Otago Regional Plan: Water under Rule 12.B.4.1.

The associated discharge of contaminants to air is considered a **permitted activity** pursuant to the Otago Regional Plan: Air, Rule 16.3.7.1.

8 ASSESSMENT OF ENVIRONMENTAL EFFECTS (AEE)

8.1 Overview

This assessment of environmental effects has been prepared in accordance with the requirements of Section 104 and the Fourth Schedule of the Resource Management Act ("the Act"). Section 104 requires an application for resource consent to include an assessment of environmental effects in such detail that corresponds with the scale and significance of the effects the activity may have on the environment.

The potential adverse effects that may arise from the proposed discharges to land are:

- Effects on soils and plants;
- Effects of ground and surface water quality;
- Effects on ecology;
- Climate change effects;
- Effects on existing water takes;
- Effects on amenity values;
- Effects on public and community;
- Effects on cultural values; and
- Cumulative effects.

This Assessment of Environmental Effects (AEE) includes an evaluation of the land application of WAS, winery wastewater, grease trap waste, and mud tank /sump waste. The WAS and winery waste are similar in nature, both contributing organic matter and essential plant nutrients (e.g. nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur) to the soil.

In contrast, grease trap and mud sump wastes contain substantially lower concentrations of these chemical constituents compared to WAS, with the exception of Total Petroleum Hydrocarbons (TPH, C7–C36). However, the concentrations of TPH in these wastes are significantly below the guideline values specified by the Ministry for the Environment (MfE, 2011) – specifically, those outlined in Table 4.20 of the guidelines (Module 4, page 68), which detail soil acceptance criteria for the protection of groundwater quality.

As such, the environmental impacts of grease trap and mud sump waste are expected to be much less significant than any potential effects of the WAS. Accordingly, the following subsections focus primarily on assessing the environmental effects associated with WAS application.

8.2 Sensitivity of Receiving Environment

The primary receiving environment for the WAS, winery wastewater, grease trap and mud tank/sump application are soils on the selected site.

Secondary receiving environments are potentially groundwater and surface water in the localities of the site, and air.

Plants, soil, groundwater, surface water, and air are all considered potentially sensitive receptors to the proposed land application of WAS. The discharge will be managed by matching the application rate and designated land area to the site's soil and environmental capacity, ensuring that the frequency, volume, and method of application are carefully controlled to result in effects that are less than minor on the receiving environment.

There are no significant sensitivities anticipated in terms of negative impacts on plant or soil health.

Groundwater sensitivity is primarily linked to the potential for leaching of contaminants through the soil profile. However, WAS, winery waste, grease trap and mud tank/sump waste will be applied in consideration of site-specific soil physical and chemical characteristics—such as permeability, cation exchange capacity, and organic matter content—minimising the risk of downward movement of leachate and effectively reducing the likelihood of groundwater contamination to negligible levels.

Surface water is inherently sensitive to land-based discharges, particularly in relation to nutrient runoff and sediment transport. To address this, the proposal incorporates careful site selection, slope management, and timing of application to avoid periods of heavy rainfall or soil saturation, thereby preventing overland flow to adjacent waterways.

The sensitivity of odour effects primarily depends on odour perception and the distance to potentially affected receptors. The remote location of the site and infrequent (once every three years) WAS application reduce the potential for offensive odour impacts. Any odour emissions are expected to be short-term and localised, and are unlikely to generate nuisance or public concern.

8.3 Consideration of Activities with Comparable Effects

The proposed activity involves the application of a single dose of WAS to a suitable-sized area of land, at a rate of 600 kg total nitrogen per hectare, once every three years, equivalent to 200 kg N/ha/yr. Activities with comparable effects include farm dairy effluent discharge, meat works effluent discharge, whey discharge, and the domestic vegetable garden activities of operating and digging in a compost heap.

These comparable activities all involve equivalent nutrient loadings and rates, potential to emit odours, and potential to contaminate soil, groundwater, and surface water. The only significant points of difference between the proposed activity and these comparable activities is the inclusion of human pathogens and that the comparable activities occur on a continual basis. Another point of difference may also be the potential negative public perception that the wider community might associate with anything involving human sewage and its derived products.

8.4 WAS Properties of Potential Concern

The key properties of the discharge that have the potential to lead to environmental concerns are;

- Nitrogen in its soluble and plant-available form which has the potential to leach into water;
- Phosphorus, which can contaminate streams if it is discharged directly into them or is able to be washed into them with run-off;
- Heavy metals, which may have the potential to contaminate either the application site soils or groundwater and surface water environments;
- Organic contaminants, which may have the potential to contaminate either the application site soils or groundwater and surface water environments;
- Odour, which if it accompanies application could cause nuisance to neighbours; and
- Pathogens, which if passed on through pasture, or run-off might potentially lead to disease outbreaks.

8.5 Effects on Soil and Plants

The application of WAS at a rate designed to supply 600 kg of total nitrogen per hectare as a one-off event every three years (equivalent to 200 kg N/ha/year) is anticipated to promote enhanced vegetative growth and increased biomass production, with no significant phytotoxic or adverse effects expected. This beneficial response is attributable to the gradual release of nutrients, particularly nitrogen, in synchrony with plant demand.

Winery waste is applied at a rate of upto 150 kg N/ha/yr due to its liquid nature.

The potential effects on the receiving soil environment are assessed based on site-specific soil physicochemical characteristics, as determined through comprehensive soil testing undertaken. Parameters such as soil texture, cation exchange capacity, organic matter content, nutrient status, and drainage class have been taken into account to ensure compatibility and environmental safety.

Based on LEI's prior experience with land application of abattoir-derived effluent sludge at annual loading rates of approximately 200 kg total nitrogen per hectare, a single triennial application of 600 kg N/ha is classified as a conservative nitrogen input. This is due to the inherent characteristics of WAS, where nitrogen is predominantly organically bound and must undergo mineralisation before becoming plant-available. Empirical data suggest that only 10–40% of the total nitrogen applied through WAS becomes agronomically available in any given year.

WAS and winery waste functions as a slow-release nutrient source, contrasting with synthetic fertilisers that supply immediately available forms of nitrogen. The organically-bound nitrogen in WAS is relatively immobile within the soil matrix and must be transformed via microbial decomposition and enzymatic processes into mineral forms (e.g., ammonium and nitrate) before uptake by plants. This slow conversion process aligns nutrient release with plant growth cycles, thereby reducing the risk of nutrient losses through leaching and volatilisation.

Nitrogen released from WAS is progressively partitioned across multiple environmental sinks, including microbial assimilation, root uptake, soil adsorption, and gaseous losses through denitrification. The rate-limited transformation and retention mechanisms significantly mitigate the potential for nitrate leaching into underlying groundwater or surface water bodies.

Consequently, the application of WAS under the proposed management regime is expected to provide agronomic benefits while maintaining environmental integrity.

At the proposed once per three years nitrogen loading rate of 600 kg N/ha through WAS application, the corresponding phosphorus (P) loading is estimated 118 kg P/ha in three years' time equivalent to 39 kg P/ha/year. This level of phosphorus input is expected to fully substitute for the site's requirement for synthetic phosphorus fertilisers over the application period. One of the key environmental advantages of utilising biosolids as a phosphorus source is the potential to significantly reduce cadmium (Cd) accumulation in agricultural soils. This is particularly important in the New Zealand context, where long-term use of superphosphate fertilisers—historically derived from Nauru Island phosphate rock—has contributed to elevated cadmium levels in many pastoral soils (Taylor et al., 2010; Kim et al., 2005).

Superphosphate fertilisers are known to contain trace concentrations of cadmium as an impurity, and their continued use can lead to gradual accumulation of this toxic metal in the soil profile. Kim et al. (2005) reported that cadmium levels in agricultural soils across New Zealand are increasing, particularly in intensively farmed regions where phosphate fertiliser use is high. Taylor et al. (2010) further noted that soils under long-term fertilisation regimes with high-P inputs show cadmium concentrations approaching or exceeding guideline thresholds for food safety and environmental protection.

A voluntary limit of 280 mg Cd/kg P has been set by the fertiliser industry for cadmium concentrations in phosphate fertilisers. Between 2003 and 2015, the mean cadmium concentration in fertiliser samples was measured at 184 mg Cd/kg P, which represents 66% of the voluntary limit (Abraham, 2018).

By offsetting the need for conventional phosphorus fertilisers, the application of WAS can interrupt this accumulation pathway. Biosolids used under regulated land application schemes typically contain much lower cadmium concentrations than imported fertiliser-grade phosphate rock, making them a safer alternative with respect to trace metal inputs (Cavanagh, 2016). As such, integrating WAS into nutrient management strategies not only meets crop phosphorus requirements but also aligns with broader goals of reducing heavy metal loading in soils and promoting long-term soil sustainability in New Zealand farming systems.

As with N, the P will be slow release, with typically 21% available and this corresponds to 25 kg P/ha/yr in the first year of three years return period. According to Reed et al. (1988) and Metcalf and Eddy (2007) mineralization of organic matter (e.g. WAS) containing nitrogen in soil takes in a much slower rate than the N fertilizers. The mineralization of organic matter nitrogen is around 30% (Table 8.1) considering the anaerobically digested and composted organic matter in in the environment according to Reed et al. (1988) and Metcalf and Eddy (2007).

Table 8.1: Mineralization Rates of Organic Nitrogen in Wastewater Sludge (Reed et al. (1988) and Metcalf and Eddy (2007))

Time After WAS Application, year+	Mineralization Rate (%)		
	WAS	Anaerobically Digested	Composted
1	40	20	10
2	20	10	5
3	10	5	3
4	5	3	3
5	3	3	3
6	3	3	3
7	3	3	3
8	3	3	3
9	3	3	3
10	3	3	3

Therefore, the applied nutrients will be slowly mineralized and slowly available to plants. This slow mineralization will replace the need for the application of nitrogen fertilizers and P fertilizers in soils.

Appendix C demonstrates that the soils generally have total P and Olsen P value lower than the medium range of 20-50 mg/L. Olsen P is the measure of plant available P. The Olsen P value in the soils imply that plant growth in will be reduced due to the deficiency of P for plants. Phosphorus (P) is an essential macronutrient in soil that plays a critical role in numerous physiological and biochemical processes in plants. It is a key component of nucleic acids (DNA and RNA), adenosine triphosphate (ATP), and phospholipids, all of which are vital for cellular energy transfer, genetic information storage, and membrane integrity. Phosphorus also influences root development, flower and seed formation, and the overall energy metabolism within plant cells. In the soil-plant system, phosphorus is primarily absorbed by plants as orthophosphate ions ($H_2PO_4^-$ and HPO_4^{2-}).

When phosphorus is deficient in soil, plants experience a significant disruption in energy-related metabolic pathways due to insufficient ATP synthesis. This limits the biosynthesis of essential macromolecules and the activation of key enzymes involved in respiration and photosynthesis. As a result, meristematic tissues (regions of active cell division) receive inadequate energy and nucleotide resources, leading to reduced cell division and elongation. Root development is also compromised, resulting in poor nutrient and water uptake.

These physiological limitations manifest as stunted growth, characterized by shortened internodes, delayed maturity, and reduced biomass accumulation. Leaves may develop a dark green to purplish pigmentation due to anthocyanin accumulation, a stress response to impaired phosphate metabolism. In severe cases, overall plant vigour declines, and reproductive development is hindered, ultimately reducing crop yield and quality. The addition of WAS in soil will reduce the need for P fertilizer application in soils to correct the P concentration in soils for optimum plant growth.

The soils chemistry results of total carbon and total nitrogen implies that the % of the parameters are lower than the lower values of optimum levels (Sparling et al., 2008) meaning that the addition of WAS will increase the concentration of carbon and nitrogen in soil that will benefit plant growth. The benefits of the application of WAS on land have been discussed in details in the positive effects Section below.

The proposed discharge to the proposed site is expected to have less than a minor effect on soil and plants.

8.6 Effects on Natural Wetlands

A small natural (ephemeral) wetland is located on the eastern side of the property. Based on historical aerial imagery and seasonal observation (e.g., Google Earth Pro time-series data), this wetland is intermittently saturated, with approximately 80% of its surface area drying during extended dry periods. Adjacent to this is a smaller, secondary wetland feature, which is likely ephemeral, as it appears to desiccate completely during certain times of the year.

Additionally, two constructed (manmade) wetlands are located on the northwestern side of the property, hydraulically connected to a creek approximately 4 km upstream. These wetlands are actively managed via a control valve installed on the creek, which allows water to be diverted or withheld as necessary to maintain wetland levels.

The closest point of the proposal to the natural wetlands is 20 metres from the WAS application area and likely 50+ metres to the applications areas currently proposed for the other discharges. Rule 12.A.1.4 allows for discharges of human sewage as a permitted activity with setbacks of 50m, and Rule 12.C.1.4A allows for discharge of solid animal effluent to land as a permitted activity with a 20-metre setback from regionally significant wetlands. Therefore, these Rules could be inferred as a "permitted baseline", and it is considered that a 20m setback will be sufficient to avoid adverse effects on natural wetlands, particularly as neither of the wetlands on-site are Regionally Significant Wetlands.

In addition to this, the soil characteristics of the proposed application area are assessed to be well-structured, with moderate to high permeability and adequate organic matter content. This will further enhance environmental protection through natural attenuation processes such as:

- Adsorption of nutrients and trace elements;
- Microbial degradation of organic matter; and
- Infiltration and buffering, reducing surface runoff potential.

The application is also subject to seasonal timing controls, which exclude application during periods of saturated soil conditions. This operational constraint will minimise the risk of surface runoff or subsurface leachate movement towards the wetland system.

Given the compliance with the 20-metre setback, the intermittent hydrology of the wetland, and the capacity of the receiving soils to assimilate and recycle nutrients, the potential effects of the proposed land application on natural wetlands will be less than minor.

8.7 Effects on Groundwater and Surface Water Quality

The proposed land application of WAS, mud sump/tank/grease trap waste, and winery wastewater onto the flat to gently undulating soils of Central Otago introduces a theoretical risk of contaminant leaching and diffuse discharge to underlying groundwater or nearby surface water bodies, primarily via vertical percolation, lateral subsurface flow, or surface runoff. Constituents of concern include nitrate-nitrogen (NO_3^--N), phosphorus, sodium, biological oxygen demand (BOD), microbial pathogens, and trace organics or metals.

However, under the proposed land management plan, these materials will be applied:

- Once every three years at a conservative rate of 600 kg total nitrogen/ha (for WAS);
- To unsaturated soils with suitable infiltration capacity; and
- Subject to strict setback distances and climate-based timing controls.

The vadose zone, which separates the ground surface from the underlying water table, serves as an effective biogeochemical buffer. In the case of this site—characterised by moderate cation exchange capacity (CEC), adequate organic matter, and relatively low hydraulic conductivity—contaminants such as ammoniacal nitrogen, phosphorus, and metal ions are expected to undergo strong adsorption, microbial transformation, and chemical immobilisation before reaching groundwater.

The WAS, and other discharges proposed for application is spadable with approximately 20% dry solids, significantly reducing the potential for free drainage, leachate formation, or aerosol generation. Winery waste, which may contain organic acids, residual ethanol, and plant-based solids, is also expected to exhibit low mobility in soil due to its high biochemical oxygen demand (BOD) and particulate-bound nutrient composition, which supports soil incorporation and microbial breakdown.

Microbial contaminants, if present, are expected to be rapidly reduced through:

- Die-off under aerobic soil conditions;
- Filtration through microporous soil matrices; and
- Biological antagonism by indigenous soil microfauna and microorganisms.

Risks to surface water quality may theoretically arise from:

- Direct application into or near watercourses;
- Overland flow during high rainfall events; or
- Subsurface discharge via hydrological connection between shallow groundwater and surface systems.

These risks are mitigated through implementation of the following best practice mitigations:

- Minimum 20-metre buffer zone to natural wetlands and 50-metre buffer zones to all other natural surface water bodies;
- 5 metres buffer from irrigation races, and 20 metres from water storage ponds;
- Application only on flat or gently sloping terrain to reduce runoff risk;
- Avoidance of application during periods of saturated soil moisture; and
- Rapid incorporation of materials into the upper soil horizon to prevent surface exposure and runoff.

Together, these mitigations ensure that nutrient fluxes, pathogen transport, and organic loading to water bodies are minimised. The limited hydraulic connectivity, combined with physicochemical filtration and microbial degradation in soils, confirms that both groundwater and surface water receptors are well-protected.

In summary, when WAS, winery waste, mud sump/tank and grease trap wastes are applied in accordance with the proposed rate, frequency, and good management practices, the resulting effects on groundwater and surface water quality will be less than minor. The receiving environment—characterised by well-buffered soils, adequate setbacks, and operational controls—offers a robust framework for sustainable land treatment. The natural attenuation of Microbial Contaminants, nitrogen, phosphorus and heavy metals have been discussed below.

8.7.1 Microbial Contaminants

The WAS will have an estimated 650,000 MPN/100 ml *E.coli* (Winery waste has 96,157 MPN/100 ml, Grease trap and mud tank/sump has no *E.coli* source implying that there *E.coli* number will be much lower than the WAS and winery waste). The protection of groundwater and surface water is ensured by treatment of the treated wastewater within the soil profile through the mechanisms of filtration, absorption and natural attrition. When the WAS is mixed in soils at a depth of around 150-200 mm, the soils continue to reduce the number of *E.coli* to negligible amounts due to the competition of the *E.coli* with the native microbes in soils.

The USEPA defines these processes as:

Slow rate land treatment *"the application of wastewater to a vegetated soil surface. The applied wastewater receives significant treatment as it flows through the plant root/soil matrix. Solids removal generally occurs at the soil surface and biological, chemical and additional physical treatment occurs as the wastewater percolates through the plant root/soil matrix"*

According to a study by the Florida University (IFAS)

"when at least two feet of unsaturated soil exists between the infiltration system and the water table, BOD_5 removals of >90%, TSS removals of >95% and faecal coliform reductions of > 99% can be expected for a functional and properly maintained septic tank. Bacteria and viruses are effectively removed by adsorption and sorption processes in the groundwater and are not transported far from the source"

In addition to the IFAS study noted above, a number of studies also show that passage of treated wastewater through the soil at a low rate and applied intermittently will enhance the natural pathogen die-off and reduce the number eventually transported into ground/surface water. In this case, WAS will be applied and mixed directly into the topsoil without any accompanying irrigation. As a result, microbial organisms will remain in the upper soil layers for a longer duration, promoting higher die-off rates before any potential movement into deeper soil layers. Given that the WAS will be applied relatively dry, the downward migration of microbes from the topsoil to the subsoil is expected to be negligible.

The main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. Results from various studies show virus reductions of 99.99% through 0.6 m of 0.12 mm diameter sand and bacteria reductions of 99.998% through 0.9 m of 0.15 mm diameter dune sand, with 92 to 97% reduction occurring in the top one centimetre. In addition, Rubin (2009) (an author of many USEPA publications) in his recent decentralised wastewater workshops in New Zealand stated that they conservatively use one log reduction of bacteria per 150 mm of travel through the soil and subsoils. Therefore, a high level of pathogen removal will be achieved before such drainage travels through the glacial till soil matrix to reach groundwater.

The above studies relate to Low Pressure Effluent Dosing (LPED) systems; however, SJA will apply WAS over a large land area and will not include any irrigation water. Therefore, it is expected that the proposed method of land application will produce better results over the discharge area as a whole.

A study by Bohrer and Converse (2000) was conducted in Wisconsin which evaluated six drip irrigation systems for the treatment of wastewater by septic tanks and aerobic units in soils that ranged from coarse sand to clay loam. They found that beyond approximately 450 mm of soil depth the faecal coliform count was below detection limits. At 150 to 300 mm soil depth the coliform count ranged from 2 to 24 MPN per gram of soil.

Therefore, it is considered that the effect of microbes on any potential receiving groundwater and surface water will be minimal. Thus, the effects of WAS, winery waste, grease trap and mud sump application through microbial processes on the receiving environment are assessed to be negligible and acceptable.

At this site, groundwater is known to be at least greater than 2 metres below ground level. During the field visit, the current owner informed the LEI scientists that groundwater had previously been encountered at a depth of approximately 6 meters during mining activities. Even if groundwater is currently present at a depth near 2 meters—which was not the case during the site visit, as the soil appeared dry at that depth—there would still be at least a 2-meter unsaturated soil profile. This unsaturated zone is likely sufficient to support natural attenuation processes, including microbial activity and organic matter decomposition.

8.7.2 Nitrogen

Nitrate-nitrogen is mobile through the soil and has the potential to adversely affect human health if present in high concentrations in drinking water. The Drinking Water Standards for New Zealand (Water Services Regulations, 2022) specify a maximum acceptable value of nitrate-nitrogen at 11.3 mg/L. The WAS has a total nitrogen concentration of 6.6% before application into the soil. The total nitrogen in WAS consists of organic nitrogen from organic matter. There will be minor mount of nitrite-nitrogen, nitrate-nitrogen and ammonium nitrogen.

According to Table 8.1, if up to 40% of the nitrogen in the WAS was mineralized that will generate 240 kg N/ha mineralized nitrogen in soil in the first year.

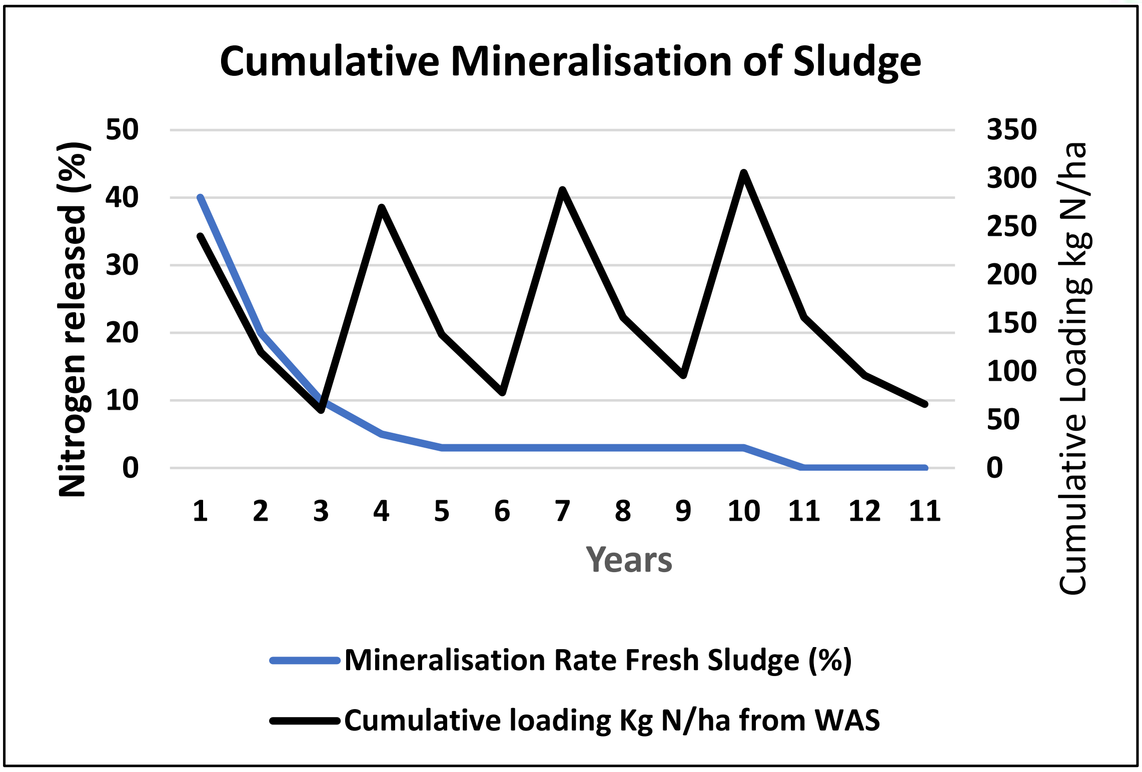

Figure 8.1: Cumulative Nitrogen Available for Plants in Soil

Figure 8.1 has been prepared following the information provided by Reed et al. (1988) and Metcalf and Eddy (2007) as shown in Table 8.1.

It is seen from Figure 8.1 that although 600 kg N/ha is applied on land as WAS, all the nitrogen is not available to plants at first year. According to Reed et al. (1988) and Metcalf and Eddy (2007), up to 40% of the N is mineralized at the first year of the organic nitrogen in organic matter implying that in first year 240 kg N will be available in soils. In 2nd year 120 kg nitrogen/ha will be mineralized and in third year 60 kg N /ha will be mineralized and available to plants. The nitrogen in soil is not accumulated as P (Brady and Weil, 2008).

In general, the top 500 mm of the soils are loamy in texture. The mineralized nitrogen will be distributed according to the Figure 8.2

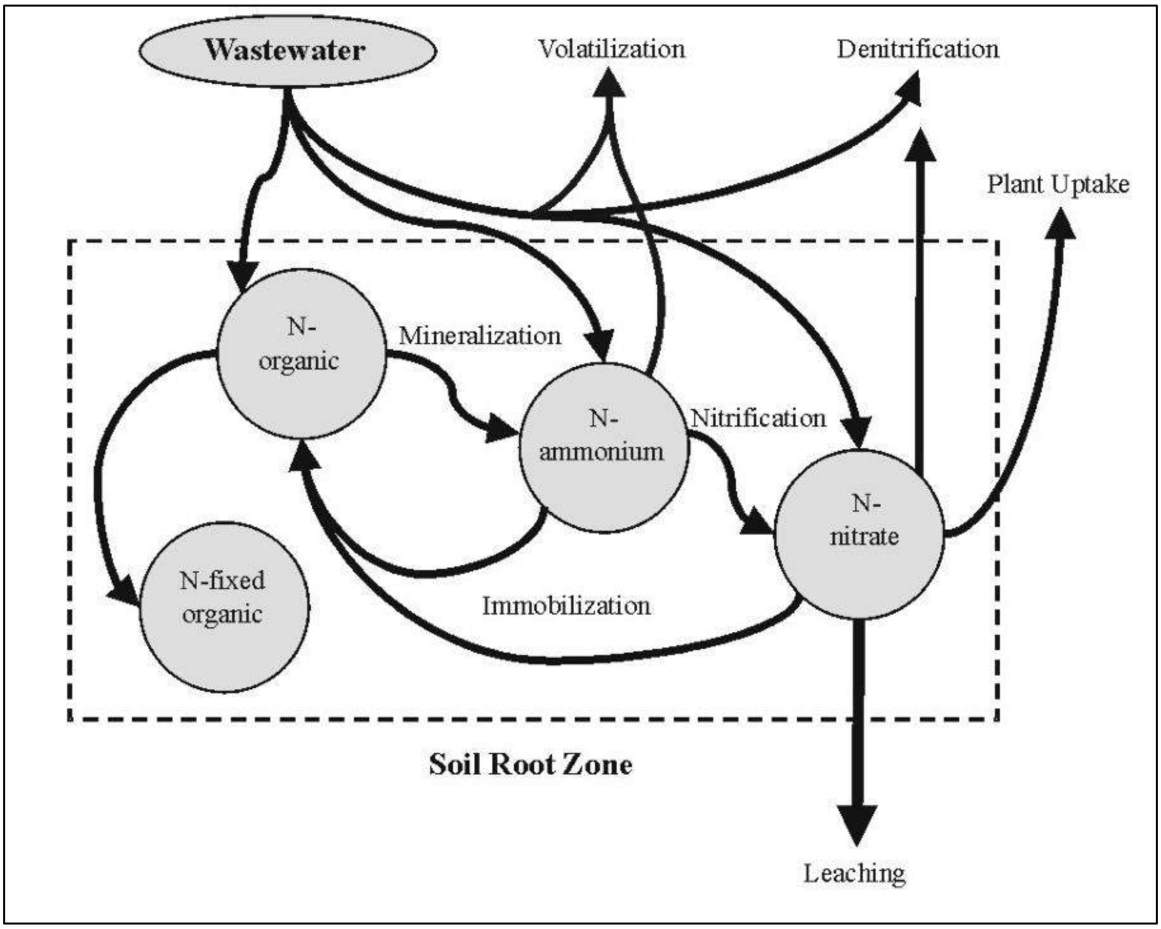

Figure 8.2: Fate of Wastewater Nitrogen in Soil (US EPA, 2006)

Beggs et. al. (2011) explains that wastewater applied to land undergoes further biological processes, with research trials indicating that the concentration of nitrogen applied to the soil is not 100% lost via leaching.

In the soil, many processes utilise nitrogen. Biological processes break down the nitrogen in the WAS in the surface and sub-surface layer, taken up by plant roots for growth, and exported by grazing or harvesting systems.

For comparison, we have provided an equivalent wastewater assessment that is more familiar to many. The soils of the proposed site are considered equivalent to loam soils. Based on the findings of Beggs et. al., (2011) (see Figure 8.3 below), the fate of wastewater nitrogen applied to land in a Loam soil is:

- 0 – 32% via root uptake from plants;
- 40 – 62% lost via Denitrification; and
- 30% lost via leaching

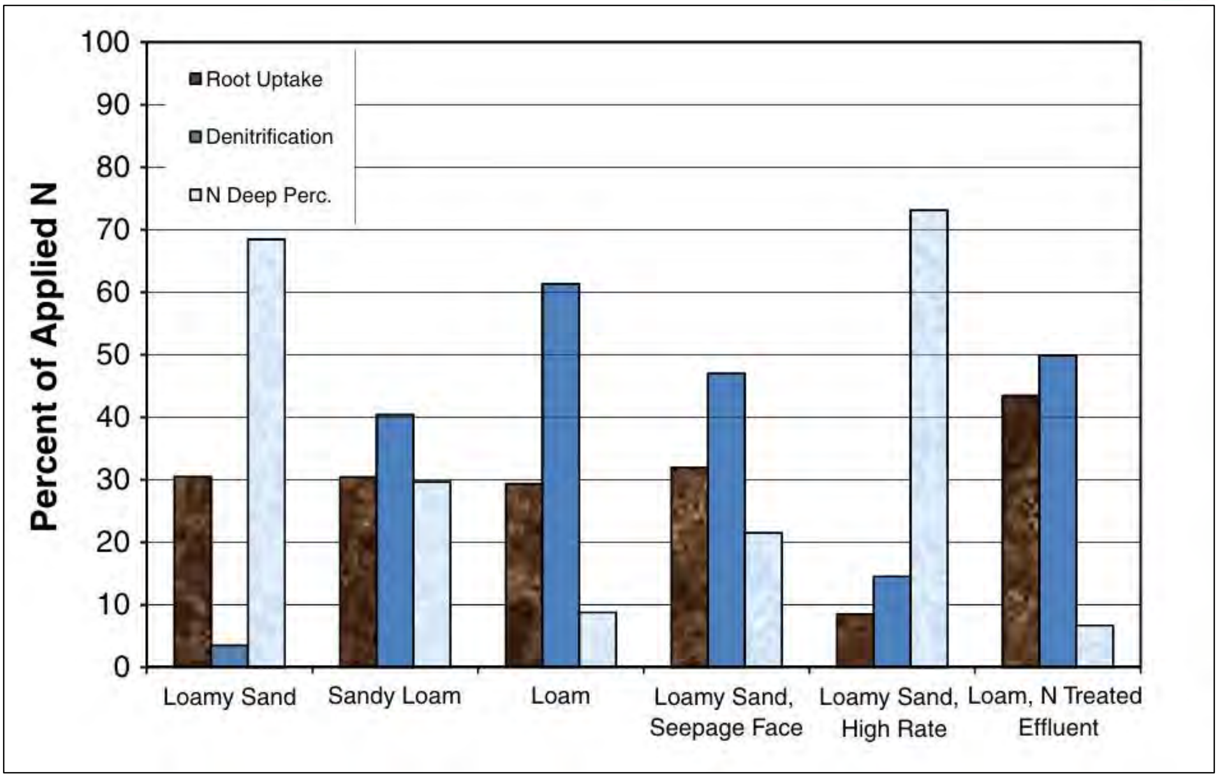

Figure 8.3: Fate of Nitrogen in Wastewater Effluent Applied to Land (Beggs, et. al., 2011)

For the proposed site, out of 600 kg N/ha applied on the first year 96-149 kg N will be denitrified. The bottom soil layer (around 1 m) consists of clay, silt and gravels which indicates that the percolation of water through those layers will be slow. Moreover, the groundwater is at least 2 m deep implying that there will be further denitrification in soil layers from 1 m to 2 m.

The soils at the proposed site have (in general) low bulk density (except Test Pit 8) implying that the soils will percolate water quickly in the topsoil. The topsoil was observed to be friable at LEI's field visit implying that the topsoil has sufficient macropores to infiltrate water especially during heavy rainfall. The S-map data demonstrates that these soils have profile available water of 94 mm in the first 100 cm implying that the rainwater will be largely preserved in the first 100 cm. As the first 2m (minimum) of the soil profile is dry, the nitrogen is not expected to reach groundwater and the nitrogen applied will be assimilated within the soils.

Li et al. (2017) and Li et al. (2013) reported that denitrifiers increase with soil depth, while nitrifiers decrease. Li et al. (2017) also provided the following proportional breakdown of nitrogen removal: ammonification followed by nitrification and denitrification constitutes 69% to 77%, plant adsorption 14% to 17%, and volatilization and other methods 6% to 17%, indicating that biological processes are the primary method of nitrogen removal in soil.

Using wastewater derived research, which is considered conservative, the 10% nitrogen loss in soil and 10% denitrification loss in soil are indicative numbers of N loss from soils where nitrogen has been applied. In literature, the amount of losses is actually much higher than that which has been mentioned in the above paragraph. The loss of nitrogen from soil through volatilisation when urea is applied under worst-case conditions can exceed 50 percent (Jones et al., 2013). The nitrogen mineralisation in WAS and winery wastewater will be at a slower rate than that of urea, and lower nitrogen volatilisation is expected.

Denitrification is a process where nitrate undergoes dissimilatory reduction to NO, N_2O, or N_2 (Robertson, 2000). Under anaerobic conditions, many soil microorganisms use nitrate as a terminal electron acceptor during respiration (Robertson, 2000). This process is a significant sink for soil nitrate and is influenced by factors such as soil moisture, temperature, nitrate concentration, and the availability of carbon (Tiedje, 1988). Irrigation can affect denitrification by altering the extent and duration of anaerobic conditions and nitrate availability. WAS and winery wastewater will provide BOD and nitrate, which soil bacteria can assimilate.

A part of WAS and winery wastewater reaching lower soil horizons will undergo further treatment, as the soil profile supports extensive grass growth due to sufficient nutrients and moisture, leading to increased organic matter and microbial activity. According to US EPA (2006) report, when 250 kg/ha of organic nitrogen is applied to land under a cut-and-leave grass management system, the nitrogen levels tend to stabilise by the third or fourth year, with only slight increases beyond that. The report indicated that around 120 kg/ha of nitrogen is returned to the soil annually from cut grass (cut and leave), when the organic nitrogen loading rate sits at 250 kg N/ha/year. That equates to about 48 percent of the nitrogen originally absorbed by the grass, while net removal (natural attenuation) remains significant at 52 percent.

The low WAS and winery wastewater application rate, rainfall and irrigation, compared to soil water storage results in a long retention time for nitrogen in the soil column, allowing for denitrification even under less-than-ideal conditions (Beggs et al., 2011). Beggs et al. (2011) observed 60% denitrification in loam soils.

The high content of carbon in WAS will enhance the microbial activity in soil, allowing the further assimilation of nitrogen through immobilisation and assimilation in the environment within 100 cm in soil (Brady and Weil, 2008; McLaren and Cameron, 1996).

As the soils are loamy and friable, the incorporated WAS will add organic matter in soils implying that the soils will have improved saturated and unsaturated hydraulic conductivity allowing the rainwater to percolate faster even in high rainfall events reducing the chance of surface run off.

Based on the preceding analysis, the potential for N leaching to ground or surface waters and any potential effects are likely to be less than minor.

8.7.3 Phosphorus

The total P concentration in the WAS is 1.3% (w/w). The application of 45.5 ton of wet WAS application will bring 39 kg P/ha/year and 118 kg P/ha/ 3-year period. Phosphorus is not very mobile within the soil profile. If we consider an extreme case that there was no plant uptake of phosphorus in soil and all the P in soil is be stored in first 30 cm, the 39 kg P/ha/year will cause an increase of 12 mg/kg (0.0012% P) P in soil., If we consider the soil profile to be 100 cm, the 39 kg P addition in soil will increase 3.55 mg P/kg soil (0.0036% P) in soil. To reach to the top of the medium range of P concentration of 1600 mg/kg through considering a soil profile of 100 cm, it will take 423 years if there is no plant uptake.

In the real field scenario, there will be large uptake by plants as P is a macronutrient element, and plants need it in a large amount.

Based on the above, the leaching/runoff of total phosphorus off the LTA is expected to be low given:

- The added WAS P is the primary source of phosphorus for the plant uptake; and
- There is a considerable vertical distance to any ground or surface water.

There is a low potential for phosphorous leaching to groundwater due to the large depth of soil matrix before any potential groundwater, and most (if not all) phosphorous will be retained within the soil profile and not be leached to groundwater. The groundwater was not encountered at 2 m depth during LEI scientist's visit to the site when soil profiles were dug at a depth of up to 2 m. The winery waste will be limited by the total nitrogen application in soils.

Based on the preceding analysis, the potential for P leaching to ground or surface waters and any potential effects are expected to be less than minor.

8.7.4 Heavy Metals

The concentrations of heavy metals measured in the transect soil samples (T1–T8) have been evaluated to assess potential environmental and agronomic risks associated with the proposed application of WAS. Results are benchmarked against the Beneficial Use of Biosolids on Land (Water New Zealand, 2025) and the Ecological Soil Guideline Values for Different Land Uses in New Zealand (Cavanagh, 2016).

Arsenic (As)

Total arsenic concentrations in the transect samples ranged from 4.2 to 6.0 mg/kg. These levels are significantly lower than the upper limit of 30 mg/kg prescribed by Water New Zealand (2025) and the ecological soil threshold of 17 mg/kg (Cavanagh, 2016). The measured values indicate that arsenic input from the applied WAS is negligible and poses minimal risk to soil microbial processes, plant uptake, or potential leaching to groundwater.

Cadmium (Cd)

Cadmium levels ranged between 0.04 and 0.09 mg/kg across the transect soils. These values are substantially below the permissible limit of 6.5 mg/kg as defined by Water New Zealand (2025), and the ecological threshold of 0.8 mg/kg (Cavanagh, 2016). Given New Zealand's historical accumulation of cadmium in agricultural soils from phosphate fertilisers sourced from Nauru (Kim et al., 2005; Taylor et al., 2010), these low concentrations confirm the proposed WAS will not exacerbate existing cadmium levels or pose food safety concerns.

Chromium (Cr)

Chromium concentrations varied from 7.0 to 19.3 mg/kg in all transects. These are well below the biosolids guideline maximum of 1500 mg/kg (Water New Zealand, 2025) and the ecological limit of 200 mg/kg (Cavanagh, 2016). Such low values suggest that chromium inputs from the WAS are minimal and present no significant hazard in terms of mobility, bioavailability, or ecotoxicity.

Copper (Cu)

Copper was detected at concentrations between 8 and 12 mg/kg. These are well within the acceptable range compared to the Water New Zealand (2025) biosolids upper limit of 750 mg/kg and the ecological guideline of 95 mg/kg (Cavanagh, 2016). The data indicate minimal risk of copper-induced phytotoxicity or microbial inhibition and may offer agronomic value by supplying trace copper to deficient soils.

Lead (Pb)

Lead levels across transects ranged from 9.7 to 12.5 mg/kg. This is far below the biosolids contaminant limit of 300 mg/kg (Water New Zealand, 2025) and the ecological limit of 160 mg/kg (Cavanagh, 2016). Given lead's strong sorption to soil particles and low plant bioavailability, the measured concentrations indicate negligible environmental or human health risk under the proposed land application scenario.

Mercury (Hg)

Mercury concentrations were consistent across all samples at 0.12 mg/kg, representing only 1.6% of the 7.5 mg/kg limit set by Water New Zealand (2025) and well below the ecological guideline of 1 mg/kg (Cavanagh, 2016). Given mercury's high toxicity and environmental persistence, the observed low levels confirm effective control and safe use of the WAS product.

Nickel (Ni)

Nickel concentrations ranged from 7.2 to 13.6 mg/kg. These are significantly below the biosolids contaminant ceiling of 135 mg/kg (Water New Zealand, 2025) and the ecological limit of 60 mg/kg (Cavanagh, 2016). These results confirm that the proposed WAS application does not pose risks of nickel toxicity or leaching and remains within acceptable soil quality limits.

Zinc (Zn)

Zinc levels ranged from 33 to 40 mg/kg across all transects. These levels are minimal compared to the 1250 mg/kg threshold in Water New Zealand (2025) and the ecological reference value of 180 mg/kg (Cavanagh, 2016). While high levels of zinc can inhibit plant growth, the current concentrations are safe and may support plant health, especially in zinc-deficient soils.

Cumulative Heavy Metal Load Assessment

All heavy metals measured in the transect samples are within the soil ecological guideline values for different land uses in New Zealand (Cavanagh, 2016). Additionally, they are well below the maximum permissible concentrations for Grade 1 biosolids as defined in the Beneficial Use of Biosolids on Land (Water New Zealand, 2025). Total zinc and copper represent less than 5% of their respective limits, while mercury and cadmium—both of high toxicological concern—are present at under 2% of their allowable concentrations. The remainder of the metals (Cr, As, Pb, Ni) range between 0.5% and 10% of their limits. These findings affirm the high quality of the WAS material, its suitability for land application, and the low risk of long-term accumulation or adverse environmental effects when applied in accordance with good agricultural practice. Figure 8.4 shows that the sludge could be applied on land safely at least for 125 years before Zn is going to reach to the Eco guideline limit (Cavanagh, 2016).

Maximum biosolids application rate calculator

Input:
Calculated:
Critical Contrasts:

Biosolids Details

Total N content	6.6	% w/w	*Calculated from sludge analysis*
Max N Application rate (Agronomic = 200)	600.0	kg N/ha/yr	*Given in application*
Max N limited biosolids application rate	9.1	dry tonnes/ha/yr	
Moisture content of biosolids	20.0	% solids	*Data supplied by applicant*
Max actual application rate	45.5	wet tonnes/ha/yr	

Soil Details (assumed)

Soil bulk density	1.2	dry tonnes/cubic m	*Default value from mean bulk density from MfE Soil Quality State Data 1996-2018*
Soil depth	100	mm	*Given in application*
Estimated Soil Mass per hectare	1200	dry tonnes/ha	
Return rate for applications	3	Years	*Assumed that 25% of site was suitable for application*

Contaminant Checking Spreadsheet

Contaminant	Guidelines Soil Limit (1) mg/kg (dry)	Soil Concentration of contaminant (2) mg/kg (dry)	Remaining Soil Capacity mg/kg (dry)	Biosolids Contaminant Concentration (3) mg/kg (dry)	Biosolids Contaminant Limit dry tonnes/ha	Limited rate per application dry tonnes/ha/yr	Years of application before soil limits are reached Years
Arsenic (As)	17	5.3	11.70	4.5	3120	156	1030
Cadmium (Cd)	0.8	0.1	0.70	1.4	600	30	198
Chromium (Cr)	200	11.4	188.60	15	15088	754	4979
Copper (Cu)	95	10.1	84.90	215	474	24	156
Lead (Pb)	160	11.3	148.70	15	11896	595	3926
Mercury (Hg)	1	0.1	0.90	1.23	878	44	290
Nickel (Ni)	60	9.4	50.60	13	4671	234	1541
Zinc (Zn)	180	36.8	143.20	455	378	19	125

Minimum individual Contaminant Rate t/yr	18.9
N limited Rate t/yr	9.1
Overall limiting rate t/yr	9.1
Total application for return rate t/yr	27.3

1 Soil limits outlined in Table 13 of the guidelines.
2 Default values drawn from average NZ soils. Original references provided in Section 12.3 of the guidelines.
3 Default values drawn from maximum allowable product concentration limits for Grade A products. Table 5 of Guide

Figure 8.4: The Years of Application of WAS Before Soil Limits (Eco-Guideline values, Cavanagh, 2016) Are Reached

Table 8.2: Concentration of Heay Metals in Grease Trap and Mud sump Waste compared to Soil Eco Guideline Values (Cavanagh, 2016)

Item	Type	As g/m^3	Cd g/m^3	Cr g/m^3	Cu g/m^3	Pb g/m^3	Ni g/m^3	Zn g/m^3
Eco-Guideline Soil Values (Limit)	**Guideline Limit**	**17**	**0.8**	**200**	**95**	**160**	**60**	**180**
Test date: 17/01/2024	Mud sump waste	<0.021	<0.0011	<0.011	<0.011	0.0029	<0.011	0.048
Test date: 8/03/2024	Grease Trap	<0.021	<0.0011	<0.011	1.08	0.0041	<0.011	0.143
Test date: 20/03/2024	Mud sump waste	0.073	0.0077	0.109	0.57	0.26	0.141	1.35

From the Table 8.2, it is seen that grease trap and mud sump waste have low heavy metals in general implying that such wastes could be applied to land for a long time, and reaching to the soil eco guideline values (Cavanagh, 2016) will take longer than the WAS application. The effects of winery wastewater heavy metals on the environment will also be less than the WAS application as sludge contains the highest amount of heavy metals among the discharge materials. Accordingly, the primary focus of the effects assessment is the impact of the WAS discharge. The potential adverse effects of WAS on the receiving environment will be less than minor, which delineates that the effects of application of winery wastewater, grease trap waste and mud sump/tank waste will also be less than minor while having the same or greater environmental benefits as discussed above.

Projections based on current application rates indicate that the cumulative accumulation of heavy metals will remain well within the ecological guideline limits for an extended period because the concentration in the added materials are all below the guideline values. Therefore, the long-term application of WAS and other wastes are expected to result in less than minor effects on soil quality and the surrounding environment.

Conclusion

Based on the comprehensive heavy metals assessment, the proposed land application of WAS, grease trap waste, mud sump/tank waste and winery wastewater are expected to have less than minor effects on soil and environmental quality. All trace element concentrations remain well within regulatory thresholds as defined by the Beneficial Use of Biosolids on Land (Water New Zealand, 2025), supporting the safe and sustainable reuse of biosolids in agricultural landscapes.

8.7.5 Direct Effects on Groundwater

The above analysis shows that due to the depth of groundwater on site, the clay soil in the soil layers around 100 cm to 200 cm and dry soil matrix , nitrogen and P will be retained in first 100 cm in soil matrix that will be slowly available to plants through soil solution and there will be natural attenuation of N and P in soils as has been discussed above in the N and P section. This delineates that as the area generally receives low rainfall with high Potential Evapotranspiration (PET), there will be less than minor effect on groundwater from the P application from WAS on this site.

8.7.6 Direct Effects on Surface Water

It is considered that the proposed WAS application on land has been designed in accordance with industry best practices and is the best practicable option for managing WAS and the other discharges to land to minimise adverse effects on surface water.

The WAS will be applied on land through soil mixing. There will be 20m setback from the natural wetlands on site and 50m from other surface water bodies. WAS application in steeper areas will be avoided from the month of April to October which will reduce the chance leaching to a surface water body. The soils have 94 mm water holding capacity in the first 100 cm in the soil profile. Considering the rainfall distribution, PET, soil texture, soil structure, soil bulk density, there is a low risk of surface runoff from the site even in high rainfall events.

Consideration is given to the potential for surface run-off resulting from either a system failure or excessive rainfall beyond normal expectations causing the soil to become saturated and the proposed discharges to be forced to the surface. This is unlikely as the soil saturated hydraulic conductivity is less than 94 m/day and the soil has water holding capacity of 94 mm in the first 100 cm.

Surface emergence of any applied waste is very unlikely due to the soil matrix and 200 mm depth of the emitter lines. For the surface water features that are located on the site areas, the proposed setback distances will further mitigate risks to surface water.

The proposed application of WAS and various wastes to land will have less than minor effects on surface water.

8.8 Effects on Ecology

Any potential impacts on aquatic ecosystems would arise indirectly through hydrological connectivity with adjacent or nearby surface water bodies. As previously described, the proposed land application of WAS will occur on privately owned, restricted-access pastoral land and will be carried out in accordance with established environmental protection protocols and recognised best management practices (BMPs).

To mitigate off-site transport of contaminants and protect downstream receiving environments, a minimum buffer distance of 50 metres will be maintained from all natural wetlands, perennial and intermittent streams, and tributaries located within or adjacent to the property. This setback is consistent with industry guidance and regulatory expectations and provides a critical attenuation zone that significantly reduces the risk of overland flow, surface runoff, or subsurface leachate migration contributing to eutrophication, microbial pollution, or sedimentation in aquatic environments.

Furthermore, a 5-metre exclusion zone will be applied around all irrigation races on-site. These engineered channels provide stock water and irrigation distribution and are considered critical infrastructure for land productivity and water quality. Maintenance of this buffer zone ensures hydraulic separation between the WAS application areas and these sensitive conveyance systems, thereby safeguarding the functional and ecological integrity of downstream water users and ecosystems.

These spatial controls are complemented by operational mitigation measures including:

- application under favourable weather conditions (i.e., avoiding periods of heavy rainfall or saturated soil moisture levels);
- low-rate surface application methods with rapid soil incorporation; and
- adherence to slope and soil hydrological suitability thresholds.

Together, these mitigation measures form a robust, site-specific risk management strategy designed to prevent mobilisation of contaminants and to support the protection of aquatic biota and riparian buffer zones.

Given the implementation of these scientifically informed setback distances, hydrological disconnection from surface water features, and operational BMPs, the proposed activity is assessed as having less than minor adverse effects on freshwater habitats, with no measurable risk to aquatic ecosystem health or downstream water quality.

8.9 Climate Change Effects

Climate change introduces both risks and opportunities for the sustainable land application of organic residuals such as WAS, winery waste, and mud sump material. With adaptive land management strategies, these materials can be utilised not only for waste minimisation but also to enhance agroecosystem resilience and contribute to climate mitigation goals.

Projected increases in mean annual temperature—ranging from 0.5–1.5°C by 2040 and up to 3.5°C by 2090—combined with a reduction in frost days, are likely to extend the growing season across many regions. This phenological shift is expected to increase overall plant productivity and facilitate enhanced uptake of key nutrients (e.g., nitrogen, phosphorus, potassium) from applied organic wastes. As a result, nutrient use efficiency improves, reducing the risk of surplus nutrients accumulating in the environment.

At the same time, the anticipated rise in extreme heat events (>30°C) may increase evapotranspiration rates. However, the organic matter content in WAS, winery waste, and mud sump material enhances the soil's water-holding capacity and aggregate stability, allowing the soil to retain moisture more effectively during dry periods. This buffering capacity supports continued plant growth and reduces irrigation demands under heat stress conditions.

Projected increases in annual rainfall—up to 10% by mid-century and 20% by 2090—may further support dilution and nutrient attenuation functions. The improved soil structure resulting from organic waste inputs increases infiltration and reduces surface runoff, allowing better use of seasonal rainfall and reducing nutrient loss to surface waters. In wetter conditions, enhanced vadose zone processes (e.g., denitrification, sorption) can help treat percolating water before it reaches groundwater, further improving the environmental performance of land application systems.

8.9.1 Additional Positive Effects Under Changing Climate Conditions

Carbon Sequestration and Climate Mitigation

The addition of organic residuals contributes directly to soil organic carbon pools. This not only improves soil structure and microbial health but also supports long-term carbon sequestration, helping to offset greenhouse gas emissions from other parts of the farming system.

Reduction in Synthetic Fertiliser Use and Emissions

The nutrient content of WAS and winery waste may partially or fully replace synthetic fertilisers. This reduces emissions from the manufacture and transportation of fertiliser products and supports a more circular, low-emissions agricultural system.

Low GHG Emission Profile from Well-Managed Applications

When applied under aerobic conditions and managed appropriately (e.g., shallow incorporation, dry weather application), these organic materials may emit minimal amounts of methane (CH_4) and nitrous oxide (N_2O)—two potent greenhouse gases. This helps maintain a low overall emission footprint from land-based waste reuse.

Improved Soil Resilience and Biological Function

Organic inputs enhance microbial activity, nutrient cycling, and soil biodiversity. This supports a biologically active soil system that is more resilient to environmental stressors like drought, heavy rainfall, and temperature extremes—all of which are expected to intensify with climate change.

Pathogen and Contaminant Management Through Natural Attenuation

Soils act as a biogeochemical filter, where contaminants and pathogens are naturally attenuated through microbial degradation, adsorption, and UV exposure. This natural buffering capacity supports safe reuse of treated organic waste products without the need for chemical sanitisation.

Promotion of Circular Bioeconomy Principles

The beneficial reuse of organic residuals exemplifies circular economy in action—closing nutrient loops, reducing waste sent to landfill, and converting residuals into valuable soil amendments. This aligns with climate-smart land use and resource recovery objectives.

Summary

Under projected climate change conditions, the land application of WAS, winery waste, and mud sump material presents substantial agronomic, environmental, and climate-related advantages. These benefits include enhanced nutrient uptake, increased soil carbon, reduced GHG emissions, improved soil water retention, and greater ecosystem resilience. With proper timing, rate control, and monitoring, these materials can be safely and productively reused on land, helping meet both environmental and climate adaptation goals

8.10 Effects on Existing Water Takes

The nearest downstream water take is RM21.003.08, held by Moran Pastoral Limited which authorises the take, retake and use of surface water from Clear Creek for the purpose of irrigation and stock water supply, located approximately 1.4 km south from the property boundary. The next closest surface water take is RM21.003.16, held by 7(2)(a) [redacted] to take, retake and use surface water as primary allocation from a tributary of Lauder Creek for the purpose of irrigation and stock water supply, located approximately 2 km east/southeast of the site. There are also two surface water takes held by Milkwell Holdings Limited, RM18.030.01 and RM22.337.01, to take and use surface water from Lauder Creek for the purpose of irrigation and stock water supply. These takes are located approximately 2.8 km southeast of the site.

As mentioned above, the groundwater table is at least 2 metres below the ground surface, with a loamy soil layer on top and a heavy clay-rich layer in the lower horizons (approximately 100 cm and below). No waste will be discharged during heavy (>10 mm/hr) rainfall events. These factors indicate that there is a very low chance of WAS, winery waste, or grease and mud sump waste migrating from the surface to the groundwater.

Furthermore, the proposed application areas include sufficient setbacks from surface water bodies and property boundaries. This significantly reduces the risk of wastewater reaching surface water or being transported off-site. Therefore, the potential effects of land application of WAS, winery waste, and grease and mud sump waste on both surface water and groundwater are considered to be less than minor.

The proposal will not result in any detectable effects on existing water takes.

8.11 Effects on Odour

There is limited potential for odour generation from the proposed discharge of WAS, winery wastewater, grease trap and mud sump waste, particularly during surface application and the short period prior to soil incorporation. However, these materials will be applied directly to soil, where they will be rapidly absorbed and biologically processed. Microbial activity within the soil will convert sulphur and nitrogen compounds into stable inorganic forms—mainly sulphate (SO_4^{2-}) and nitrate (NO_3^-)—while the remaining fractions will persist in organic forms. These ions will either be taken up by plants or held within the soil matrix through anion exchange and adsorption processes. As a result, gaseous emissions of sulphur dioxide or nitrogen oxides are not expected beyond background levels typical of normal agricultural compost applications.

The WAS proposed for application has a dry solids content of approximately 20%, giving it a cohesive, spadeable texture that minimises volatility and reduces the risk of aerosol formation. This further limits the potential for airborne transport of pathogens or contaminants.

Odour intensity is expected to be low, with a character typical of organic materials such as compost or treated biosolids. The thickening and dewatering processes carried out prior to transport and application significantly reduce odour levels. Combined with the implementation of 10-metre buffer distances from public roads and 200 metres from sensitive receptors such as dwellings, it is highly unlikely that any odour will be perceptible beyond the immediate area of application.

Additionally, the proposed return period for WAS application is once every three years, which substantially reduces the frequency of potential odour-generating events. This extended interval allows sufficient time for the soil to assimilate nutrients and organic matter between applications, minimising cumulative effects.

Any odour emissions are expected to be of short duration, generally limited to a few hours per application event. Given the small quantities involved and the localised nature of the discharge, any odour effects will be minor, transient, and confined to the application area.

From a biosecurity perspective, the solid and fibrous structure of the WAS eliminates the need for spraying or fine particle distribution. The material will be applied in cohesive clumps, greatly reducing the potential for off-site movement or pathogen mobilisation. The absence of free water and the practice of immediate or near-term incorporation into the soil also limit the risk of vector attraction.

In conclusion, considering the nature of the materials, their transformation in soil, the low application frequency, the use of buffer zones, and the minimal emission potential, the proposed land application activities are assessed as having less than minor odour and air quality effects.

8.12 Effects on Amenity, Community and Heritage Values

The proposed site is located on a privately owned, remote parcel of land that is primarily used for grazing purposes. Public access to the site is restricted under normal circumstances, and there are no designated public walkways, recreational areas, or culturally significant landmarks within or adjacent to the property.

The nearest residential dwelling is located at a distance of approximately 200 metres from the application area, with this buffer zone maintained to minimise any potential adverse effects on visual or sensory amenity.

The surrounding landscape is characterised by a rural environment, with agricultural activities such as livestock grazing, crop cultivation, and the use of farm machinery forming an integral part of the area's amenity character. The transport of WAS, winery wastewater, and grease trap, mud sump/tank waste by trucks, as well as the use of spreading equipment, is consistent with typical rural operations where the movement of stock trucks, fertiliser deliveries, and feed transport is commonplace. The selection of this site ensures that these activities will not result in traffic congestion or disturbances beyond what is typically experienced in a rural context.

Importantly, the application of WAS is expected to have beneficial effects on the condition of the land by contributing essential plant nutrients and increasing soil organic carbon content. These inputs are likely to enhance soil fertility and vegetative growth over time, resulting in a visibly greener and more productive landscape. Such an outcome aligns positively with the existing rural land use and may even improve the visual amenity of the site.

Given the restricted public access, the compatibility of the proposed activities with existing rural land use patterns, the beneficial impact on vegetation cover, and the absence of cultural or heritage conflicts, the overall effects of the proposed discharge on amenity, community, cultural, and heritage values are considered to be less than minor.

8.13 Cultural Values

There are no identified sites of cultural or historical significance on or immediately adjacent to the application area. The engagement process with Aukaha has had the following outcomes:

- Kā Rūnaka are in support of the project;
- No particular areas of cultural significance were identified; and
- Written approval was provided with agreement regarding monitoring in year 1. The Applicant has proposed a condition which is in alignment with kā Rūnaka's request.

Therefore, effects on cultural values do not need to be assessed, although are considered acceptable.

8.14 Cumulative Effects

The proposed WAS application and other discharges to land proposed at this site will be carefully managed through a range of preventative and mitigative measures. Firstly, the use of buffer zones—50 metres from natural water bodies and 5 metres from irrigation races—minimizes the likelihood of nutrient or microbial runoff into aquatic environments. These buffers, combined with timing applications to avoid rainfall and saturated conditions, provide an effective barrier against cumulative nutrient loading or sedimentation in nearby waterways. The adherence to good land management practices further supports this outcome.

Air quality concerns, particularly odour, are addressed through the physical characteristics of the WAS, which is spadeable and relatively dry (20% solids), significantly reducing aerosol formation and odour dispersal. Odour intensity is weakened by the mixing of WAS with soils.

From a social and amenity standpoint, the remote and private nature of the application site reduces visual and sensory effects, while its compatibility with existing rural activities ensures the proposal blends well with the local character. This rural context—where the presence of farm vehicles and spreading equipment is typical—further reduces the likelihood of cumulative nuisance or disruption to the community.

Nutrient build-up in soils, shifts in soil microbiota, or the gradual movement of contaminants into groundwater are all valid concerns. Ongoing soil and groundwater monitoring, transparent data sharing with iwi, and periodic system reviews are essential to mitigating these effects. A research collaboration on this project with University of Canterbury will monitor the effects and guide the management of the WAS in an environmentally friendly way.

In summary, while the activity is expected to result in less than minor environmental, cultural, and community effects in the short term, cumulative impacts must be proactively managed. This involves continuous monitoring (proposed conditions Section 9), adaptive management, and culturally informed governance to ensure long-term sustainability and acceptability.

8.15 Positive Effects

The long-term, managed application of organic residuals such as municipal WAS, winery wastewater, and mud sump material delivers a range of benefits to soil health, plant growth, and the climate system, especially when applied under controlled rates and consistent monitoring. The potential positive effects of the proposal are outlined below:

8.15.1 Soil Quality Enhancement

Increased soil organic matter (SOM): Regular inputs of organic material improve SOM content, enhancing soil structure, aggregation, and microbial biodiversity. This improves aeration, root penetration, and moisture retention, especially in Pallic and Semiarid soils known for structural vulnerability and low organic carbon.

Improved water-holding capacity: Over successive applications, the soil's ability to retain water increases, reducing the impact of drought stress and enhancing resilience under climate change-induced dry periods.

Enhanced nutrient content and retention: As the WAS is rich in nutrients, thus the application of the sewage WAS, winery waste and mud sump waste will bring plant nutrients in soils. Soils will exhibit improved Cation Exchange Capacity (CEC), allowing better retention of key nutrients (e.g., K^+, Ca^{2+}, Mg^{2+}), reducing leaching losses and improving fertiliser-use efficiency.

Buffering of soil pH: Organic inputs support pH stability, especially in low-buffering soils, aiding in the sustained availability of essential nutrients and minimising nutrient lock-up.

8.15.2 Plant Productivity and Agronomic Gains

Steady nutrient supply: WAS provides a slow-release source of macronutrients (especially nitrogen and phosphorus), promoting consistent plant uptake across the growing season and reducing reliance on synthetic fertilisers.

Improved crop and pasture yield: Enhanced root development and nutrient availability support increased biomass production, with positive effects on pasture quality, crop growth, and overall land productivity.

Soil biological stimulation: Increased microbial biomass and enzyme activity leads to better nutrient cycling and disease suppression, supporting healthier and more vigorous plant growth.

8.15.3 Climate Change Mitigation and Resilience

Soil carbon sequestration: Regular organic matter addition contributes to long-term carbon storage in soils, helping to mitigate greenhouse gas emissions by removing CO_2 from the atmosphere.

Avoidance of fertiliser-derived emissions: By substituting for synthetic fertilisers, these organic amendments reduce fossil fuel use and GHG emissions associated with fertiliser manufacture and distribution.

Low-emission nutrient delivery: As a slow-release, non-liquid amendment, WAS minimises the risk of N_2O and CH_4 emissions—two high-global-warming-potential gases—compared to untreated effluents or broadcast fertilisers.

Improved drought and flood resilience: Soils enhanced with organic amendments demonstrate greater infiltration, reduced runoff, and improved capacity to buffer against climate extremes, such as high-intensity rainfall or prolonged dry periods.

When applied at environmentally safe intervals (e.g., once every three years) and under good land management practices, the cumulative application of WAS and similar organic materials enhances soil health, sustains plant productivity, and contributes to climate resilience. These cumulative positive effects position land application as a strategic tool for sustainable agriculture, environmental stewardship, and circular bioeconomy development in the face of ongoing climate change.

9 PROPOSED CONDITIONS OF CONSENT

The applicant proposes the following consent conditions and seeks a consent term of 35 years.

Condition 20 sets out a 12-month intensive monitoring period where effects on soil health and water quality are monitored for the WAS application, and discharge methodologies and site management are reviewed in consultation with Aukaha and the Consent Authority to provide surety that the monitoring results reflect what was expected. If any changes are required to improve the management, this can be agreed with both parties. This condition is proposed based on discussions had at the pre-application stage with the Consent Authority and with Rūnaka.

9.1 Conditions volunteered

Specific	
1.	The Waste Materials authorised by this Discharge Permit shall be restricted to the discharge to land identified in Figure 3.2 of the application legally described as Section 25 and Section 47 Block V Lauder Survey District, and Section 20 Block V Lauder Survey District of: 1. Waste activated sludge. 2. Winery waste, 3. Grease trap and mud sump/tank type waste application. 4. Similar materials which when applied do not exceed Soil Eco-Guidelines Soil Limit, mg/kg (dry weight) as per Condition 9.
2.	The following restrictions shall apply: a. The total volume of waste activated sludge (WAS) discharged shall not exceed equivalent to 34.2 tonnes of N/yr or 102.5 tonnes of N in a 3-year return period (This is the nitrogen equivalent to 200 kg N/ha/year or 600 kg N/ha in every three years return period). b. The total volume of grease trap waste and wastewater discharged shall not exceed 20 cubic metres per day. c. The total volume of mud sump type waste and wastewater discharged shall not exceed 20 cubic metres per day d. The total volume of winery waste and wastewater discharged shall not exceed 20 cubic metres per day. e. The total volume of grease trap waste and wastewater discharged shall not exceed 1,200 cubic metres per year. f. The total volume of mud sump type waste and wastewater discharged shall not exceed 1,200 cubic metres per year. g. The total volume of winery waste and wastewater discharged shall not exceed 1,200 cubic metres per year.
3.	The land disposal area shall not be used: a. For roading whether sealed or unsealed; b. As a hardstanding area; c. For erecting buildings or any non-effluent systems structures; d. For activities that require intensively manage grass surfaces (e.g. grass tennis courts or bowling greens or golf tees and greens).

<table>
<tr><td>4.</td><td>All discharges authorised by this consent must comply with the following separation distances:
a. 10 metres from any property boundary;
b. 20 metres from any public roads;
c. 20 metres from natural wetlands;
d. 50 metres from any other natural surface watercourses;
e. 20 metres from any storage ponds;
f. 5 metres from any irrigation races; and
g. 200 metres from any residential dwellings.</td></tr>
<tr><td>5.</td><td>The consent holder must ensure there is no offensive or objectionable odour beyond the property boundary.</td></tr>
<tr><td>6.</td><td>The discharge of waste activated sludge shall not exceed 600 kg N/ha in any one application.</td></tr>
<tr><td>7.</td><td>The consent holder shall ensure that waste activated sludge is incorporated into the soil to a depth of at least 50 mm, within 24 hours of the application being discharged to the land application area.</td></tr>
<tr><td>8.</td><td>The consent holder shall ensure that 12 months following WAS being discharged to an area of the land application area, no human edible crops are harvested.</td></tr>
<tr><td>9.</td><td>Every five years prior to the discharge of waste material authorised by this consent to land, the consent holder shall demonstrate in the next annual report to the Consent Authority that the loading rates will not cause the soil to a depth of 200mm to exceed soil Eco-Guidelines Soil Limit, mg/kg (dry weight) presented in the table below.
<table>
<tr><th>Contaminant’s (Trace Elements/Heavy Metals) Name</th><th>Eco-Guidelines Soil Limit, mg/kg (dry weight)</th></tr>
<tr><td>Arsenic (As)</td><td>17</td></tr>
<tr><td>Cadmium (Cd)</td><td>0.8</td></tr>
<tr><td>Chromium (Cr)</td><td>200</td></tr>
<tr><td>Copper (Cu)</td><td>95</td></tr>
<tr><td>Lead (Pb)</td><td>160</td></tr>
<tr><td>Mercury (Hg)</td><td>1</td></tr>
<tr><td>Nickel (Ni)</td><td>60</td></tr>
<tr><td>Zinc (Zn)</td><td>180</td></tr>
</table>
</td></tr>
<tr><td>10.</td><td>Waste Materials are not authorised to be discharged to land if the calculation for that material type required by condition 10 shows the application will exceed one or more of Trace Element/Heavy Metals in soils.</td></tr>
</table>

Performance Monitoring	
11.	The consent holder shall collect a sample of waste activated sludge every 500 m^3 of discharge each year and have it analysed for the following parameters: (a) Total Nitrogen (b) Total Phosphorus (c) Total Potassium (d) Total Arsenic (e) Total Cadmium (f) Total Chromium (g) Total Copper (h) Total Lead (i) Total Nickel (j) Total Zinc All sampling results obtained shall be included in an annual report (Condition 20) and results forwarded to the Consent Authority on request.
12.	The consent holder shall collect a sample from the base of the grease trap and mud sump trench (1.5 – 2 m bgl), every 150 m of trench length and have it analysed for the following parameters: (a) Total Arsenic (b) Total Cadmium (c) Total Chromium (d) Total Copper (e) Total Lead (f) Total Nickel (g) Total Zinc (h) pH (i) Total Petroleum Hydrocarbons All sampling results obtained shall be included in an annual report (Condition 20) and results forwarded to the Consent Authority on request.
13.	The consent holder shall collect a sample of winery waste every 100 m^3 of discharge each year and have it analysed for the following parameters: (a) TSS (b) $cBOD_5$ (c) Total Calcium (d) Total Magnesium (e) Total Sodium (f) Total Nitrogen (g) Dissolved Reactive Phosphorus (h) Total Potassium (i) Sodium Absorption Ratio (j) pH All sampling results obtained shall be included in an annual report (Condition 20) and results forwarded to the Consent Authority on request.

14.	The consent holder shall collect a sample of grease trap and mud sump waste respectively every 200 m^3 of discharge and have it analysed for the following parameters: (a) Total Arsenic (b) Total Cadmium (c) Total Chromium (d) Total Copper (e) Total Lead (f) Total Nickel (g) Total Zinc (h) pH (i) Total Petroleum Hydrocarbons All sampling results obtained shall be included in an annual report (Condition 20) and results forwarded to the Consent Authority on request.
15.	All sampling techniques employed in respect of the conditions of this consent shall be acceptable to the Consent Authority. All analyses undertaken in connection with this consent shall be performed by an IANZ registered laboratory or otherwise as specifically approved by the Consent Authority.
16.	The consent holder shall maintain records of the dates, types and volumes of waste discharged to the land area and this is to be included in the annual report (Condition 20).
17.	The consent holder shall ensure that the land disposal area, sprayer truck, soil injection system (if used) and associated equipment are always maintained in an efficient and effective operating condition, including at minimum, but not limited to: (a) A summary of any malfunctions or breakdowns and the corrective action taken; (b) The inspection of the land disposal area to ensure that no surface ponding occurs. (c) A summary of any complaints received, the validity of each complaint and the corrective action taken; and (d) Any other issues considered relevant by the consent holder.
18.	Prior to the exercise of this consent, the consent holder shall prepare and forward to the Consent Authority an Operations and Management Manual for the treatment and land dispersal system to ensure its effective and efficient operation at all times. The system shall be operated in accordance with this manual at all times, which shall be updated as appropriate. The manual shall be to the satisfaction of the Consent Authority and include, as a minimum: (a) site map that shows the discharge locations, and sampling sites; (b) key operational matters including weekly, monthly and annual maintenance checks; (c) monitoring requirements and procedures (including monitoring of the disposal field for ponding and odour); (d) contingency plans in the event of system malfunctions or breakdowns (including provision for the removal and disposal of effluent by tanker truck should there be prolonged system failure); (e) the means of receiving and dealing with any complaints; (f) key personnel and contact details; and (g) emergency contact phone numbers. At all times, the consent holder shall ensure that the Consent Authority has a copy of the most recent version of the Operations and Management Manual.

19.	a) For the first twelve months after the first exercise of this consent: i. The discharge of waste activated sludge (WAS) must be limited to a maximum area of 50 hectares (total); and ii. All discharges authorised by this consent must be subject to a monitoring programme which enables effects on soil health and water quality to be observed. The monitoring programme, including monitoring locations and frequencies, must be set out within the OMM required by Condition 18. b) On the anniversary of exercise, the Consent Holder must, within 20 working days, prepare and submit a *Monitoring Summary Report* to Otago Regional Council and Aukaha. i. The Report must include: 1. A summary of monitoring results from the monitoring programme set out in the OMM; 2. An analysis of the monitoring results and an assessment of any effects 3. If the analysis of the monitoring results shows an unanticipated adverse effect, or potential unanticipated adverse effect, on any receiving environment, an assessment of changes proposed to mitigate or remove those effects. 4. An assessment of any other changes proposed to the discharge methods and site management. ii. The Consent Holder must provide reasonable opportunity for kā Rūnaka and Otago Regional Council to review the Monitoring Summary Report and provide their feedback on any proposed changes. *Advice note: If feedback is not received within 20 workings days, the changes as proposed will be deemed acceptable.* c) Within three months of the submission of the Monitoring Summary Report, the consent holder must provide the following to Otago Regional Council and Aukaha: i. A summary of any responses received; and ii. An updated OMM including any refinements to discharge methodologies, the monitoring programme, or site management. d) If the Monitoring Summary Report shows potential adverse effect, the application of WAS will be restricted to a maximum additional area of 50 hectares of the site over the following twelve months.

20.	The Consent holder must prepare and provide an annual report for the period 1 June to 31 May to the Consent Authority by 15 August each year. The report must include but not be limited to: (a) All sampling and analysis results required under conditions of this Consent, including identification of any effects, trends and any remediation/mitigation measures implemented by the Consent Holder; (b) Details regarding discharge waste stream types, volumes and loading rates for each type of waste to: i. Land application areas; and ii. Disposal trenches and/or soil injection areas. (c) All monitoring requirements undertaken by the consent holder as stipulated in the most up to date version of the OMP accepted by the Consent Authority; (d) Record of all malfunctions/breakdowns including any corrective action(s) taken; (e) A summary of any complaints received; and (f) Details of any updates or changes to the OMP as required by the Consent Authority.
General	
21.	No ponding or surface run-off of waste or wastewater shall occur as a result of the exercise of this consent.
Review	
24.	The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary of the commencement of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which becomes evident after the date of commencement of the consent; or b) Ensuring the conditions of this consent are consistent with any National Environmental Standards, Regulations, relevant plans and/or the Otago Regional Policy Statement; or c) Requiring the consent holder to adopt the best practicable option, in order to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

10 STATUTORY ASSESSMENT

10.1 Relevant Documents

The following statutory documents are considered relevant to the application:

- Resource Management Act 1991 (RMA)
- National Policy Statement for Freshwater Management (NPS-FM)
- Otago Regional Policy Statement 2019 (po-RPS)
- Proposed Otago Regional Policy Statement 2021 (pRPS)
- Otago Regional Plan: Water for Otago (RPW)
- Te Rūnanga o Ngāi Tahu Freshwater Policy Statement (FPS)
- Kāi Tahu ki Otago Natural Resource Management Plan 2005 (NRMP)

An assessment of the relevant provisions of these documents will be given below.

10.2 Part II of the Act

Section 104 of the RMA sets out the matters to be considered when assessing an application for a resource consent. These matters are subject to Part 2, the purpose and principles, which are set out in Sections 5 to 8 of the Act. Those matters that are considered for this application are as follows.

10.2.1 Section 5 - Purpose

The purpose of the Resource Management Act 1991 is to promote the sustainable management of natural and physical resources.

In Section 5, sustainable management means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while:

a. Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
b. Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and
c. Avoiding, remedying or mitigating any adverse effects of activities on the environment.

The proposal is consistent with the purpose of the Act in that it enables the Applicant to provide for the social and economic wellbeing of the community, while avoiding or mitigating any adverse effects on the environment of servicing that community with respect to the various discharges to land proposed and managing them in an environmentally friendly way i.e., waste reuse.

It is considered to be an efficient and effective use of the land resource. It will enable removing potential contaminants as it passes through the soil. When the various aspects of the proposal are weighed up it is considered that on balance this proposal is consistent with the purpose of the Act and sustains the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations.

The proposed activity is therefore consistent with the purpose of the RMA.

10.2.2 Section 6 – Matters of National Importance

Section 6 sets out matters of national importance. For the discharge of contaminants to land the following matters are relevant.

In achieving the purpose of the RMA, it is necessary to recognise and provide for the following matters of national importance –

(a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development:
(d) The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:
(e) The relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga;
(f) The protection of historic heritage from inappropriate subdivision, use, and development;
(g) The protection of protected customary rights;
(h) The management of significant risks from natural hazards.

Section 6 (a) and (e) are relevant to the proposed activity and has been given regard in the Section below (Assessment of Environmental Effects) of this application.

The Applicant recognises the need to manage the discharge of WAS, winery wastewater, grease trap and mud sump waste to land to ensure that there are no adverse effects on the quality of freshwater and the relationship of Māori and their culture and traditions with land and water. Overall, it is considered that the matters of national importance identified in the Act have been appropriately recognised and provided for in the design of, and management proposed for the discharges to land.

10.2.3 Section 7 – Other Matters

Section 7 sets out a number of other matters that need to be taken in to account for this application.

In achieving the purpose of the RMA, it is also necessary for all persons exercising functions and powers under it to have particular regard to –

(a) Kaitiakitanga;
(aa) The ethic of stewardship;
(b) The efficient use and development of natural and physical resources;
(c) The maintenance and enhancement of amenity values;
(d) Intrinsic value of ecosystems;
(e) Maintenance and enhancement of the quality of the environment;
(f) Any finite characteristics of natural and physical resources;
(g) -
(h) -
(i) The effects of climate change

The application is consistent with the relevant matters in Section 7 of the Act. It allows for the Applicant to support economic and cultural wellbeing, whilst avoiding adverse effects on the environment and human health. The proposed system will be an efficient use of resources and will be resilient to the impacts of climate change. It is therefore considered that the Applicant has had particular regard to Section 7.

10.2.4 Part 8 – Treaty of Waitangi

Part 8 of the Act requires all persons exercising functions and powers under it in relation to managing the use, development and protection of natural and physical resources to take into account the principles of the Treaty of Waitangi. The Applicant has considered potential effects on other cultural values, particularly around waterbodies, and taken into consideration the sensitivities of the receiving environment when selecting a suitable site and management method. The Applicant has engaged Rūnaka from the early stages of this proposal and received feedback on the suitability of the site for the proposed discharge. Therefore, the ToW has been taken into account.

10.3 Regional Plan: Water for Otago (RPW)

The RPW has been operative since 1 January 2004. The purpose of the plan is to promote the sustainable management of Otago's water resources and covers all freshwater resources in Otago. This document regulates the environmental effects created by activities that may affect freshwater. The relevant objectives and policies to the proposed activities are assessed below. Generally, any provisions directed at Councils are not assessed.

Table 10.1: RPW Relevant Objectives and Policies Assessment

Provision	Assessment
Objectives 5.3.3, 5.3.4, 5.3.5, 5.3.7, Policy 5.4.2: To protect the natural character, maintain amenity values, public access, and heritage values associated with Otago's rivers and their margins.	There are sufficient setbacks to avoid any potentially adverse effects on natural character, amenity values, public access or heritage values associated with the nearest surface water body.
Policy 5.4.3: Avoid adverse effects on existing lawful uses of surface or groundwater.	As assessed in the Assessment of Environmental Effects Section 8 of this report, adverse effects on Clear Creek, Lauder Creek Tributary, the onsite dam, and stock water pond will be avoided through good management practices, the nature of the discharge and the nature of the site, therefore being consistent with this policy.
Policies 6.4.10A5, 6.4.10AC: Avoid in any aquifer: (a) Contamination of groundwater or surface water; and (b) Permanent aquifer compaction.	There will not be any significant contamination of groundwater given the depth to groundwater, good management practices and absence of irrigation water.
Policy 6.4.10B: To have regard to avoiding adverse effects on existing groundwater takes	As assessed in Section 8 adverse effects on existing groundwater takes are avoided and/or minimised.
Objectives 7.A.1-7.A.3: To enable the discharge of contaminants to land in a way that maintains water quality and supports natural and human use values and manage discharges to reduce adverse effects, including cumulative effects, on water quality.	The discharge of contaminants will not degrade water quality and there is not expected to be any significant effect on water quality given the method of application, rate of application, soil types, time of application, good monitoring and general good management practices. Therefore, the proposal is consistent with these objectives.
Policy 7.B.3: Allow discharges of contaminants to groundwater that have minor effects. Objectives 9.3.1 and 9.3.3: To sustain the recognised uses of groundwater and maintain the quality of groundwater.	There is potential for leaching of contaminants to groundwater, however it is expected to have only less than minor effects as the ground water was observed to be less than 2 m and good management practices will be followed.

For the reasons stated in the table above, the proposal is considered consistent with the RPW.

10.4 National Policy Statement for Freshwater Management 2020 (NPS-FM)

The NPS-FM provides local authorities with direction on how to manage freshwater. This document has been in force since 3 September 2020 and the Consent Authority is required to give effect to this document when making decisions on consent applications. Therefore, where relevant, the Applicant has assessed the relevant objectives and policies to the proposed activities.

Table 10.2: NPS-FM Relevant Objectives and Policies Assessment

Provision	Assessment
Objective 2.1: Natural and physical resources must be managed in a way that prioritises: (a) First, the health and well-being of waterbodies and freshwater ecosystems (b) Second, the health needs of people (c) Third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.	The health and well-being of waterbodies and freshwater ecosystems is prioritised through low application rates, careful selection of the application areas and following good management practices. The health needs of people are provided for and maintained, and the ultimate purpose of the activity is to reuse resources to improve soil health and agricultural production. Therefore, the proposal is generally consistent with this objective.
Policy 2: Tangata whenua are actively involved in freshwater management, and Māori freshwater values are identified and provided for.	Tangata whenua have been consulted with from the early stages of the project, and have provided their written approval to the application. Therefore the proposal is consistent with this policy.
Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.	Freshwater is managed in an integrated way that recognises the interconnectedness between land and water, including the potential effects of WAS, winery waste, grease and mud sump discharges can have on freshwater. Therefore, the proposal is considered consistent with this policy.
Policy 4: Freshwater is managed as part of NZ's integrated response to climate change.	This consent application has assessed the effects of the proposal taking into account climate change. Therefore, it is considered consistent with this policy.
Policy 15: Communities are enabled to provide for their social, economic, and cultural well-being in a way that is consistent with this National Policy Statement.	Communities are enabled to provide for their social, economic, and cultural well-being and therefore the proposal is consistent with this policy.

Overall, the proposed activities are generally consistent with the NPS-FM.

10.5 Otago Regional Policy Statement

The Otago Regional Policy Statement (RPS) was declared fully operative on 4 March 2024. The RPS provides an overarching policy framework that must be given effect to when Council's prepare their regional plan(s). The relevant objectives and policies to this application are assessed below. Generally any provisions directed at the Consent Authority have not been assessed.

Table 10.3: RPS Relevant Objectives and Policies Assessment

Provision	Assessment
Objectives 1.1 and Policies 1.1.1 and 1.1.2: Otago's resources are used sustainably to promote economic, social and cultural wellbeing for its people and communities.	The discharge of WAS, winery waste, grease and mud sump discharges to land allows for appropriate management and therefore supports wellbeing. It also supports the reuse of organic wastes allowing improvement in soil health and plant production which brings economic and social benefits.
Objective 1.2 and Policy 1.2.1: Recognise and provide for integrated management of natural and physical resources.	The proposal is considered to be for integrated management of the discharge of WAS, winery waste, grease and mud sump to support the improvement of soil health and plant production.
Objective 2.1 and Policies 2.1.1 and 2.1.2: The principles of Te Tiriti o Waitangi are taken into account.	Through engagement with iwi and consideration of site suitability, the Applicant has taken Te Tiriti o Waitangi principles into account.
Objective 2.2 and Policies 2.2.1 and 2.2.2: Kai Tahu values, interests and customary resources are recognised and provided for including recognising sites of cultural significance.	Tangata whenua have been consulted with from the early stages of the project, and have provided their written approval to the application. Therefore the proposal is consistent with this policy.
Objective 3.1, Policies 3.1.1, 3.1.3, 3.1.4, 3.1.6, 3.1.7, 3.1.8: The values of ecosystems and natural resources are recognised and maintained including on freshwater, water allocation, air quality, soil values and erosion.	The values of ecosystems and natural resources are recognised and maintained and any potential effects on these values will be less than minor as assessed in Section 8. Therefore, the proposal is considered consistent with these objectives and policies.
Objective 4.2 and Policy 4.2.2: Otago's communities are prepared for and able to adapt to the effects of climate change, including using the best relevant climate change data, applying a precautionary approach and encouraging system resilience.	The potential effects of climate change have been assessed in Section 8 and therefore the proposal is considered generally consistent with this policy.
Objective 5.2 and Policies 5.2.1 and 5.2.3: Recognise and protect historic heritage.	There is no known historic heritage near the site that may be affected by the proposal. Therefore, the proposal is considered consistent with these objectives and policies.
Objective 5.4, Policies 5.4.1, 5.4.2: Avoid and/or minimise adverse effects of discharges to land, water and air and have an adaptive management approach.	Potential adverse effects of the discharges to land have been avoided and/or minimised as assessed in Assessment of Environmental Effects Section 8 of this report.

The proposed activities are generally consistent with the po-RPS.

10.6 Proposed Otago Regional Policy Statement 2021 (pRPS)

The pRPS sets the direction for future management of Otago's natural and physical resources. This is a reviewed Regional Policy Statement that was notified on 26 June 2021. The relevant objectives and policies to this application are assessed below. Generally any provisions directed at the Consent Authority have not been assessed.

In this document objectives are identified by an "O" and policies identified by a "P".

Table 10.4: pRPS Relevant Objectives and Policies Assessment

Provision	Assessment
MW-O and MW-P1-P3: Give effect to Te Tiriti o Waitangi, safeguard the mauri and life-supporting capacity of natural resources.	The mauri and life-supporting capacity of natural resources will be safeguarded, and the proposal is considered consistent with these objectives and policies.
IM-O1: Safeguard natural systems and the ecosystem services they offer, and the well-being of present and future generations.	The proposed activities will not have significant adverse effects on ecosystem services and the well-being of present and future generations will be preserved. Therefore, the proposal is considered generally consistent with this objective.
IM-O2: Recognise that the environment is an interconnected system. IM-P3: Provide for mana whenua cultural values in achieving integrated management.	The consent application recognises the environment is an interconnected system and cultural values have been provided for therefore being consistent with this objective and policy.
IM-O3: Preserve environmental integrity, form, function and resilience for future generations.	As assessed in Section 8 of this report, there will be less than minor effects on the receiving environment therefore the proposal will be consistent with this objective.
IM-P9: By 2030 Otago's communities have established responses for adapting to the impacts of climate change, are adjusting their lifestyles to follow them, and are reducing their greenhouse gas emissions to achieve net-zero carbon emissions by 2050.	The Applicant has considered impacts of climate change. Therefore, this is generally consistent with working toward the goals set out in this policy.
IM-P11: Enhance environmental resilience to the adverse effects of climate change.	The potential effects of climate change have been considered thus being consistent with this policy.
IM-P13: Otago's environmental integrity, form, function, and resilience, and opportunities for future generations, are protected by recognising and specifically managing the cumulative effects of activities on natural and physical resources in plans and explicitly accounting for these effects in other resource management decisions.	An assessment of cumulative effects was given in Section 8 therefore being consistent with this policy.
IM-P14: Preserve opportunities for future generations by: (1) Identifying limits to both growth and adverse effects of human activities beyond which the environment will be degraded. (2) Requiring that activities are established in places, and carried out in ways, that are within those limits and are compatible with the natural capabilities and capacities of the resources they rely on, and (3) Regularly assessing and adjusting limits and thresholds for activities over time in light of the actual and potential environmental impacts.	The environment will not be degraded as a result of the proposed activities, they are considered compatible with the natural capabilities of the resources relied on, and the effects will be monitored through the soil and water sampling. Therefore, the proposal is considered consistent with this policy.

Provision	Assessment
LF-WAI-O1: The mauri of Otago's water bodies and their health and well-being is protected.	The mauri of nearby water bodies and their health and well-being will be protected.
LF-WAI-P1: In all management of fresh water in Otago, prioritise: (1) first, the health and well-being of water bodies and freshwater ecosystems; (2) second, the health and well-being needs of people; and (3) third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.	The health and well-being of waterbodies and freshwater ecosystems is prioritised through the management of this activity by ensuring that the selection of the application areas are appropriately positioned from surface water bodies to avoid adverse effects on freshwater. The health needs of people are provided for and maintained, and the ultimate purpose of the activity is to provide for social, economic and cultural wellbeing by supporting a proposed subdivision. Therefore, the proposal is generally consistent with this policy.
LF-WAI-P3: Use an integrated approach of the use of freshwater and land that recognises and sustains connections between waterbodies, sustains habitats of Mahika kai and indigenous species, maintains the health and well-being of freshwater, has regard to foreseeable climate change risks and cumulative effects.	An integrated management approach has been taken and regard had to foreseeable climate change risks and cumulative effects. Therefore, the proposal is consistent with this policy.
LF-VM-O7: Land and water are managed as integrated natural resources.	Land and water are managed as integrated natural resources therefore being consistent with this objective.
LF-VM-O2: In the Clutha Mata-au FMU: (1) management of the FMU recognises that: (a) the Clutha Mata-au is a single connected system ki uta ki tai, and (b) the source of the wai is pure, coming directly from Tawhirimatea to the top of the mauka and into the awa, (2) fresh water is managed in accordance with the LF–WAI objectives and policies, (3) the ongoing relationship of Kāi Tahu with wāhi tūpuna is sustained, (4) water bodies support thriving mahika kai and Kāi Tahu whānui have access to mahika kai, (5) indigenous species migrate easily and as naturally as possible along and within the river system, (6) the national significance of the Clutha hydro-electricity generation scheme is recognised, (7) in addition to (1) to (6) above: (a) in the Upper Lakes rohe, the high quality waters of the lakes and their tributaries are protected, recognising the significance of the purity of these waters to Kāi Tahu and to the wider community. (8) the outcomes sought in (7) are to be achieved within the following timeframes: (a) by 2030 in the Upper Lakes rohe.	There is no direct discharge to water, thus minimising adverse effects on freshwater. As assessed in Assessment of Environmental Effects Section 8, any potential adverse effects of the activities on freshwater will be less than minor. Therefore, the proposal is considered generally consistent with this objective.
LF-FW-O8-O10 and P9 and P13: The health and well-being, and natural character of wetlands, lakes and rivers is protected, and the	The health and well-being and natural character of the nearby surface waterbodies are considered to be protected therefore the proposal is consistent with these policies.

Provision	Assessment
flood attenuation capacity of wetlands is maintained.	
LF-LS-O11: The life-supporting capacity of Otago's soil resources is safeguarded and the availability and productive capacity of highly productive land for primary production is maintained now and for future generations. LF-LS-O12: The use of land maintains soil quality. LF-LS-P16: Recognise maintaining soil quality requires the integrated management of land and freshwater resources. LF-LS-P17: Maintain the mauri, health and productive potential of soils.	The life-supporting capacity of Otago's soil resources is safeguarded, and soil quality will be maintained. The proposal will be consistent with these objectives and policies.
HCV-WT-P1-P2: Kāi Tahu relationships with wāhi tūpuna are sustained and wāhi tūpuna are protected by avoiding, remedying or mitigating adverse effects on cultural values. HCV-HH-O3, P3 and P5: Recognise, preserve and protect historic heritage.	Cultural values have been taken into account and Rūnaka engaged with from the land suitability assessment stages. Written approval has been obtained from Aukaha on behalf of kā Rūnaka. The proposal is therefore consistent with these policies.

Overall, the proposal is consistent with the pRPS.

10.7 Iwi Management Plans

10.7.1 Kai Tahu ki Otago Natural Resource Management Plan 2005

The Kai Tahu ki Otago Natural Resource Management Plan (NRMP) 2005 contains several objectives and policies of relevance to this application. The main general objectives that relate to this application include that there is no discharge of human waste directly to water and that contaminants being discharged directly or indirectly to water are reduced.

There are specific policies that relate to discharges. The relevant ones to this application include:

- To require land disposal for human wastewater and contamination.
- To require consideration of alternatives and use of new technology for discharge renewal consents.
- To require monitoring of all discharges be undertaken on a regular basis and all information, including an independent analysis of monitoring results, be made available to KTkO.
- To encourage Management Plans for all discharge activities that detail the procedure for containing spills and including plans for extraordinary events.
- To require all discharge systems be well maintained and regularly serviced.
- To require visible signage informing people of the discharge area; such signs are to be written in Māori as well as English.
- To require groundwater monitoring for all discharges to land.

There will be no discharge of human wastewater to water. The proposed land application will maintain minimum setback distances from sensitive areas, alternative options have been considered, routine monitoring of the discharges will be required by conditions of consent, a Management Plan will be in place, discharge systems will be routinely maintained, and signage can be erected if there is likely to be any public access near to the application areas. Written approval has been obtained from kā Rūnaka and therefore the proposal is considered consistent with the NRMP.

10.8 Conclusion

Overall, it is considered that the proposed WAS, winery waste, grease trap and mud sump/tank type discharges to land are generally consistent with the objectives and policies of the relevant statutory documents. Specifically, the proposed activity recognises and provides for the relationship Kai Tahu have with Otago's water resources and promotes the sustainable management of Otago's land resources. The proposed activity has been specifically designed to mitigate any adverse effects on surface and groundwater. Finally, it is considered that appropriate monitoring and review conditions are proposed to ensure that any unforeseen adverse effects associated with the activity can be dealt with should they arise.

11 CONSENT DURATION

A 35-year resource consent term is sought for the discharge of WAS, winery waste, grease trap waste, and mud sump/tank waste to land. The consent term sought reflects the need for long-term certainty in managing organic residuals and supports the continuity of a sustainable land application programme for waste streams that are not suited to municipal reticulation.

The proposed term is justified on the following grounds:

- The land application system has been carefully designed and established to meet long-term environmental performance standards.

- Discharges will occur under controlled conditions, ensuring that any potential adverse effects on soil, water, air, and ecological values are less than minor.

- The activity will be conducted in accordance with an Operations and Management Plan that includes detailed procedures for application timing, site selection, incorporation techniques, and buffer zone maintenance, as well as a robust monitoring programme to detect any adverse environmental changes.

- A clear adaptive management framework is included to ensure that, should environmental monitoring indicate effects beyond anticipated levels, corrective action can be promptly implemented to prevent degradation.

- The site is not connected to any alternative community wastewater system, and the land application of these residuals represents the best practicable option available for their beneficial reuse.

- The activity contributes to nutrient recycling, soil improvement, and waste diversion from landfill, delivering positive outcomes for land productivity and environmental sustainability.

- The proposed duration supports community reliance on a consistent and effective system and reduces the frequency of re-consenting processes, enabling operational and planning certainty.

- Given the low environmental risk profile of the proposed discharge, the inclusion of ongoing monitoring and responsive mitigation strategies, and the absence of feasible alternative disposal routes, a 35-year term is considered entirely appropriate. No reduction in term is warranted based on current planning, environmental, or operational considerations.

12 CONCLUSION

Given the scale, controlled nature, and environmental safeguards incorporated into the proposal, the proposal will have less than minor effects on the receiving environment. In summary:

- The proposed land application system comprises a total of 178.57 hectares for WAS application, winery wastewater, and grease trap and mud sump material, representing an integrated, land-based treatment approach that promotes sustainable organic waste management.

- All land application areas have been designed to comply with the following minimum setback distances: 10 metres from any road or property boundary, 20 metres from natural wetlands, 50 metres from all other natural surface watercourses, 20 metres from storage ponds, 5 metres from irrigation races, and 200 metres from any residential dwellings; thereby minimising potential adverse effects on human and environmental receptors.

- The application of treated organic materials to land will contribute to improving soil fertility, structure, microbial function, and nutrient availability, particularly in nutrient-depleted or low organic matter soils, leading to enhanced plant productivity and ecosystem resilience.

- The proposal facilitates the beneficial reuse of nutrients (e.g., nitrogen, phosphorus, potassium) that would otherwise be lost to landfill, aligning with circular economy principles and regional waste minimisation goals.

- The proposed activity is consistent with the objectives and policies of the relevant statutory documents; particularly those encouraging sustainable land use, soil conservation, and protection of surface water and groundwater quality.

- A comprehensive assessment of alternatives confirms that the selected approach represents the best practicable option (BPO) under section 105 of the RMA, considering environmental, technical, and operational factors.

- The discharge activities will be implemented in accordance with an Operations and Management Plan, supported by a robust monitoring and reporting framework to ensure continued compliance with consent conditions and early identification of potential adverse effects.

- The nature of the material, its spadeable consistency (approximately 20% dry solids), and the quick incorporation practices proposed will minimise odour, pathogen mobilisation, and aerosol generation, ensuring that air quality and amenity values are maintained.

- The proposed discharges will not result in objectionable odour, visible contamination, or adverse effects on water quality, aquatic life, or stock water suitability when carried out in accordance with the consent conditions.

In conclusion, the activity supports the sustainable management of natural and physical resources while ensuring that any actual or potential adverse effects are avoided, remedied, or mitigated to a level that is less than minor.

A 35-year consent term is sought to provide operational certainty, support a large infrastructure investment, and enable ongoing adaptive management and environmental monitoring across the life of the consent. This term is considered appropriate given the controlled application method, strong environmental safeguards, and the essential nature of the service to the community and waste generators.

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14 APPENDICES

Appendix A: Land Title
Appendix B: Site Observation Memo
Appendix C: Soil Investigation Memo
Appendix D: Sludge Test Results June 2025
Appendix E: Aukaha Written Approval
Appendix F: Landowner Written Approval

APPENDIX A

Land Title

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD
Search Copy

R.W. Muir
Registrar-General
of Land

Identifier **OT10B/341**
Land Registration District **Otago**
Date Issued 14 June 1985

Prior References
OT102/20

Estate Fee Simple
Area 228.6508 hectares more or less
Legal Description Section 25 and Section 47 Block V Lauder Survey District

Registered Owners
Moran Pastoral Limited

Interests

Subject to Section 8 Mining Act 1971

Subject to Section 5 Coal Mines Act 1979

Exploration Permit embodied in Register OT9D/517 - 22.6.1995 at 9.04 am

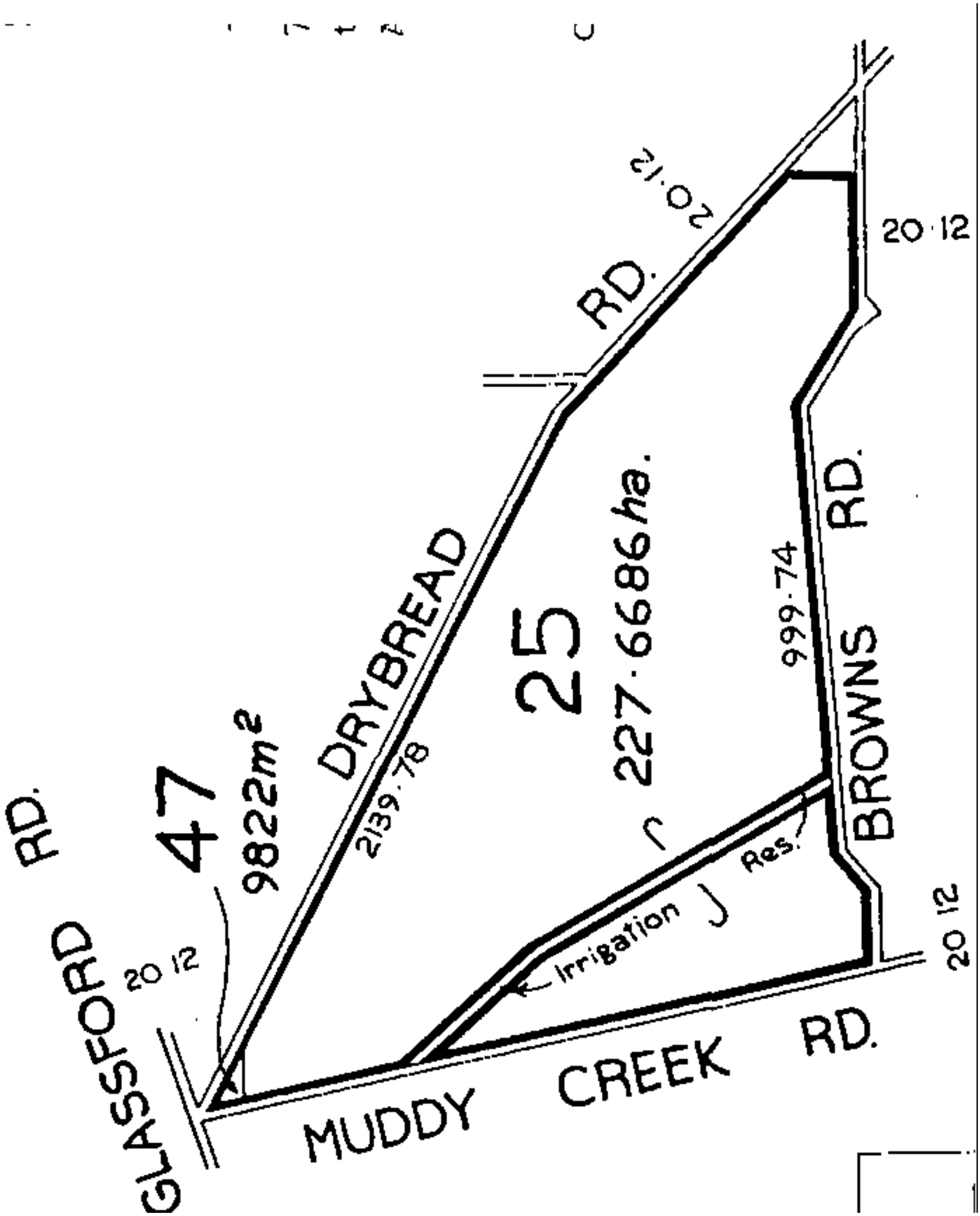
8410556.1 Mining Certificate pursuant to Section 417 Resource Management Act 1991 to (now) 7(2)(a) [redacted], Moran Pastoral Limited and B J & C M McKenzie Limited - 10.3.2010 at 3:29 pm

9052285.1 Notice of Access Rights over part Section 25 Block V Lauder Survey District pursuant to Section 83 Crown Minerals Act 1991- 15.5.2012 at 4:47 pm

9255221.1 Notice pursuant to Section 195(2) Climate Change Response Act 2002 - 30.11.2012 at 4:51 pm (Affects Section 25 Block V Lauder Survey District)

13310065.4 Mortgage to ASB Bank Limited - 23.5.2025 at 2:33 pm

13310065.5 Mortgage to Viewpoint Farm Limited - 23.5.2025 at 2:33 pm


DRYBREAD RD.
20·12
25
227·6686 ha.
2139·78
999·74
BROWNS RD.
47
9822m²
GLASSFORD RD.
20 12
Irrigation Res.
MUDDY CREEK RD.
20 12

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier **OT392/70**
Land Registration District **Otago**
Date Issued 17 December 1956

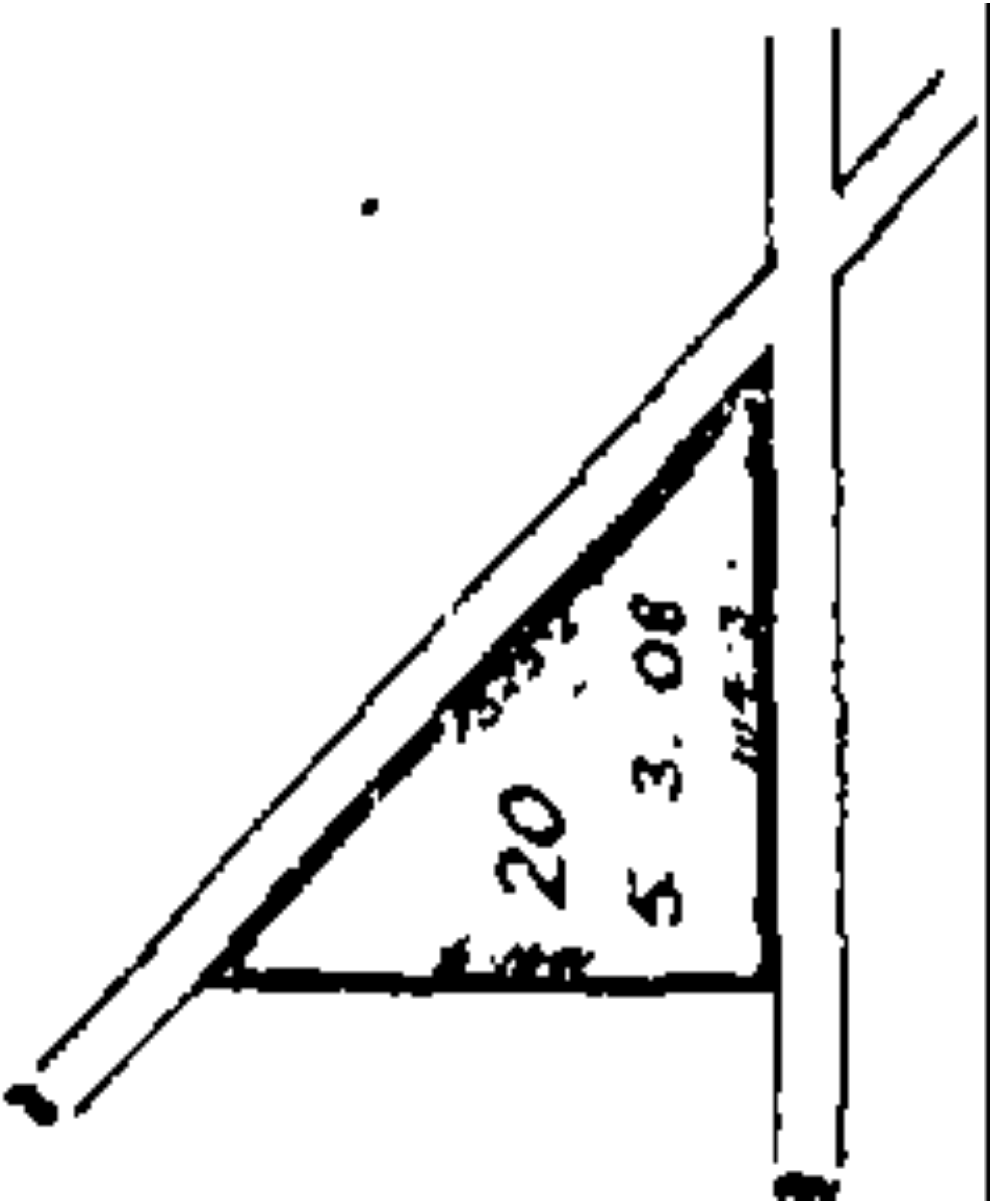
Prior References
WA 8/5

Estate Fee Simple
Area 2.3472 hectares more or less
Legal Description Section 20 Block V Lauder Survey District
Registered Owners
Moran Pastoral Limited

Interests

13310065.4 Mortgage to ASB Bank Limited - 23.5.2025 at 2:33 pm

13310065.5 Mortgage to Viewpoint Farm Limited - 23.5.2025 at 2:33 pm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APPENDIX B

Site Observation Memo

MEMORANDUM **Job 11006**

To: S J Allen Holdings Limited

From: Lowe Environmental Impact

Date: 10 June 2025

Subject: Brown Road, Lauder Land Application Area Site Walkover Photos

BACKGROUND

This memo summarises Lowe Environmental Impact's (LEI) site walkover of the proposed site at Brown Road, Lauder for the land application of waste activated sludge (WAS), grease trap type waste, mud tank/sump type waste, and winery wastewater on land. The purpose of the visit was to investigate the sites characteristics, including the soils, existing land use, and proximity to watercourses. Included are photographs from the site investigation and observations made during the visit.

LEI SITE INVESTIGATION

LEI staff carried out a site investigation at the proposed site on Brown Road, Lauder from the 2nd to 4th April 2025. The investigation included:

- A site walkover and observations.
- 9 machine excavated test pits and associated soil profiles (Figure 1) results and findings included in a separate soil assessment memo.
- 9 transect samples (Figure 1); results and findings included in a separate soil assessment memo.

General Site Observations

- The site is well fenced and has good road access surrounding the property.
- The ground cover at the site comprises lucerne, kale and pasture.
- Two surface watercourses run through the site: Clear Creek and a tributary of Lauder Creek.
- The site's topography is generally flat, with some steeper areas associated with the banks of surface watercourses.
- Located at the western side of the site are two main storage ponds, one is a storage dam used for irrigation, and the other is a pond used for stock water.
- A smaller storage pond is situated at the central part of the site used for irrigation purposes, supplied via irrigation races that convey water from the main storage dam.
- The land is irrigated using flood/border dyke irrigation methods.
- No evidence of spray irrigation systems (e.g., spray guns, pivots) were observed during the site visit.

The following sections provide a breakdown of the land area at the location of each of the 9 test pits and accompanying site photos.

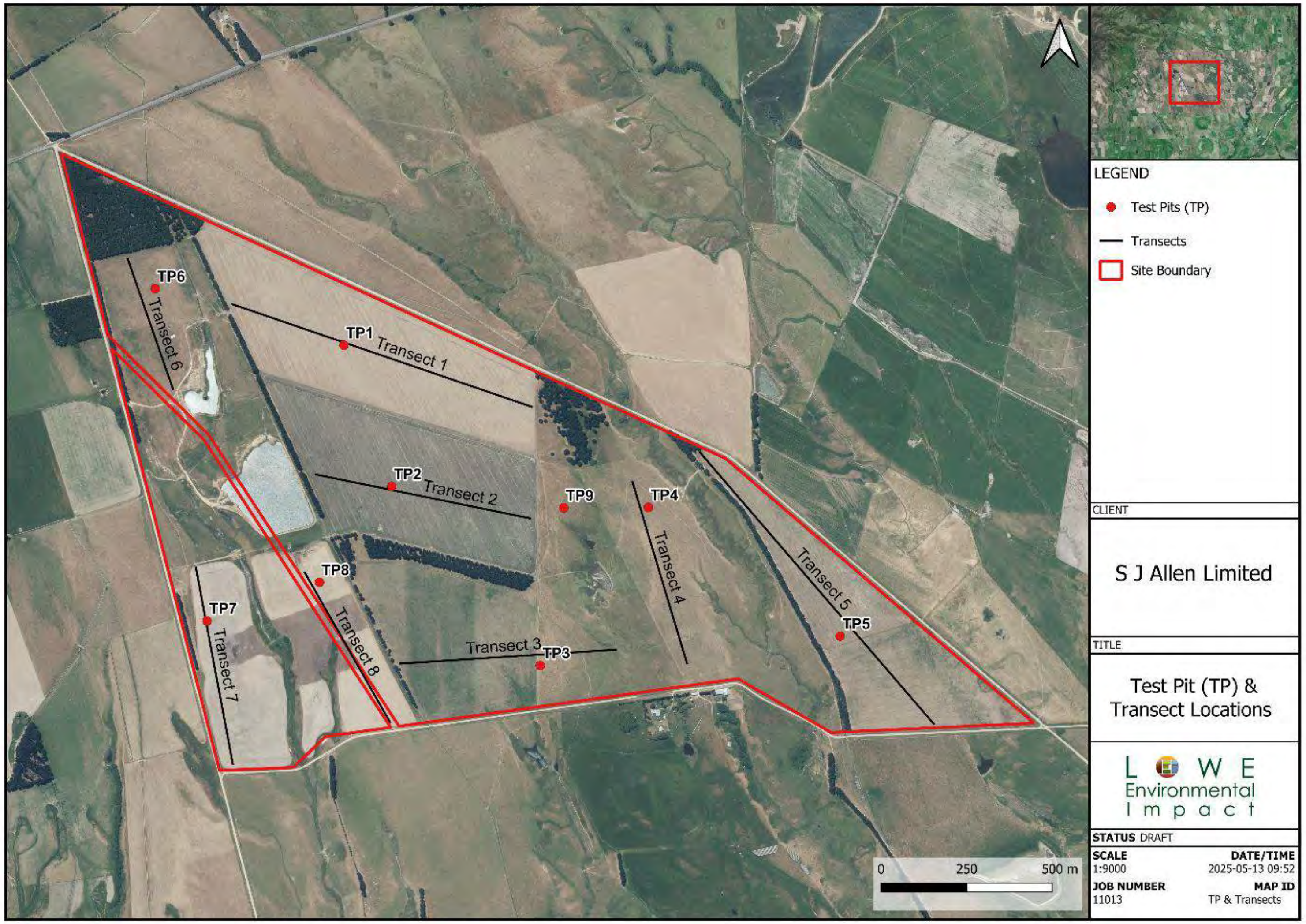


Figure 1: Test Pit (TP) and Transect Locations

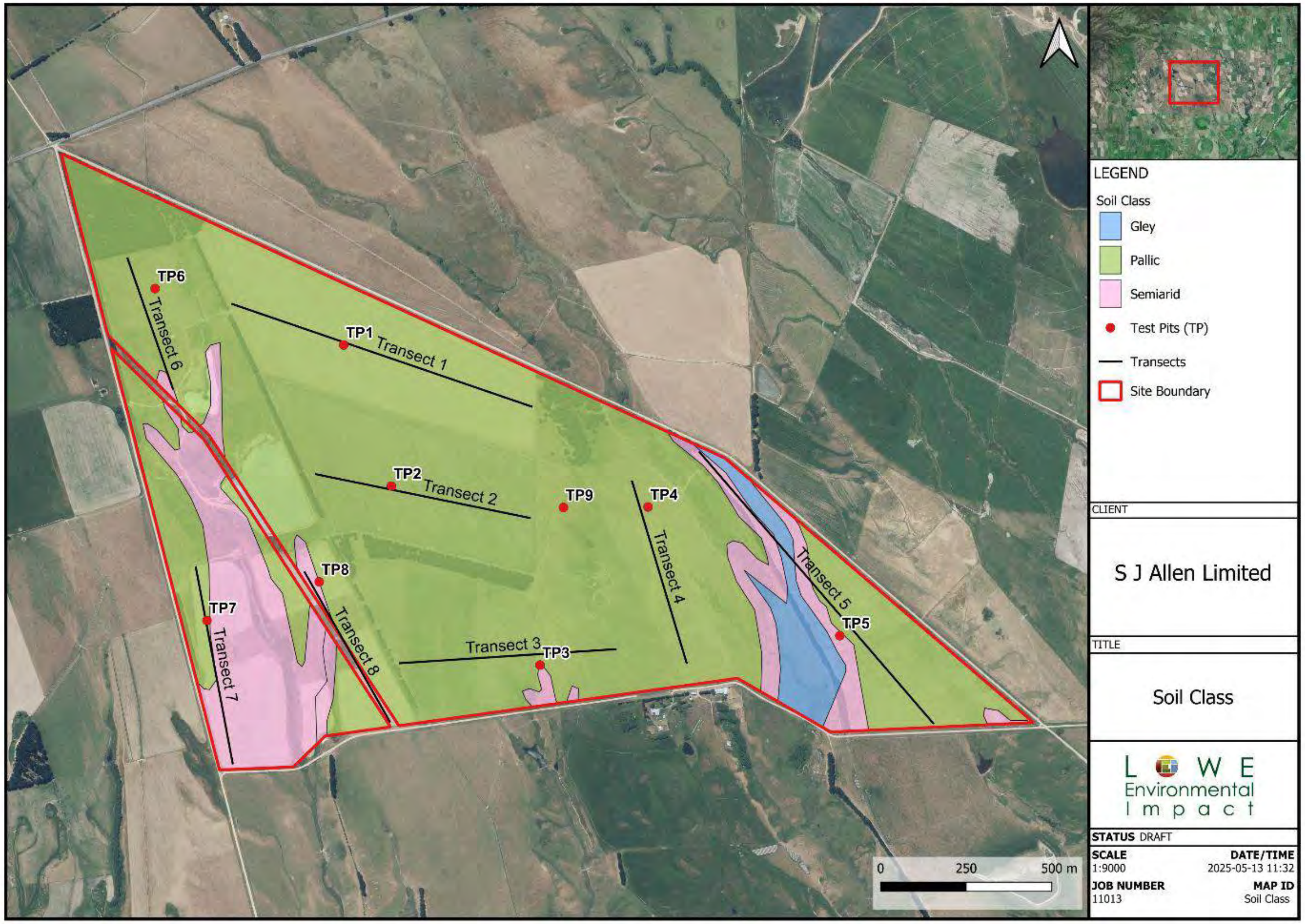


Figure 2: S-Map Soil Classification

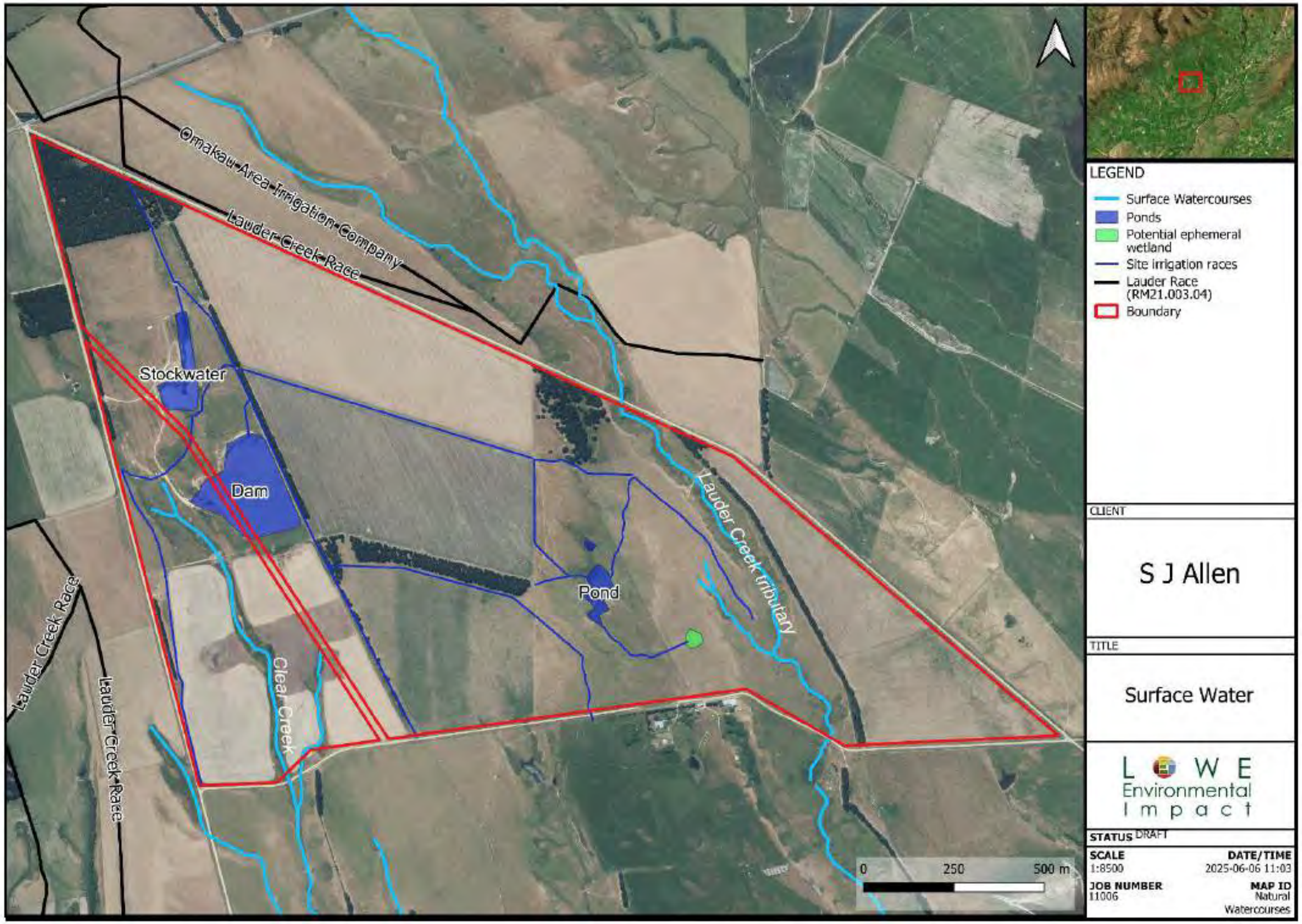


Figure 3: Site Surface Water Features

TEST PIT AND TRANSECT AREA 1

- **Location:** Central northern part of the site.
- **S-map Soil Class:** Pallic soils.
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally flat.
- **Ground Cover:** Lucerne.

Additional Information:
Area 1 is generally flat across the entire area (Figure 4, Figure 5, Figure 6) A shelterbelt of planted pine trees is situated along the western area boundary. Stones were visible at the ground surface across the entire area (Figure 7). Cows were observed within the area during the site visit.

Figure 4: Area 1 Looking Northeast

Figure 5: Area 1 Looking South

Figure 6: Area 1 Looking West

Figure 7: Area 1 Ground Surface

TEST PIT AND TRANSECT AREA 2

- **Location:** Central part of the site.
- **S-map Soil Class:** Pallic soils.
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally flat, with irrigation dykes across the area.
- **Ground Cover:** Dryland pasture.

Additional Information:
Area 2 is generally flat with irrigation dykes present across the entire area (Figure 8, Figure 9). An irrigation race runs along the northern boundary of the area (approximately 5 m from the fence line), observed to be dry during the site visit (Figure 10). A shelterbelt of planted pine trees is situated along the western and southern boundaries. A fence bisects the area near the centre, running from north to south, dividing it into two sections.

Figure 8: Area 2 Looking North

Figure 9: Area 2 Looking South

Figure 10: Area 2 looking Southwest; Irrigation Race Visible

TEST PIT AND TRANSECT AREA 3

- **Location:** Central southern part of the site.
- **S-map Soil Class:** Predominantly Pallic soils with a small section of Semiarid soils at the southern boundary.
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally Flat.
- **Ground Cover:** Kale crop.

Additional Information:

Area 3 is generally flat across the entire area (Figure 11, Figure 12). Irrigation races run along the northern and western boundaries (Figure 10). Water was observed flowing from the western boundary irrigation race beneath Brown Road toward the adjacent southern property during the site visit. A shelterbelt of planted pine trees is situated along the northern and western boundaries. The area is cropped in kale (Figure 14), and cows were observed grazing the area.

Figure 11: Area 3 Looking North from Brown Road

Figure 12: Area 3 Looking Northwest from Brown Road

Figure 13: Area 3 Looking North from Brown Road; Irrigation Race Along the Western Boundary Visible

Figure 14: Area 3 Ground Cover

TEST PIT AND TRANSECT AREA 4

- **Location:** Central east part of the site.
- **S-map Soil Class:** Predominantly Pallic soils, with some Semiarid and Gley soils along the eastern boundary.
- **Soil Drainage**: Imperfectly drained, with some well and poorly drained areas along the eastern boundary.
- **Topography:** Generally flat, with some steeper areas associated with the banks of Lauder Creek tributary.
- **Ground Cover:** Dryland Pasture

Additional Information:

Area 4 is generally flat (Figure 15), with some steeper areas near the banks of Lauder Creek tributary (Figure 24, Figure 25). Lauder Creek tributary flows through the eastern part of the site, with the direction of flow from north to south (Figure 18, Figure 19). There is a smaller storage pond near the centre of the site (Smaller Storage Pond
Figure 26). An irrigation race is present at the northern part of the area in a U-shape (Figure 16, Figure 17), and another leads from the smaller storage pond. Both irrigation races were dry during the site visit. Approximately 250 m east of the small storage pond, a slight depression in the landscape exhibited different vegetation, potentially including sedge or rush species, suggesting a potential ephemeral wetland, though it was dry at the time of the visit (Figure 27). A shelterbelt of planted pine is situated along the eastern boundary. Sheep were observed grazing the area during the site visit. A road track crosses the Lauder Creek tributary at the northern part of the area, providing vehicle access across the watercourse (Figure 20, Figure 21, Figure 22, Figure 23).

Figure 15: Area 4 Looking North

Figure 16: Area 4 Irrigation Race Looking Northeast

Figure 17: Area 4 Irrigation Race looking South

Lauder Creek Tributary

Figure 18: Lauder Creek Tributary Looking South from Drybread Road

Figure 19: Lauder Creek Tributary Looking South from Drybread Road

Figure 20: Lauder Creek Tributary at Road Track Crossing Looking North

Figure 21: Lauder Creek Tributary at Road Track Crossing Looking Southeast

Figure 22: Lauder Creek Tributary at Road Track Crossing Looking South

Figure 23: Lauder Creek Tributary at Road Track Crossing

Figure 24: Lauder Creek Tributary Looking North from Brown Road

Figure 25: Lauder Creek tributary looking North from Brown Road

Smaller Storage Pond

Figure 26: Smaller Storage Pond looking South

Potential Ephemeral Wetland

Figure 27: Potential Ephemeral Wetland

TEST PIT AND SPREADING AREA 5

- **Location:** Eastern part of the site.
- **S-map Soil Class:** Predominantly Pallic soils with some Semiarid and Gley soils along the western boundary.
- **Soil Drainage**: Imperfectly drained, with some well drained and poorly drained areas along the western boundary.
- **Topography:** Generally flat, becoming steeper at the southeastern corner.
- **Ground Cover:** Lucerne and dryland pasture.

Additional Information:

Area 5 is generally flat, with a steeper area at the southeastern corner, sloping down at the intersection of Drybread Road and Brown Road. A shelterbelt of planted pine trees is situated along the western boundary. A fence bisects the area near the centre, running from east to west dividing it into two sections (Figure 27). The northern section of the area is cropped in lucerne (Figure 26), and the southern section is dryland pasture (Figure 28).

Figure 28: Northern Section of Area 5 Looking Southeast from Drybread Road

Figure 29: Area 5 Fence Looking West

Figure 30: Southern Section of Area 5 Looking Southwest

TEST PIT AND SPREADING AREA 6

- **Location:** Northwestern part of the site.
- **S-map Soil Class:** Mostly Pallic soils with some Semiarid soils.
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally flat with some steeper areas around the stock water pond and irrigation dam.
- **Ground Cover:** Dryland pasture

Additional Information:

Area 6 is generally flat (Figure 29, Figure 30), with some steeper areas around the storage ponds. Two main ponds are located within the area (Figure 35), one is a pond used for stock water (Figure 32, Figure 33, Figure 34) and the other is a storage dam used for irrigation (Figure 36, Figure 39). Two vehicle access points from Muddy Creek Road are located along the western boundary. There is an area of pine trees at the northeastern corner. A shelterbelt of planted pine trees is situated along the western and eastern boundaries. The top of Clear Creek is situated to the west of the irrigation storage dam (Figure 38, Figure 39, Figure 40, Figure 41). There is also a soil mound/stockpile located to the west of the irrigation dam (Figure 31).

Figure 31: Area 6 Looking Northwest from the Stock Water Pond

Figure 32: Area 6 Looking South from the Irrigation Dam

Figure 33: Area 6 Soil Mound/Stockpile Looking North

Stock Water Pond

Figure 34: Northern End of Stock Water Pond Looking Northeast

Figure 35: Northern End of Stock Water Pond Looking East

Figure 36: Stock Water Pond Looking South

Figure 37: Stock Water Pond (left) and Irrigation Dam (right) Looking East

Irrigation Dam

Figure 38: Irrigation Dam Looking East

Figure 39: Irrigation Dam looking East

Clear Creek

Figure 40: Northern End of Clear Creek looking West from the Irrigation Dam

Figure 41: Northern End of Clear Creek Looking Southwest from the Irrigation Dam

Figure 42: Northern End of Clear Creek Looking Northwest

Figure 43: Northern End of Clear Creek Looking Northwest

Figure 44: Clear Creek looking South from the Fence at the Northern End of Area 7

TEST PIT AND TRANSECT AREA 7

- **Location:** Southwestern part of the site.
- **S-map Soil Class:** Predominantly Semiarid soils with some Pallic soils.
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally flat in some areas, becoming more undulating toward the southern end and steeper along the banks of Clear Creek.
- **Ground Cover:** Lucerne.

Additional Information:

The northern part of Spreading Area 7 is generally flat, becoming more undulating towards southern end (Figure 43) and steeper along the banks of Clear Creek (Figure 44, Figure 45). A water race runs along the western boundary which was dry when observed (Figure 46, Figure 47) and a small shelterbelt of planted pine trees lines this boundary. Some depressions and potential backfilled areas were observed during the site visit, possibly from past mining activity (Figure 48, Figure 49).

Figure 45: Southwestern Corner of Area 7 Looking Southwest Toward the Intersection of Muddy Creek Road and Drybread Road

Figure 46: Southwestern Corner of Area 7 looking East Toward Clear Creek

Figure 47: Southwestern Corner of Area 7 Looking Northeast Toward Clear Creek

Figure 48: Area 7 Irrigation Race Looking North

Figure 49: Area 7 Irrigation Race Looking South

Figure 50: Area 7 Backfilled Area Looking West Toward Muddy Creek Road

Figure 51: Area 7 Backfilled Area Looking East

Figure 52: Area 7 Looking North from Brown Road.

TEST PIT AND TRANSECT AREA 8

- **Location:** Southwestern part of the site.
- **S-map Soil Class:** Pallic soils and Semiarid soils.
- **Soil Drainage**: Imperfectly drained with a small well drained area.
- **Topography:** Generally flat.
- **Ground Cover:** Lucerne.

Additional Information:

Area 8 is generally flat (Figure 51, Figure 52). A sparsely planted shelterbelt is situated along the eastern boundary (Figure 53). A small section of Clear Creek is located at the southeastern part of the area, which was dry when visited. A fence bisects the area near the centre, running from east to west dividing it into two sections (Figure 54).

Figure 53: Area 8 Looking West Toward Muddy Creek Road

Figure 54: Area 8 Looking North

Figure 55: Area 8 Looking East

Figure 56: Area 8 Looking South Toward Brown Road; Clear Creek Visible (right)

TRANSECT AREA 9

- **Location:** Central Part of the site.
- **S-map Soil Class:** Pallic Soils
- **Soil Drainage**: Imperfectly drained.
- **Topography:** Generally flat
- **Ground Cover:** Lucerne and pasture

Additional Information:

Area 8 is generally flat (Figure 58, Figure 59, Figure 60, Figure 61, Figure 62, Figure 63). There is an area of pine trees located at the northern part of the area (Figure 57). An irrigation race runs along the western boundary (Figure 55) and at the northern end of the area (Figure 57). A storage pond used for irrigation is situated at the central part of area (Figure 64, Figure 65). Water is sourced from the storage dam and is conveyed to the pond via irrigation races (Figure 66). Sheep were observed in the area during the site visit.

Figure 57: Northwestern Corner of Area 9 Looking South; Irrigation Race Along the Western Boundary Visible

Figure 58: Northwestern Corner of Area 9 Looking Southeast

Figure 59: Northwestern Corner of Area 9 Looking East

Figure 60: Area 9 Looking North

Figure 61: Area 9 Looking Northeast

Figure 62: Area 9 Looking South

Figure 63: Area 9 Looking Southwest

Figure 64: Area 9 Looking Southeast

Figure 65: Area 9 Looking West

Figure 66: Smaller Irrigation Storage Pond Looking South

Figure 67: Smaller Irrigation Storage Pond Looking East

Figure 68: Irrigation Race leading to Irrigation Pond Looking West

SUMMARY

Overall, LEI's site walkover of the proposed site at Brown Road, Lauder showed that the site layout is generally consistent with the latest aerial imagery. Ground cover includes lucerne, kale crop and dryland pasture. Shelterbelts of planted pine trees line some paddock boundaries, and some small stands of pine trees are present. The site is well-fenced with good road access. Two surface watercourses run through the site: Clear Creek and a tributary of Lauder Creek. The site's topography is generally flat, with some steeper areas, mostly associated with the banks of surface watercourses. Located at the western side of the site are two main storage ponds, one is a storage dam used for irrigation, and the other is a pond used for stock water. A smaller storage pond is situated at the central part of the site used for irrigation purposes, supplied via irrigation races that convey water from the main storage dam. Sheep and cattle were observed grazing areas of the site during the visit.

APPENDIX C

Soil Investigation Memo

Job 11013

MEMORANDUM

To:	Simon Spark
From:	[redacted] and Analese Fon
Date:	23 June 2025
Subject:	**Soil Assessment Report, Lauder for S.J. Allen**

The memo outlines the findings from the site investigation conducted by Lowe Environmental Impact (LEI) staff between 2nd to 4th April 2025, assessing the suitability of the site for the application of sludge, winery waste, grease trap and mud sump waste.

OVERVIEW

SJ Allen (SJA) currently transports Waste Activated Sludge (WAS) from the Queenstown Lakes District Council (QLDC) community Wastewater Treatment Plants (WWTPs) to landfill, resulting in significant annual disposal costs. To pursue a more sustainable and economically viable solution, SJA is seeking resource consent for the discharge of WAS (referred to as sludge), as well as winery waste, grease trap waste, and mud sump waste to land.

SJA is in discussions with a local property owner near Lauder, with the intention to either purchase the land or enter into a Joint Venture (JV) arrangement. The property, approximately 230 hectares in size, has been identified as a potential site for the land application of sludge and other organic waste streams.

To progress this initiative, SJA has engaged Lowe Environmental Impact (LEI) to carry out a detailed land suitability assessment and to prepare an Assessment of Environmental Effects (AEE) and consent application for the proposed land application of sludge, winery waste, and grease trap and mud sump waste.

This soil investigation memo forms a critical part of the AEE and consent application. It presents the findings of the site investigation, describing the soil's physical and chemical properties and evaluating its capacity to safely receive and process the proposed waste streams through land application.

The site location and soil classification are shown in Figure 1 and Figure 2 respectively.

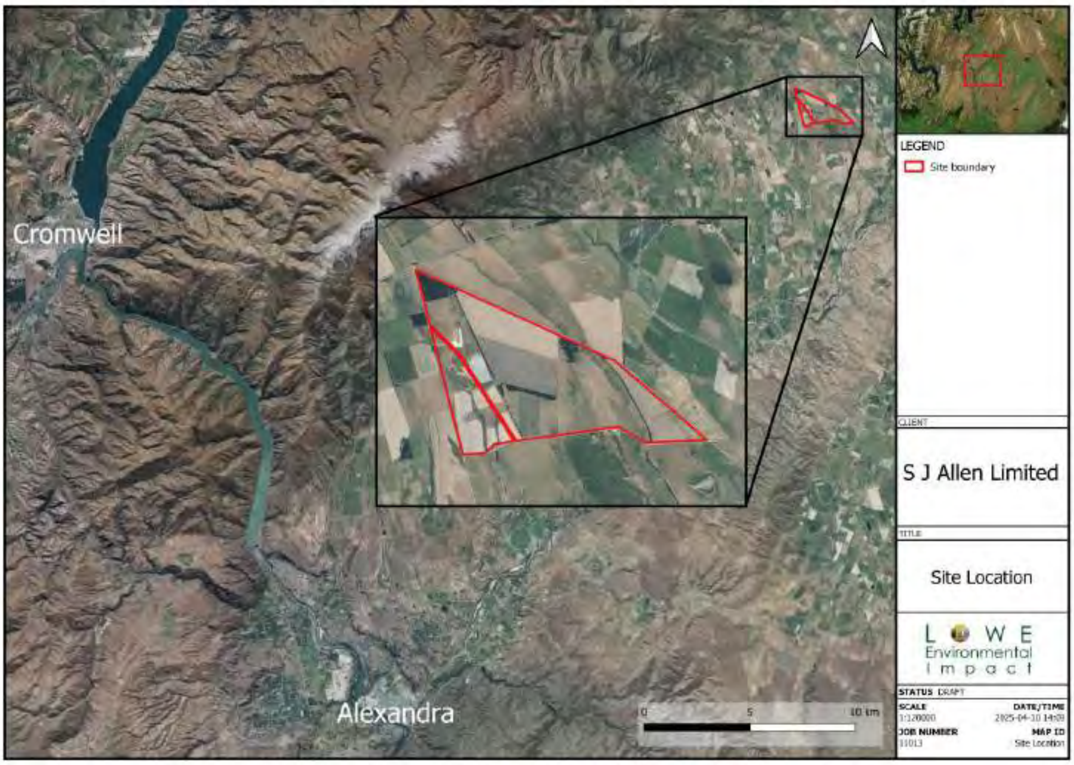


Figure 1: Site Location

SITE CHARACTERISTICS

Soil Desktop Analysis

Before the field investigation, LEI conducted an S-map database analysis to understand the likely properties of the soils at the site. According to S-map, the soils underlying the site are classed as Palic, semi-arid and Gley soils (Figure 2).

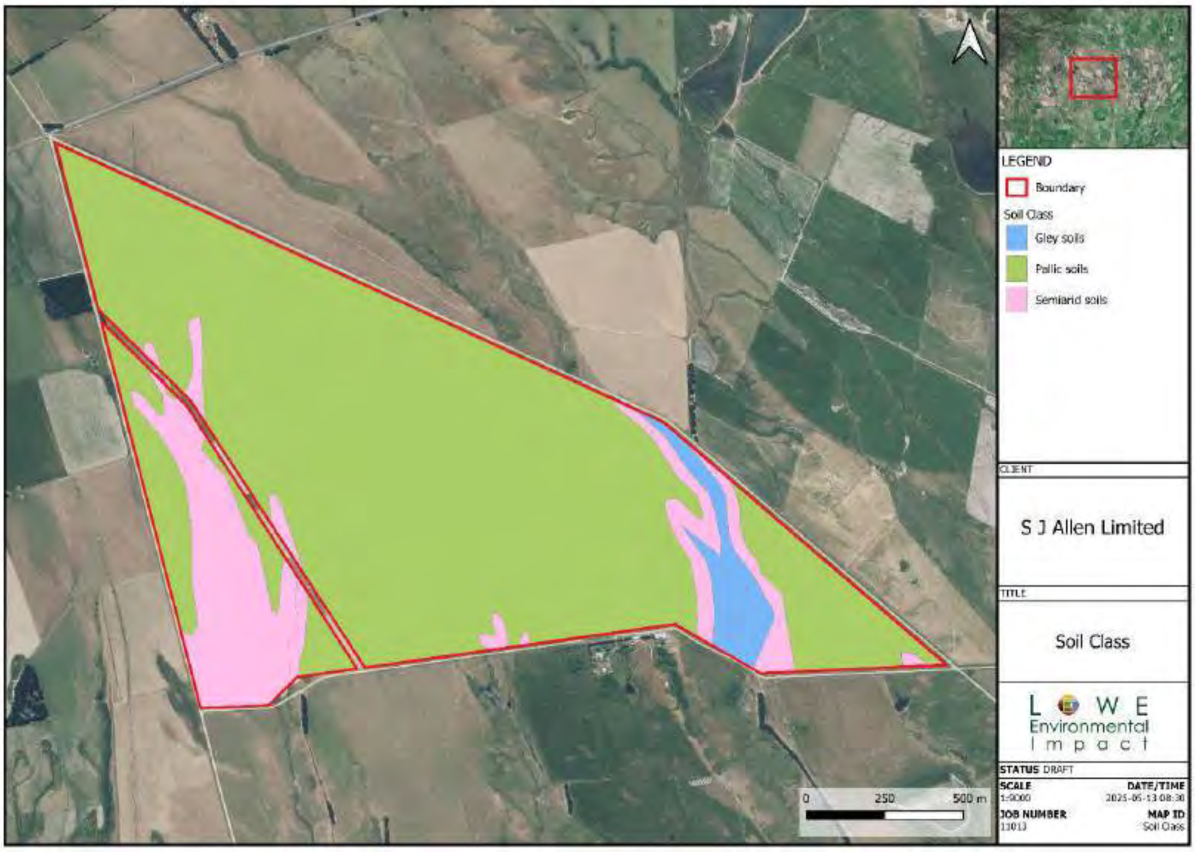


Figure 2: Soil Class According to S-map, Landcare Research

Pallic Soils
According to S-map information, Pallic Soils have pale-coloured subsoils, due to low contents of iron oxides, have weak soil structure, and high density in subsurface horizons. Pallic Soils tend to be dry in summer and wet in winter. The soil is formed in alluvial sand, silt or gravel deposited by running water, from schist parent material.

The topsoil typically has loam texture and is slightly stony. The subsoil has dominantly loam textures, with a very gravelly layer from less than 45 cm mineral soil depth to more than 100 cm. The plant rooting depth extends beyond 1m.

Generally, the soil is imperfectly drained with a high vulnerability of waterlogging in non-irrigated conditions and has moderate 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.

The soil sibling of Aged Argillic Pallic Soils (PJA) is Lindi_4a.1 which comprises 188 ha or 81.5% of the site according to S-map.

The soil profile texture is loam. The topsoil is slightly stony and the topsoil clay ranges 15-25%. The first 10-15 cm is loamy weak, followed by loamy fine slightly firm, very stony loamy compact and extremely stony clayey having thickness of 10-15 cm, 20-30 cm and 40-65 cm subsequently. The permeability of the soil profile is rapid, moderate, moderately slow and slow from top to bottom layers up to 125 cm.

Semiarid Soils

The Semi-arid soils at the property comprise two siblings: Laud_2b.1, covering 27 ha (11.6% of the site area) and Becks_5a.1, covering 8 ha (3.6% of the site area).

Laud_2b.1

This sibling is from the Mottled Argillic Semiarid Soils (SJM) and covers 27 ha or 11.6% of the property. This soil belongs to the Semiarid soil order of the New Zealand soil classification. Semiarid Soils are dry for most of the growing season, and rainfall is not sufficient to leach through the soil, so lime and salts accumulate in the lower subsoil. Nutrient levels are relatively high, but the soils must be irrigated to produce high yields. It is formed in fresh to moderately weathered rock, from soft mudstone parent material. The topsoil typically has silt texture and is stoneless.

The subsoil has dominantly clay textures, with a rock contact at less than 100 cm of the mineral soil depth. The plant rooting depth is 30 - 60 (cm), due to soil material of high density and/or high penetration resistance. Generally, the soil is imperfectly drained with high vulnerability of water logging in non-irrigated conditions, and has moderate to low soil water holding capacity. Inherently these soils have a very high structural vulnerability and a moderate N leaching potential, which should be accounted for when making land management decisions.

Becks_5a.1

Becks_5a.1 sibling, part of the Saline Argillic Semiarid Soils (SJQ), covers a smaller area of 8 ha or 3.6% of the property. Like the Lauder soils, Becks soils also require irrigation to maintain productivity, as the natural rainfall is insufficient to prevent the accumulation of salts and lime in the subsoil. This soil belongs to the Semiarid soil order of the New Zealand Soil Classification.

Semiarid soils are dry for most of the growing season, and rainfall is insufficient to leach through the soil, resulting in the accumulation of lime and salts in the lower subsoil. Nutrient levels are relatively high, but the soils must be irrigated to produce high yields. These soils are formed from fresh to moderately weathered rock, primarily from soft mudstone parent material.

The topsoil typically has a silt texture and is stoneless. The subsoil predominantly has clay textures, with a gravel content of less than 3%. The plant rooting depth is between 30 and 70 cm due to the presence of soil material with high density and/or high penetration resistance.

In general, the soil is well-drained with a low vulnerability to waterlogging in non-irrigated conditions, and it has moderate to low soil water-holding capacity. Inherently, these soils have a high structural vulnerability and a high nitrogen (N) leaching potential, which should be carefully managed.

Gley Soils

The property also includes Gley soils, specifically classified as Typic Orthic Gley Soils. These soils are represented by the Flaxton_105a.1 sibling, covering 8 hectares, or 3.3% of the property.

This soil belongs to the Gley soil order of the New Zealand soil classification. Gley soils are strongly affected by waterlogging, have been chemically reduced, have light grey subsoils, and usually have reddish brown or brown mottles. Waterlogging occurs in winter and spring, and some soils remain wet all year. It is formed in alluvial sand silt or gravel deposited by running water, from schist parent material. The topsoil typically has silt texture and is stoneless. The subsoil has dominantly silt 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 poorly drained with high vulnerability of water logging in non-irrigated conditions, and has high soil water holding capacity. Inherently these soils have a high structural vulnerability and a very low N leaching potential, which should be accounted for when making land management decisions.

FIELD VISIT

Soil Profile Observation

A site investigation was undertaken by a soil scientist and an environmental scientist from LEI from the 2ndto 4th April 2025. The investigation included a site walkover, observations, and a detailed soil investigation comprised of nine machine excavated test pits to a depth of approximately 2 m below the existing ground surface, and the collection of transect soil samples. The location of the test pits/soil profile and transect samples is shown in Figure 3.

A soil profile is a vertical cross-section of the soil that reveals the sequence of natural soil horizons—each representing distinct pedogenic processes, physicochemical properties, and mineralogical compositions.

Understanding the soil profile is essential for accurately characterizing soil genesis, classification, and functional behaviour within the pedosphere. Detailed knowledge of the soil profile enables the identification of key parameters such as horizon depth, texture, structure, bulk density, porosity, permeability, and chemical constituents (e.g., pH, CEC, base saturation, salinity, and nutrient status), which are critical for land evaluation and sustainable resource management.

In agricultural systems, soil profile interpretation informs decisions on crop selection, irrigation scheduling, nutrient management, and erosion control, directly impacting productivity and resilience. In the context of biosolids or sludge application, soil profile analysis is imperative to assess the suitability of receiving soils, determine the risk of leaching and contaminant migration, and develop site-specific application rates and buffer zones. The vertical distribution of soil horizons governs the transport and fate of organic matter, pathogens, heavy metals, and nutrients applied within the sludge, thereby influencing long-term soil health, groundwater protection, and regulatory compliance within land application schemes.

The soil profile and transect sampling locations were selected to understand the nature of the soils at the site for potential sludge application.

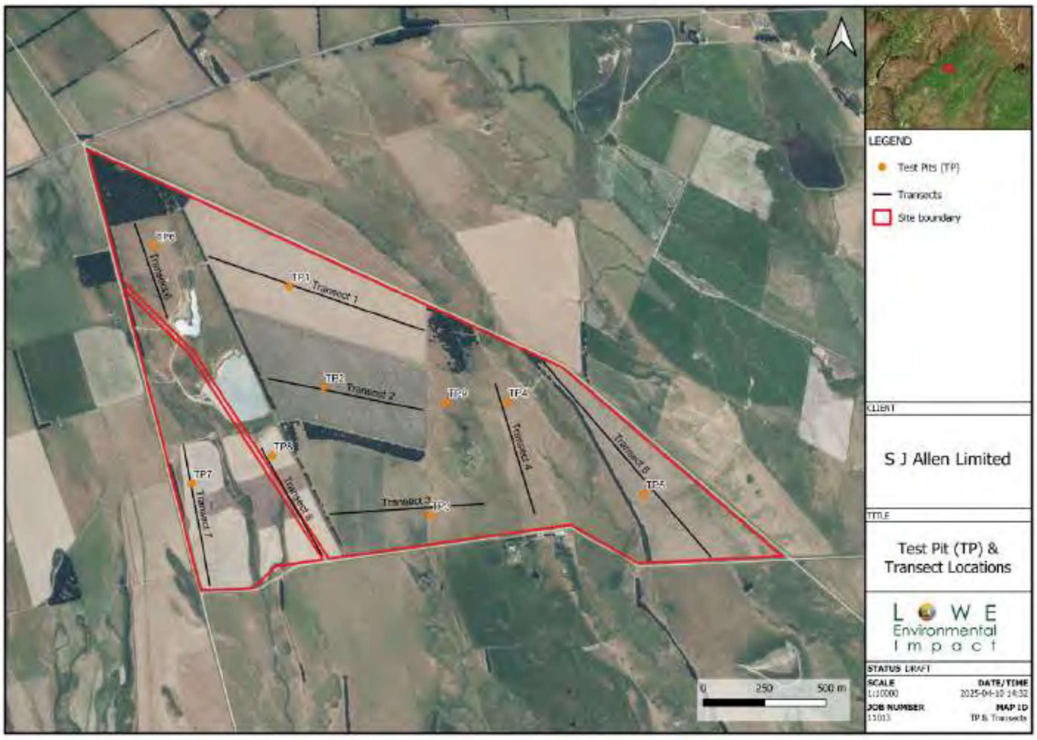


Figure 3: Soil Profile Locations (TP) and Transcends Sampling Locations on the Site

Eight transect samples were collected from areas deemed to be representative of the area for soil's physical and chemical properties analysis.

A total of nine test pits were excavated across the eight transect locations. An additional test pit (Test Pit 9) was excavated among Transects 1, 2, 3 and 4.

For each test pit, a soil profile analysis was conducted, including observations of soil colour, soil texture, soil structure, root depth and abundance, presence and percentage of mottling, moisture conditions, groundwater, and bypass flow signs. The soil profile at each site was photographed and logged.

All test pits had gravels. No bypass flowpaths, mottles or groundwater were observed, to depths of up to 2 m below the ground surface. The absence of mottles in the soil profiles may be due to the fact that these soils at the site receive a very small amount of rainfall year-round as shown in Table 1, with high evapotranspiration.

A description of the potential spreading areas, accompanied by photographs has been appended in the main AEE and consent application.

Table 1: Rainfall and Evapotranspiration Scenario in the Area (www.niwa.co.nz)

Average 1970-2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall average (mm)	62	49	41	44	45	39	30	29	34	51	51	61
Evapotranspiration (PET) (mm)	161	123	93	47	25	11	15	32	65	100	128	156
Surplus/ Deficit (mm)	-100	-74	-52	-3	20	27	15	-3	-32	-48	-77	-95

The field observation of the soil profiles has been given in Table 2 to Table 10. The field observation suggest that all soil profiles appear to be Pallic soils, however, S-map shows that Test Pit 5 is located at the boundary between Pallic and Semi-Arid soils, with TP 5 point reflecting soil characteristics of both soil classes. The nature of the soil materials (the gravels size and amount) implies that the soils are more likely to be Pallic soils which have been originated from schists that is evident from the geology of the area. Furthermore, there was no sign of lime or salt accumulation in the topsoil and subsoil in Test Pit 5 (5A horizon, the first layer in Test Profile 5 and 5B horizon, the second layer in Test Profile 5) horizons chemical analysis (Figure 4 - Figure 29).

Table 2: Test Pit (TP) 1

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	40 cm
Total excavation depth (m)	2 m
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat
Comments	No sign of groundwater up to 2 meters
Location	Lat: 44.99972° S, Lon: 169.65256° E WGS84

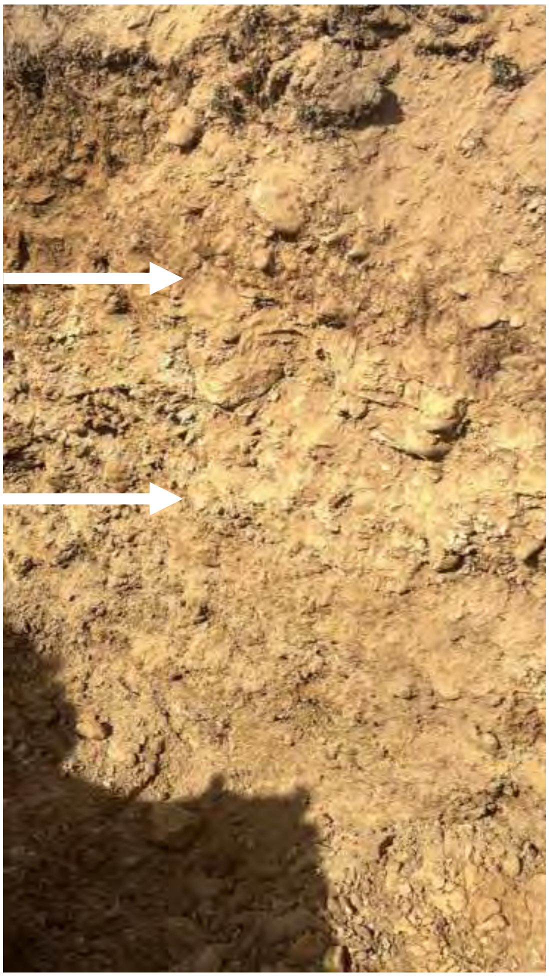
Horizon	Depth (cm)	Description	Image
A	0 - 40	Dry, 5YR 3/2 Dark Reddish Brown Coloured Soil. Roots up to 50 cm, root abundance Common, Slightly Sticky, Slightly Plastic, Medium loam soil texture, slightly gravely (5-15%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
B	40 - 80	Dry, 10YR 7/8 Yellow Coloured Soil, Few roots. Slightly Sticky, Slightly Plastic, Medium loam soil texture, moderately gravely (15-35%), Apedal, single grain, No soil structure/structureless, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
C	80-150	Dry, 10YR 4/6 Dark Yellowish Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clayey loam soil texture, Slightly gravely (5-15%), Apedal, Massive, no soil structure/structureless, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	

Table 3: Test Pit (TP) 2

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	50 cm
Total excavation depth (m)	1.5 m
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat with dykes across the area for irrigation
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00286° S, Lon: 169.65401° E WGS84

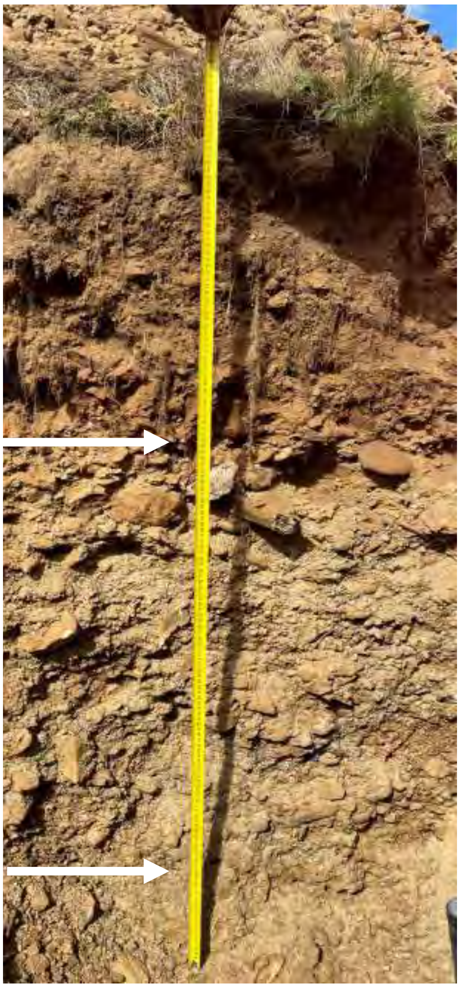
Horizon	Depth (cm)	Description	Image
A	0-50	Dry, 10YR 5/6 Yellowish Brown Coloured Soil, roots up to 60 cm, common abundance. Slightly Sticky, Slightly Plastic, Medium loam soil texture, slightly gravely (5-15%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
B	50-100	Dry, 10YR 6/6 Brownish Yellow Coloured Soil, few roots. Slightly Sticky, Slightly Plastic, Medium loam soil texture, Very gravely (36-70%), Apedal, single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
C	90 – 150	Dry, 10YR 4/3 Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clay loam soil texture, Moderately gravely (5-15%), Apedal, Massive, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	

Table 4: Test Pit (TP) 3

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	40 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00792° S, Lon: 169.65950° E WGS84

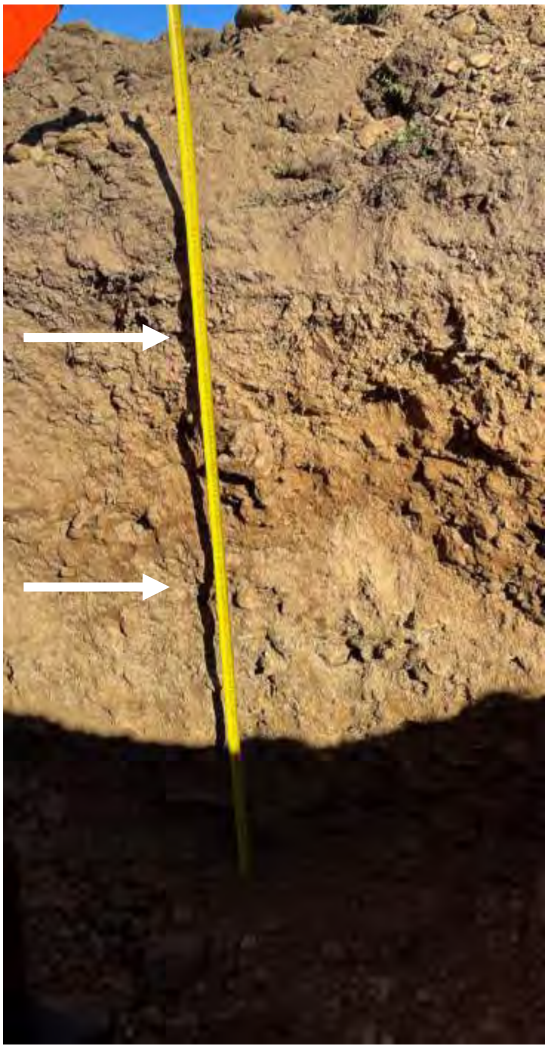
Horizon	Depth (cm)	Description	Image
A	0-25	Dry, 7.5YR 2.5/2 Very Dark Brown Coloured Soil, Common root abundance. Slightly Sticky, Slightly Plastic, Silty loam soil texture, slightly gravely (5-15%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
B	25-75	Dry, 7.5YR 5/6 Strong Brown Coloured Soil, few root abundance. non Sticky, non Plastic, Medium loam soil texture, Moderately gravely (15-35%), Apedal, single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
C	75-150	Dry, 7.5YR 4/6 Strong Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clayey soil texture, Moderately gravely (5-15%), Apedal, Massive, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	

Table 5: Site 4

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	40 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat with steeper areas at the banks of Lauder Creek Tributary
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00410° S, Lon: 169.66353° E WGS84

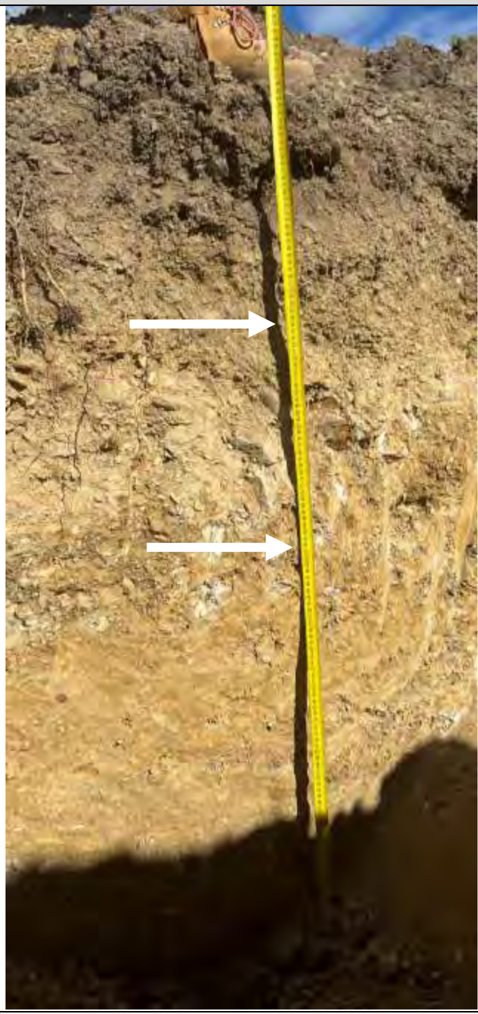
Horizon	Depth (cm)	Description	Image
A	0-40	5YR 3/3 Dark Reddish Brown Coloured Soil, roots up to 50 cm, Common root abundance, Slightly Sticky, Slightly Plastic, Blocky soil structure, fine size, Clay loam soil texture, No gravels, No mottles, Indistinct, Irregular boundary, no bypass flow signs.	
B	40-80	10Y 5/6 Yellowish Brown Coloured Soil, few root abundance. Silty clay loam soil texture, Slightly Plastic but less than topsoil, slightly sticky, Moderately gravely, Blocky soil structure, slightly firm, no mottles, no bypass flow signs	
BC	80+	10YR 4/6 Dark Yellowish Brown Coloured Soil, no roots. Slightly plastic, Slightly sticky, Clayey soil texture, Moderately gravely (15-35%) No structure, Apedal, Massive, no bypass flow signs.	

Table 6: Test Pit (TP) 5

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	20 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat with a gradual slope towards the intersection between Drybread Road and Brown Road
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00770° S, Lon: 169.67056° E WGS84

Horizon	Depth (cm)	Description	Image
A	0 - 30	Dry, 5Y 3/3 Dark Olive Grey Coloured Soil, Many root abundance. Slightly Sticky, Slightly Plastic, Silty loam soil texture, Moderately gravely (15-35%), Blocky soil structure, fine size, Slightly firm, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
B	30-60	Dry, 5Y 4/2 Olive Grey Coloured Soil, few root abundance. non Sticky, non Plastic, Medium Loam soil texture, Moderately gravely (15-35%), Apedal, single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	
C	60-150	Dry, 5Y 7/2 Light Grey Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clay loam soil texture, Very gravely (35-70%), Apedal, Single grain, no soil structure, No mottles, Indistinct, Smooth boundary, no bypass flow signs.	

Table 7: Test Pit (TP) 6

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	40 cm
Total excavation depth (m)	2 m
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat, slightly sloping down around the stock water pond and irrigation dam
Comments	No sign of groundwater up to 2 meters
Location	Lat: 44.99783° S, Lon: 169.64575° E WGS84

Horizon	Depth (cm)	Description	Image
A	0-30	7.5YR 3/3 Dark Brown Coloured Soil, roots up to 50 cm, Common root abundance, Slightly Sticky, Slightly Plastic, Medium loam soil texture, Slightly gravely (5-15%), Blocky soil structure, fine size, No mottles, Sharp, Smooth boundary, no bypass flow signs.	
B1	30-65	7.5YR 5/6 Strong Brown Coloured Soil, few rrot abundance. Medium loam soil texture, Slightly Plastic, slightly sticky, Moderately gravely, Apedal, Single grain, no structure, no mottles, no bypass flow signs.	
B2	65-85	7.5YR 5/4 Brown Coloured Soil, no roots, Very gravely (35-70%), non plastic, non sticky, Clay loam soil texture, Blocky, weak, no bypass flow signs.	
C	85-200	7.5YR 3/3 Dark Brown Coloured Soil, no roots, Slightly gravely (5-15%), Slightly plastic, Slightly sticky, Clayey soil texture, Apedal, massive, no bypass flow signs.	

Table 8: Test Pit (TP) 7

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	50 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat, becoming more undulating towards the southern end of the area and steeper along the banks of Clear Creek
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00660° S, Lon: 169.64720° E WGS84

Horizon	Depth (cm)	Description	Image
A	0-50	Dry, 7.5YR 3/2 Dark Brown Coloured Soil. Roots up to 60 cm, Common root abundance, Slightly Sticky, Slightly Plastic, Silty clay loam soil texture, very slightly gravely (1-5%), Blocky soil structure, medium size, Slightly firm, No mottles, Indistinct, Occluded boundary, no bypass flow signs.	
B	50-100	Dry, 10YR 6/6 yellowish Brown Coloured Soil, few root abundance. Slightly Sticky, Slightly Plastic, Silty Clay loam soil texture, Moderately gravely (15-35%), Apedal, Diffuse, Occluded boundary, Massive, no bypass flow signs.	
C	100-150	Dry, 7.5YR 5/6 Strong Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Clay loam soil texture, Slightly gravely (5-15%), Apedal, Massive, No mottles, Indistinct, Occluded boundary, no bypass flow signs.	

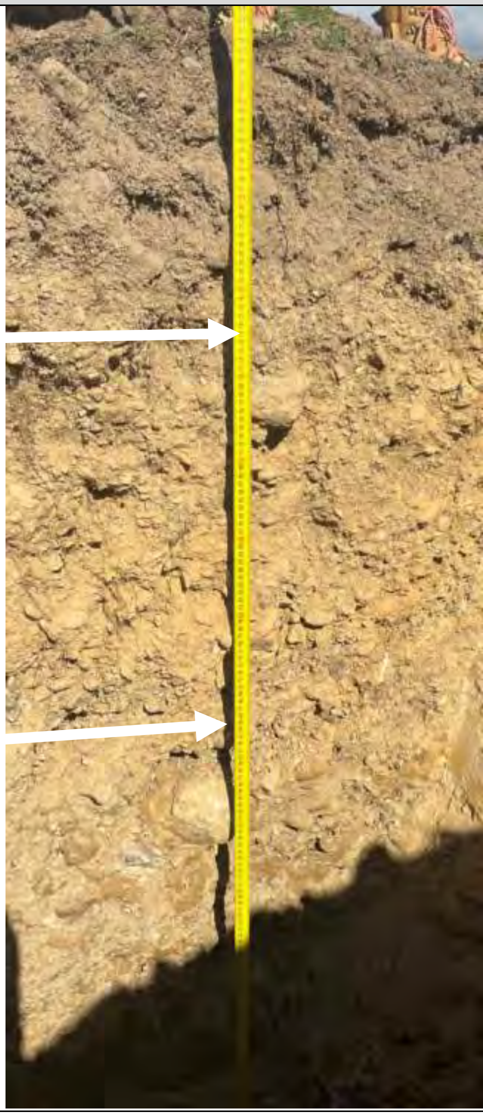
Table 9: Test Pit (TP) 8

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	30 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00566° S, Lon: 169.65118° E WGS84

Horizon	Depth (cm)	Description	Image
A	0-30	Dry, 7.5YR 3/3 Dark Brown Coloured Soil, Common root abundance. Roots up to 30 cm, Slightly Sticky, Slightly Plastic, Silty clay loam soil texture, very slightly gravely (1-5%), Blocky soil structure, medium size, Slightly firm, No mottles, Indistinct, Occluded boundary, no bypass flow signs.	
B	30-90	Dry, 10YR 6/8 Brownish yellow Coloured Soil, few root abundance, Non Sticky, slightly Plastic, Sandy clay loam soil texture, Very gravely (35-70%), Apedal, Diffuse, Occluded boundary, Massive, no bypass flow signs.	
C	90-150	Dry, 10 YR 5/6 Strong Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Silty Clay soil texture, Slightly gravely (5-15%), Apedal, Massive, No mottles, Indistinct, Occluded boundary, no bypass flow signs.	

Table 10: Test Pit (TP) 9

Soil	Lindis stony fine sandy loam (S-map)
NZSC	Aged Argillic Pallic Soils (PJA)
Site name	Lauder
Drainage	Imperfectly drained (S-map)
Topsoil depth (cm)	30 cm
Total excavation depth (m)	1.5
Limiting horizon	-
Weather	Sunny
Topography of the area	Generally flat
Comments	No sign of groundwater up to 1.5 meters
Location	Lat: 45.00408° S, Lon: 169.66054° E WGS84

Horizon	Depth (cm)	Description	Image
A	0-30	Dry, 10YR 5/2 Greyish Brown Coloured Soil. Roots up to 60 cm, Common root abundance. Slightly Sticky, Slightly Plastic, Clay loam soil texture, very slightly gravely (1-5%), spheroidal soil structure, medium size, Slightly firm, No mottles, Abrupt, Occluded boundary, no bypass flow signs.	
B	30-80	Dry, 7.5YR 6/6 Reddish yellow Coloured Soil, few root abundance. Slightly sticky, slightly plastic, medium loam soil texture, Very gravely (35-70%), Apedal, Diffuse, Occluded boundary, Single grain, no bypass flow signs.	
C	80-150	Dry, 10 YR 5/8 Yellowish Brown Coloured Soil, no roots. Slightly Sticky, Slightly Plastic, Silty clay soil texture, Slightly gravely (5-15%), Apedal, Massive, No mottles, Indistinct, Occluded boundary, no bypass flow signs.	

LABORATORY ANALYSIS OF SOIL PROPERTIES

Two types of soil samples were collected from each of the 9 Test Pits (Table 11):

- Soil core samples (analysed at Landcare Research for soil pores and bulk density) and
- Soil samples from the topsoil (A horizon) and subsoil (B horizon) from each Test Pit (analysed at Hill Laboratory for chemical analysis)

Additionally, 8 transect soil samples were collected from the locations as shown in Figure 3. The transect samples were collected along a transect line at depths of 0-15 cm using a soil corer. Samples were collected approximately every 15-20 meters along each transect line. The collected soil samples from each transect was mixed thoroughly to get a representative soil sample (Table 12).

For Transect 3, two soil samples were collected and analysed separately due to the presence of two different vegetation types along the transect: 'T3 Crop' which was cropped with kale, and 'T3' which had grass cover.

Table 11: Soil Test Pit Samples Number Clarification

Soil Profile (Test Pit) Samples	Topsoil is the A horizon and Sub soil is the B horizon. Detailed descriptions of these layers can be found in the Soil Profile / Test Pit Tables (from Table 2 to Table 10)
1A	Test Pit 1 (Topsoil)
1B	Test Pit 1 (Subsoil)
2A	Test Pit 2 (Topsoil)
2B	Test Pit 2 (Subsoil)
3A	Test Pit 3 (Topsoil)
3B	Test Pit 3 (Subsoil)
4A	Test Pit 4 (Topsoil)
4B	Test Pit 4 (Subsoil)
5A	Test Pit 5 (Topsoil)
5B	Test Pit 5 (Subsoil)
6A	Test Pit 6 (Topsoil)
6B	Test Pit 6 (Subsoil)
7A	Test Pit 7 (Topsoil)
7B	Test Pit 7 (Subsoil)
8A	Test Pit 8 (Topsoil)
8B	Test Pit 8 (Subsoil)
9-0-30 cm	Test Pit 9 (Topsoil)
9-30-60 cm	Test Pit 9 (Subsoil)
9-60-90 cm	Test Pit 9 (Subsoil)
9-90-120 cm	Test Pit 9 (Subsoil)

Table 12: Transect Soil Samples Number Clarification

Transect Samples Notation	Actual Meaning
T1	Transect soil sample 1
T2	Transect soil sample 2
T3	Transect soil sample 3 covered with grass
T3-Crop	Transect soil sample 3 covered with Kale
T4	Transect soil sample 4
T5	Transect soil sample 5
T6	Transect soil sample 6
T7	Transect soil sample 7
T8	Transect soil sample 8

The results of the laboratory analysis of soils have been given below.

SOIL PHYSICAL PROPERTIES

To understand the Physical properties, soil core samples from each Test Pits (top soil, 0-15 cm) was taken and sent to Landcare Research for soils physical property analysis.

The soil core samples have been collected from the top 0-15 cm of the soils from the Test Pits to understand the bulk density, particle density, porosity and water holding capacity of soils. Table 13 shows the Soil's Particle Density, Bulk Density and Porosity at different Test Pits and Table 14 shows the water holding capacity of soils at different Test Pits.

The soils having bulk density near to one implies that there are sufficient pore spaces for microbes and plant roots to have favourable condition for their optimum growth and production.

Test Pit 2 had the lowest bulk density 1.05 (g cm^{-3}) whereas the Test Pit 8 had the highest bulk density of 1.33 (g cm^{-3}) (Table 13).

Table 13: Soil's Particle Density, Bulk Density and Porosity at Different Test Pits

Test Pits	Particle density (g cm^{-3})	Dry bulk density (g cm^{-3})	Porosity (%)	Micro-porosity (-10 kPa) (%)	Air Capacity (%)	Field Capacity (%)
Test Pit 1	2.55	1.22	52	32	23	29
Test Pit 2	2.52	1.05	58	39	26	33
Test Pit 3	2.57	1.28	50	30	22	28
Test Pit 4	2.52	1.12	56	35	23	33
Test Pit 5	2.50	1.07	57	33	28	29
Test Pit 6	2.55	1.25	51	32	23	28
Test Pit 7	2.61	1.29	51	35	19	31
Test Pit 8	2.60	1.33	49	27	24	25
Test Pit 9	2.55	1.21	52	33	21	31

Test Pit 2 had the highest gravimetric water content 55 (%w/w) at saturation whereas the Test Pit 8 had the lowest gravimetric water content of 36 (%w/w) at saturation (Table 14).

Table 14: Water Holding Capacity of Soils at Different Test Pits

Test Pits	Gravimetric water content				Volumetric water content			
	@ FM	@ Sat	@ -5 kPa	@ -10 kPa	@ FM	@ Sat	@ -5 kPa	@ -10 kPa
	(%w/w)	(%w/w)	(%w/w)	(%w/w)	(%v/v)	(%v/v)	(%v/v)	(%v/v)
Test Pit 1	11	43	26	24	13	52	32	29
Test Pit 2	21	55	37	31	23	58	39	33
Test Pit 3	11	39	23	22	14	50	30	28
Test Pit 4	12	50	32	29	13	56	35	33
Test Pit 5	14	54	31	27	15	57	33	29
Test Pit 6	12	41	25	23	15	51	32	28
Test Pit 7	9	39	27	24	11	51	35	31
Test Pit 8	6	36	21	19	8	49	27	25
Test Pit 9	12	43	27	26	14	52	33	31

(FM = Field Moisture)

SOIL CHEMICAL PROPERTIES

To evaluate the chemical properties of the soil, representative samples were collected and submitted for analysis to an accredited laboratory (Hill Laboratories).

A total of 9 composite soil samples (including both 'T3' and 'T3 Crop') were taken for soil chemistry analysis across the 8 transects in proximity of each of the sampling locations. Samples were retrieved using a foot corer to a depth of 150 mm at 10-15 m intervals across an approximate 300 m transect, resulting in 10-20 cores per sample. Collected samples across the transects were taken from areas that are generally flat and likely to be suitable for sludge application, and were situated away from features such as gateways, fence lines, troughs, and vehicle tracks etc. The soil samples from each transect were mixed to get a representative composite sample each transect. As previously mentioned, two composite samples were collected from Transect 3 as one area was cropped with kale (T3 Crop) and another area had grass cover (T3).

A total of 20 samples from the test pit soil profiles were taken for soil chemistry analysis. For Test Pits 1-8, two soil samples were collected from the topsoil (A horizon) and subsoil (B horizon). For Test Pit 9, four soil samples were collected from the following depths: 0-30 cm, 30-60 cm, 60-90 cm and 90-120 cm. Samples were tested at Hill Laboratories for the following parameters:

- pH
- Olsen P, total nitrogen, total phosphorus and total carbon %
- Exchangeable cations (Potassium, Calcium, Magnesium & Sodium) and Cation Exchange Capacity (CEC)
- Total carbon, total nitrogen, C/N ratio and organic matter for transect samples
- Heavy Metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn)

Soil analysis results are included in Appendix A and are discussed below.

pH

Optimal soil pH is crucial for plant growth and nutrient availability. For pasture growth, the ideal pH range is between 5.5 and 6.3 (Sparling et al., 2008). This range ensures that essential nutrients are readily available to plants. Alkaline pH can reduce the availability of essential macronutrients like phosphorus, iron, and manganese, potentially leading to nutrient deficiencies that affect plant growth (Brady and Weil, 2008; McLaren and Cameron, 1996).

Maintaining soil pH within the optimal range is vital for healthy plant growth and maximizing agricultural productivity.

The pH values in the samples from the test pit soil profiles from the A horizon (topsoil) and B horizon (subsoil) ranged from 5.0 to 6.0. The lowest pH (5.0) was observed in sample 3A, and the highest pH (6.0) in sample 6B.

The pH values from the test pit soil profile samples are presented in Figure 4. pH is a measure of the acidity or alkalinity of a substance, with values ranging from 0 to 14. A pH of 7 is neutral, values below 7 are acidic, and values above 7 are alkaline.

Soil pH is a measure of how acidic or alkaline the soil is, on a scale from 0 to 14. It influences the availability of essential nutrients and affects microbial activity in the soil (Sparling et al., 2008). Alkaline pH can reduce the availability of essential macronutrients like phosphorus, iron, and manganese, potentially leading to nutrient deficiencies that affect plant growth (Brady and Weil, 2008; McLaren and Cameroon, 1996). With elevated levels, there is an increased likelihood of elevated calcium, magnesium, sodium and potassium in soil solution which can create osmotic pressure for plants that hinders plant water and nutrient uptake.

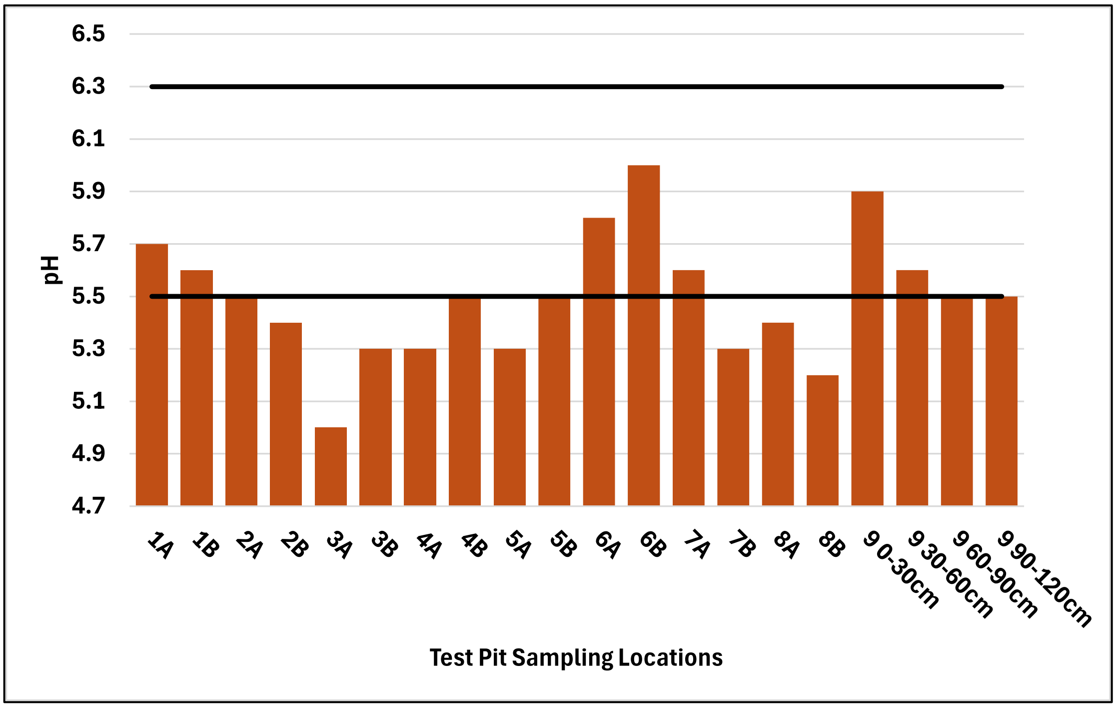


Figure 4: pH of Soil Samples in the Test Pits (Soil Profiles)

The pH values for the transect samples ranged from 5.4 to 5.9, with the lowest pH observed in samples T3 and T4, and the highest in T3 Crop (Figure 5).

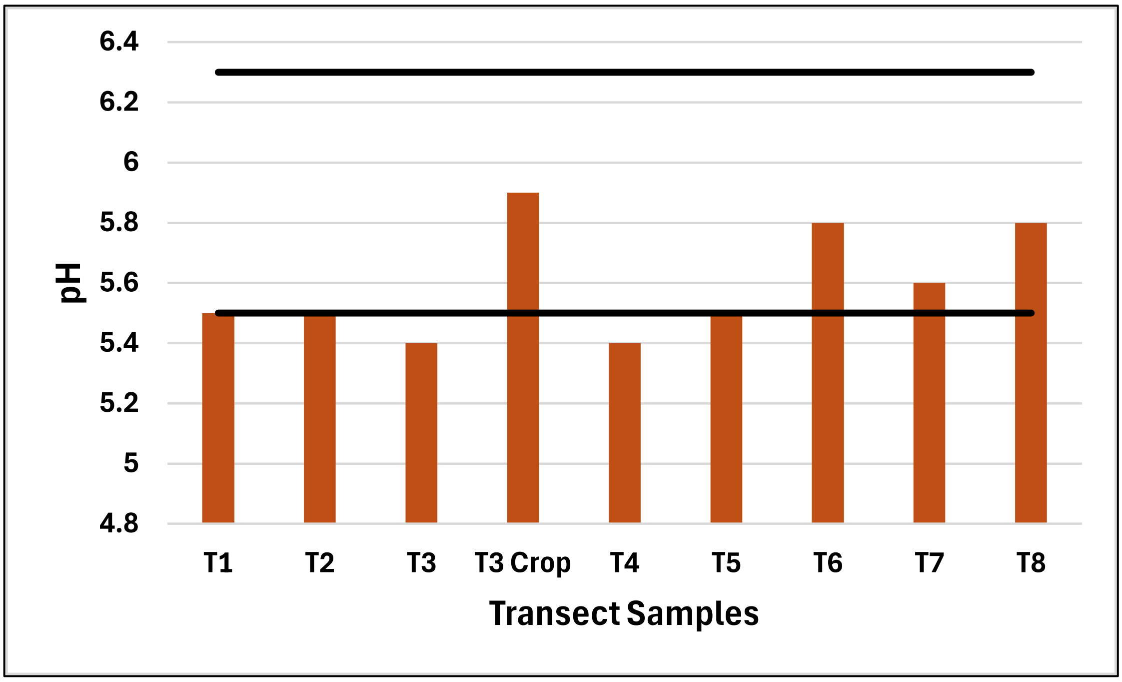


Figure 5: pH of Soil Samples in the Transects

Maintaining pH within the optimal range is beneficial for nutrient availability and plant growth.

Olsen P

The Olsen P values for the test pit soil profile samples ranged from 4 to 29 (Figure 6). The lowest value (4) was observed in samples 8A and 9 90-120cm, while the highest value (29) was recorded in sample 5B. None of the samples exceeded the highest limit of 50 of the adequate range of Olsen P in soils for plant growth, with all values being much lower as reported by Sparling et al. (2008).

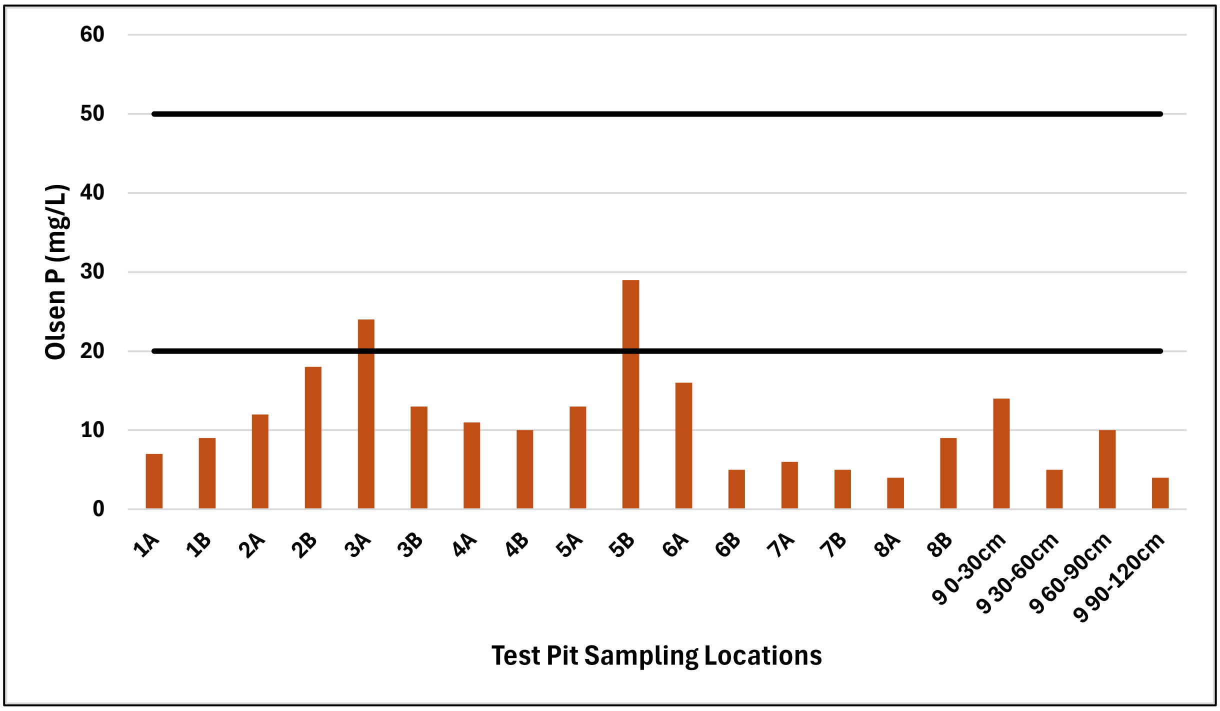


Figure 6: Olsen P in Soil Samples in the Test Pits (Soil Profiles)

The Olsen P values for the transect samples are presented in Figure 7 below. The Olsen P values across all samples fall below the adequate lower range threshold of 20 mg/kg (Sparling et al., 2008), indicating phosphorus deficiency across each transect area. The highest Olsen P concentration is found in the T4 sample (16), followed closely by T3 Crop (15), while the lowest values (9) are observed in T6, T7, and T8.

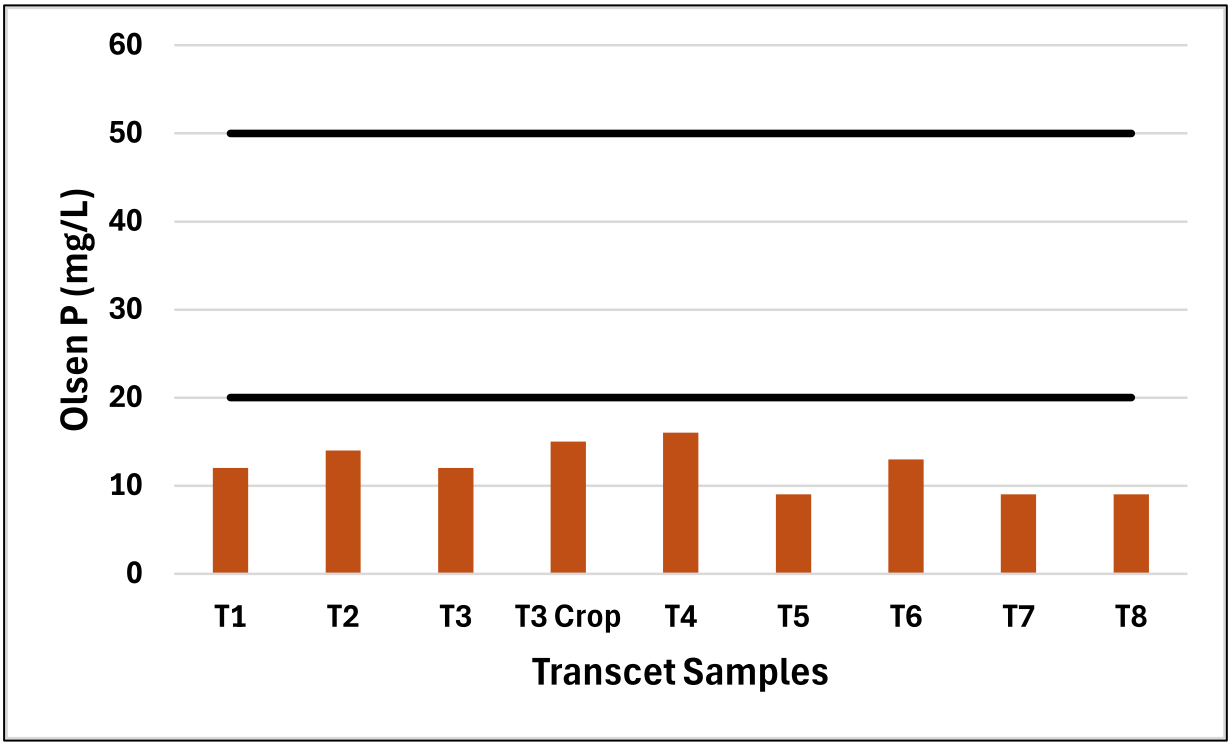


Figure 7: Olsen P in Soil Samples in the Transects

These results suggest that none of the soils meet the recommended phosphorus levels for optimal plant growth, potentially limiting crop productivity. The overall trend highlights the need for phosphorus fertilization or soil amendments to elevate the available P to within the optimal range of 20–50 mg/kg. Addressing these deficiencies will be crucial for improving soil fertility and ensuring healthy plant development across the transects.

Olsen P is a measure of plant-available phosphorus (P) in soils (Olsen et al., 1954). Unlike total phosphorus, which encompasses both labile (available) and non-labile (unavailable) pools, Olsen P quantifies the fraction of phosphorus that is readily soluble or weakly adsorbed to soil particles and thus directly accessible for plant uptake during the growing season.

Understanding Olsen P is critical for effective nutrient management because phosphorus is a key macronutrient involved in energy transfer (ATP), nucleic acid synthesis, and root development. However, phosphorus is also highly immobile in soil, and its availability is tightly regulated by sorption-desorption equilibria, pH, and interactions with aluminium (Al^{3+}), iron (Fe^{3+}), and calcium (Ca^{2+}) compounds.

Thus, reliance on total P alone can be misleading when evaluating soil fertility. Monitoring Olsen P provides a more accurate assessment of phosphorus availability that enhances crop productivity while minimising the risk of environmental P losses through runoff or leaching. Additionally, Olsen P data are essential for evaluating the effectiveness of organic amendments, such as sludge in supplying plant-available phosphorus under field conditions.

Total Phosphorus

The total phosphorus concentration in the transect soil samples ranges from 0.05 to 0.06% with the highest concentration being 0.063% in the T3 Crop sample and the lowest at 0.047% in the T7 sample (Figure 8). The T3 Crop sample had the highest total phosphorus concentration.

The total phosphorus in the transect samples imply that the whole area has total P on the lower end of the typical values observed in soils. According to McLaren and Cameron (1996), the concentration of total P in soils ranges from 0.02 to 0.15%. The concentration of total P is lower than half of the typical values in the transect samples.

The soils at the site will require P fertilizer application for optimum plant production as the Olsen P and total phosphorus is either lower than the range or close to the lower range in most of the samples. The Olsen P values in the transect samples and soil profile samples show that the soils at the site generally have low plant available P content.

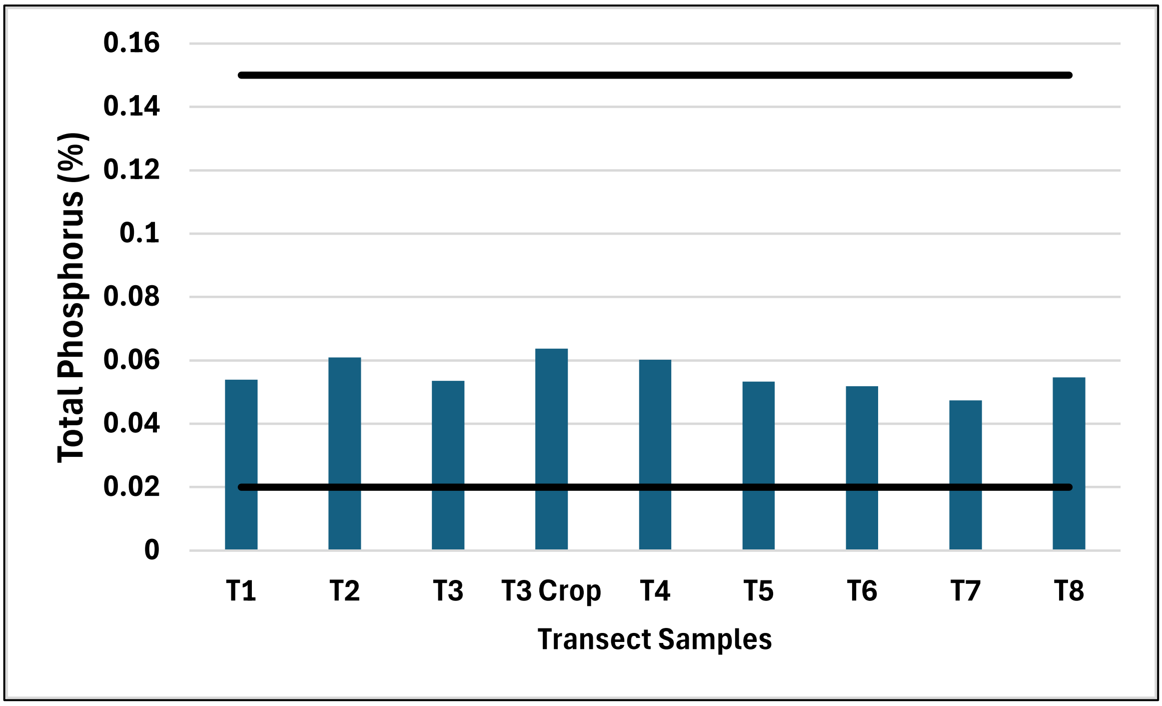


Figure 8: Total P (%) in Soil Samples in the Transects

Total phosphorus (Total P) refers to the sum of all forms of phosphorus present in the soil, including inorganic and organic, labile and non-labile fractions. This encompasses phosphorus in solution, adsorbed to soil particles, incorporated in soil minerals (such as apatite), bound to organic matter, or occluded within secondary compounds. Phosphorus is an essential macronutrient for plants, critically involved in energy metabolism (ATP/ADP), nucleic acid synthesis, enzyme regulation, photosynthesis enhancement, and root architecture development (Brady and Weil, 2008). It also contributes significantly to reproductive processes such as flowering and seed formation.

While total P provides an indication of the overall phosphorus reservoir in the soil, it does not differentiate between phosphorus that is plant-available and that which is strongly bound or immobilized in soil matrices. In highly weathered or phosphorus-fixing soils—such as those with high iron and aluminum oxide content or allophanic soils—total P can be relatively high, yet the proportion accessible to plants may be extremely limited due to strong adsorption and fixation reactions.

Understanding total P is important for assessing the long-term phosphorus capital of the soil and for evaluating the cumulative impacts of P application, sludge application, or organic amendments. For example, when materials such as sewage sludge, winery waste, grease trap residues and mud sump are applied to land, they contribute to the total phosphorus pool. However, their agronomic value and environmental risk depend on how much of that total phosphorus becomes plant-available over time. (Brady and Weil, 2008).

Phosphorus in soils plays a pivotal role in energy transfer within plants by forming ATP, the molecule that stores and transports chemical energy critical for growth processes. Adequate soil phosphorus accelerates root development, enabling plants to establish robust underground systems that enhance water and nutrient uptake. By promoting cell division and enlargement, phosphorus contributes to vigorous shoot growth and healthy foliage. Sufficient phosphorus levels support early seedling vigor and uniform crop establishment, giving plants a competitive advantage during the critical initial stages of growth. Phosphorus is also crucial for flowering and fruit set, directly impacting crop yield and quality by facilitating reproductive development. Moreover, phosphorus aids in strengthening plant defences against various stress factors, including drought and disease, by enhancing metabolic efficiency and resilience.

Overall, maintaining optimal phosphorus concentrations in soils is fundamental for sustaining high productivity and ensuring the successful completion of plants' life cycles. The addition of phosphorus (P) will benefit plant growth by enhancing nutrient availability and supporting vital physiological processes (Sparling et al., 2008, Brady and Weil, 2008, McLaren and Cameron, 1996).

Total Carbon

Soil carbon is the measure of soil organic and inorganic carbon. In mineral soils (such as the soils present in these areas) it is usually the organic matter that comprises most of the total carbon (Brady and Weil, 2008).

The Total Carbon (TC) in the transect samples ranged from 2.9% to 4.9%, with a range of 2.0%, indicating moderate variability in carbon content. The majority of values cluster between 3.3% and 4.3%, suggesting a relatively stable baseline with occasional outliers (e.g., the peak at 4.9% and the low of 2.9%) (Figure 9).

TC serve as an indicator of organic matter, soil health, or material composition. Higher TC value reflects enriched organic activity or carbon sequestration potential, while lower values (e.g., 2.9%) signal lower microbial activity, weak soil structure, less soil aeration, less root penetration etc. Organic matter addition will improve the soil's carbon content allowing for the improvement for overall soil health.

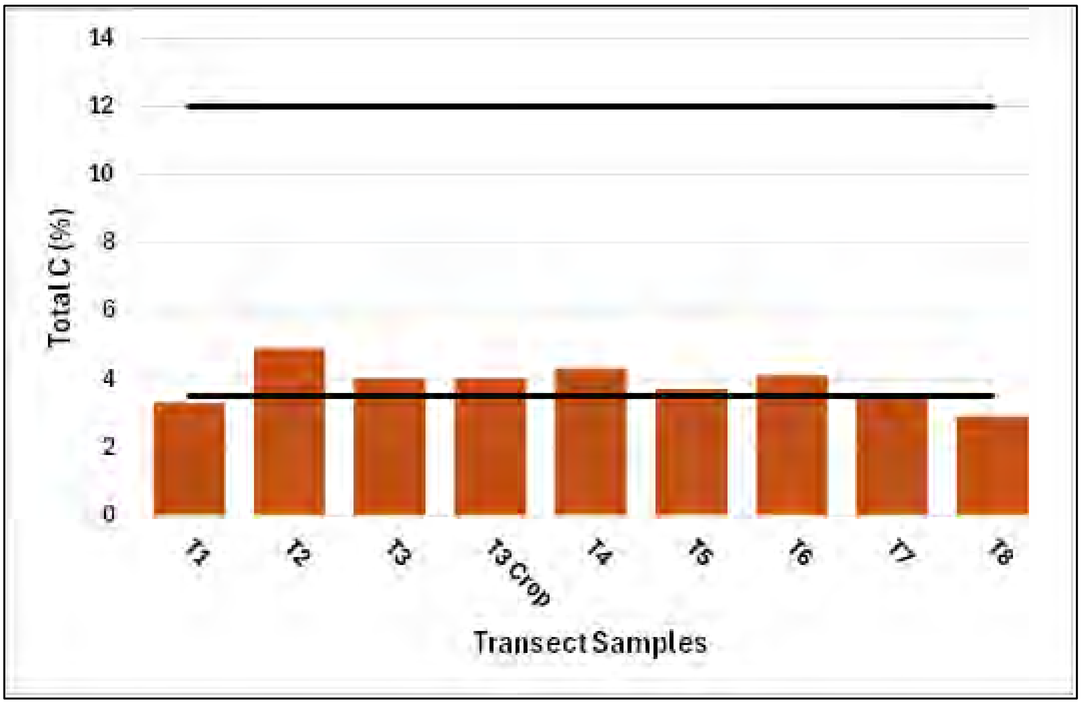


Figure 9: Total Carbon in Transect Samples

There are no upper limits defined for soil carbon levels, with the general principle being 'more is better.' However, the desirable minimum level is 3.5% for soils, including Pallic Soils (Sparling et al., 2008). Soil carbon encompasses both organic and inorganic forms, such as carbonate and bicarbonate salts. The sites soils have soil carbon and organic matter at the lower end of the adequate range (Sparling et al., 2008), indicating the addition of organic matter/total carbon will contribute to a healthy soil ecosystem.

A healthy soil ecosystem is crucial for environmental sustainability and human well-being, offering numerous benefits. Rich in beneficial microorganisms like bacteria, fungi, and earthworms, healthy soils facilitate nutrient cycling by breaking down organic matter and releasing nutrients that plants can absorb, thus maintaining soil fertility and reducing the need for chemical fertilizers. The balanced physical structure of healthy soils improves water retention and infiltration, reducing surface runoff and soil erosion, and preserving soil integrity. Healthy soils provide a stable habitat for microorganisms that decompose organic material, recycle nutrients, and maintain balanced pH levels, promoting better root growth and robust plant development. Additionally, healthy soils contribute to carbon sequestration, mitigating climate change by storing carbon that would otherwise be released as carbon dioxide.

Overall, a healthy soil ecosystem is essential for sustaining agricultural productivity, preserving biodiversity, and supporting ecosystem resilience and climate regulation. High soil carbon levels imply a high amount of organic matter, which acts as a buffer to balance soil pH and nutrients.

CN Ratio

The carbon-to-nitrogen (C:N) ratio in the transect soil samples ranged from 11.15 (T8) to 12.90 (T3) (Figure 10), indicating relatively consistent and balanced organic matter decomposition conditions across the transects. All samples fall within the typical range for agricultural soils (around 11–15), suggesting that microbial activity is likely not limited by nitrogen availability and this range is good for the environmental and growth perspective of plants in pasture soils (Sparling et al., 2008). The slightly higher C:N ratio in T3 may indicate a marginally slower decomposition rate or a greater input of carbon-rich organic matter. Conversely, the lower C:N ratio in T8 suggests more rapid organic matter turnover and potentially better nitrogen mineralization, which can support plant nutrient availability.

Overall, the uniformity of the C:N ratios implies stable organic matter dynamics, with no significant nutrient imbalances across the transects.

The carbon-to-nitrogen (C:N) ratio is a critical parameter in soil and organic matter management, representing the proportion of organic carbon to total nitrogen in a given material. It directly influences microbial activity, nutrient mineralization, and the rate of organic matter decomposition. A balanced C:N ratio (typically between 10:1 and 20:1) is essential for efficient microbial processing, as soil microorganisms use carbon as an energy source and nitrogen for cellular synthesis. When organic inputs such as biosolids, or sludge are applied to land, their C:N ratio determines whether they will cause net mineralization—releasing plant-available nitrogen—or immobilization, temporarily binding nitrogen and limiting its availability to crops.

Materials with high C:N ratios (e.g., sawdust) tend to decompose slowly and can tie up nitrogen, while those with low C:N ratios (e.g., fresh sludge or manure) decompose rapidly, often releasing nitrogen that can enhance fertility but may also leach if not managed properly. Understanding the C:N ratio is therefore fundamental for optimizing nutrient cycling, improving soil structure, and ensuring environmentally responsible land application of organic amendments.

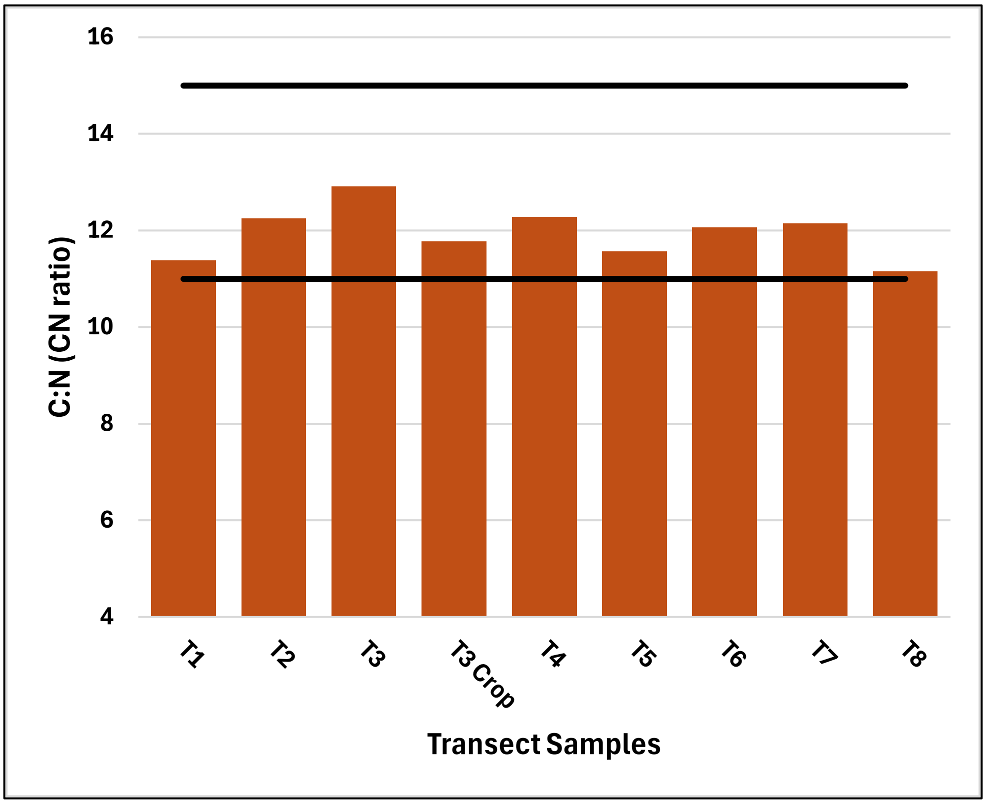


Figure 10: CN ratio (C:N) in Transect Samples

Total Nitrogen

The total nitrogen content in the soil samples shows variability across the transects, with values ranging from 0.26% (T8) to 0.40% (T2) (Figure 11). Only T2 is in the adequate threshold of 0.35% - 0.65% (Sparling et al., 2008), suggesting it has just sufficient nitrogen for supporting healthy plant growth without additional inputs. Samples T3 Crop, T4, and T6 are just at or slightly below the adequate lower limit, indicating marginal sufficiency and the potential need for monitoring or light supplementation. In contrast, the lowest values in T7 (0.28%) and T8 (0.26%) fall well below the adequate range, highlighting nitrogen deficiency that could limit crop productivity.

Overall, most of the soils are below the adequate nitrogen threshold and far from highest level of adequate (0.65%), emphasizing the need for improved nitrogen management across the transects.

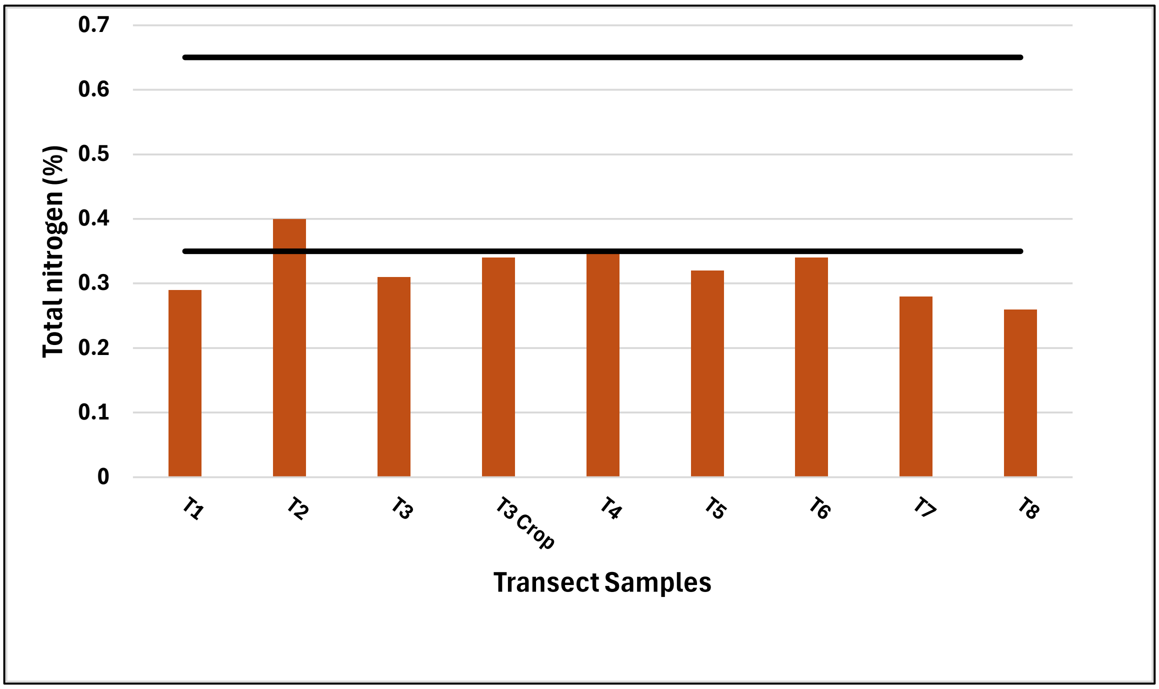


Figure 11: Total Nitrogen (%) in Transect Samples

Nitrogen (N) is a vital macronutrient, integral to a suite of biochemical and physiological processes that underpin plant development and productivity. It constitutes a fundamental element in the molecular structure of amino acids, the monomeric units of proteins; purine and pyrimidine bases of nucleic acids (DNA and RNA); chlorophyll pigments; and a multitude of redox-active cofactors and secondary metabolites. Nitrogen assimilation primarily occurs via root uptake of nitrate (NO_3^-) and ammonium (NH_4^+) ions, which are subsequently reduced and incorporated into glutamine and glutamate through the glutamine synthetase–glutamate synthase (GS-GOGAT) pathway, forming the core of nitrogen metabolism. Sufficient nitrogen availability enhances meristematic activity, augments canopy expansion through increased cell division and elongation, and elevates net photosynthetic rate by upregulating chloroplast biogenesis and Rubisco synthesis.

Nitrogen's influence extends to enhancing reproductive efficiency, stimulating the biosynthesis of phytohormones such as cytokinins and gibberellins, and facilitating seed and fruit development. Its deficiency disrupts carbon-nitrogen balance, downregulates photosynthetic gene expression, and leads to systemic nitrogen remobilization, often observed as foliar chlorosis, reduced specific leaf area, diminished biomass allocation to above-ground tissues, and impaired yield formation. Given its high mobility in the soil-plant-atmosphere continuum and susceptibility to transformation via microbial nitrification, denitrification, and ammonia volatilization, nitrogen management in soils is vital. These include synchronizing N supply with plant demand, incorporating controlled-release fertilizers, and applying organic amendments such as sludge (Brady and Weil, 2008).Total nitrogen (TN) represents the combined organic and inorganic forms of nitrogen, which are vital for soil fertility, microbial activity, and plant growth.

CATIONS
Soil Profiles

Exchangeable Potassium

The analysis of potassium (K) levels across different soil horizons and depths from the test pit soil profile samples revealed considerable variation in potassium availability. According to the established adequate range for exchangeable potassium (0.5–0.8 me/100g), only six horizons met or exceeded the lower threshold: 2A (0.79 me/100g), 3A (0.95 me/100g), 3B (0.65 me/100g), 4A (0.72 me/100g), 6A (0.70 me/100g), and 9 (0–30 cm depth) (1.22 me/100g). Notably, 3A and the top 30 cm of profile 9 exceed the upper limit, indicating high potassium availability that could be beneficial for crop uptake and root zone nutrition (Figure 12).

The remaining horizons, including 1A (0.27), 1B (0.18), 2B (0.23), 5A (0.34), 5B (0.19), 6B (0.06), 7A (0.32), 7B (0.18), 8A (0.23), 8B (0.31), and the deeper layers of profile 9 (30–60 cm: 0.32, 60–90 cm: 0.25, 90–120 cm: 0.16) fall below the adequate lower limit. These low values indicate limited potassium availability, especially in subsoil and B horizons, which could restrict nutrient uptake during periods of deep rooting or drought stress.

The trend suggests that while surface layers in some profiles contain sufficient or surplus potassium, subsoil layers generally lack adequate K. Potassium supplementation may be necessary to correct deficiencies in soils where there is low potassium especially those in A horizons where the concentration is less than the medium range lower limit to improve plant growth and yield.

Potassium (K^+) is a critical macronutrient involved in a wide array of physiological and biochemical processes in higher plants, despite not being a structural constituent of organic molecules. It functions primarily as an inorganic osmoticum, playing a central role in the regulation of cell turgor, stomatal aperture modulation, and maintenance of cellular water potential gradients. Potassium is also a key activator of over 60 enzymatic systems, including those involved in ATP synthesis, carbohydrate metabolism, and protein biosynthesis. It is essential for phloem loading and assimilate translocation, facilitating the movement of photosynthates from source to sink tissues, thereby supporting reproductive development and storage organ filling.

At the cellular level, K^+ modulates the electrochemical potential across plasma membranes and tonoplasts, which is critical for ion homeostasis and nutrient uptake through K^+-coupled transport mechanisms. Potassium enhances the efficiency of photosynthetic processes by stabilizing chloroplast structure, optimizing stomatal conductance, and sustaining the activity of key enzymes such as pyruvate kinase and ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco). Adequate K supply is also linked to improved abiotic stress tolerance, as it enhances osmoregulation under drought and salinity stress and suppresses the accumulation of reactive oxygen species (ROS) by modulating antioxidant defense systems.

Moreover, potassium contributes to biotic stress resistance by reinforcing cell wall integrity through increased synthesis of cellulose and lignin precursors, thereby limiting pathogen ingress and enhancing structural resilience. Deficiency symptoms typically manifest as marginal leaf chlorosis and necrosis, weak stalks, and reduced translocation efficiency, culminating in compromised crop yield and quality. Therefore, the precise management of potassium—through soil testing, nutrient budgeting, and targeted applications—is indispensable for maximizing plant performance, particularly in intensive cropping systems and when integrating organic waste streams such as biosolids or sludge into nutrient management plans (Brady and Weil, 2008).

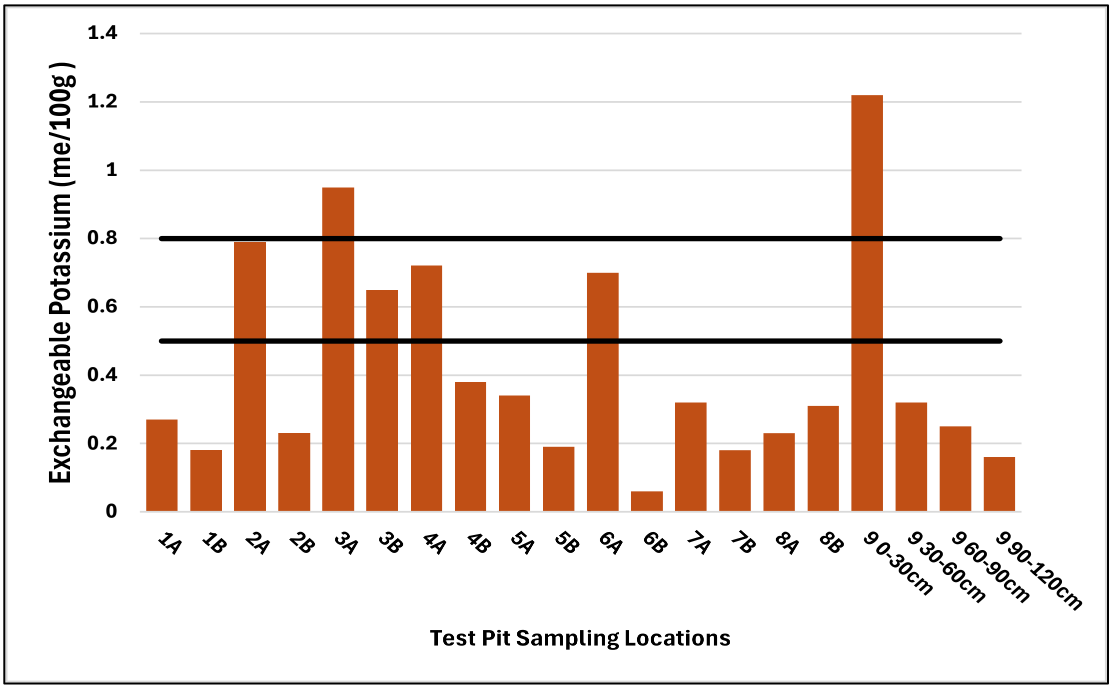


Figure 12: Exchangeable Potassium in Different Depths in Soil Profiles

Exchangeable Calcium in Soil Profiles

Calcium in soil is essential for plant growth as it helps maintain soil structure, improves root development, and regulates nutrient uptake. It is a key component of cell walls, promoting cell strength and stability, and also helps neutralise soil acidity, improving overall soil health and plant productivity (Brady and Weil, 2008).

Calcium concentrations across the soil profiles consistently fall below the typical medium range of 6–12 me/100g (Hill laboratory test reports, attached), indicating a widespread deficiency throughout both surface and subsoil horizons. The highest calcium level recorded is 5.7 me/100g in horizon 7A, which is still below the lower threshold. Other relatively higher values are observed in 3A (5.1), 4A (4.2), 5A (4.7), 6A (4.8), and 9 (0–30 cm, 4.3), reflecting moderately sufficient levels in the topsoil but still not within the medium range (Figure 13).

Most B horizon and deeper layer samples (e.g., 1B <0.5, 2B <0.5, 4B: 1.0, 5B: 1.0, 9 30–120 cm: 1.6–1.2) show significantly low calcium levels. Horizons 1B and 2B are below the detection limit (<0.5), highlighting critically poor calcium reserves in these soils.

The prevalence of calcium deficiency across A horizons suggests that calcium addition will improve plant growth.

Exchangeable calcium (Ca^{2+}) refers to the fraction of calcium ions that are electrostatically adsorbed onto the negatively charged sites of soil colloids—primarily clay minerals and organic matter—and are readily displaceable by neutral salt solutions. As a key base cation, exchangeable Ca plays a pivotal role in maintaining soil structural integrity, nutrient exchange capacity, and rhizosphere pH buffering. It contributes significantly to the cation exchange capacity (CEC) of soils and is crucial for mediating ion competition, especially in soils with high sodium (Na^+) levels, where adequate Ca^{2+} concentrations help prevent clay dispersion and maintain favourable soil aggregation.

Calcium is also essential for plant physiological functions, including cell division, membrane stability, and the formation of calcium pectate cross-links in the middle lamella of cell walls, which are vital for structural rigidity and pathogen resistance. It serves as a secondary messenger in numerous signal transduction pathways, regulating processes such as root elongation, stomatal closure, and abiotic stress responses. Exchangeable Ca is particularly important in acidic or weathered soils where base saturation is low and leaching losses of divalent cations are high. Insufficient exchangeable Ca can impair root development, nutrient uptake efficiency (notably of potassium and magnesium), and overall crop performance.

In the context of land application of organic amendments, such as sludge, winery waste, and grease trap residues, monitoring exchangeable Ca is essential for assessing the amendment's liming potential, nutrient contribution, and its role in ameliorating sodium-induced sodicity. High exchangeable Ca levels can improve soil physical properties and mitigate the negative effects of excessive Na^+, thereby enhancing soil structure, hydraulic conductivity, and root penetrability. Therefore, exchangeable calcium serves as both a fertility parameter and a soil quality indicator, critical for sustainable soil management and optimized plant nutrition.

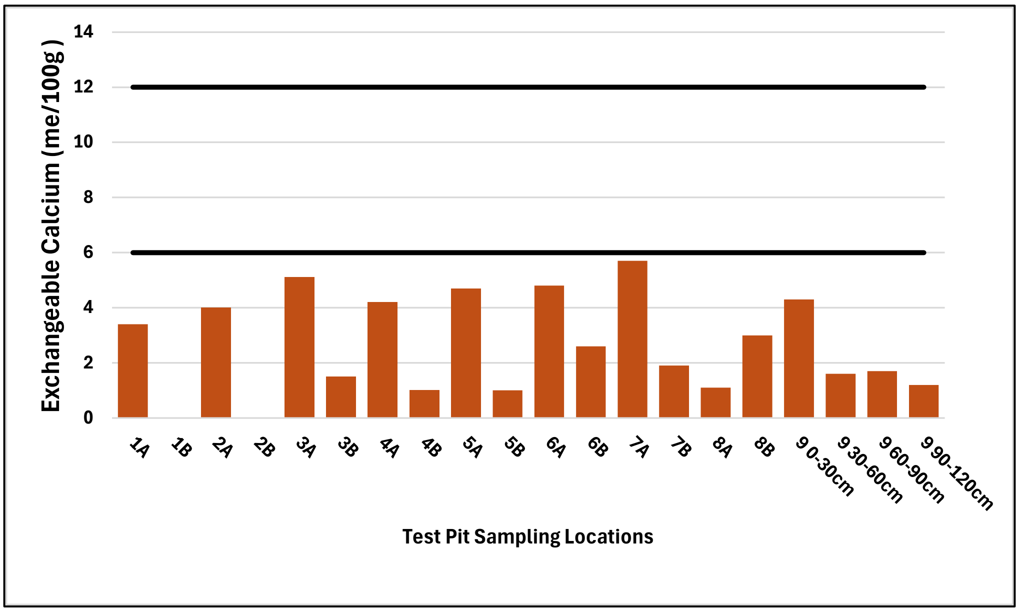


Figure 13: Exchangeable Calcium in Different Depths in Soil Profiles

Exchangeable Magnesium in Soil Profiles

Magnesium is essential for plant health, playing a crucial role in several physiological processes. It is a central component of chlorophyll, allowing plants to convert sunlight into energy. It also aids in phosphate metabolism, acting as a carrier of phosphorus within the plant. A deficiency in magnesium can lead to symptoms such as interveinal chlorosis, leaf necrosis, and stunted growth (Brady and Weil, 2008).

Magnesium concentrations across the soil profile show that most horizons fall below the medium range of 1–3 me/100g (Hill laboratory test reports, attached), indicating widespread Mg deficiency. Only five horizons meet or exceed the lower threshold: 3A (1.32), 4A (1.19), 6B (1.08), 7A (1.12), and 9 (0–30 cm: 1.35) (Figure 14). These layers are likely to supply sufficient magnesium for plant growth, particularly in the upper root zone.

The remaining horizons, including 1A (0.64), 2A (0.62), 3B (0.53), 6A (0.89), and all subsoil layers below 30 cm from test pit soil profile 9, fall below the medium range. Notably, 2B (<0.04) and 5B (0.16) are much lower than the medium range, potentially affecting plant physiological functions such as photosynthesis and enzyme activation.

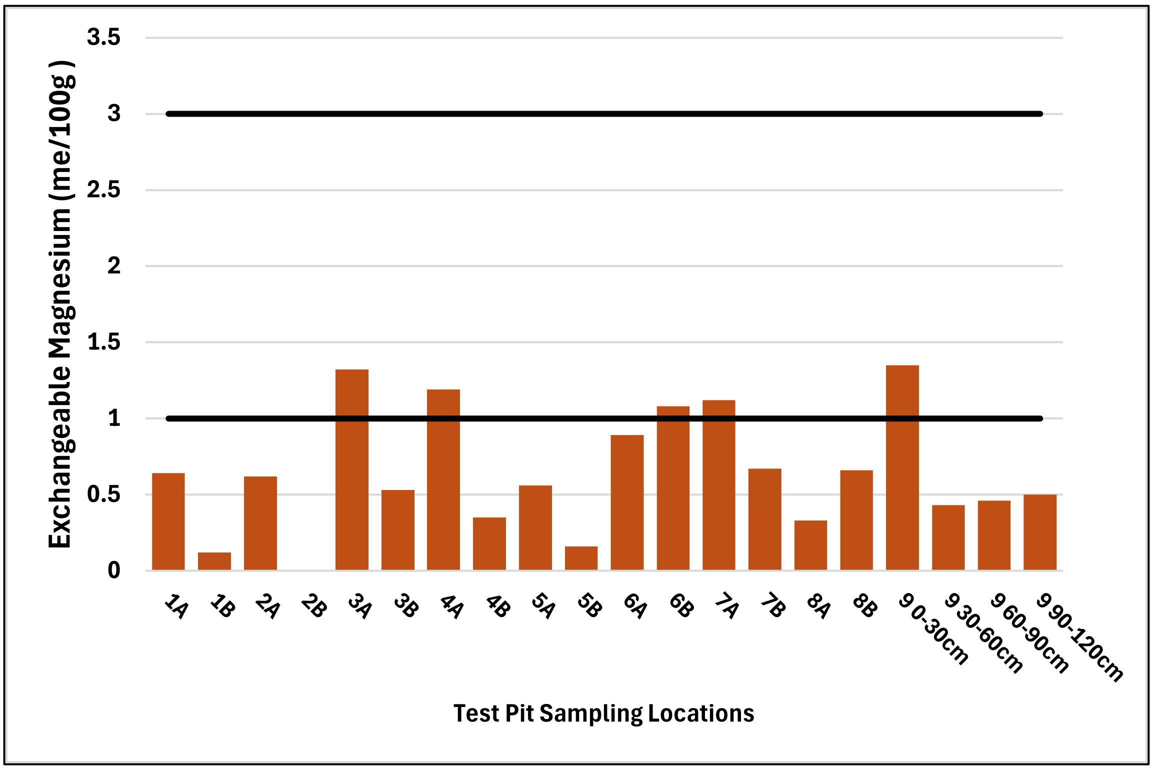


Figure 14: Exchangeable Magnesium in Different Depths in Soil Profiles

Exchangeable magnesium (Mg^{2+}) represents the fraction of magnesium ions that are electrostatically adsorbed onto the negatively charged surfaces of soil colloids—such as clay minerals and soil organic matter—and are readily displaced by cation-exchange reactions. Exchangeable Mg is a key contributor to the cation exchange capacity (CEC) of soils and plays a crucial role in the regulation of soil pH, nutrient balance, and flocculation of clay particles. Magnesium is an essential plant macronutrient, acting as the central atom in the chlorophyll molecule, and is indispensable for photosynthetic carbon assimilation. It also functions as a cofactor for numerous enzymes involved in ATP synthesis, nucleic acid metabolism, and protein biosynthesis.

In plant physiological systems, Mg^{2+} facilitates the translocation of assimilates through the phloem and is integral to ribosome stabilization and energy transfer reactions. Sub-optimal exchangeable Mg levels can lead to interveinal chlorosis in older leaves, reduced photosynthetic efficiency, and impaired reproductive development. Soils with low Mg^{2+} availability—particularly acid, sandy, or leached profiles—require precise management to prevent nutrient imbalances. Furthermore, high levels of competing cations such as Ca^{2+}, K^{+}, or NH_4^{+} can suppress Mg^{2+} uptake due to antagonistic interactions at the root-soil interface.

In the context of organic waste application—such as sludge, winery waste, and grease trap residues, exchangeable Mg is a vital indicator of the amendment's agronomic value and its potential impact on soil cation ratios, particularly the Ca:Mg and Mg:K ratios, which influence soil structure, nutrient dynamics, and plant health. Monitoring and managing exchangeable Mg is therefore critical for maintaining soil fertility, optimizing plant nutrition, and ensuring the sustainable land application of organic materials without inducing nutrient antagonism or physical degradation of the soil matrix (Brady and Weil, 2008).

Exchangeable Sodium in Soil Profiles

The concentration of sodium in soils is crucial because it significantly impacts soil structure, water infiltration, and plant health. High levels of sodium can lead to soil dispersion, where soil particles break apart, reducing soil porosity and permeability. This can cause poor water infiltration and drainage, leading to waterlogging and reduced oxygen availability for plant roots. Additionally, excess sodium can displace essential nutrients like calcium and magnesium, making them less available to plants and potentially leading to nutrient deficiencies. Managing sodium levels is essential to maintain soil health, ensure proper water movement, and support optimal plant growth (Brady and Weil, 2008).

Sodium concentrations in all soil horizons are consistently below the typical range of 0.2 to 0.5 me/100g (Hill laboratory test reports, attached) (Figure 15). Measured values are <0.05 and 0.06 me/100g across the soil profile samples, indicating uniformly low sodium concentrations.

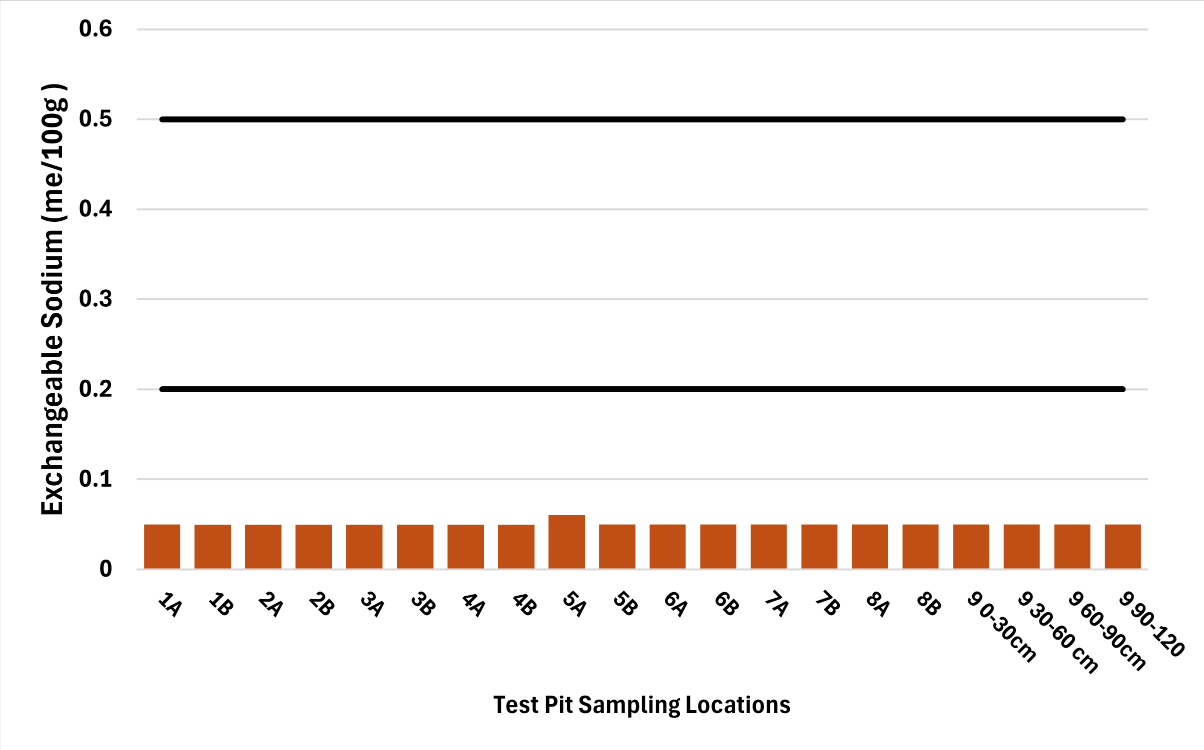


Figure 15: Exchangeable Sodium in Different Depths in Soil Profiles

Exchangeable sodium (Na^+) refers to the fraction of sodium ions electrostatically bound to the negatively charged sites on soil colloids—primarily clay minerals and organic matter. Although not considered an essential nutrient for most plants, Na^+ can become a dominant exchangeable cation in certain soils, particularly in sodic soils, where it adversely affects both soil physical structure and hydraulic properties. Unlike divalent cations (e.g., Ca^{2+}, Mg^{2+}), which promote flocculation and aggregation of clay particles, excessive exchangeable Na^+ leads to clay dispersion, pore blockage, and a reduction in water infiltration and aeration, contributing to poor soil tilth and compaction.

The proportion of Na^+ in the soil's cation exchange complex is quantitatively expressed by the Exchangeable Sodium Percentage (ESP), which is a critical diagnostic criterion for identifying sodic conditions. An ESP greater than 15% typically signifies sodicity, although adverse effects on soil structure may occur at even lower thresholds depending on soil texture and mineralogy. Elevated exchangeable Na^2 can also induce ion antagonism, impairing the root uptake of essential nutrients such as potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}), ultimately compromising plant health and productivity.

In the context of land application of organic and industrial wastes—such as sludge, winery waste, and grease trap waste residues it is imperative to monitor exchangeable Na^+ levels due to the potential accumulation of sodium in the soil profile. Repeated applications of sodium-rich amendments can increase ESP and degrade soil structure, particularly in fine-textured or poorly drained soils. Therefore, exchangeable sodium serves as a critical soil quality indicator, influencing both agronomic performance and the long-term sustainability of land application practices (Brady and Weil, 2008).

CEC in Soil Profiles

Cation Exchange Capacity (CEC) is a key indicator of the soil's capability to supply and retain sufficient amount of cations and supply these to plants. It measures the soil's capacity to hold positively charged ions (cations) such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), and ammonium ($NH4^{+}$). Soils with a high CEC can store and release nutrients over time, buffering against nutrient leaching and ensuring their availability for plant uptake. Additionally, CEC influences soil pH and helps maintain nutrient balance, promoting healthy plant growth and productivity (Brady and Weil, 2008).

The Cation Exchange Capacity (CEC) values across the test pit soil profile samples range from a low of 5 me/100g (observed in horizons 2B and 6B) to a high of 18 me/100g in horizon 3A (Figure 16). Most horizons have CEC values below the typical lower limit of 12 me/100g (Hill laboratory test reports, attached), indicating limited nutrient retention capacity in much of the soil profile. Only a few horizons such as 3A (18), 4A (15), and 7A (13) exceed or meet the lower limit, suggesting better nutrient-holding potential in these layers. Horizons like 2B (5), 6B (5), and 4B (6) have the lowest CEC values, which could reduce nutrient availability and increase vulnerability to leaching. The variability in CEC suggests differences in soil texture, organic matter, and mineralogy between horizons. Maintaining or improving CEC in the lower horizons is important for overall soil fertility and sustained plant growth.

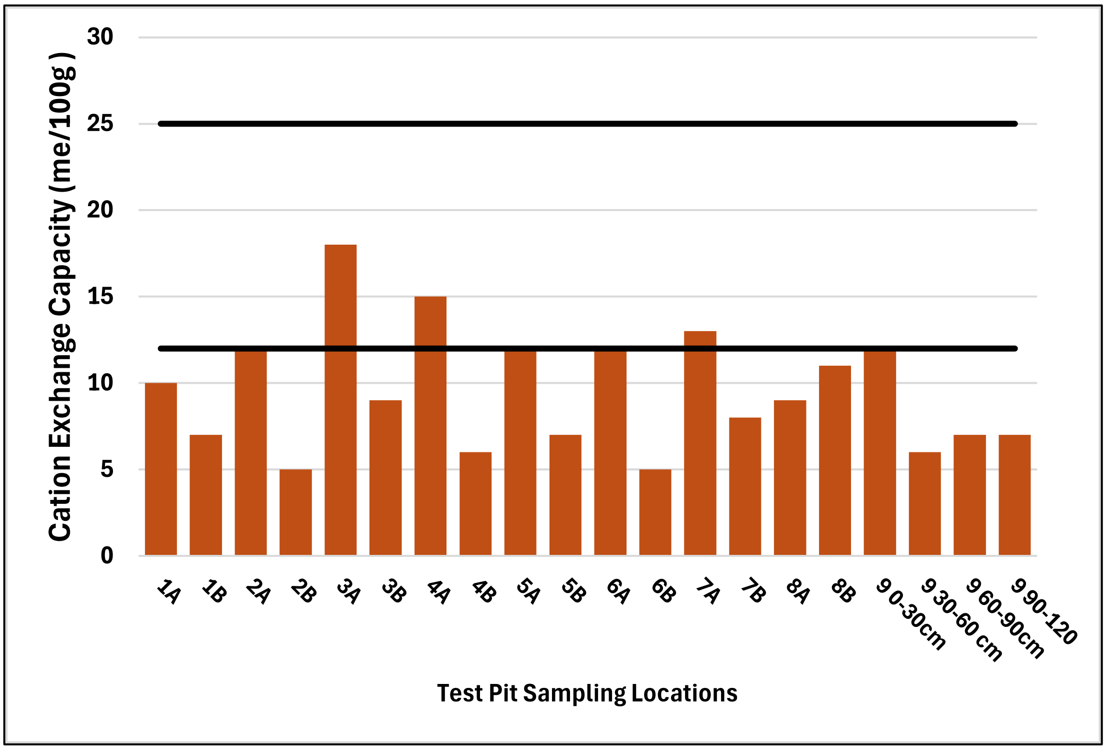


Figure 16: Cation Exchange Capacity (CEC) in Different Depths in Soil Profiles

CEC is a measure of a soil's ability to hold and exchange positively charged ions (cations) such as calcium, magnesium, potassium, and sodium. It reflects the soil's fertility potential because higher CEC means the soil can retain more essential nutrients for plant uptake. Soils with adequate CEC provide a better nutrient reservoir, improving nutrient availability and reducing nutrient losses through leaching.

In the sampled horizons, many soils have CEC values below the typical medium limit of 12 me/100g (Hill laboratory test reports, attached), indicating limited nutrient-holding capacity.

Low CEC soils are more vulnerable to nutrient depletion and may require more frequent fertilization to maintain crop productivity. Additionally, soils with low CEC often have poor soil structure, which can restrict root penetration and reduce water retention. This can increase susceptibility to soil erosion, as weaker soil aggregates are more easily displaced by wind or water.

Maintaining or improving CEC through organic matter addition and proper soil management can enhance soil structure, promote root growth, and improve moisture retention. Ultimately, understanding CEC variability across soil horizons helps in tailoring nutrient management strategies for optimal plant growth and sustainable land use. Addressing low CEC soils is critical for long-term soil health and agricultural productivity. Sewage sludge could be an option to add organic matter in soils to improve soil's CEC.

Soil Transect Samples

Exchangeable Potassium in Transect Samples

The potassium levels in the transect soil samples range from 0.32 to 0.92 me/100g (Figure 17), compared to the typical medium range of 0.5–0.8 me/100g (Hill laboratory test reports, attached). The highest potassium concentration is found in T4 (0.92), which slightly exceeds the upper limit, indicating a surplus that may not be harmful but suggests potassium enrichment. The lowest value is observed in T3 Crop (0.32), below the medium range and signalling a potential potassium deficiency that could limit plant growth and reduce yield. Samples T2, T3, T6, and T7 fall within the optimal range, while T1, T5, and T8 are just below the lower limit, suggesting marginally low availability.

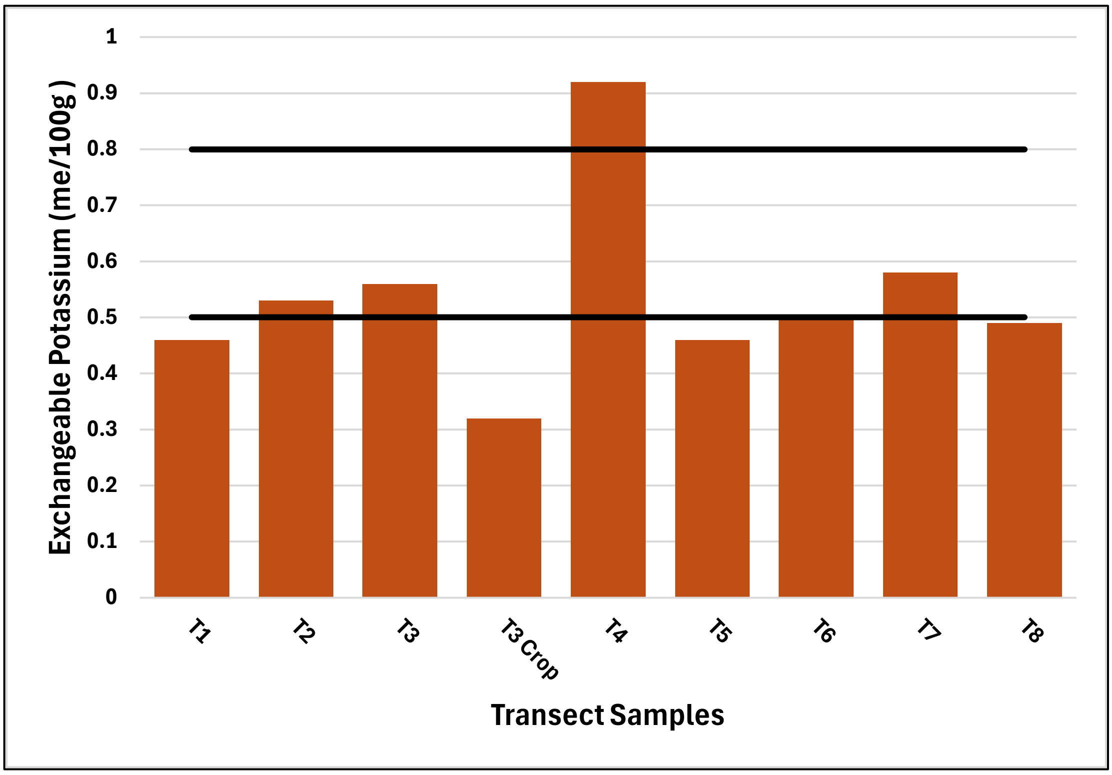


Figure 17: Exchangeable Potassium in Soil Transect Samples

Exchangeable Calcium in Transect Samples

The calcium content in the transect soil samples varies from 3.9 to 8.7 me/100g (Figure 18), relative to the medium range of 6–12 me/100g (Hill laboratory test reports, attached). The highest calcium level is found in T3 Crop (8.7), well within the adequate range and supportive of healthy plant development. However, T3 (3.9) shows the lowest calcium concentration, indicating a clear deficiency that could impair root development and nutrient uptake. Most samples, including T1, T2, T3, T4, and T8, are below the typical lower limit, suggesting widespread calcium deficiency. Only T3 Crop and T5 are in the medium range, while T6 and T7 are marginally low, pointing to the need for calcium amendments in several areas. Addressing these deficiencies is vital to improve soil structure, pH buffering, and overall plant health.

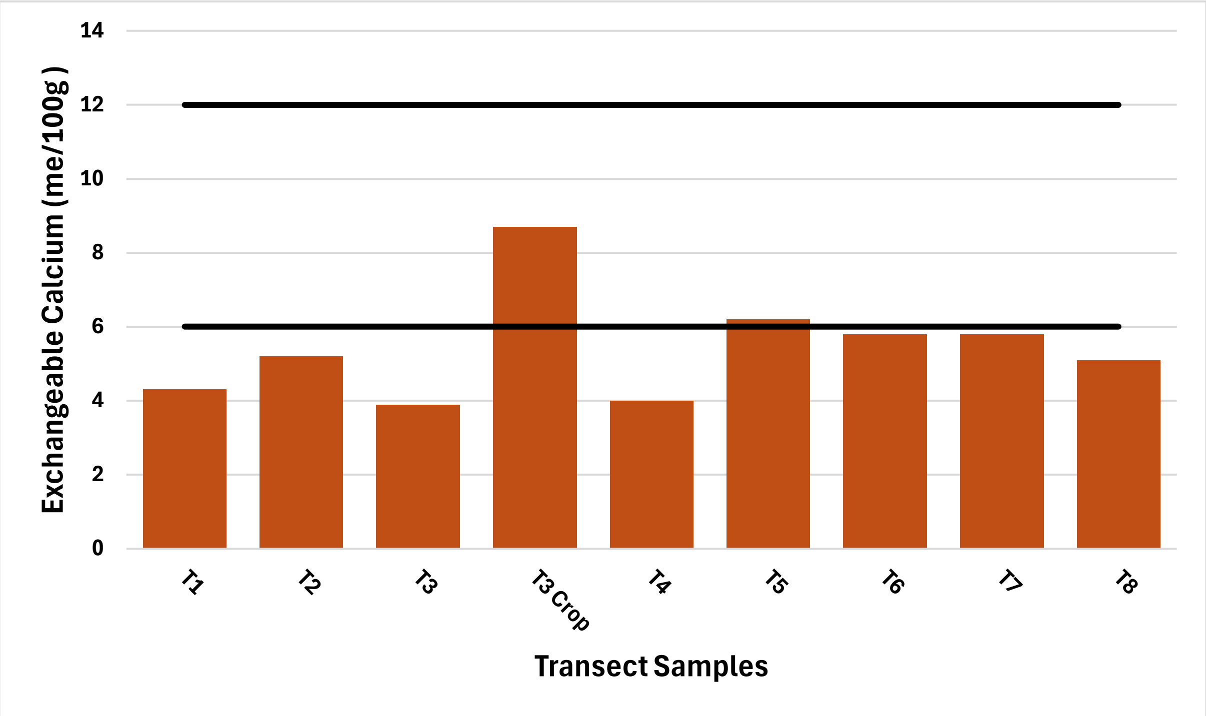


Figure 18: Exchangeable Calcium in Soil Transect Samples

Exchangeable Magnesium in Transect Samples

The magnesium content in the transect soil samples ranges from 0.63 to 1.34 me/100g (Figure 19), against the typical medium range of 1–3 me/100g (Hill laboratory test reports, attached). The highest value is recorded in T3 (1.34), indicating sufficient magnesium for plant physiological processes like photosynthesis and enzyme activation. The lowest magnesium concentration is seen in T1 (0.63), suggesting a deficiency that may impact plant growth and chlorophyll production. Only T3, T4, and T7 fall within the medium range, while the remaining transect samples are below the lower limit, indicating a widespread magnesium deficiency. Sample T6 is just below adequate, requiring careful monitoring. Addressing these deficiencies is important to maintain nutrient balance, especially for crops with high magnesium demand.

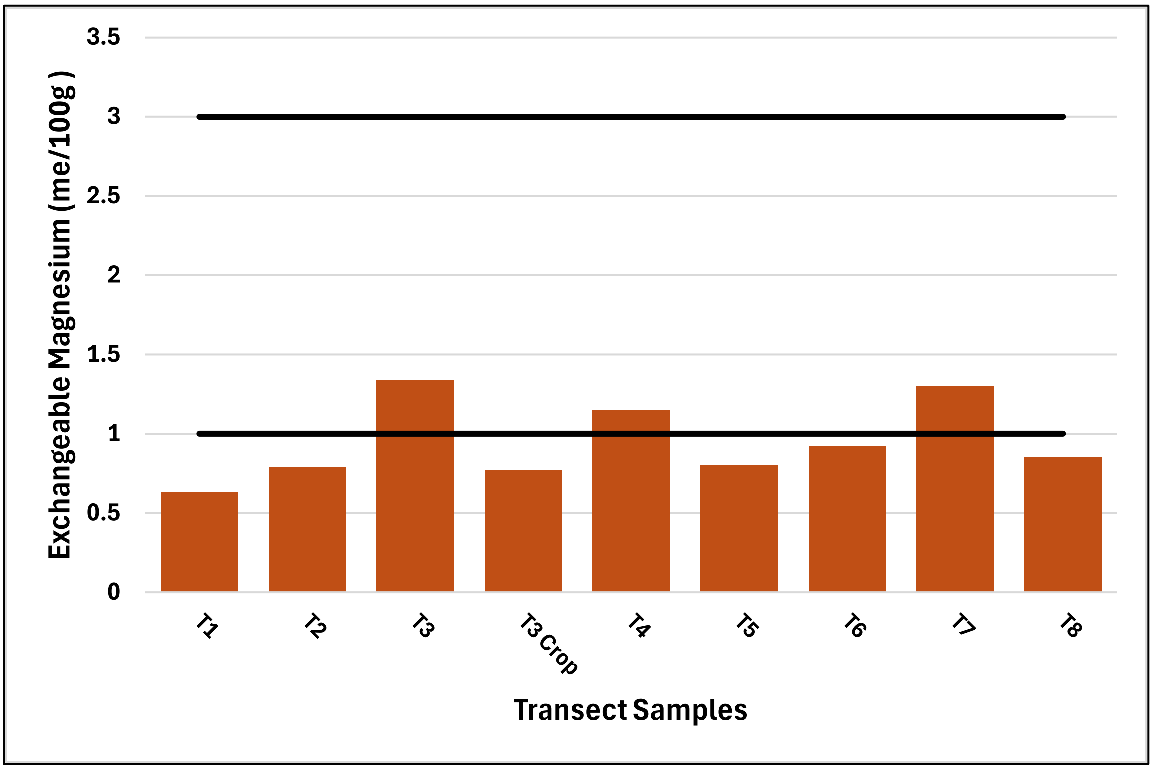


Figure 19: Exchangeable Magnesium in Soil Transect Samples

Exchangeable Sodium in Transect Samples

Sodium levels across all the transect soil samples are significantly below the medium range lower limit of 0.2 me/100g (Hill laboratory test reports, attached), with values ranging from 0.05 to 0.07 me/100g (Figure 20). The highest sodium level is found in T7 (0.07 me/100g), while the rest of the samples show minimal variation with values of 0.05 or 0.06 me/100g. None of the samples fall within the medium range, indicating a universal low sodium in the tested soils.

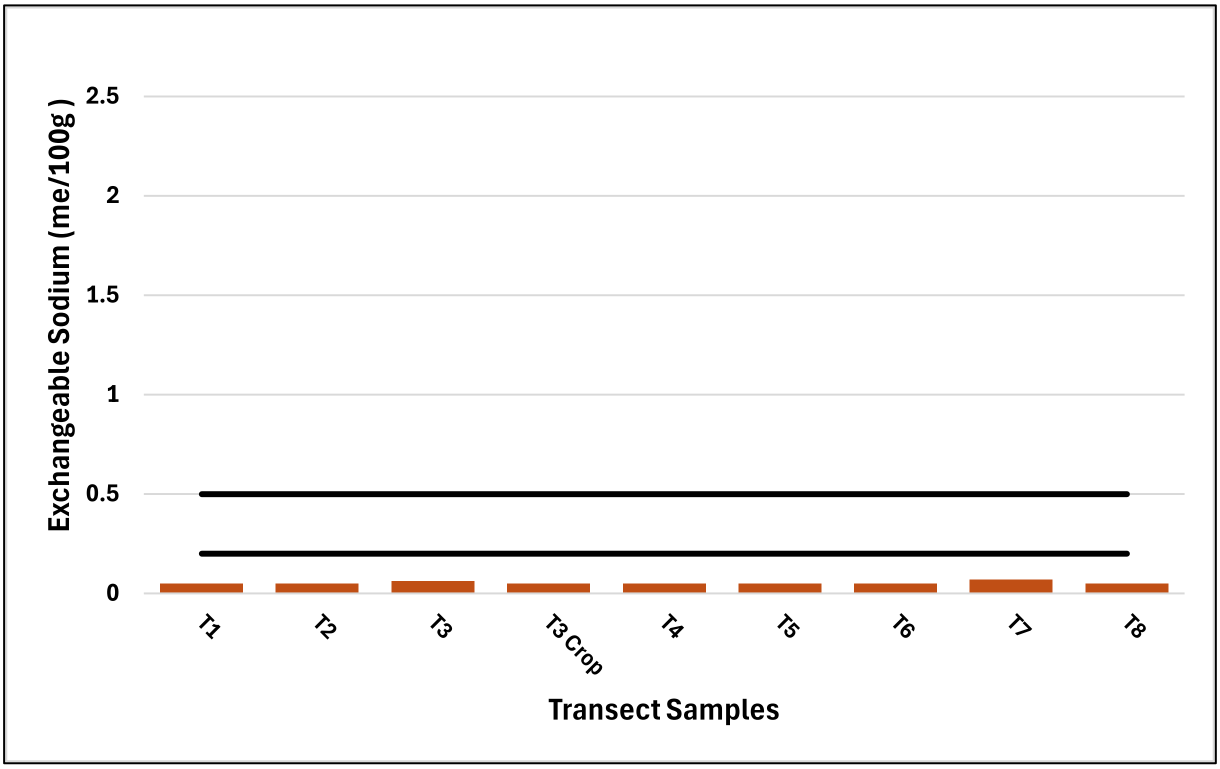


Figure 20: Exchangeable Sodium in Soil Transect Samples

CEC in Transect Samples

Cation Exchange Capacity (CEC) values across the transect soil samples range from 11 to 14 me/100g, falling mostly within the adequate range of 12–25 me/100g (Hill laboratory test reports, attached) (Figure 21). The highest CEC is observed in T2 and T3 Crop (14 me/100g), suggesting good potential for holding and exchanging nutrients. However, T1 and T8 show slightly lower values at 11 me/100g, just below the adequate threshold, indicating moderate nutrient retention capacity. CEC is crucial for soil fertility, influencing nutrient availability, soil buffering capacity, and resilience against leaching and degradation.

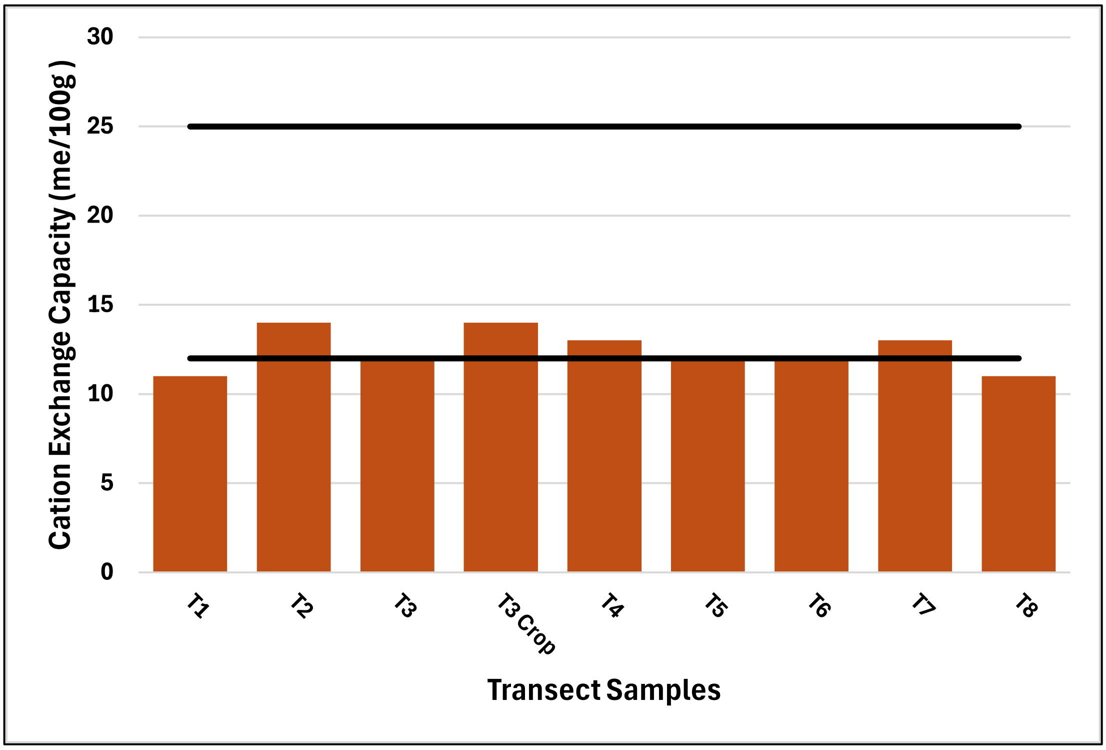


Figure 21: Cation Exchange Capacity (CEC) in Soil Transect Samples

Heavy Metals in Transect Samples

The transect soils samples were also tested for heavy metals, including total Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc.

Arsenic in Transect Samples

The total arsenic concentrations in the transect soil samples range from 4.2 mg/kg in T7 to 6 mg/kg in T1 (Figure 22), showing relatively low variability across the sites. All values are significantly below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) concentrations suggest minimal risk to human health, plant uptake, or groundwater contamination. The slightly elevated value in T1 may reflect natural background levels or minor historical inputs, but it does not approach regulatory concern. Overall, arsenic concentrations across the transects indicate a healthy soil environment with no signs of contamination.

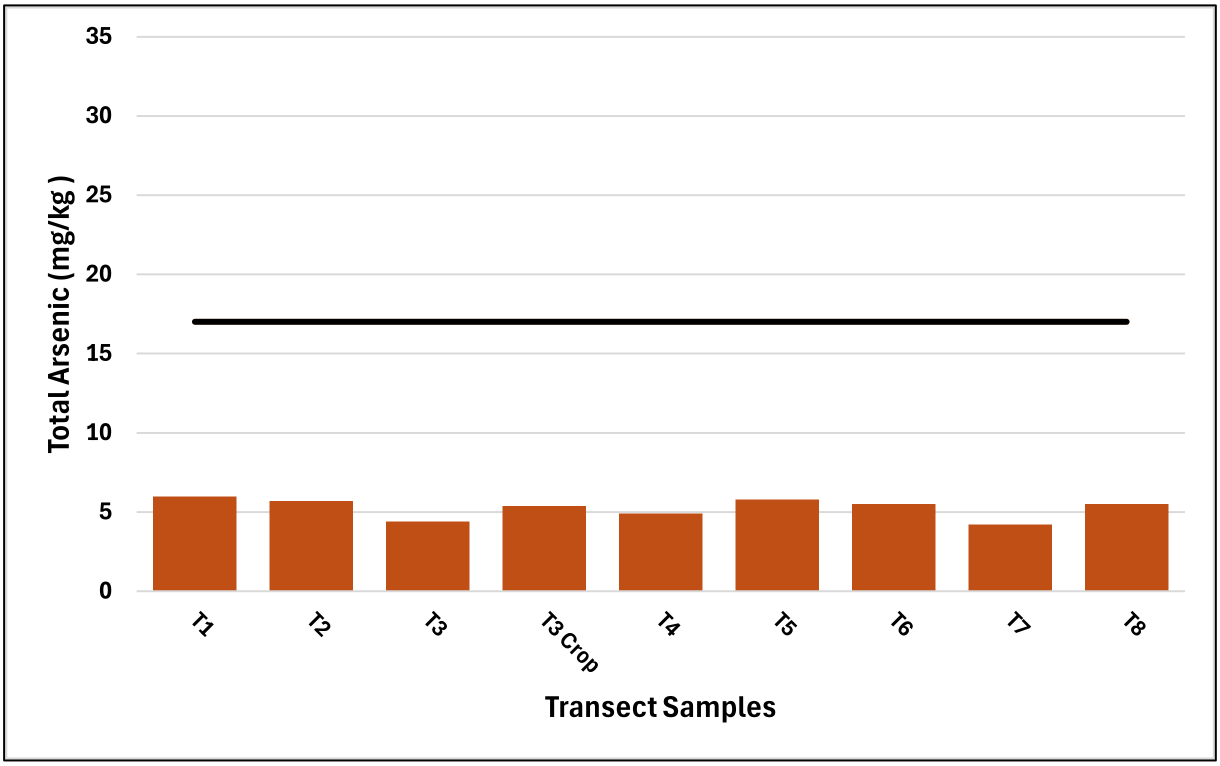


Figure 22: Total Arsenic in Transect Soil Samples

Cadmium in Transect Samples

The total cadmium concentrations across all transect soil samples (T1 to T8 including T3 Crop) range from 0.04 to 0.09 mg/kg (Figure 23), which are significantly lower than the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 0.8 mg/kg. These low values indicate minimal cadmium accumulation in the soils, suggesting limited impact from phosphate fertilizers or industrial pollutants, which are common sources of cadmium contamination. The data reflect a safe soil environment with respect to cadmium, posing no concern for plant uptake or food chain contamination. Overall, cadmium levels are well within acceptable environmental and agricultural safety margins.

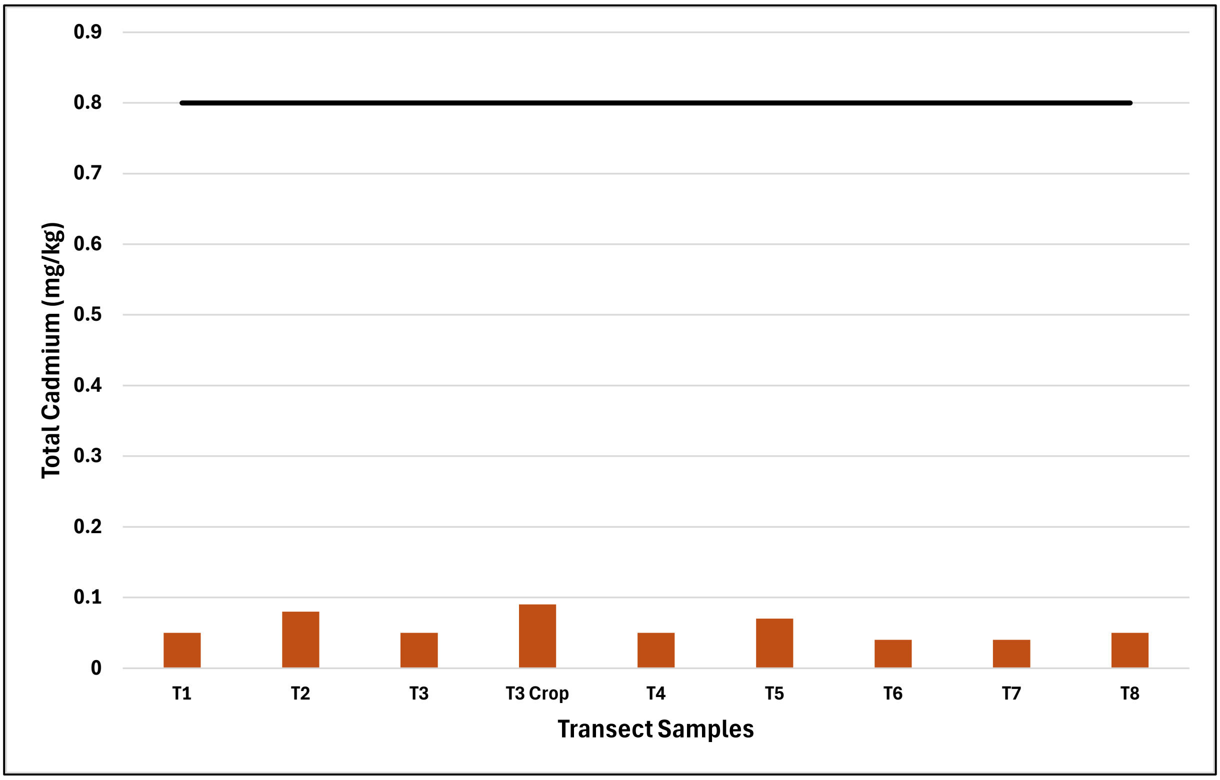


Figure 23: Total Cadmium in Transect Soil Samples

Chromium in Transect Samples

The total chromium concentrations in the transect soil samples vary from 7 mg/kg in T3 to 19.3 mg/kg in T2 (Figure 24), indicating moderate variability across the sites. All measured values are well below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 200 mg/kg, indicating no environmental or health concerns related to chromium contamination. Overall, chromium levels are low and consistent with typical background concentrations in soils, posing minimal risk to plant growth or soil health across the transects.

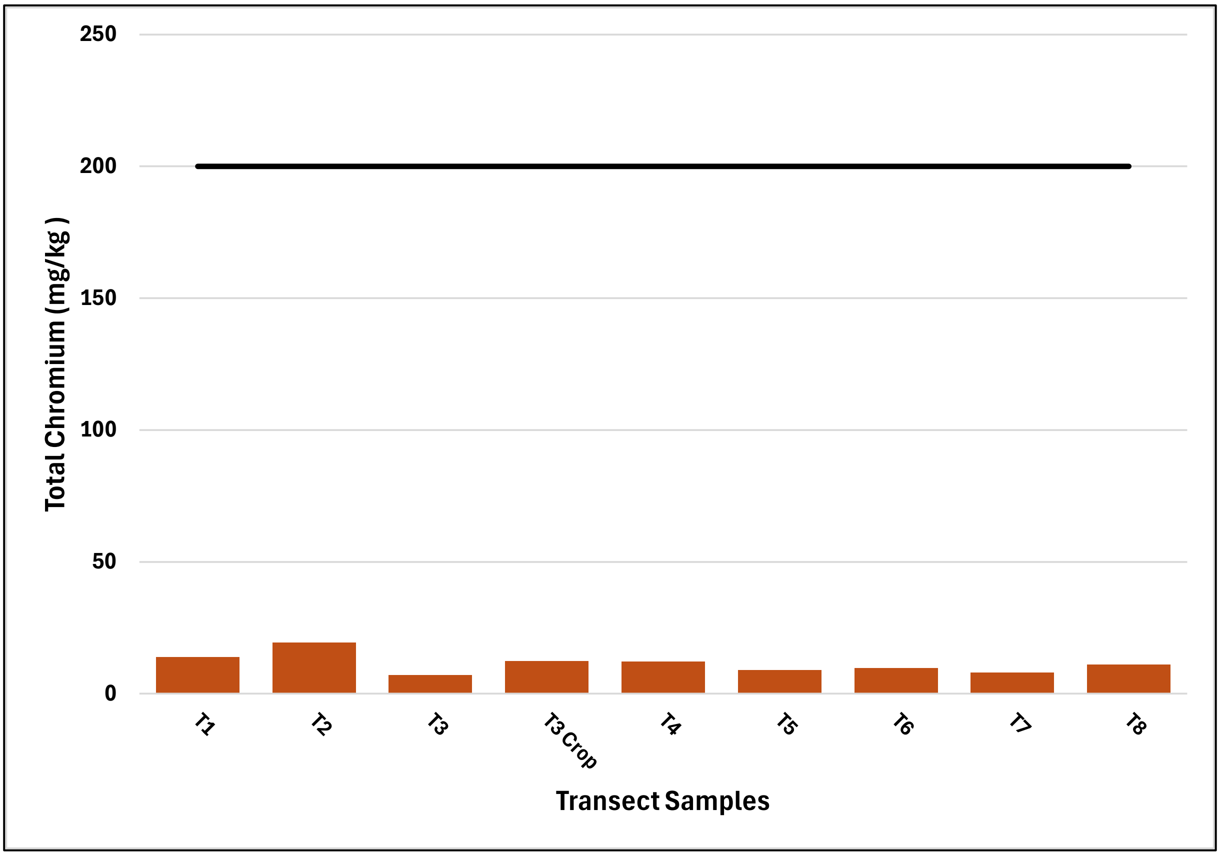


Figure 24: Total Chromium in Transect Soil Samples

Copper in Transect Samples

The total copper concentrations in the transect soil samples range from 8 mg/kg in T5 to 12 mg/kg in T3 Crop (Figure 25), showing only slight variation across the sites. All values are well below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 95 mg/kg, indicating no risk of copper contamination or toxicity in these soils.

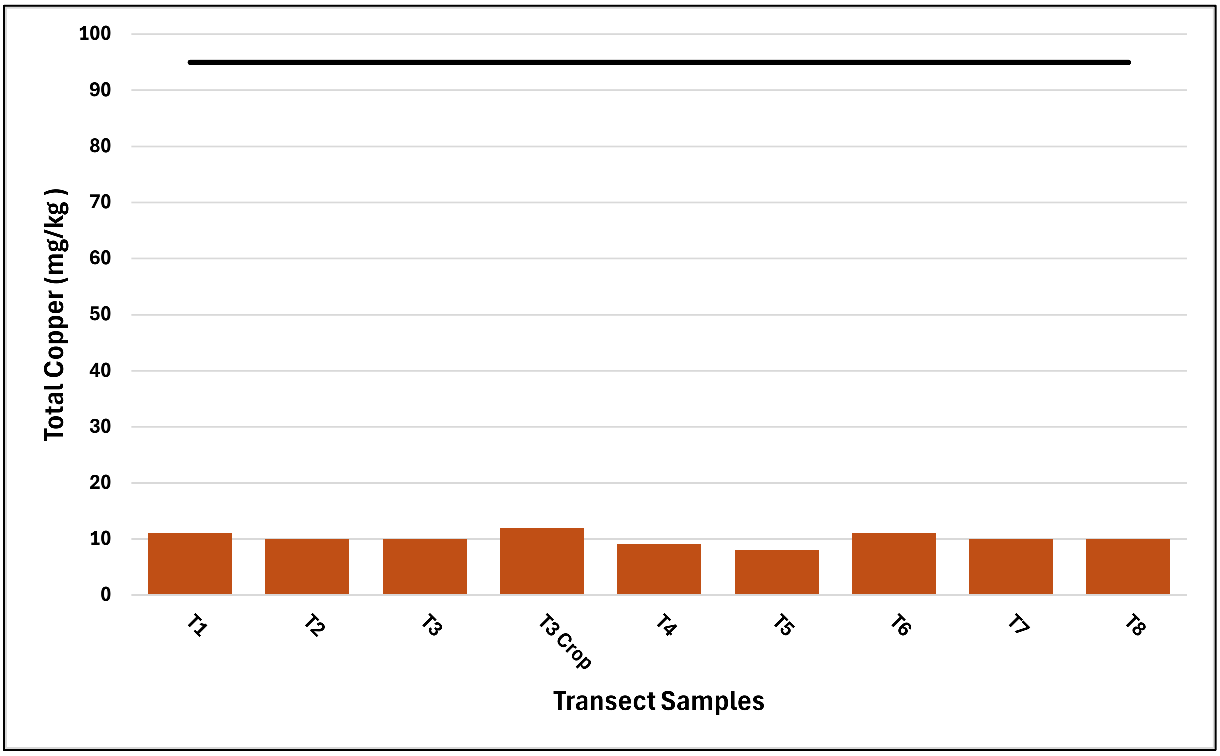


Figure 25: Total Copper in Transect Soil Samples

Lead in Transect Samples

The total lead concentrations in the transect soil samples range from 9.7 mg/kg in T5 to 12.5 mg/kg in T1 (Figure 26), reflecting low variation and uniformly low levels across the transects. All measured values are far below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 160 mg/kg, indicating no concern for lead contamination in these soils. These values are consistent with typical background levels in uncontaminated agricultural or natural soils. The slightly higher concentration in T1 (12.5 mg/kg) is still well below the limit does not pose any environmental or health risk. Overall, the transect samples show a clean soil profile in terms of lead content, supporting safe use for agricultural or ecological purposes.

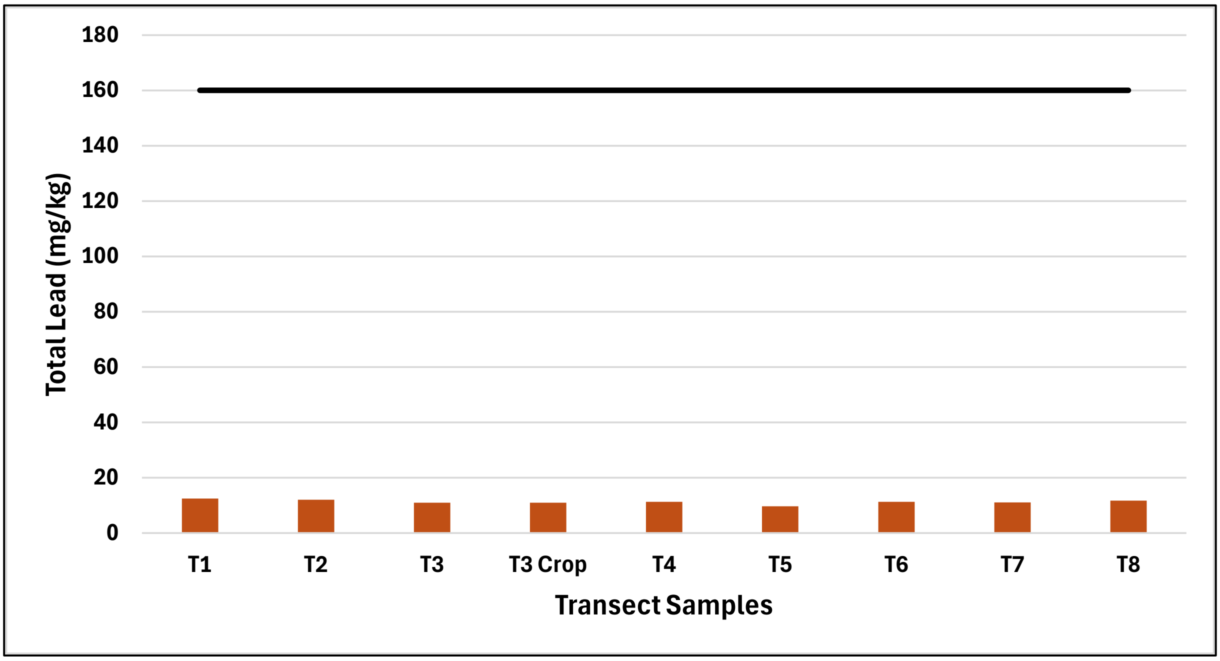


Figure 26: Total Lead in Transect Soil Samples

Mercury in Transect Samples

The total mercury concentration in all transect soil samples is consistently < 0.12 mg/kg (which is the detection limit) (Figure 27), which is well below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 1 mg/kg. This uniform and low level of mercury indicates minimal risk of contamination from anthropogenic sources such as industrial activity or agrochemicals. The values reflect a healthy soil environment in terms of mercury content, posing no threat to plant, animal, or human health. These results confirm that mercury is not an environmental concern across the transects.

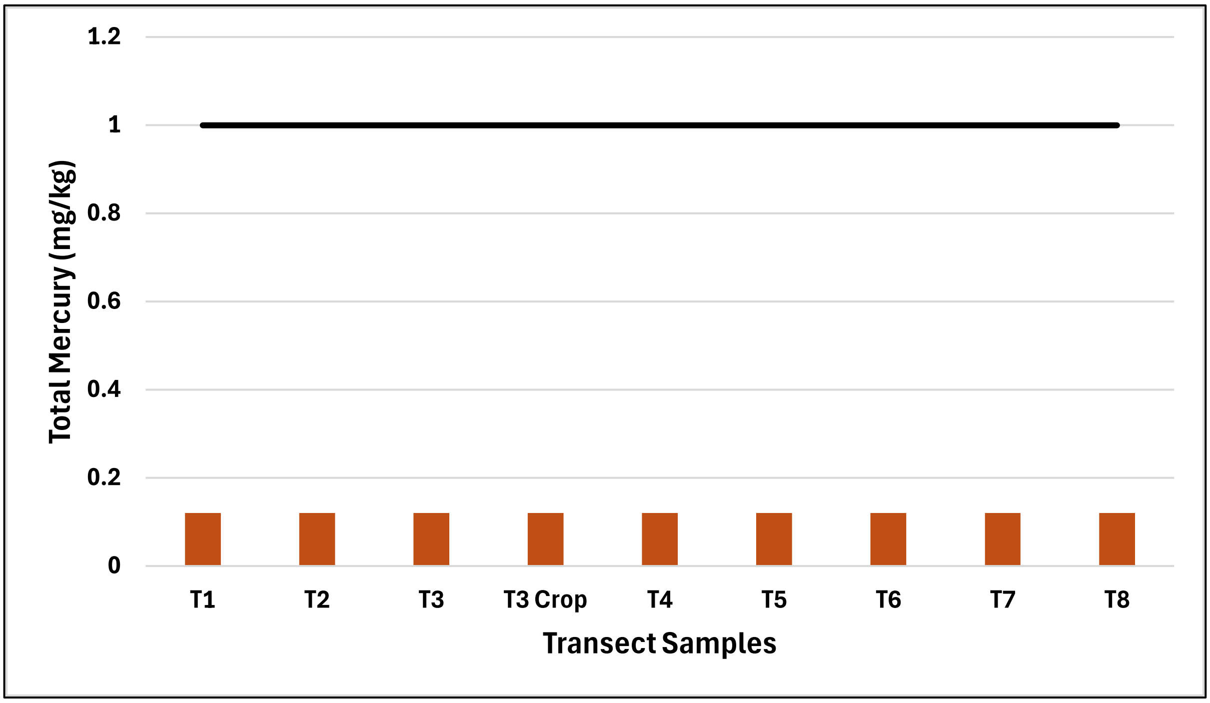


Figure 27: Total Mercury in Transect Soil Samples

Nickel in Transect Samples

The total nickel concentrations in the transect soil samples range from 7.2 mg/kg in T7 to 13.6 mg/kg in T2 (Figure 28). All values are significantly below the Ecological soil guideline value for different land use in NZ limit of 60 mg/kg (Cavanagh, 2016), indicating no risk of nickel toxicity in these soils. The slightly higher concentration in T2 (13.6 mg/kg) is still well below the upper limit and is not of concern. The results across the transects suggest the area is free from industrial or anthropogenic nickel contamination. Overall, the nickel levels in all transect samples are within safe bounds for environmental and agricultural purposes.

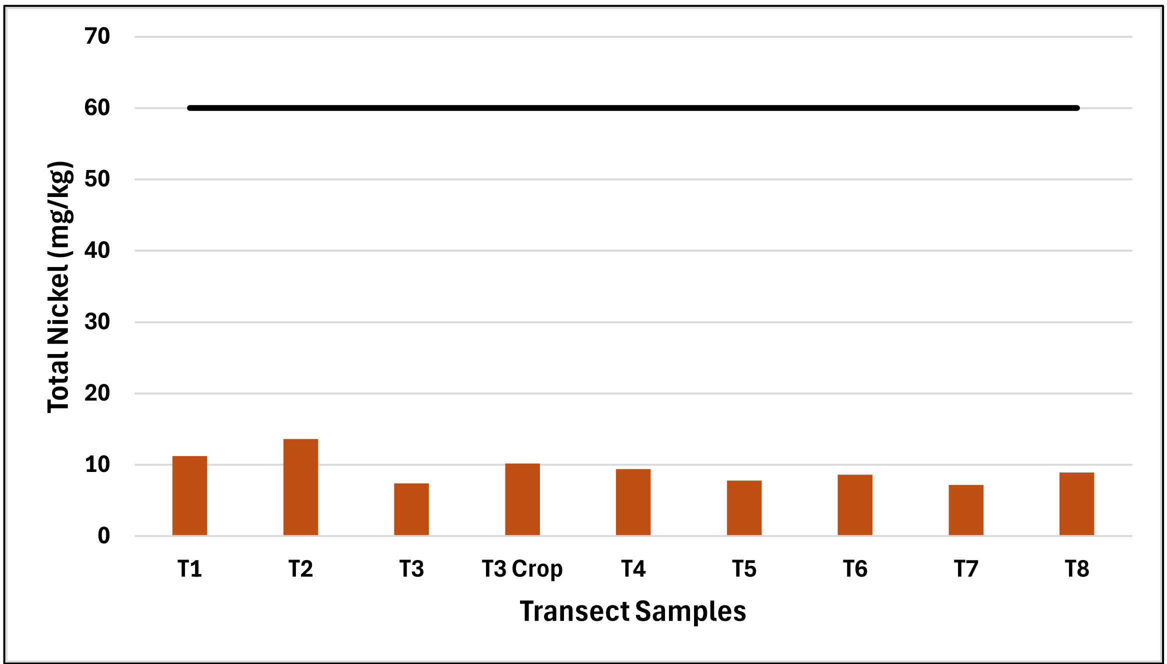


Figure 28: Total Nickel in Transect Soil Samples

Zinc in Transect Samples

The total zinc concentrations across the transect soil samples range from 33 mg/kg in T5 to 40 mg/kg in T1 (Figure 29). These values are all well below the Ecological soil guideline value for different land use in NZ (Cavanagh, 2016) limit of 180 mg/kg, indicating that zinc levels are within safe limits for agricultural and environmental health. The relatively small variation in zinc concentrations suggests a consistent distribution of zinc across the transects, possibly influenced by soil management or parent material. The highest zinc level in T1 (40 mg/kg) and the lowest in T6 (33 mg/kg) reflect only minor differences across the site. Overall, the data confirms that zinc does not pose a contamination concern in any of the transect soil samples.

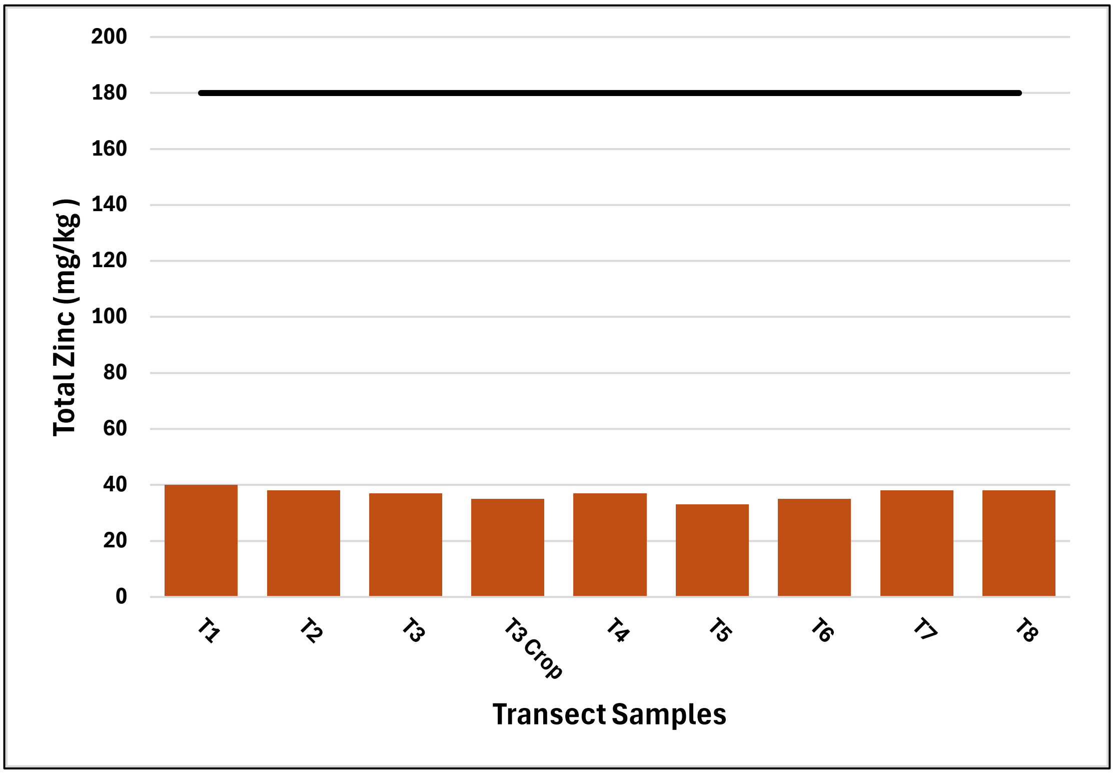


Figure 29: Total Zinc in Transect Soil Samples

The Water New Zealand (2025) contaminant grade 1 limits are higher than the Ecoguideline values (cavanagh, 2016) which means that if the values comply with the Eco guideline values will also comply with the Water New Zealand (2025) guideline values.

SUMMARY

The soil assessment at the Lauder site shows that most physical and chemical parameters fall at the lower end of typical or adequate ranges.

Bulk density, porosity, and water holding capacity vary across test pits, but the data suggest that an increase in organic matter could improve bulk density, enhancing the soil's water retention, aeration, root penetration, and faster water movement through the A horizon. Chemical analysis indicates low levels of key nutrients, including phosphorus, nitrogen, potassium, calcium, and magnesium. Both Olsen P and total phosphorus concentrations are below the recommended thresholds for optimal plant growth. Total nitrogen concentrations in most transect samples are also suboptimal, indicating restricted nutrient availability for crops.

Soil carbon levels point to low organic matter, with potential for improvement to support microbial activity and overall soil health.

Cation exchange capacity (CEC) values are below the preferred range in many horizons, limiting the soil's ability to hold and exchange nutrients. Exchangeable sodium levels are low, which benefits soil structure. The cations concentration delineates limited overall cation content.

Heavy metal concentrations are well below guideline limits, posing no environmental concern and confirming the site's suitability for land application. Incorporating sludge rich in organic matter and nutrients is expected to enhance soil fertility, structure, and moisture dynamics, making the site more productive and sustainable.

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APPENDIX A

Soil Reports

Lindis_4a.1

Report generated: 2-Oct-2024 from https://smap.landcareresearch.co.nz

Lindi_4a.1 (100% of the mapunit at location (1335964, 5011647), 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 Otago Regional Council, Fertiliser Association, Dunedin Rural Development and MWLR.

Soil Classification

Soil Classification:
Aged Argillic Pallic Soils (PJA)

Family Name:
Lindis (Lindi)

Sibling Name:
Lindis_4a.1 (Lindi_4a.1)

Soil profile material
Angular stony soil

Depth class (diggability)
Shallow (15 - 30 cm)

Profile texture
loam

Parent Material

Stones/rocks
schist rock

Soil material
schist rock

Origin
Alluvium

Soil Sibling Concept

This soil belongs to the Pallic soil order of the New Zealand soil classification. Pallic Soils have pale coloured subsoils, due to low contents of iron oxides, have weak soil structure and high density in subsurface horizons. Pallic Soils tend to be dry in summer and wet in winter. It is formed in alluvial sand silt or gravel deposited by running water, from schist parent material.

The topsoil typically has loam texture and is slightly stony. The subsoil has dominantly loam textures, with very gravelly layer from less than 45 cm mineral soil depth to more than 100 cm. The plant rooting depth extends beyond 1m.

Generally the soil is imperfectly drained with high vulnerability of water logging in non-irrigated conditions, and has moderate 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.

Allan Hewitt ©

Argillic
Pallic

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.
- This information sheet is licensed by Landcare Research on an "as is" and "as available" basis and without any warranty of any kind, either express or implied.
- 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.

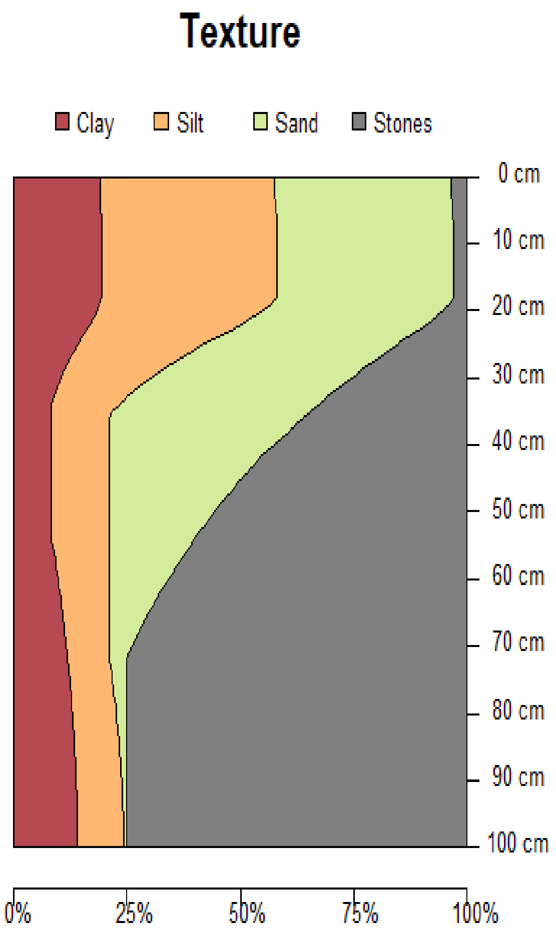
Lindis_4a.1

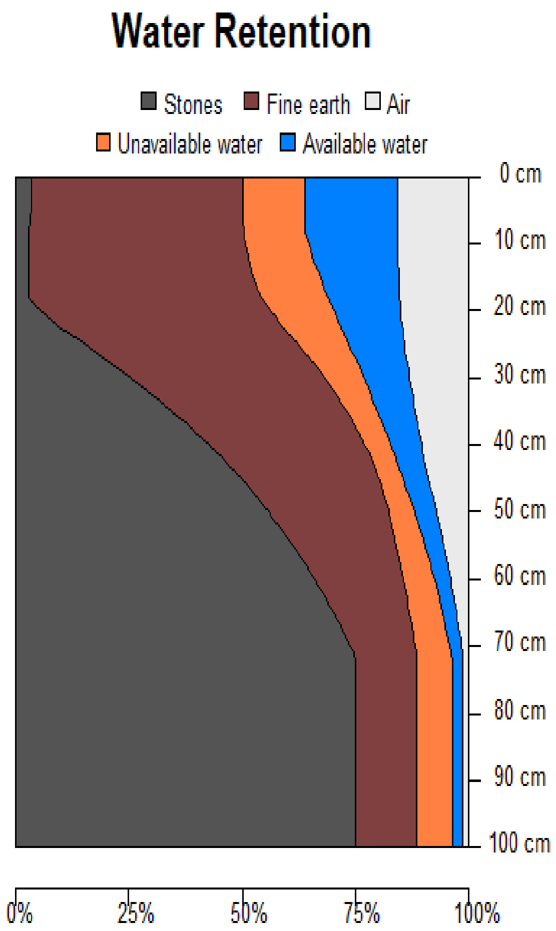
Soil horizons

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

Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Weak	10 - 15 cm	1 - 5 %	15 - 25 %	30 - 50 %	rapid
Loamy Fine Slightly Firm	5 - 15 cm	1 - 5 %	15 - 25 %	30 - 50 %	moderate
Very Stony Loamy Compact	20 - 30 cm	21 - 50 %	8 - 18 %	40 - 90 %	moderately slow
Extremly Stony Clayey	40 - 65 cm	60 - 90 %	35 - 60 %	1 - 30 %	slow

* 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.

Lindis_4a.1

Soil physical properties

Depth class (diggability)
Shallow (15 - 30 cm)

Potential rooting depth
Unlimited

Rooting barrier
No significant barrier within 1

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
Shallow

Texture profile
Loam

Topsoil stoniness
Slightly stony

Topsoil clay range
15 - 25 %

Drainage class
Imperfectly drained

Permeability profile
Moderate over slow

Depth to slowly permeable horizon
35 - 55 (cm)

Permeability of slowest horizon
Slow (< 4 mm/h)

Aeration in root zone
Limited

Profile available water

(0 - 30cm or root barrier)	(0 - 60cm or root barrier)	(0 - 100cm or root barrier)
Moderate (49 mm)	Moderate (73 mm)	Moderate (94 mm)

Dry bulk density

topsoil	subsoil
1.25 g/cm³	1.50 g/cm³

Soil chemical properties

Topsoil P retention
Low (19%)

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 (0.70)

Pugging vulnerability
not available yet

Septic tank installation category
A1 if slope > 15 deg otherwise B4

Contaminant management

N leaching vulnerability
Medium

P leaching vulnerability
not available yet

Dairy effluent (FDE) risk category
B

Water management

Water logging vulnerability
High

Drought vulnerability - if not irrigated
Moderate

Bypass flow
High

Hydrological soil group
D

Relative Runoff Potential

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

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.

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: **Lindi_4a.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

Otago Regional Council

Lauder_2b.1

Report generated: 2-Oct-2024 from https://smap.landcareresearch.co.nz

Laud_2b.1 (100% of the mapunit at location (1335886, 5010893), 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 Otago Regional Council, Fertiliser Association, Dunedin Rural Development and MWLR.

Soil Classification

Soil Classification:
Mottled Argillic Semiarid Soils (SJM)

Family Name:
Lauder (Laud)

Sibling Name:
Lauder_2b.1 (Laud_2b.1)

Soil profile material
Moderately deep soil

Depth class (diggability)
Moderately deep (45 - 90 cm)

Profile texture
silt over clay

Parent Material

Stones/rocks
soft mudstone rock

Soil material
soft mudstone rock

Origin
Rock

Soil Sibling Concept

This soil belongs to the Semiarid soil order of the New Zealand soil classification. Semiarid Soils are dry for most of the growing season, and rainfall is not sufficient to leach through the soil, so lime and salts accumulate in the lower subsoil. Nutrient levels are relatively high, but the soils must be irrigated to produce high yields. It is formed in fresh to moderately weathered rock, from soft mudstone parent material.

The topsoil typically has silt texture and is stoneless. The subsoil has dominantly clay textures, with a rock contact at less than 100 cm of the mineral soil depth. The plant rooting depth is 30 - 60 (cm), due to soil material of high density and/or high penetration resistance.

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

Allan Hewitt ©

Argillic Semiarid

About this publication

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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.

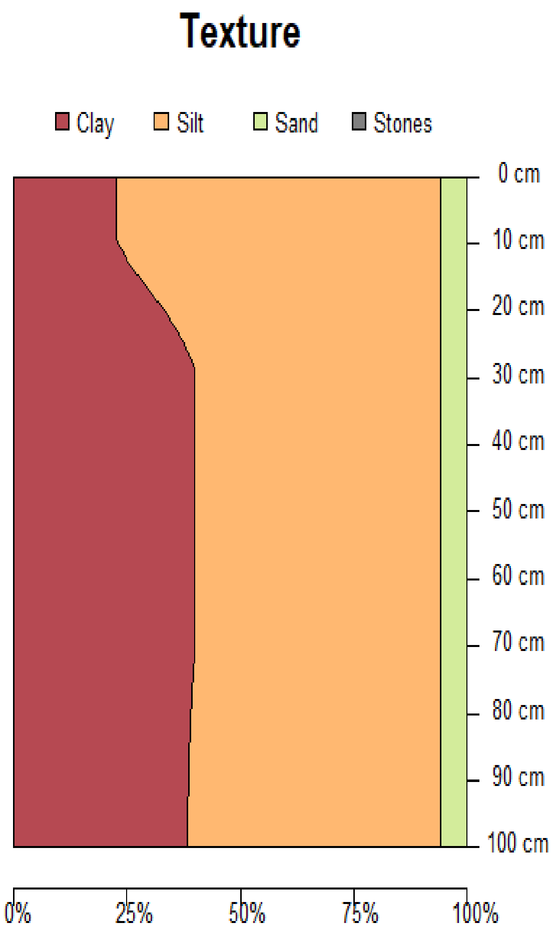
Lauder_2b.1

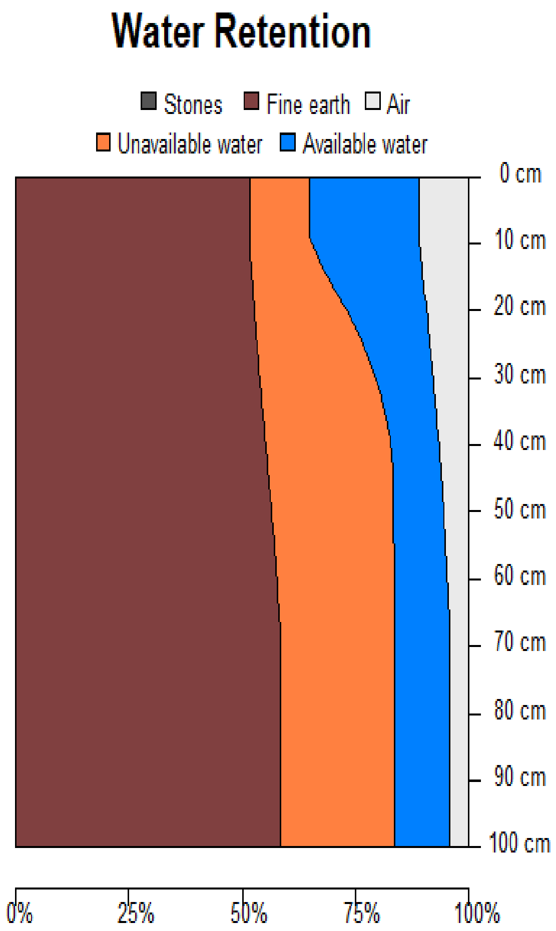
Soil horizons

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

Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Fine Slightly Firm	10 - 20 cm	0 %	20 - 25 %	2 - 10 %	moderate
Clayey Fine Sl Firm	20 - 40 cm	0 %	30 - 50 %	2 - 10 %	moderately slow
Clayey Coarse	40 - 70 cm	0 %	30 - 50 %	2 - 10 %	slow

* 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.

Lauder_2b.1

Soil physical properties

Depth class (diggability)
Moderately deep (45 - 90 cm)

Potential rooting depth
30 - 60 (cm)

Rooting barrier
Low penetration soil material

Depth to hard rock
No hard rock within 1 m

Depth to soft rock
Moderately deep

Depth to stony layer class
Moderately deep

Texture profile
Silt over clay

Topsoil stoniness
Stoneless

Topsoil clay range
20 - 25 %

Drainage class
Imperfectly drained

Permeability profile
Moderate over slow

Depth to slowly permeable horizon
30 - 60 (cm)

Permeability of slowest horizon
Slow (< 4 mm/h)

Aeration in root zone
Limited

Profile available water

(0 - 30cm or root barrier)	(0 - 60cm or root barrier)	(0 - 100cm or root barrier)
High (56 mm)	Moderate (76 mm)	Moderate to low (76 mm)

Dry bulk density

topsoil	subsoil
1.25 g/cm³	1.20 g/cm³

Soil chemical properties

Topsoil P retention
Low (11%)

Soil management factors

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

Soil structure integrity

Structural vulnerability
Very high (0.78)

Pugging vulnerability
not available yet

Septic tank installation category
A1 if slope > 15 deg otherwise B1

Contaminant management

N leaching vulnerability
Medium

P leaching vulnerability
not available yet

Dairy effluent (FDE) risk category
B

Water management

Water logging vulnerability
High

Drought vulnerability - if not irrigated
Moderate

Bypass flow
High

Hydrological soil group
D

Relative Runoff Potential

Slope	0-3°	4-7°	8-15°	16-25°	>25°
Risk	M	H	H	VH	VH

SINDI - Soil quality Indicators

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Soil information for OVERSEER

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Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Laud_2b.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.

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Becks_5a.1

Report generated: 2-Oct-2024 from https://smap.landcareresearch.co.nz

Becks_5a.1

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.

Soil Classification

Soil Classification:
Saline Argillic Semiarid Soils (SJQ)

Family Name:
Becks (Becks)

Sibling Name:
Becks_5a.1 (Becks_5a.1)

Soil profile material
Stoneless soil

Depth class (diggability)
Deep (> 1 m)

Profile texture
silt over clay

Parent Material

Stones/rocks
not applicable

Soil material
soft mudstone rock

Origin
Rock

Soil Sibling Concept

This soil belongs to the Semiarid soil order of the New Zealand soil classification. Semiarid Soils are dry for most of the growing season, and rainfall is not sufficient to leach through the soil, so lime and salts accumulate in the lower subsoil. Nutrient levels are relatively high, but the soils must be irrigated to produce high yields. It is formed in fresh to moderately weathered rock, from soft mudstone parent material.

The topsoil typically has silt texture and is stoneless. The subsoil has dominantly clay textures, with gravel content of less than 3%. The plant rooting depth is 30 - 70 (cm), due to soil material of high density and/or high penetration resistance.

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

About this publication

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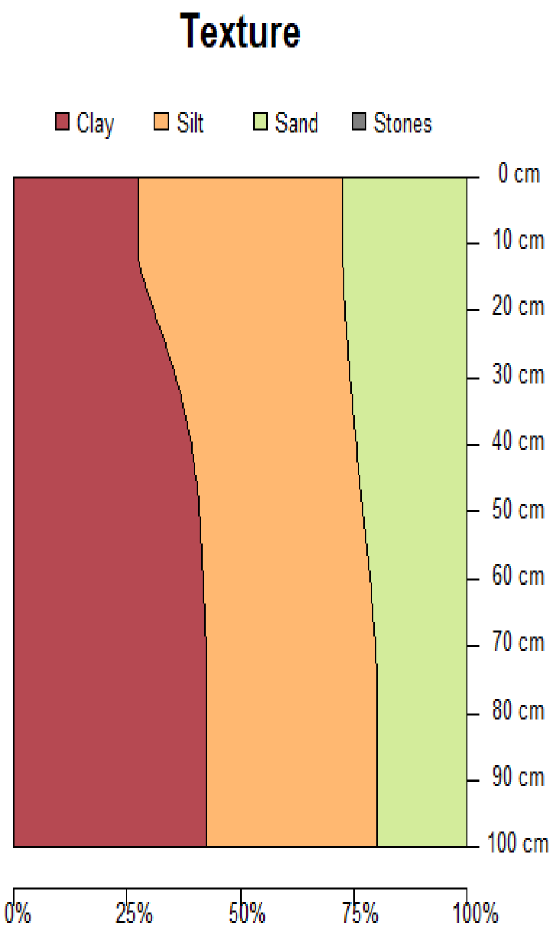
Becks_5a.1

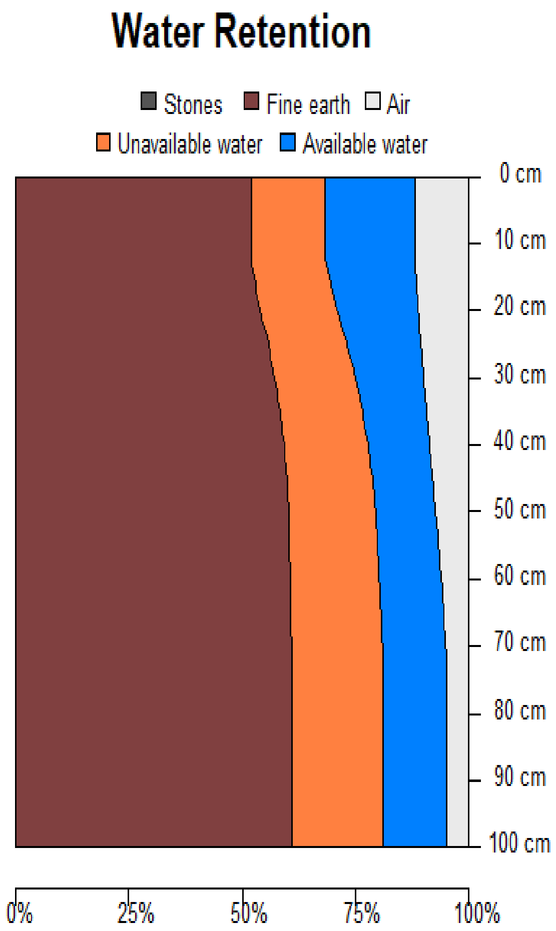
Soil horizons

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

Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Fine Slightly Firm	10 - 30 cm	0 %	20 - 35 %	10 - 45 %	moderate
Clayey Fine Sl Firm	20 - 40 cm	0 %	30 - 45 %	10 - 40 %	moderately slow
Clayey Coarse	30 - 70 cm	0 %	35 - 50 %	10 - 30 %	slow

* 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.

Soil physical properties

Depth class (diggability)
Deep (> 1 m)

Potential rooting depth
30 - 70 (cm)

Rooting barrier
Low penetration soil material

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 over clay

Topsoil stoniness
Stoneless

Topsoil clay range
20 - 35 %

Drainage class
Well drained

Permeability profile
Moderate over slow

Depth to slowly permeable horizon
30 - 70 (cm)

Permeability of slowest horizon
Slow (< 4 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)
High (54 mm)	Moderate (83 mm)	Moderate to low (83 mm)

Dry bulk density

topsoil	subsoil
1.25 g/cm³	1.20 g/cm³

Soil chemical properties

Topsoil P retention
Low (11%)

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 (0.66)

Contaminant management

N leaching vulnerability
High

P leaching vulnerability
not available yet

Water management

Water logging vulnerability
Moderate

Drought vulnerability - if not irrigated
Moderate

Bypass flow
High

SINDI - Soil quality Indicators

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- Learn about the effect each indicator has on soil quality and some general management practices that could be implemented to improve soil quality.

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: **Becks_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 .

Flaxton_105a.1

Report generated: 2-Oct-2024 from https://smap.landcareresearch.co.nz

Flax_105a.1 (100% of the mapunit at location (1337535, 5010753), 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 Otago Regional Council, Fertiliser Association, Dunedin Rural Development and MWLR.

Soil Classification

Soil Classification:
Typic Orthic Gley Soils (GOT)

Family Name:
Flaxton (Flax)

Sibling Name:
Flaxton_105a.1 (Flax_105a.1)

Soil profile material
Soil with stones (non contra

Depth class (diggability)
Moderately deep (60 - 85 cm)

Profile texture
silt

Parent Material

Stones/rocks
schist rock

Soil material
schist and soft mudstone roc

Origin
Alluvium

Soil Sibling Concept

This soil belongs to the Gley soil order of the New Zealand soil classification. Gley soils are strongly affected by waterlogging, have been chemically reduced, have light grey subsoils, and usually have reddish brown or brown mottles. Waterlogging occurs in winter and spring, and some soils remain wet all year. It is formed in alluvial sand silt or gravel deposited by running water, from schist parent material.

The topsoil typically has silt texture and is stoneless. The subsoil has dominantly silt 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 poorly drained with high vulnerability of water logging in non-irrigated conditions, and has high soil water holding capacity. Inherently these soils have a high structural vulnerability and a very low N leaching potential, which should be accounted for when making land management decisions.

Allan Hewitt ©

Orthic Gley

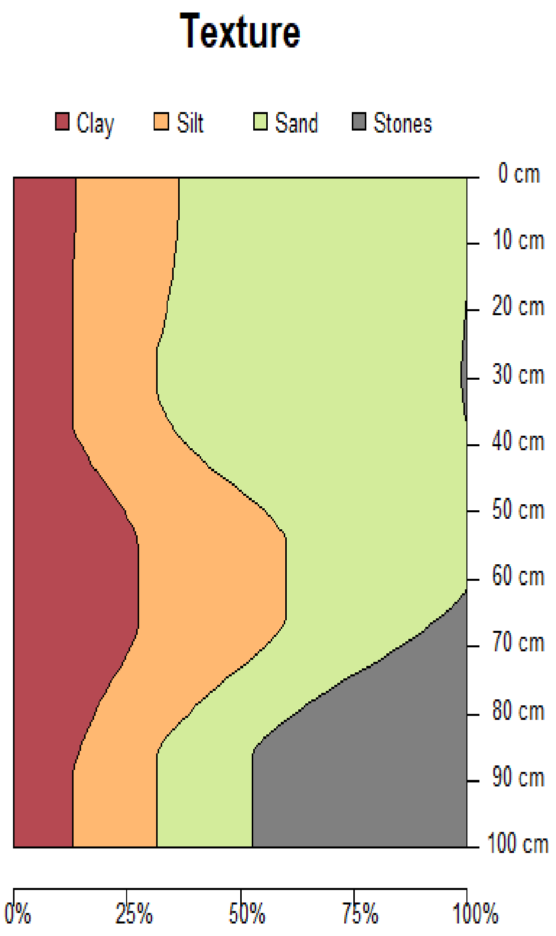
Flaxton_105a.1

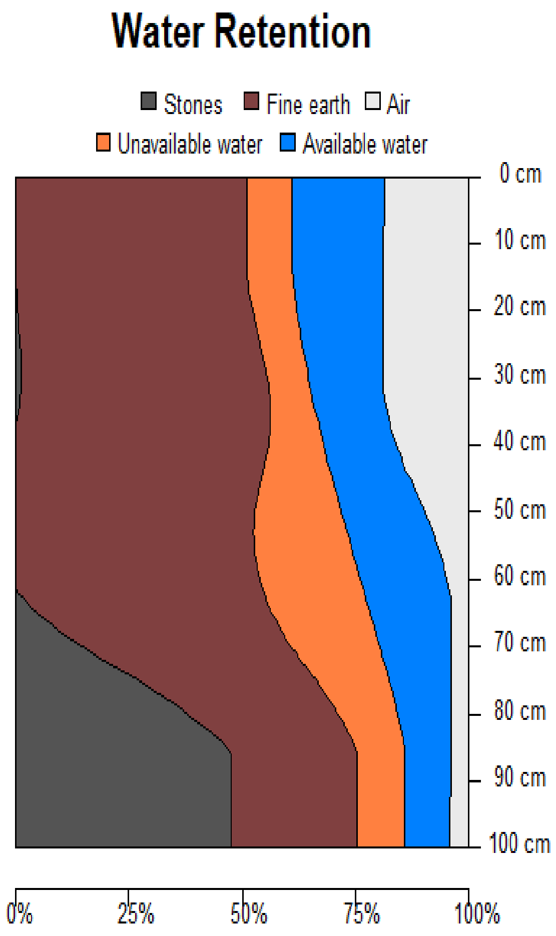
Soil horizons

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

Functional Horizon	Thickness	Stones	Clay*	Sand*	Permeability
Loamy Weak	20 - 30 cm	0 %	8 - 18 %	40 - 90 %	rapid
Loamy Weak	15 - 25 cm	0 %	8 - 18 %	40 - 90 %	moderate
Loamy Coarse Firm	25 - 30 cm	0 %	20 - 35 %	30 - 50 %	slow
Very Stony Loamy Compact	15 - 40 cm	35 - 60 %	20 - 35 %	30 - 50 %	moderately slow

* 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.

Soil physical properties

Depth class (diggability)
Moderately deep (60 - 85 cm)

Potential rooting depth
Unlimited

Rooting barrier
No significant barrier within 1

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
Silt

Topsoil stoniness
Stoneless

Topsoil clay range
8 - 18 %

Drainage class
Poorly drained

Permeability profile
Moderate over slow

Depth to slowly permeable horizon
35 - 55 (cm)

Permeability of slowest horizon
Slow (< 4 mm/h)

Aeration in root zone
Very limited

Profile available water

(0 - 30cm or root barrier)	(0 - 60cm or root barrier)	(0 - 100cm or root barrier)
High (58 mm)	High (110 mm)	High (166 mm)

Dry bulk density

topsoil	subsoil
1.00 g/cm³	1.20 g/cm³

Soil chemical properties

Topsoil P retention
Medium (38%)

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 B2

Contaminant management

N leaching vulnerability
Very low

P leaching vulnerability
not available yet

Dairy effluent (FDE) risk category
B

Water management

Water logging vulnerability
High

Drought vulnerability - if not irrigated
Low

Bypass flow
High

Hydrological soil group
D

Relative Runoff Potential

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

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.

Soil information for OVERSEER

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Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Flax_105a.1**

Considerations when using Smap soil properties in OVERSEER

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APPENDIX B

Soil Physics and Soil Chemistry Test Reports

Soil Physics Laboratory
Analytical Report

Manaaki Whenua – Landcare Research
Riddet Rd, Massey University Campus,
Private Bag 11052, Palmerston North 4442
Phone: +64 6 353 4800

Manaaki Whenua
Landcare Research

Job number: PJ24047

Customer: [redacted], Lowe Environmental Impact

Date received: 11th April 2025

Date Analysed: 2nd to 16th May 2025

Date reported: 19th May 2025

Core number	Name	ID number	Remarks	Particle density (g/cm^3)	Dry bulk density (g/cm^3)	Porosity (%)	Micro-Porosity (-5 kPa) (%)	Air Capacity (-10 kPa) (%)	Field capacity (%)
961	Site 6 - 0-15 cm	PP24-1889		2.55	1.25	51	32	23	28
929	Site 7 - 0-15 cm	PP24-1891		2.61	1.29	51	35	19	31
754	Site 8 - 0-15 cm	PP24-1893		2.60	1.33	49	27	24	25
679	Site 2 - 0-50 cm	PP24-1895		2.52	1.05	58	39	26	33
945	Site 1 - 0-15 cm	PP24-1897		2.55	1.22	52	32	23	29
718	Site 4 - 0-15 cm	PP24-1899		2.52	1.12	56	35	23	33
884	Site 9 - 0-15 cm	PP24-1901		2.55	1.21	52	33	21	31
729	Site 5 - 0-15 cm	PP24-1903		2.50	1.07	57	33	28	29
985	Site 3 - 0-15 cm	PP24-1905		2.57	1.28	50	30	22	28

Sample name	Gravimetric water content (%w/w)			
	As supplied	Saturation (calc.)	5 kPa	10 kPa
961	12	41	25	23
929	9	39	27	24
754	6	36	21	19
679	21	55	37	31
945	11	43	26	24
718	12	50	32	29
884	12	43	27	26
729	14	54	31	27
985	11	39	23	22

Sample name	Volumetric water content (%v/v)			
	As supplied	Saturation (calc.)	5 kPa	10 kPa
961	15	51	32	28
929	11	51	35	31
754	8	49	27	25
679	23	58	39	33
945	13	52	32	29
718	13	56	35	33
884	14	52	33	31
729	15	57	33	29
985	14	50	30	28

Micro-porosity cited here is determined between total porosity and air filled porosity at -5 kPa.
Air Capacity cited here is determined between total porosity and tension of -10 kPa.

References:

Gradwell, M.W. 1972: Methods for physical analysis of soils. *Scientific Report 10C.* Lower Hutt, N.Z. Soil Bureau.

7(2)(a) [redacted]

Laboratory Manager – Soil Physics

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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516	svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025	
		Date Reported:	07-May-2025	
		Quote No:	137475	
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	[redacted]	

Soil Analysis Results

Sample Name:		1A	1B	2A	2B	3A	3B
Lab Number:		3867516.1	3867516.2	3867516.3	3867516.4	3867516.5	3867516.6
Sample Type:		SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil
Sample Type Code:		S10	S147	S10	S147	S10	S147
pH	pH Units	5.7	5.6	5.5	5.4	5.0	5.3
Olsen Phosphorus	mg/L	7	9	12	18	24	13
Potassium	me/100g	0.27	0.18	0.79	0.23	0.95	0.65
Potassium	%BS	2.6	2.6	6.6	4.2	5.3	7.5
Potassium	MAF units	5	5	13	6	15	16
Calcium	me/100g	3.4	< 0.5	4.0	< 0.5	5.1	1.5
Calcium	%BS	33	5	34	3	29	17
Calcium	MAF units	4	< 1	4	< 1	5	2
Magnesium	me/100g	0.64	0.12	0.62	< 0.04	1.32	0.53
Magnesium	%BS	6.3	1.7	5.2	0.5	7.4	6.1
Magnesium	MAF units	14	3	11	< 1	23	14
Sodium	me/100g	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sodium	%BS	0.2	0.3	0.2	0.1	0.1	0.2
Sodium	MAF units	< 2	< 2	< 2	< 2	< 2	< 2
CEC	me/100g	10	7	12	5	18	9
Total Base Saturation	%	42	10	46	7	41	31
Volume Weight	g/mL	0.96	1.23	0.80	1.33	0.78	1.20

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		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	[redacted]

Soil Analysis Results

Sample Name:		4A	4B	5A	5B	6A	6B
Lab Number:		3867516.7	3867516.8	3867516.9	3867516.10	3867516.11	3867516.12
Sample Type:		SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil
Sample Type Code:		S10	S147	S10	S147	S10	S147
pH	pH Units	5.3	5.5	5.3	5.5	5.8	6.0
Olsen Phosphorus	mg/L	11	10	13	29	16	5
Potassium	me/100g	0.72	0.38	0.34	0.19	0.70	0.06
Potassium	%BS	4.9	5.8	2.9	2.6	6.1	1.3
Potassium	MAF units	12	10	7	5	13	2
Calcium	me/100g	4.2	1.0	4.7	1.0	4.8	2.6
Calcium	%BS	29	15	40	15	41	54
Calcium	MAF units	4	2	6	2	6	4
Magnesium	me/100g	1.19	0.35	0.56	0.16	0.89	1.08
Magnesium	%BS	8.1	5.5	4.7	2.3	7.7	22.5
Magnesium	MAF units	23	11	12	4	19	33
Sodium	me/100g	< 0.05	< 0.05	0.06	< 0.05	< 0.05	< 0.05
Sodium	%BS	0.2	0.5	0.5	0.2	0.2	0.4
Sodium	MAF units	< 2	2	3	< 2	< 2	< 2
CEC	me/100g	15	6	12	7	12	5
Total Base Saturation	%	42	27	48	20	55	78
Volume Weight	g/mL	0.84	1.34	0.98	1.22	0.93	1.36

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		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	[redacted]

Soil Analysis Results

Sample Name:		7A	7B	8A	8B	9 0-30cm	9 30-60cm
Lab Number:		3867516.13	3867516.14	3867516.15	3867516.16	3867516.17	3867516.18
Sample Type:		SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Sub-Soil
Sample Type Code:		S10	S147	S10	S147	S10	S147
pH	pH Units	5.6	5.3	5.4	5.2	5.9	5.6
Olsen Phosphorus	mg/L	6	5	4	9	14	5
Potassium	me/100g	0.32	0.18	0.23	0.31	1.22	0.32
Potassium	%BS	2.5	2.2	2.6	2.7	9.9	5.0
Potassium	MAF units	6	5	6	6	22	8
Calcium	me/100g	5.7	1.9	1.1	3.0	4.3	1.6
Calcium	%BS	43	23	12	26	35	25
Calcium	MAF units	7	3	2	4	5	3
Magnesium	me/100g	1.12	0.67	0.33	0.66	1.35	0.43
Magnesium	%BS	8.6	8.1	3.8	5.8	10.9	6.7
Magnesium	MAF units	24	19	10	15	27	12
Sodium	me/100g	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sodium	%BS	0.4	0.6	0.2	0.2	0.2	0.3
Sodium	MAF units	2	3	< 2	< 2	< 2	< 2
CEC	me/100g	13	8	9	11	12	6
Total Base Saturation	%	55	34	19	35	56	37
Volume Weight	g/mL	0.94	1.25	1.31	1.01	0.88	1.27

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		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	[redacted]

Soil Analysis Results

Sample Name:		9 60-90cm	9 90-120cm	T1	T2	T3	T3 Crop
Lab Number:		3867516.19	3867516.20	3867516.21	3867516.22	3867516.23	3867516.24
Sample Type:		SOIL General, Sub-Soil	SOIL General, Sub-Soil	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor
Sample Type Code:		S147	S147	S10	S10	S10	S10
pH	pH Units	5.5	5.5	5.5	5.5	5.4	5.9
Olsen Phosphorus	mg/L	10	4	12	14	12	15
Potassium	me/100g	0.25	0.16	0.46	0.53	0.56	0.32
Potassium	%BS	3.4	2.4	4.2	3.9	4.8	2.3
Potassium	MAF units	7	4	10	9	11	6
Calcium	me/100g	1.7	1.2	4.3	5.2	3.9	8.7
Calcium	%BS	23	17	40	37	33	63
Calcium	MAF units	3	2	6	6	5	10
Magnesium	me/100g	0.46	0.50	0.63	0.79	1.34	0.77
Magnesium	%BS	6.2	7.4	5.8	5.7	11.5	5.5
Magnesium	MAF units	13	15	15	15	30	16
Sodium	me/100g	< 0.05	< 0.05	< 0.05	< 0.05	0.06	< 0.05
Sodium	%BS	0.6	0.4	0.2	0.2	0.5	0.3
Sodium	MAF units	3	< 2	< 2	< 2	3	< 2
CEC	me/100g	7	7	11	14	12	14
Total Base Saturation	%	33	28	50	47	50	71
Volume Weight	g/mL	1.30	1.31	1.03	0.86	0.99	0.94
Organic Matter*	%	-	-	5.7	8.5	6.9	6.9
Total Carbon*	%	-	-	3.3	4.9	4.0	4.0
Total Nitrogen*	%	-	-	0.29	0.40	0.31	0.34
'Total' Phosphorus	mg/kg	-	-	539	609	535	637
'Total' Zinc*	mg/kg	-	-	40	38	37	35
'Total' Copper*	mg/kg	-	-	11	10	10	12
'Total' Chromium*	mg/kg	-	-	13.9	19.3	7.0	12.4
'Total' Arsenic*	mg/kg	-	-	6.0	5.7	4.4	5.4
'Total' Lead*	mg/kg	-	-	12.5	12.1	11.0	11.0
'Total' Nickel*	mg/kg	-	-	11.2	13.6	7.4	10.2
'Total' Mercury*	mg/kg	-	-	< 0.12	< 0.12	< 0.12	< 0.12
'Total' Cadmium*	mg/kg	-	-	0.05	0.08	0.05	0.09

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		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	[redacted]

Soil Analysis Results

Sample Name:		T4	T5	T6	T7	T8
Lab Number:		3867516.25	3867516.26	3867516.27	3867516.28	3867516.29
Sample Type:		SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor
Sample Type Code:		S10	S10	S10	S10	S10
pH	pH Units	5.4	5.5	5.8	5.6	5.8	-
Olsen Phosphorus	mg/L	16	9	13	9	9	-
Potassium	me/100g	0.92	0.46	0.50	0.58	0.49	-
Potassium	%BS	7.3	3.7	4.0	4.6	4.4	-
Potassium	MAF units	18	9	9	12	10	-
Calcium	me/100g	4.0	6.2	5.8	5.8	5.1	-
Calcium	%BS	32	50	46	46	45	-
Calcium	MAF units	5	8	7	7	6	-
Magnesium	me/100g	1.15	0.80	0.92	1.30	0.85	-
Magnesium	%BS	9.2	6.5	7.4	10.3	7.6	-
Magnesium	MAF units	24	18	19	28	19	-
Sodium	me/100g	< 0.05	< 0.05	< 0.05	0.07	< 0.05	-
Sodium	%BS	0.3	0.3	0.4	0.5	0.3	-
Sodium	MAF units	< 2	< 2	< 2	3	< 2	-
CEC	me/100g	13	12	12	13	11	-
Total Base Saturation	%	49	61	58	61	58	-
Volume Weight	g/mL	0.93	1.01	0.90	0.97	0.99	-
Organic Matter*	%	7.4	6.4	7.1	5.9	5.0	-
Total Carbon*	%	4.3	3.7	4.1	3.4	2.9	-
Total Nitrogen*	%	0.35	0.32	0.34	0.28	0.26	-
'Total' Phosphorus	mg/kg	602	533	519	474	546	-
'Total' Zinc*	mg/kg	37	33	35	38	38	-
'Total' Copper*	mg/kg	9	8	11	10	10	-
'Total' Chromium*	mg/kg	12.2	9.0	9.8	8.0	11.1	-
'Total' Arsenic*	mg/kg	4.9	5.8	5.5	4.2	5.5	-
'Total' Lead*	mg/kg	11.3	9.7	11.3	11.1	11.7	-
'Total' Nickel*	mg/kg	9.4	7.8	8.6	7.2	8.9	-
'Total' Mercury*	mg/kg	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	-
'Total' Cadmium*	mg/kg	0.05	0.07	0.04	0.04	0.05	-

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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a)

Sample Name: 1A **Lab Number:** 3867516.1
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.7	5.8 - 6.3			
Olsen Phosphorus	mg/L	7	20 - 30			
Potassium	me/100g	0.27	0.50 - 0.80			
Calcium	me/100g	3.4	6.0 - 12.0			
Magnesium	me/100g	0.64	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	10	12 - 25			
Total Base Saturation	%	42	50 - 85			
Volume Weight	g/mL	0.96	0.60 - 1.00			

Base Saturation %	K 2.6	Ca 33	Mg 6.3	Na 0.2
MAF Units	K 5	Ca 4	Mg 14	Na < 2

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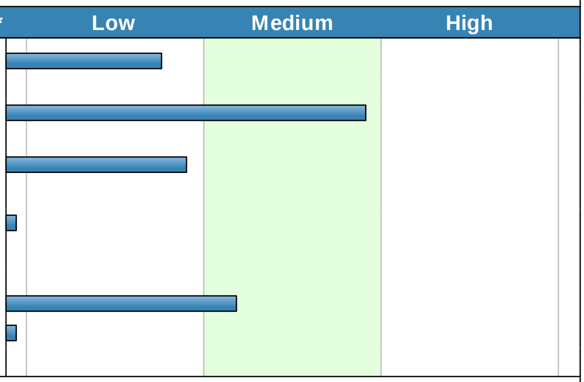
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 1B **Lab Number:** 3867516.2
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*
pH	pH Units	5.6	5.8 - 6.8
Olsen Phosphorus	mg/L	9	1 - 10
Potassium	me/100g	0.18	0.20 - 0.70
Calcium	me/100g	< 0.5	3.0 - 10.0
Magnesium	me/100g	0.12	0.50 - 2.00
Sodium	me/100g	< 0.05	0.00 - 0.40
CEC	me/100g	7	5 - 15
Total Base Saturation	%	10	45 - 75
Volume Weight	g/mL	1.23	
Base Saturation %		K 2.6 Ca 5	Mg 1.7 Na 0.3
MAF Units		K 5 Ca < 1	Mg 3 Na < 2



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		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 2A **Lab Number:** 3867516.3
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*
pH	pH Units	5.5	5.8 - 6.3
Olsen Phosphorus	mg/L	12	20 - 30
Potassium	me/100g	0.79	0.50 - 0.80
Calcium	me/100g	4.0	6.0 - 12.0
Magnesium	me/100g	0.62	1.00 - 3.00
Sodium	me/100g	< 0.05	0.20 - 0.50
CEC	me/100g	12	12 - 25
Total Base Saturation	%	46	50 - 85
Volume Weight	g/mL	0.80	0.60 - 1.00

Base Saturation %	K 6.6	Ca 34	Mg 5.2	Na 0.2
MAF Units	K 13	Ca 4	Mg 11	Na < 2

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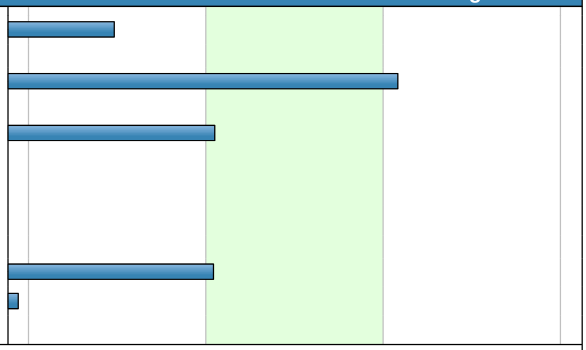
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 2B **Lab Number:** 3867516.4
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.4	5.8 - 6.8			
Olsen Phosphorus	mg/L	18	1 - 10			
Potassium	me/100g	0.23	0.20 - 0.70			
Calcium	me/100g	< 0.5	3.0 - 10.0			
Magnesium	me/100g	< 0.04	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	5	5 - 15			
Total Base Saturation	%	7	45 - 75			
Volume Weight	g/mL	1.33				
Base Saturation %		K 4.2	Ca 3	Mg 0.5	Na 0.1	
MAF Units		K 6	Ca < 1	Mg < 1	Na < 2	



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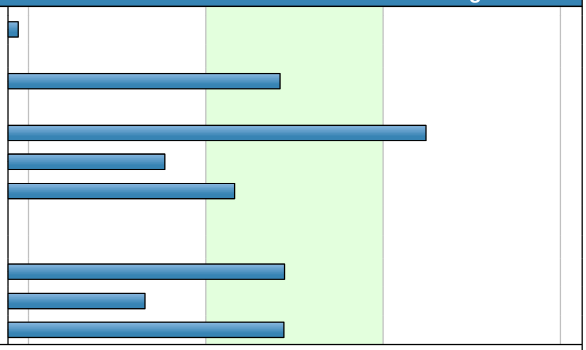
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 3A **Lab Number:** 3867516.5
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.0	5.8 - 6.3			
Olsen Phosphorus	mg/L	24	20 - 30			
Potassium	me/100g	0.95	0.50 - 0.80			
Calcium	me/100g	5.1	6.0 - 12.0			
Magnesium	me/100g	1.32	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	18	12 - 25			
Total Base Saturation	%	41	50 - 85			
Volume Weight	g/mL	0.78	0.60 - 1.00			
Base Saturation %		K 5.3	Ca 29	Mg 7.4	Na 0.1	
MAF Units		K 15	Ca 5	Mg 23	Na < 2	



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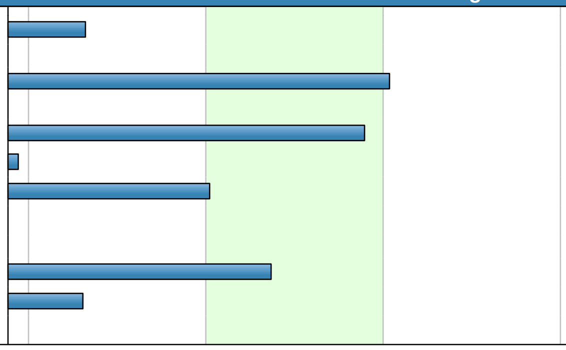
		Date Reported:	07-May-2025	
		Quote No:	137475	
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: 3B **Lab Number:** 3867516.6

Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.3	5.8 - 6.8			
Olsen Phosphorus	mg/L	13	1 - 10			
Potassium	me/100g	0.65	0.20 - 0.70			
Calcium	me/100g	1.5	3.0 - 10.0			
Magnesium	me/100g	0.53	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	9	5 - 15			
Total Base Saturation	%	31	45 - 75			
Volume Weight	g/mL	1.20				
Base Saturation %		K 7.5	Ca 17	Mg 6.1	Na 0.2	
MAF Units		K 16	Ca 2	Mg 14	Na < 2	



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		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 4A **Lab Number:** 3867516.7
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*
pH	pH Units	5.3	5.8 - 6.3
Olsen Phosphorus	mg/L	11	20 - 30
Potassium	me/100g	0.72	0.50 - 0.80
Calcium	me/100g	4.2	6.0 - 12.0
Magnesium	me/100g	1.19	1.00 - 3.00
Sodium	me/100g	< 0.05	0.20 - 0.50
CEC	me/100g	15	12 - 25
Total Base Saturation	%	42	50 - 85
Volume Weight	g/mL	0.84	0.60 - 1.00

Base Saturation %	K 4.9	Ca 29	Mg 8.1	Na 0.2
MAF Units	K 12	Ca 4	Mg 23	Na < 2

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		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 4B **Lab Number:** 3867516.8

Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.8			
Olsen Phosphorus	mg/L	10	1 - 10			
Potassium	me/100g	0.38	0.20 - 0.70			
Calcium	me/100g	1.0	3.0 - 10.0			
Magnesium	me/100g	0.35	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	6	5 - 15			
Total Base Saturation	%	27	45 - 75			
Volume Weight	g/mL	1.34				
Base Saturation %		K 5.8	Ca 15	Mg 5.5	Na 0.5	
MAF Units		K 10	Ca 2	Mg 11	Na 2	

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		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 5A **Lab Number:** 3867516.9
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.3	5.8 - 6.3			
Olsen Phosphorus	mg/L	13	20 - 30			
Potassium	me/100g	0.34	0.50 - 0.80			
Calcium	me/100g	4.7	6.0 - 12.0			
Magnesium	me/100g	0.56	1.00 - 3.00			
Sodium	me/100g	0.06	0.20 - 0.50			
CEC	me/100g	12	12 - 25			
Total Base Saturation	%	48	50 - 85			
Volume Weight	g/mL	0.98	0.60 - 1.00			
Base Saturation %		K 2.9	Ca 40	Mg 4.7	Na 0.5	
MAF Units		K 7	Ca 6	Mg 12	Na 3	

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		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 5B **Lab Number:** 3867516.10
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.8			
Olsen Phosphorus	mg/L	29	1 - 10			
Potassium	me/100g	0.19	0.20 - 0.70			
Calcium	me/100g	1.0	3.0 - 10.0			
Magnesium	me/100g	0.16	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	7	5 - 15			
Total Base Saturation	%	20	45 - 75			
Volume Weight	g/mL	1.22				
Base Saturation %		K 2.6	Ca 15	Mg 2.3	Na 0.2	
MAF Units		K 5	Ca 2	Mg 4	Na < 2	

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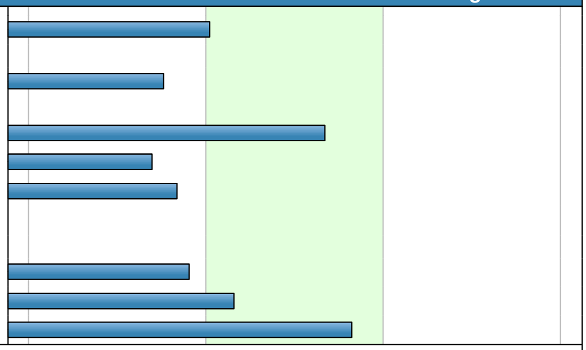
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: 6A **Lab Number:** 3867516.11
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.8	5.8 - 6.3			
Olsen Phosphorus	mg/L	16	20 - 30			
Potassium	me/100g	0.70	0.50 - 0.80			
Calcium	me/100g	4.8	6.0 - 12.0			
Magnesium	me/100g	0.89	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	12	12 - 25			
Total Base Saturation	%	55	50 - 85			
Volume Weight	g/mL	0.93	0.60 - 1.00			
Base Saturation %		K 6.1	Ca 41	Mg 7.7	Na 0.2	
MAF Units		K 13	Ca 6	Mg 19	Na < 2	



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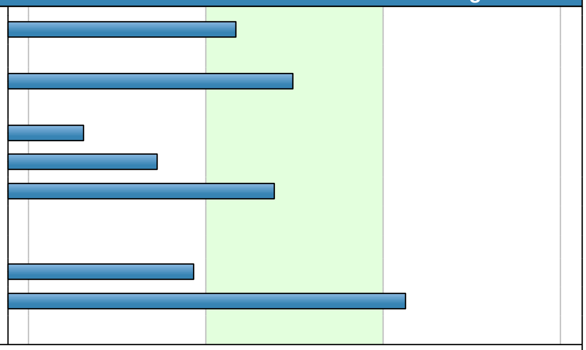
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: 6B **Lab Number:** 3867516.12
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	6.0	5.8 - 6.8			
Olsen Phosphorus	mg/L	5	1 - 10			
Potassium	me/100g	0.06	0.20 - 0.70			
Calcium	me/100g	2.6	3.0 - 10.0			
Magnesium	me/100g	1.08	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	5	5 - 15			
Total Base Saturation	%	78	45 - 75			
Volume Weight	g/mL	1.36				
Base Saturation %		K 1.3	Ca 54	Mg 22.5	Na 0.4	
MAF Units		K 2	Ca 4	Mg 33	Na < 2	



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		Quote No:	137475
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		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 7A **Lab Number:** 3867516.13
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.6	5.8 - 6.3			
Olsen Phosphorus	mg/L	6	20 - 30			
Potassium	me/100g	0.32	0.50 - 0.80			
Calcium	me/100g	5.7	6.0 - 12.0			
Magnesium	me/100g	1.12	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	13	12 - 25			
Total Base Saturation	%	55	50 - 85			
Volume Weight	g/mL	0.94	0.60 - 1.00			
Base Saturation %		K 2.5	Ca 43	Mg 8.6	Na 0.4	
MAF Units		K 6	Ca 7	Mg 24	Na 2	

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		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 7B **Lab Number:** 3867516.14
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.3	5.8 - 6.8			
Olsen Phosphorus	mg/L	5	1 - 10			
Potassium	me/100g	0.18	0.20 - 0.70			
Calcium	me/100g	1.9	3.0 - 10.0			
Magnesium	me/100g	0.67	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	8	5 - 15			
Total Base Saturation	%	34	45 - 75			
Volume Weight	g/mL	1.25				
Base Saturation %		K 2.2	Ca 23	Mg 8.1	Na 0.6	
MAF Units		K 5	Ca 3	Mg 19	Na 3	

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		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 8A **Lab Number:** 3867516.15
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.4	5.8 - 6.3			
Olsen Phosphorus	mg/L	4	20 - 30			
Potassium	me/100g	0.23	0.50 - 0.80			
Calcium	me/100g	1.1	6.0 - 12.0			
Magnesium	me/100g	0.33	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	9	12 - 25			
Total Base Saturation	%	19	50 - 85			
Volume Weight	g/mL	1.31	0.60 - 1.00			
Base Saturation %		K 2.6	Ca 12	Mg 3.8	Na 0.2	
MAF Units		K 6	Ca 2	Mg 10	Na < 2	

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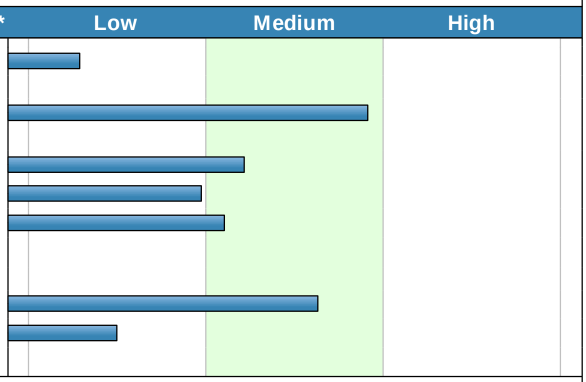
Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 8B **Lab Number:** 3867516.16
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*
pH	pH Units	5.2	5.8 - 6.8
Olsen Phosphorus	mg/L	9	1 - 10
Potassium	me/100g	0.31	0.20 - 0.70
Calcium	me/100g	3.0	3.0 - 10.0
Magnesium	me/100g	0.66	0.50 - 2.00
Sodium	me/100g	< 0.05	0.00 - 0.40
CEC	me/100g	11	5 - 15
Total Base Saturation	%	35	45 - 75
Volume Weight	g/mL	1.01	
Base Saturation %		K 2.7 Ca 26 Mg 5.8 Na 0.2	
MAF Units		K 6 Ca 4 Mg 15 Na < 2	



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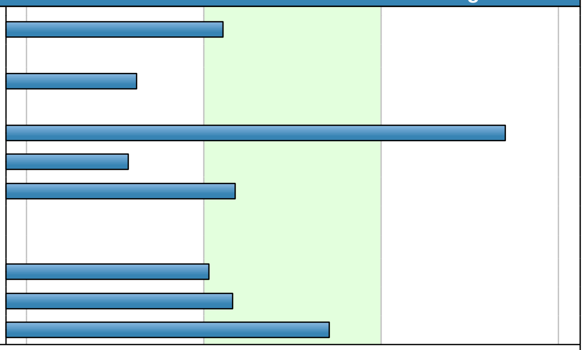
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 9 0-30cm **Lab Number:** 3867516.17
Sample Type: SOIL General, Outdoor (S10)

Analysis	Units	Level Found	Medium Range*
pH	pH Units	5.9	5.8 - 6.3
Olsen Phosphorus	mg/L	14	20 - 30
Potassium	me/100g	1.22	0.50 - 0.80
Calcium	me/100g	4.3	6.0 - 12.0
Magnesium	me/100g	1.35	1.00 - 3.00
Sodium	me/100g	< 0.05	0.20 - 0.50
CEC	me/100g	12	12 - 25
Total Base Saturation	%	56	50 - 85
Volume Weight	g/mL	0.88	0.60 - 1.00



Base Saturation %	K 9.9	Ca 35	Mg 10.9	Na 0.2
MAF Units	K 22	Ca 5	Mg 27	Na < 2

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Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 9 30-60cm **Lab Number:** 3867516.18
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.6	5.8 - 6.8			
Olsen Phosphorus	mg/L	5	1 - 10			
Potassium	me/100g	0.32	0.20 - 0.70			
Calcium	me/100g	1.6	3.0 - 10.0			
Magnesium	me/100g	0.43	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	6	5 - 15			
Total Base Saturation	%	37	45 - 75			
Volume Weight	g/mL	1.27				
Base Saturation %		K 5.0	Ca 25	Mg 6.7	Na 0.3	
MAF Units		K 8	Ca 3	Mg 12	Na < 2	

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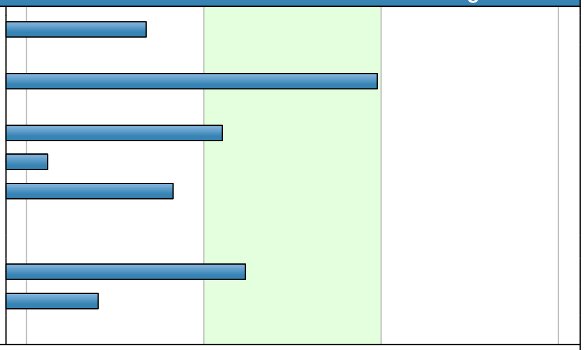
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: 9 60-90cm **Lab Number:** 3867516.19
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.8			
Olsen Phosphorus	mg/L	10	1 - 10			
Potassium	me/100g	0.25	0.20 - 0.70			
Calcium	me/100g	1.7	3.0 - 10.0			
Magnesium	me/100g	0.46	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	7	5 - 15			
Total Base Saturation	%	33	45 - 75			
Volume Weight	g/mL	1.30				
Base Saturation %		K 3.4	Ca 23	Mg 6.2	Na 0.6	
MAF Units		K 7	Ca 3	Mg 13	Na 3	



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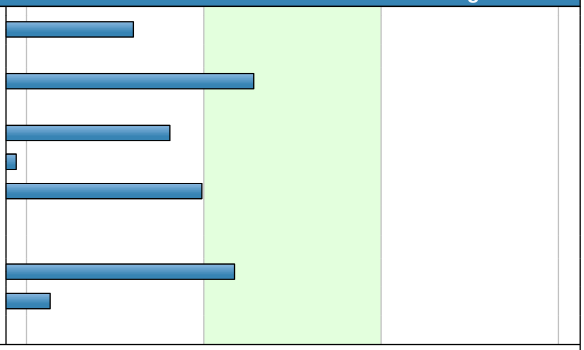
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025	
		Date Reported:	07-May-2025	
		Quote No:	137475	
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: 9 90-120cm **Lab Number:** 3867516.20
Sample Type: SOIL General, Sub-Soil (S147)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.8			
Olsen Phosphorus	mg/L	4	1 - 10			
Potassium	me/100g	0.16	0.20 - 0.70			
Calcium	me/100g	1.2	3.0 - 10.0			
Magnesium	me/100g	0.50	0.50 - 2.00			
Sodium	me/100g	< 0.05	0.00 - 0.40			
CEC	me/100g	7	5 - 15			
Total Base Saturation	%	28	45 - 75			
Volume Weight	g/mL	1.31				
Base Saturation %		K 2.4	Ca 17	Mg 7.4	Na 0.4	
MAF Units		K 4	Ca 2	Mg 15	Na < 2	



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		Quote No:	137475	
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: T1 **Lab Number:** 3867516.21
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.3			
Olsen Phosphorus	mg/L	12	20 - 30			
Potassium	me/100g	0.46	0.50 - 0.80			
Calcium	me/100g	4.3	6.0 - 12.0			
Magnesium	me/100g	0.63	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	11	12 - 25			
Total Base Saturation	%	50	50 - 85			
Volume Weight	g/mL	1.03	0.60 - 1.00			
Organic Matter*	%	5.7	7.0 - 17.0			
Total Carbon*	%	3.3				
Total Nitrogen*	%	0.29	0.30 - 0.60			
'Total' Phosphorus	mg/kg	539	700 - 1600			
'Total' Zinc*	mg/kg	40				
'Total' Copper*	mg/kg	11				
'Total' Chromium*	mg/kg	13.9				
'Total' Arsenic*	mg/kg	6.0				
'Total' Lead*	mg/kg	12.5				
'Total' Nickel*	mg/kg	11.2				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.05				
Base Saturation %		K 4.2	Ca 40	Mg 5.8	Na 0.2	
MAF Units		K 10	Ca 6	Mg 15	Na < 2	

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		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T2 **Lab Number:** 3867516.22
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.3			
Olsen Phosphorus	mg/L	14	20 - 30			
Potassium	me/100g	0.53	0.50 - 0.80			
Calcium	me/100g	5.2	6.0 - 12.0			
Magnesium	me/100g	0.79	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	14	12 - 25			
Total Base Saturation	%	47	50 - 85			
Volume Weight	g/mL	0.86	0.60 - 1.00			
Organic Matter*	%	8.5	7.0 - 17.0			
Total Carbon*	%	4.9				
Total Nitrogen*	%	0.40	0.30 - 0.60			
'Total' Phosphorus	mg/kg	609	700 - 1600			
'Total' Zinc*	mg/kg	38				
'Total' Copper*	mg/kg	10				
'Total' Chromium*	mg/kg	19.3				
'Total' Arsenic*	mg/kg	5.7				
'Total' Lead*	mg/kg	12.1				
'Total' Nickel*	mg/kg	13.6				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.08				
Base Saturation %		K 3.9	Ca 37	Mg 5.7	Na 0.2	
MAF Units		K 9	Ca 6	Mg 15	Na < 2	

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		Date Reported:	07-May-2025	
		Quote No:	137475	
		Order No:		
		Client Reference:	11013	
		Add. Client Ref:	Lauders	
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]	

Sample Name: T3 **Lab Number:** 3867516.23
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*
pH	pH Units	5.4	5.8 - 6.3
Olsen Phosphorus	mg/L	12	20 - 30
Potassium	me/100g	0.56	0.50 - 0.80
Calcium	me/100g	3.9	6.0 - 12.0
Magnesium	me/100g	1.34	1.00 - 3.00
Sodium	me/100g	0.06	0.20 - 0.50
CEC	me/100g	12	12 - 25
Total Base Saturation	%	50	50 - 85
Volume Weight	g/mL	0.99	0.60 - 1.00
Organic Matter*	%	6.9	7.0 - 17.0
Total Carbon*	%	4.0	
Total Nitrogen*	%	0.31	0.30 - 0.60
'Total' Phosphorus	mg/kg	535	700 - 1600
'Total' Zinc*	mg/kg	37	
'Total' Copper*	mg/kg	10	
'Total' Chromium*	mg/kg	7.0	
'Total' Arsenic*	mg/kg	4.4	
'Total' Lead*	mg/kg	11.0	
'Total' Nickel*	mg/kg	7.4	
'Total' Mercury*	mg/kg	< 0.12	
'Total' Cadmium*	mg/kg	0.05	

Base Saturation %	K 4.8	Ca 33	Mg 11.5	Na 0.5
MAF Units	K 11	Ca 5	Mg 30	Na 3

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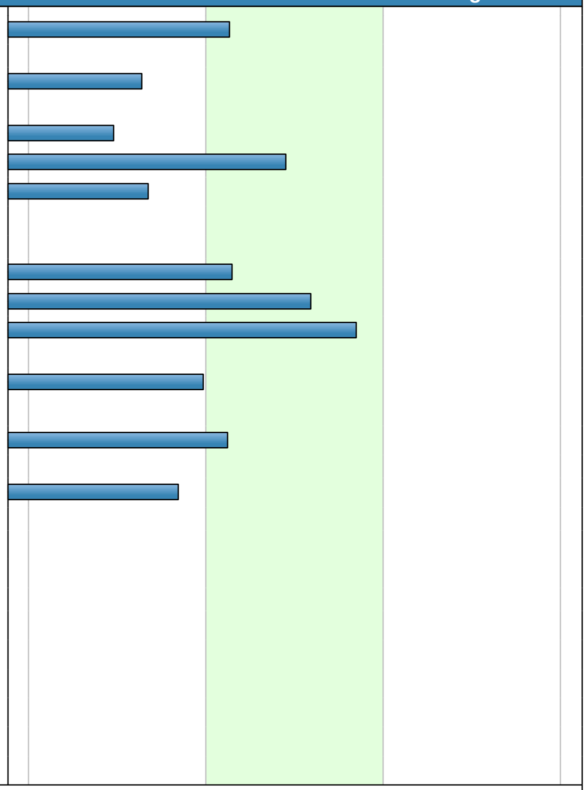
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T3 Crop **Lab Number:** 3867516.24
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.9	5.8 - 6.3			
Olsen Phosphorus	mg/L	15	20 - 30			
Potassium	me/100g	0.32	0.50 - 0.80			
Calcium	me/100g	8.7	6.0 - 12.0			
Magnesium	me/100g	0.77	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	14	12 - 25			
Total Base Saturation	%	71	50 - 85			
Volume Weight	g/mL	0.94	0.60 - 1.00			
Organic Matter*	%	6.9	7.0 - 17.0			
Total Carbon*	%	4.0				
Total Nitrogen*	%	0.34	0.30 - 0.60			
'Total' Phosphorus	mg/kg	637	700 - 1600			
'Total' Zinc*	mg/kg	35				
'Total' Copper*	mg/kg	12				
'Total' Chromium*	mg/kg	12.4				
'Total' Arsenic*	mg/kg	5.4				
'Total' Lead*	mg/kg	11.0				
'Total' Nickel*	mg/kg	10.2				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.09				
Base Saturation %		K 2.3	Ca 63	Mg 5.5	Na 0.3	
MAF Units		K 6	Ca 10	Mg 16	Na < 2	



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		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T4 **Lab Number:** 3867516.25
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*
pH	pH Units	5.4	5.8 - 6.3
Olsen Phosphorus	mg/L	16	20 - 30
Potassium	me/100g	0.92	0.50 - 0.80
Calcium	me/100g	4.0	6.0 - 12.0
Magnesium	me/100g	1.15	1.00 - 3.00
Sodium	me/100g	< 0.05	0.20 - 0.50
CEC	me/100g	13	12 - 25
Total Base Saturation	%	49	50 - 85
Volume Weight	g/mL	0.93	0.60 - 1.00
Organic Matter*	%	7.4	7.0 - 17.0
Total Carbon*	%	4.3	
Total Nitrogen*	%	0.35	0.30 - 0.60
'Total' Phosphorus	mg/kg	602	700 - 1600
'Total' Zinc*	mg/kg	37	
'Total' Copper*	mg/kg	9	
'Total' Chromium*	mg/kg	12.2	
'Total' Arsenic*	mg/kg	4.9	
'Total' Lead*	mg/kg	11.3	
'Total' Nickel*	mg/kg	9.4	
'Total' Mercury*	mg/kg	< 0.12	
'Total' Cadmium*	mg/kg	0.05	

Base Saturation %	K 7.3	Ca 32	Mg 9.2	Na 0.3
MAF Units	K 18	Ca 5	Mg 24	Na < 2

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		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T5 **Lab Number:** 3867516.26
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.5	5.8 - 6.3			
Olsen Phosphorus	mg/L	9	20 - 30			
Potassium	me/100g	0.46	0.50 - 0.80			
Calcium	me/100g	6.2	6.0 - 12.0			
Magnesium	me/100g	0.80	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	12	12 - 25			
Total Base Saturation	%	61	50 - 85			
Volume Weight	g/mL	1.01	0.60 - 1.00			
Organic Matter*	%	6.4	7.0 - 17.0			
Total Carbon*	%	3.7				
Total Nitrogen*	%	0.32	0.30 - 0.60			
'Total' Phosphorus	mg/kg	533	700 - 1600			
'Total' Zinc*	mg/kg	33				
'Total' Copper*	mg/kg	8				
'Total' Chromium*	mg/kg	9.0				
'Total' Arsenic*	mg/kg	5.8				
'Total' Lead*	mg/kg	9.7				
'Total' Nickel*	mg/kg	7.8				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.07				
Base Saturation %		K 3.7	Ca 50	Mg 6.5	Na 0.3	
MAF Units		K 9	Ca 8	Mg 18	Na < 2	

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		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T6 **Lab Number:** 3867516.27
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.8	5.8 - 6.3			
Olsen Phosphorus	mg/L	13	20 - 30			
Potassium	me/100g	0.50	0.50 - 0.80			
Calcium	me/100g	5.8	6.0 - 12.0			
Magnesium	me/100g	0.92	1.00 - 3.00			
Sodium	me/100g	< 0.05	0.20 - 0.50			
CEC	me/100g	12	12 - 25			
Total Base Saturation	%	58	50 - 85			
Volume Weight	g/mL	0.90	0.60 - 1.00			
Organic Matter*	%	7.1	7.0 - 17.0			
Total Carbon*	%	4.1				
Total Nitrogen*	%	0.34	0.30 - 0.60			
'Total' Phosphorus	mg/kg	519	700 - 1600			
'Total' Zinc*	mg/kg	35				
'Total' Copper*	mg/kg	11				
'Total' Chromium*	mg/kg	9.8				
'Total' Arsenic*	mg/kg	5.5				
'Total' Lead*	mg/kg	11.3				
'Total' Nickel*	mg/kg	8.6				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.04				
Base Saturation %		K 4.0	Ca 46	Mg 7.4	Na 0.4	
MAF Units		K 9	Ca 7	Mg 19	Na < 2	

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		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T7 **Lab Number:** 3867516.28
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*	Low	Medium	High
pH	pH Units	5.6	5.8 - 6.3			
Olsen Phosphorus	mg/L	9	20 - 30			
Potassium	me/100g	0.58	0.50 - 0.80			
Calcium	me/100g	5.8	6.0 - 12.0			
Magnesium	me/100g	1.30	1.00 - 3.00			
Sodium	me/100g	0.07	0.20 - 0.50			
CEC	me/100g	13	12 - 25			
Total Base Saturation	%	61	50 - 85			
Volume Weight	g/mL	0.97	0.60 - 1.00			
Organic Matter*	%	5.9	7.0 - 17.0			
Total Carbon*	%	3.4				
Total Nitrogen*	%	0.28	0.30 - 0.60			
'Total' Phosphorus	mg/kg	474	700 - 1600			
'Total' Zinc*	mg/kg	38				
'Total' Copper*	mg/kg	10				
'Total' Chromium*	mg/kg	8.0				
'Total' Arsenic*	mg/kg	4.2				
'Total' Lead*	mg/kg	11.1				
'Total' Nickel*	mg/kg	7.2				
'Total' Mercury*	mg/kg	< 0.12				
'Total' Cadmium*	mg/kg	0.04				

Base Saturation %	K 4.6	Ca 46	Mg 10.3	Na 0.5
MAF Units	K 12	Ca 7	Mg 28	Na 3

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Private Bag 3205
Hamilton 3240 New Zealand

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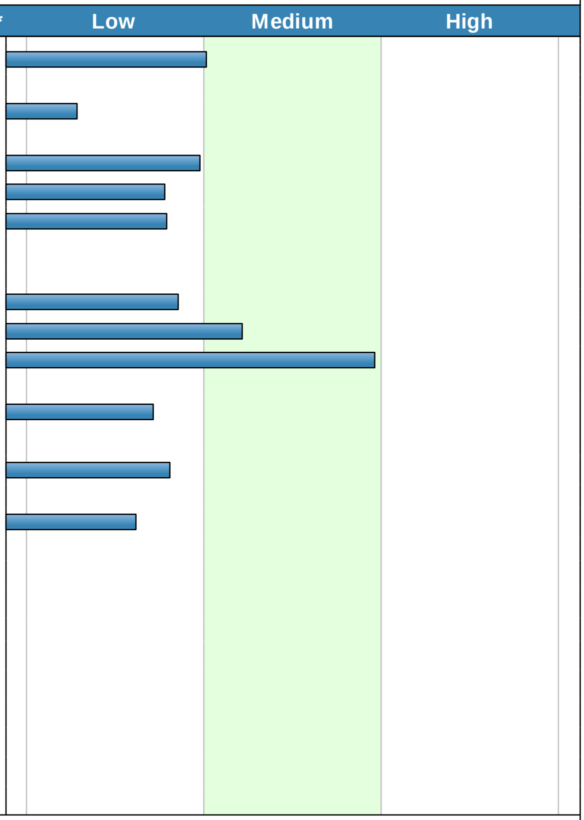
www.hill-labs.co.nz

Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Name: T8 **Lab Number:** 3867516.29
Sample Type: SOIL General, Outdoor (S10)

Analysis		Level Found	Medium Range*
pH	pH Units	5.8	5.8 - 6.3
Olsen Phosphorus	mg/L	9	20 - 30
Potassium	me/100g	0.49	0.50 - 0.80
Calcium	me/100g	5.1	6.0 - 12.0
Magnesium	me/100g	0.85	1.00 - 3.00
Sodium	me/100g	< 0.05	0.20 - 0.50
CEC	me/100g	11	12 - 25
Total Base Saturation	%	58	50 - 85
Volume Weight	g/mL	0.99	0.60 - 1.00
Organic Matter*	%	5.0	7.0 - 17.0
Total Carbon*	%	2.9	
Total Nitrogen*	%	0.26	0.30 - 0.60
'Total' Phosphorus	mg/kg	546	700 - 1600
'Total' Zinc*	mg/kg	38	
'Total' Copper*	mg/kg	10	
'Total' Chromium*	mg/kg	11.1	
'Total' Arsenic*	mg/kg	5.5	
'Total' Lead*	mg/kg	11.7	
'Total' Nickel*	mg/kg	8.9	
'Total' Mercury*	mg/kg	< 0.12	
'Total' Cadmium*	mg/kg	0.05	
Base Saturation %		K 4.4 Ca 45	Mg 7.6 Na 0.3
MAF Units		K 10 Ca 6	Mg 19 Na < 2



The above nutrient graphs compare the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information.
IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Analyst's Comments

Samples 1-29 Comment:
The medium or optimum range guidelines shown in the histogram report relate to sampling protocols as per Hill Laboratories' crop guides and are based on reference values where these are published. Results for samples collected to different depths than those described in the crop guide should be interpreted with caution.
For pastoral soils, the medium ranges are specific for a 75mm sample depth, but if a 150mm sampling depth is used the nutrient levels measured may appear low against these ranges, as nutrients are typically more concentrated in the top of the soil profile. These soil profile differences are altered upon cultivation or contouring.
Further explanation of the derivation of the medium and optimum ranges is available on request.

Samples 1-4, 6, 8-12, 14-16, 18-21, 23, 29 Comment:
The low CEC level found in this soil indicates that it can only retain cation nutrients (potassium, calcium, magnesium and sodium) at low levels. The normal ranges and the derived histograms are based on a typical soil with a CEC level between 12 and 25 me/100g.

Samples 2, 4, 6, 8, 10, 12, 14, 16, 18-20 Comment:
Sub-soil analysis is generally conducted to investigate whether the soil is appropriate for deep root development of plants such as grape-vines. Nutrient uptake from subsoil is generally very low so the nutrient levels reported for subsoil are less important than pH, Aluminium (exchangeable) and Soluble Salts (field).

Samples 21-29 Comment:
The medium range shown describes typical 'Total' Phosphorus levels for mineral soils in New Zealand. The 'Total' P test has not been correlated against pasture growth response rates so should be interpreted along with other observations.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-29
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-29
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH. In-house.	0.1 pH Units	1-29
Olsen Phosphorus	Olsen extraction followed by Molybdenum Blue colorimetry. In-house method.	1 mg/L	1-29
Potassium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	1 MAF units	1-29
Calcium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	1 MAF units	1-29
Magnesium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	1 MAF units	1-29
Sodium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	2 MAF units	1-29
Organic Matter*	Organic Matter is 1.72 x Total Carbon.	0.2 %	21-29
Total Carbon*	Determined by NIR, calibration based on Total Carbon by Dumas combustion.	0.1 %	21-29
Total Nitrogen*	Determined by NIR, calibration based on Total N by Dumas combustion.	0.04 %	21-29

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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	[redacted]

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
'Total' Phosphorus	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements. In-house.	65 mg/kg	21-29
'Total' Zinc*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	4 mg/kg	21-29
'Total' Copper*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-OES. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	4 mg/kg	21-29
'Total' Chromium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.2 mg/kg	21-29
'Total' Arsenic*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.2 mg/kg	21-29
'Total' Lead*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.10 mg/kg	21-29
'Total' Nickel*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.2 mg/kg	21-29
'Total' Mercury*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.10 mg/kg	21-29
'Total' Cadmium*	Nitric/hydrochloric digestion (based on US EPA 200.2) followed by ICP-MS. (Total recoverable nutrients reported on a dry weight basis) The levels from this method are referred to as 'Totals' in quotation marks, as they will be a slight under-estimation of the true Totals for some elements.	0.02 mg/kg	21-29

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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3867516 svhpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	24-Apr-2025
		Date Reported:	07-May-2025
		Quote No:	137475
		Order No:	
		Client Reference:	11013
		Add. Client Ref:	Lauders
Phone:	03 359 3059	**Submitted By:**	7(2)(a) [redacted]

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Potassium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.01 me/100g	1-29
Calcium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.5 me/100g	1-29
Magnesium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.04 me/100g	1-29
Sodium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.05 me/100g	1-29
Potassium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.1 %BS	1-29
Calcium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	1 %BS	1-29
Magnesium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.2 %BS	1-29
Sodium	1M Neutral ammonium acetate extraction followed by ICP-OES. In-house.	0.1 %BS	1-29
CEC	Summation of extractable cations (K, Ca, Mg, Na) and extractable acidity. May be overestimated if soil contains high levels of soluble salts or carbonates. In-house.	2 me/100g	1-29
Total Base Saturation	Calculated from Extractable Cations and Cation Exchange Capacity.	5 %	1-29
Volume Weight	The weight/volume ratio of dried, ground soil. In-house.	0.01 g/mL	1-29

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 02-May-2025 and 07-May-2025. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

7(2)(a) [redacted]

Quality Assurance Coordinator - Agriculture

APPENDIX D

Sludge Test Results June 2025

R J Hill Laboratories Limited
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Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	3907839 SPv2
Contact:	[redacted]	**Date Received:**	04-Jun-2025
	C/- Lowe Environmental Impact Limited	**Date Reported:**	25-Jun-2025
	PO Box 29288	**Quote No:**	138184
	Christchurch 8540	**Order No:**	
		Client Reference:	
		Submitted By:	[redacted]

Sample Type: Sludge

	Sample Name:	Sludge
	Lab Number:	3907839.1
Individual Tests		
Total Recoverable Calcium	mg/kg dry wt	7,200
Total Recoverable Magnesium	mg/kg dry wt	3,700
Total Recoverable Phosphorus	mg/kg dry wt	15,500
Total Recoverable Potassium	mg/kg dry wt	5,800
Total Recoverable Sodium	mg/kg dry wt	350
Total Sulphur*‡	g/100g dry wt	0.54
pH	pH Units	6.85
Total Nitrogen*	g/100g dry wt	6.6
Total Carbon*	g/100g dry wt	40
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg		
Total Recoverable Arsenic	mg/kg dry wt	8
Total Recoverable Cadmium	mg/kg dry wt	0.73
Total Recoverable Chromium	mg/kg dry wt	14
Total Recoverable Copper	mg/kg dry wt	122
Total Recoverable Lead	mg/kg dry wt	8.5
Total Recoverable Mercury	mg/kg dry wt	0.31
Total Recoverable Nickel	mg/kg dry wt	10
Total Recoverable Zinc	mg/kg dry wt	280

Analyst's Comments

‡ Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - SGS Report

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sludge

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed).	-	1
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed).	-	1
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1

Sample Type: Sludge			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2 (modified).	-	1
Total Recoverable Calcium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2 (modified).	100 mg/kg dry wt	1
Total Recoverable Magnesium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2 (modified).	40 mg/kg dry wt	1
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2 (modified).	40 mg/kg dry wt	1
Total Recoverable Potassium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2 (modified).	100 mg/kg dry wt	1
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2 (modified).	40 mg/kg dry wt	1
Total Sulphur*	LECO S144 Sulphur Determinator, high temperature furnace, infra-red detector. Subcontracted to SGS, Westport. ASTM 4239.	0.010 g/100g dry wt	1
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition.	0.10 pH Units	1
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1
Total Carbon*	Catalytic Combustion (900°C, O_2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 05-Jun-2025 and 25-Jun-2025. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

7(2)(a) [redacted]

Client Services Manager - Environmental

ANALYSIS REPORT

WP25-15547

Client: R J Hill Laboratories Ltd
Private Bag 3205
Waikato Mail Centre
Hamilton 3240 NEW ZEALAND
Attention: Invoices

Received: 12-Jun-2025
Completed: 24/06/2025
Job Number: WP25-15547
Report Number: 0000031648
Order Reference: PO103349

Sample ID	ESO_CSA06V S % LOR 0.01
3907839.1	0.538

Date Start/End Analysis (24/6/2025 - 24/6/2025)

* - Denotes non accredited tests

APPLIED METHODS:

ESO_CSA06V: Total sulphur/carbon, LECO Method: SGS Global method

ANALYSIS REPORT

WP25-15547

Client:	R J Hill Laboratories Ltd Private Bag 3205 Waikato Mail Centre Hamilton 3240 NEW ZEALAND Attention: Invoices	**Received:**	12-Jun-2025
		Completed:	24/06/2025
		Job Number:	WP25-15547
		Report Number:	0000031648
		Order Reference:	PO103349

Signed and dated on 24-Jun-2025

7(2)(a) [redacted]

Laboratory Supervisor

APPENDIX E

Aukaha Written Approval

Aukaha

KIA KAHA, AU KAHA

Aukaha ref: TAI6133

13th August 2025
S J Allen Holdings
C/- [redacted]
Lowe Environmental Impact
Email: [redacted]

Tēna koe [redacted]

Application

Kāti Huirapa Rūnaka ki Puketeraki and Te Rūnanga o Ōtākou (hereby kā Rūnaka) understand that S J Allen Holdings is applying for resource consent to discharge waste activated sludge from the Wānaka wastewater treatment plant, grease trap type waste, mud tank / sump type waste and winery wastewater (collectively 'waste products') to a 229 ha land parcel bordered by Muddy Creek Rd, Drybread Rd and Brown Rd, approximately 35 km northeast of Alexandra.

The Affected Party

Aukaha writes this letter on behalf of kā Rūnaka, whose takiwā includes the site the application relates to. Kā Rūnaka exercise rakatiratakа and kaitiakitaka over all the natural resources within their takiwā. Kā Rūnaka representatives have provided direction on this application.

Decision

During November 2024 discussions about site suitability, the applicant stated that they will be applying for a discharge permit for the whole site (excluding waterway setbacks), but during the first 12-months, only a small portion shall receive discharge as a trial period.

After this 12-month trial, the monitoring results shall be collated into a report detailing the effects on the receiving environment. The applicant agreed to share this report with kā Rūnaka (via Aukaha Ltd), for their feedback on the impacts from a cultural perspective. This report will also include any proposed changes to the methodologies to further mitigate and minimise effects on the receiving environment.

Kā Rūnaka and the applicant agreed that there must be condition generally in accordance with the wording included in Appendix 1 around minimising effects on the receiving environment, *or*, that if the condition differs materially from the wording in Appendix 1, the proposed wording change be agreed with kā Rūnaka (via Aukaha Ltd) before granting the consent. This reflects the reality that the exact wording will be refined at the consent conditions stage of council process.

This staged approach to the discharge to land, and the sharing of monitoring results was endorsed by kā Rūnaka to ensure that there were no unforeseen adverse effects on the receiving environment. The applicant also agreed that kā Rūnaka (via Aukaha Ltd) shall be provided with the annual report summarising the activity over the previous year as per condition 20 of the proposed conditions.

Kā Rūnaka **provide affected party approval** for the activity and understand that they may withdraw written approval by giving written notice to the consent authority if there is a hearing, or before the application is determined if there is no hearing. This letter is specific to the above proposal and any changes made to the application will require further consultation with kā Rūnaka.

Nāku noa, nā

7(2)(a) [redacted]

Interim Chief Executive, Aukaha

cc: Kāti Huirapa Rūnaka ki Puketeraki,
Te Rūnaga o Ōtākou

Appendix 1: Proposed wording of condition regarding effects on the receiving environment

Kā Rūnaka have provided direction on how they would like to see any unforeseen effects on the receiving environment during the trial period to be addressed. This direction is aligned with the approach proposed by the applicant; however, it must be noted that the exact wording must be refined at the consent conditions stage of council process to meet the council expectations from an enforceability perspective. The following text details the intent of the condition to address this:

If, after the trial period, the monitoring results show the discharge of waste products has adverse effects on the receiving environment which are greater than predicted, or unforeseen, by the application, the consent holder shall either revise the operations and management plan in consultation with kā Rūnaka and the Otago Regional Council (ORC) or through another process mutually agreed with kā Rūnaka and the ORC in order to remediate these effects. The timeframe for any required remediation will be set during the consultation process.

APPENDIX F

Landowner Written Approval

Otago Regional Council

Written Approval of Affected Persons
Form 8A

Section 95E, Resource Management Act 1991

Resource Consent Applicant's Details

Applicant(s) name (*please write all names in full*): S J Allen Holdings Limited

Consent number (*if known*):

Affected Person's Details

Full name(s) (*please list the full names of all persons and/or organisations providing their written approval*):

A. Michael James Moran

B. Abby Kate Moran

C. Moran Pastoral Ltd

Tick whether you are the:

[✓] Owner [ ] Occupier Other (please specify)

Address of affected property:

Brown Road Lauder 9377

Details of Proposal

I/We hereby give written approval to the following activity that is the subject of a resource consent application (*please provide a brief description of the proposed activity*):

Land Application of waste Activated Sludge Winery Wastewater, Grease trap Waste and Mud tank/sump Waste at Brown Road Lauder

Address of proposed activity:

Brown Road Lauder 9377

Information Sighted

I have read or sighted the following information:

1. Full application for resource consent ☑
2. Assessment of Environmental Effects ☐
3. Plans as follows (*Please list plan title, author and date*): ☐

Declaration

☐ I/We have signed each page of the plans in respect of the proposal. These need to accompany this form.

☑ I/We understand that by giving my/our written approval, the Council when considering the application cannot take account of any actual or potential effects of the activity on my/our property.

☑ I/We understand that at any time before the hearing, if there is one, or, if there is not, before the application is determined, I/we may give notice in writing to the Council that this approval is withdrawn.

Note: You should only sign below if you fully understand the proposal. If you require the resource consent process to be explained you can contact the Customer Service Team at the Council who can provide you with information.

Signature(s):	7(2)(a) [redacted]	Date:	13/08/2025
Signature(s):		Date:	13/08/2025.
Signature(s):	C.	Date:	

Privacy Information: The Council requires the information you have provided on this form to process your application under the RMA and to collect statistics. The Council will hold and store the information, including all associated reports and attachments, on a public register. The details may also be made available to the public on the Council's website. These details are collected to inform the general public and community groups about all consents which have been processed or issued through the Council. If you would like to request access to, or correction of any details, please contact the Council.

Notes to affected person signing written approval

Conditional written approvals cannot be accepted.

There is no obligation to sign this form, and no reasons need to be given.

If this form is not signed, the application may be notified with an opportunity for submissions.

If signing on behalf of a trust or company, please provide additional written evidence that you have signing authority.