BEFORE	Independent Commissioners appointed by Tasman District Council
IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application by CJ Industries Ltd for land use consent RM200488 for gravel extraction and associated site rehabilitation and amenity planting and for land use consent RM200489 to establish and use vehicle access on an unformed legal road and erect associated signage

EVIDENCE OF REECE BLACKBURN HILL ON BEHALF OF CJ INDUSTRIES LTD "SOIL MANAGEMENT AND LAND PRODUCTIVITY"

15 July 2022

1. INTRODUCTION

1.1 My full name is Reece Blackburn Hill. I am a Soil Consultant at Landsystems.

1.2 The applicant has applied for resource consents authorising the extraction of gravel, stockpiling of topsoil, and reinstatement of quarried land, with associated amenity planting, signage and access formation at 134 Peach Island Road, Motueka:

(a) RM200488 land use consent for gravel extraction and associated site rehabilitation and amenity planting, and

(b) RM200489 land use consent to establish and use vehicle access on an unformed legal road and erect associated signage.

1.3 My evidence addresses the soil management and land productivity of the activities for which consent is sought.

Qualifications and Experience

1.4 I hold a Doctor of Philosophy in Soil Science from Lincoln University (2000), a Master of Applied Science in Soil Science from Lincoln University (1994), and a Bachelor of Science with a double major in Biological Sciences and Earth Sciences from University of Waikato (1988).

1.5 I have completed a Correspondence Certificate in Wine from Eastern Institute of Technology and the Advanced Sustainable Nutrient Management FLRC Short Course from Massey University.

1.6 I am a past President of the New Zealand Society of Soil Science (2014-2016), and a current member of the New Zealand Society of Soil Science, New Zealand Association of Resource Management, and the New Zealand Institute of Agricultural & Horticultural Science.

1.7 I have 19 years' experience as a Soil Scientist at Waikato Regional Council, six years' experience as a Soil Consultant at Landsystems, of which I have been full time in this role for the past three years, and three years' experience mapping forest soils in Tasmania.

1.8 I specialise in soil characterisation, soil mapping, land use capability assessment, regional soil policy, soil quality and catchment and land management. I have applied these skills in numerous projects within Waikato Regional Council and Landsystems, working with individual landowners including farmers and growers, regional and district council staff, Crown Research Organisations, Universities, and Ministry staff (MPI and MfE).

1.9 I was lead reviewer for the Ministry for the Environment review of national soil quality monitoring and indicators and established the soil quality monitoring programmes for Waikato Regional Council and Nelson City Council. I was lead author of the soil quality monitoring chapter of "Land and Soil Monitoring: A guide for SOE and regional council reporting".

1.10 I have advised central government and district and regional councils throughout New Zealand in relation to soil management, land use capability, high class soils and the use of soil map information. This included regional council representation on the Land Use Capability Classification System (LUCCS) Governance Group.

1.11 I have undertaken property scale soil and Land Use Capability (LUC) assessments to identify high class soils for subdivision applications and farm land management, and regional scale soil mapping in the Waikato, Auckland, Bay of Plenty, Marlborough and Otago regions.

1.12 As part of my role at Waikato Regional Council, I was Lead Technical Writer for the Soils chapter (Chapter 14) of the Waikato Regional Policy Statement which became operative in 2016. Chapter 14 included a policy on High Class Soils (Policy 14.2).

1.13 I have prepared soil management plans for quarry and cropping land rehabilitation in the Auckland region.

1.14 In 2020, I provided technical soils expertise to support The Waikato District Plan (Stage 1) review, with my main input focussing on Subdivision Rules and high class soils.

1.15 In 2021, I provided a review of the Productive Land Classification for Tasman District Council.

1.16 My technical skills and experience directly relevant to my assessment include:

(a) Property scale soil and LUC assessments on land in the Otago region with stony soils.

(b) Soil management plans for quarry and cropping land rehabilitation in the Auckland region,

(c) Soil quality monitoring and reporting for regional councils, and

(d) Revision of the Productive land Classification for Tasman District Council.

1.17 I have not undertaken a site visit. My evidence is based on the property scale soil and Land Use Capability (LUC) assessment provided by LandVision, and regional scale soil and LUC map information.

Purpose and Scope of Evidence

1.18 The purpose of my evidence is to assess the soil and land management, versatility and site productivity effects of the proposal, and to provide recommendations to avoid, remedy or mitigate adverse effects on the soil, land, air and waterways.

1.19 I have prepared evidence in relation to:

a) The soil and land use capability units of the site.

b) Recommendations to avoid, remedy or mitigate adverse effects of the proposal, relating to soil management, land productivity, and soil loss to water.

c) Potential effects on the environment related to land productivity, and soil loss to water.

d) Consistency with policy direction relating to soil management, land productivity, and soil loss to water.

e) Comment on matters raised in submissions relating to soil management, land productivity, and soil loss to water.

f) Comment on matters raised in s42A report relating to soil management, land productivity, and soil loss to water.

Code of Conduct

1.20 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014 and I agree to comply with it. My evidence is within my area of expertise, however where I make statements on issues that are not in my area of expertise, I will state whose evidence I have relied upon. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in my evidence.

2. EXECUTIVE SUMMARY

2.1 The detail of my assessment, including my effects assessment, is provided by my report *Soil Management Plan and assessment of soil related effects 134 Peach Island Road, Motueka* (**Appendix 1**).

2.2 In this evidence I provide an overview of the key findings from my report. I also provide additional comments relating to my report, policy direction, permitted baseline, submissions and the s 42A report.

2.3 Based on the assessment against the Tasman Resource Management Plan (TRMP) definition for land of high productive value provided in my report (Appendix 1) and the productivity assessment provided in Mr Nelson's evidence, the land on the site is not classed as land of high productive value.

2.4 Based on my assessment of the LandVision report and the regional soil and LUC map information, I consider the LandVision report to provide more detailed and accurate soil and LUC map information than the available regional scale soil and LUC map information for the site in question.

2.5 The soil descriptions provided in the property scale soil and LUC assessment by LandVision indicates that with the exception of soil type 3, all the other soils types on the Peach Island Road site are shallow or very shallow.

2.6 Based on the soil types and LUC units identified in the LandVision report, the soils on the Peach Island Road site are most likely to be less productive than deeper Riwaka soils in the surrounding area, especially where they are on land with LUC units 1s1 and 2s1.

2.7 The land area outside the stop bank is not suitable for agricultural land development due to limitations of an inherent seasonally high water table, flood risk, and variable or shallow soil depth.

2.8 The Peach Island Road site land inside the stop bank has soil limitations that restrict production and the range of land uses that it is suitable for over the long term. These soil limitations are related to the shallow and variable soil depth to gravels which reduce rooting depth for orchard trees, restrict cultivation for arable use and increase the within site management requirements for production.

2.9 Adherence to the Soil Management Plan will ensure that the removal, management and placement of soil avoids or minimises impacts on the soil properties prior and following placement, and that the re-established soil can over the long term retain or exceed the soil versatility of the original soil on the site.

2.10 Following soil reinstatement, plant roots will be able to extend themselves through the total volume of the restored materials to seek nutrients and moisture.

2.11 Provided large rocks are removed prior to placement and the relocated topsoil is rock free, the resulting land should provide improved soil for cropping and horticulture.

2.12 Reduced site productivity and impacts on soil physical properties following reinstatement of the soil post gravel extraction are anticipated in the short term (0-3 years). However, careful soil management throughout the operation and following reinstatement of the soil will reduce impacts on soil properties such that any impacts are likely to only be short term (0-3 years) while the pasture establishes and restores soil structure and soil biology.

2.13 Key to the effective re-establishment of the soil on the gravel extraction site are careful pre-planning, adherence to the guidance provided in the soil management plan, and the training of all staff involved.

2.14 Staging the gravel extraction reduces the loss of productive land on the site during extraction of gravels and reduces the volume of soil requiring stockpiling and the time the soil is stockpiled.

2.15 Provided the activity is managed in accordance with those recommendations, the re-established soil is likely to remain productive at a similar level as the original soil and will have similar, or potentially have greater soil versatility than the original soil pre-gravel extraction.

2.16 Applying the Tasman Resource Management Plan definition for land of high productive value, the Peach Island Road site land pre gravel extraction, in my opinion, is not classed as land of high productive value. This includes land inside and outside the stop bank.

2.17 Following gravel extraction and reinstalment of the soil profile, the land is likely to be classed as land of high productive value based on the Tasman Resource Management Plan definition.

2.18 Applying Tasman District's Productive Land Classification pre gravel extraction, only the LUC 3w1 land on the Peach Island Road site is classed as land suitable for cropping and horticulture. This is in agreement with the LandVision report. The wetness limitation of LUC 3w1 land means that the area will not be suitable for horticulture crops requiring well drained soils.

2.19 Applying Tasman District's Productive Land Classification post gravel extraction, the land suitable for cropping and horticulture will not be reduced by the proposed activities and could potentially increase post gravel extraction (providing the soil management guidance provided in the Soil Management Plan is adhered to).

2.20 Potential for soil loss to water is associated with soil storage, transport, preparation of the receiving surface, soil placement, and post placement management. Provided the guidance in the Soil Management Plan is followed, the risk of any soil loss to water from soil related activities is considered minimal, and any effects less than minor.

3. EVIDENCE

3.1 The main body of my evidence is provided by my report *Soil Management Plan and assessment of soil related effects, 134 Peach Island Road, Motueka* (**Appendix 1**) which includes:

a) an overview of the soils and LUC units assessed at property scale by LandVision,

b) a Soil Management Plan detailing the removal and replacement of soil materials, soil storage, soil transport, and post placement soil management; and

c) an assessment of effects relating to soil management, soil versatility, land productivity, and soil loss to water.

3.2 In addition to my report I provide the following:

a) Comment on points not covered in my attached report.

b) Overview and additional comment on points covered in my attached report.

c) Comment on consistency with policy direction relating to soil management, land productivity, and soil loss to water.

d) Comment on matters raised in submissions relating to soil management, land productivity, and soil loss to water.

e) Comment on matters raised in s42A report relating to soil management, land productivity, and soil loss to water.

Proposed noise bund

3.3 It is my understanding that the Applicant's Acoustic Engineer is proposing a noise bund. It is expected that the bund will require some overburden/fill to be piled up then topsoiled and grassed. The bund can be removed the end of the Stage 2 and 3 works.

3.4 The bund is centrally located on the site and well away from waterways (see Appendix 2).

3.5 For this activity, the criteria for soil transport and soil stockpile management (including sediment control measures) in the Soil Management Plan should be applied.

3.6 Given the central location of the noise bund (well away from waterways) and provided the Soil Management Plan criteria are followed, I consider the control measures will mitigate any potential for soil loss to water.

Productive capacity of the site

3.7 Based on the assessment against the Tasman Resource Management Plan (TRMP) definition for land of high productive value provided in my report (Appendix 1) and the productivity assessment provided in Mr Nelson's evidence, the land on the site is not classed as land of high productive value. The land on the site fails to meet the requirements of the final sentence of the definition which states 'where that combination is to such a degree that it makes the land capable of producing crops at a high rate or across a wide range'.

3.8 Based on the LandVision assessment and Mr Nelson's memo shallow and very shallow soils on the site (as identified and mapped in the LandVision assessment) and the variable distribution of soils (and LUC classes) across the site were confirmed.

3.9 In his evidence (paragraph 3.5), Mr Nelson states that the 'site would likely be unsuitable for a new kiwifruit development due to the high soil variability' and that 'while apples could be grown in this site the yield and quality is likely to be inferior to other preferred locations'.

3.10 Mr Nelson further states (in paragraph 3.7) that 'due to the shallowness of the soil, weakly developed nature, and underlying gravels it is likely that the site would be unsuitable for any agricultural/horticultural enterprise that required soil cultivation, or crops that required higher levels of nutrient/fertiliser use such as market gardening, hops or kiwifruit'.

Potential effects on the environment

3.11 For my assessment of potential effects on the environment, as relevant to soil management and land productivity I refer you to my report titled *Soil Management Plan and assessment of effects, 134 Peach Island Road, Motueka* (**Appendix 1**).

3.12 In summary, the effects of the proposal on soil properties are soil physical effects related to soil compaction, loss of soil structure and degradation of soil aggregates during removal, transport and storage, and compaction of the soil material during placement. In turn, these can lead to impeded soil drainage (reducing air and water flow pathways in the soil), reduced soil water storage capacity, and reduced soil pores for biological activity. Soil fertility is not considered to be of primary concern as this can be remedied with the addition of fertiliser.

3.13 For my recommendations to avoid, remedy or mitigate adverse effects of the proposal, relating to soil management and land productivity I refer you to my report titled *Soil Management Plan and assessment of effects, 134 Peach Island Road, Motueka* (**Appendix 1**).

3.14 In summary, recommendations to avoid, remedy or mitigate adverse effects of the proposal, relating to soil management and land productivity addresses effects on soil properties and soil loss to water across all soil management related activities including soil removal, soil transport and storage, preparation of receiving surface, fill and soil properties, soil placement and post placement management.

3.15 A summary of the recommendations to avoid, remedy, or mitigate effects on soil properties is provided in Table 5 (page 22) of my report.

3.16 Recommendations to avoid, remedy, or mitigate effects on soil loss to water is provided in Table 3 (page 16) of my report.

Productive land policy assessment

3.17 Although I do not consider the site (pre gravel extraction) to be land of high productive value, it does have some productive value and so I have gone on to consider how effects on productive capacity can be avoided, remedied or mitigated.

3.18 For productive land-related matters, relevant provisions are found in Chapters 5, 7 and 12 of the TRMP.

3.19 In my opinion, the key policy directions for the purposes of assessing the actual and potential effects of the proposal on productive land and soils and the proposal's consistency with the TRMP are:

(a) Avoid loss of value of all productive land to meet the needs of future generations, in particular land of high productive value.

(b) Retain opportunities for activities that are not rural production activities while avoiding loss of land with high productive value.

(c) Retain and enhance opportunities for animal and plant production on land with high productive value.

(d) Protect specific resources of value like hard rock.

(e) Avoid, remedy, or mitigate effects of earthworks and extraction on the actual or potential productive values of soil, especially on land with high productive value, and on soil.

3.20 I am not a planner, but I am able to provide an opinion on those provisions from a technical (land productivity) perspective. I consider that the proposal is consistent with these requirements based on the following:

(a) The productive potential of the land for food production for future generations will be retained. While there may be a short-term (0-3 years) reduction compared to current productive capacity following gravel extraction, I expect that reduction to be fully remedied beyond that timeframe.

(b) The re-established land will remain available for productive use, rather than being permanently lost from production (as is the effect of other activities such as subdivision on such land).

(c) Based on my productive land assessment (presented in my report) and providing the recommendations in the Soil Management Plan are adhered to, the reinstated land is likely to be of high productive value, according to the definition provided by the TRMP.

(d) The re-established land will have a reinstated soil profile that when compared with the range of soils pre extraction, has greater rooting depth and is less variable in soil depth across the site. These factors provide greater ability to manage the productive land (i.e. the soil profile properties are more consistent than the original soil on the site), especially for cropping (all soil depths will be below cultivation depth, rather than having to manage around shallow soils), and also for irrigation (i.e. improved soil texture and soil depth allow for consistent irrigation of the land and more efficient use of the freshwater resource).

(e) Returning the affected land to productive land retains (at least) and potentially enhances opportunities for animal and plant production on land with high productive value due to improved soil profile depth and the deeper fine textured, soil profile.

(f) Increased production potential of the site following reinstatement of the soil profile is also noted in Mr Nelson's evidence (paragraph 3.16), where he states that 'given that the depth of reinstated topsoil may still be relatively shallow across the whole site, being a consistent depth means that it could be more accurately managed. In this case apples or grapes may be suitable. Both these crops have relatively low nutrient demand particularly nitrogen and would be easier to manage for reduced environmental impact'.

(g) The Soil Management Plan is focussed on the soil management and the intention of returning the land to productive use at a level equivalent or better than its current state. Multiple strategies such as pre-planning, training, periodic quality control, opportunity for process refinement, and monitoring are in place to ensure all effects are minimised and the restoration of productive capacity is effective.

Matters raised in submissions

3.21 I provide comment on the submissions relating to soil management under the following headings:

(a) Zoning and productive land

(b) Land rehabilitation

(c) Erosion

Location/zoning including productive land

3.22 The main concerns raised in the submissions is that the site consists of land zoned Rural 1, and that the proposed gravel extraction will result in the loss of productive land.

3.23 In response, the Soil Management Plan (Appendix 1) provides detailed recommendations for reinstatement of the soil. Following these recommendations will ensure the reinstated soil profile is at least equivalent in its productive potential to the current soil on the site. Additionally, SOPs, training of staff, and ongoing monitoring and refinement of activities will ensure that correct procedures are followed and the reinstated soil retains its productive potential.

Land rehabilitation

3.24 The reinstatement of the soil profile will follow soil management-based guidelines provided in the Soil Management Plan (Appendix 1). The Soil Management Plan focuses on replacing the soil components (subsoil and topsoil) using procedures to minimise soil compaction and replace the soil profile as close to what currently exists on site, that is with a subsoil an overlying topsoil. Post placement management includes revegetation and low intensity land use (i.e. pasture with low stocking rates and no cropping) to ensure soil structure and biological activity have time to develop and the soils on the site can return to their productive potential.

3.25 For site productivity effects associated with the reinstated soil profile, I refer you to the evidence provided by Mr Nelson. In his evidence, Mr Nelson states that 'it is likely after reinstatement, if correctly undertaken, that the high soil variation across the block would be reduced, making for more accurate soil water and nutrient management', and 'this would enable crops such as apples or grapes to be grown'.

Erosion

3.26 The main concerns raised in the submissions is that the activities will result in increased erosion.

3.27 Erosion potential on the site is primarily a factor of exposure of bare soil, which can result in sheet erosion from wind, and rill erosion from the flow of surface water. Additionally erosion potential increases as slope increases.

3.28 The slopes on the site are flat to undulating (0-7 degrees). These low slopes provide minimal risk for erosion if vegetated. Therefore the main erosion risk is associated with exposure of bare soil.

3.29 Incremental gravel extraction and reinstatement of the soil will be used to minimise the size of the area exposed at any one time, reducing the potential for erosion.

3.30 Revegetation of these areas will occur within a month of reinstatement of the soil and be actively management following revegetation (post placement management is described in the Soil Management Plan) to ensure full vegetative cover is achieved and maintained.

3.31 To retain any sediment that results from soil movement on site, the Soil Management Plan includes the requirement for sediment controls . I consider these measures will be effective at maintaining soil on-site.

Matters raised in s 42A report

3.32 In the following sections I address matters raised in the s 42A report that are relevant to soil related matters including:

(a) Points raised in Attachment 6 - Land production values,

(b) Points raised in Attachment 6 - Addendum and comments on draft soil management plan

(c) soil loss to water.

Points raised in Attachment 6 – Land production values

3.33 In paragraph 1, page 121 of Ms Langford's review states that the presence of orchards and horticultural production neighbouring areas is evidence of the potential of the land on the Peach Island Road site. I note however, that based on the NZLRI LUC map information the soils with the most intensive uses in these areas are on LUC units 1s2+2s2 (to the north east) and 2s2 (to the south), and as such are likely to have a greater fine soil matrix depth than the soils identified on the Peach Island Road site, with LUC units 3s1, 4s1, 5s1 and 6s1. As a consequence it is very likely that the Peach Island Road site land has less potential that these other areas with only slight soil depth limitations. Confirmation of this would require property scale assessment of the soils and LUC units. In addition, it is agreed between Ms Langford and myself that the land outside the stop bank has limited productive capacity due to its propensity to flood.

3.34 Paragraph 5, page 121 states that the stoniness of the fluvial recent soils can be overcome by land management and crop selection, and that stoniness (and soil depth depth) is not a productivity excluding or productivity-compromising criterion. I agree that stoniness is not necessarily productivity excluding. However, stoniness, especially at shallow depths will restrict the range of crops and horticultural production, and therefore the land is less versatile.

3.35 For site productivity effects, I refer you to the evidence provided by Mr Nelson. In his evidence, Mr Nelson notes the limitations for horticultural use and management on the site associated with the soils, stating (in paragraph 3.7) that 'due to the shallowness of the soil, weakly developed nature, and underlying gravels it is likely that the site would be unsuitable for any agricultural/horticultural enterprise that required soil cultivation, or crops that required higher levels of nutrient/fertiliser use such as market gardening, hops or kiwifruit'.

3.36 In the section 'Some further observations' Ms Langford states that the land would have to be reinstated in such a way that its high productivity was not compromised, and further notes that fluvial recent soils are particularly prone to damage from disturbance, making them unsuitable for the gravel extraction proposed.

3.37 Fluvial recent soils are young soils (10s to 100s of years old) with only weak soil development. Cropping and horticultural production enterprises commonly cultivate and recontour these soils on establishment and as part of ongoing crop production. This land remains highly productive. The disturbance to the topsoil and upper subsoil from these land use activities is very similar to the disturbance resulting from reinstating the soil following gravel extraction.

3.38 In paragraph 2 of the same section, Ms Langford comments that reinstating land productivity even under highly controlled conditions on a mature soil with well-structured soil properties is not easily possible, and more so on fluvial recent soils. In my opinion, the reinstated soil profile is more likely to have soil development characteristics similar to weakly developed fluvial recent soils rather than mature soils with well-structured soil properties. Provided the extracted gravels are replaced with a fine soil subsoil and topsoil in a way that the soil physical properties are not compromised by compaction, the reinstated soil profile will retain the same productive potential or improve to a similar level as the neighbouring land areas with deeper fine soil matrix soils. The recommendations in the Soil Management Plan provide for the soils to be managed in this way.

3.39 In the same paragraph (paragraph 2) Ms Langford states that 'positive examples of other sites do not exist!'. Based on the two available reports, this is so. However, on reading the reports for these two examples, it is evident that their failure was primarily due to poor operational procedures, which included the use of contaminated cleanfill (Campbell, 2017) and placement of the soil materials when wet by heavy machinery, resulting in compaction and impeded soil drainage (McQueen 1983).

3.40 In my opinion, these examples do not indicate that the reinstated soil cannot be successfully returned to productive use, instead they reinforce the need to follow correct soil management procedures that will ensure the impacts are minimised. An example of successful establishment of a pear orchard on rehabilitated soil is provided on page 21 of my attached report (Appendix 1).

Points raised in Attachment 6 - Addendum and comments on draft soil management plan

3.41 Since receiving the 'Addendum and comments on draft soil management plan' (pages 123-125, Attachment 6 – Land production values – review by Mirka Langford) the draft Soil Management Plan has been revised. The revised Soil Management Plan is contained within my report 'Soil management plan and assessment of soil related effects for 134 Peach Island Road, Motueka' which is provided as part of my evidence (Appendix 1).

3.42 In addition to my report provided I have the following comments.

3.43 I agree with Ms Langford's comment on page 123, that the land outside the stop bank should not be considered as suitable for agricultural land development other than extension grazing (and is therefore not land of high productive value) due to flood risk.

3.44 A revised assessment of the PLC (1994) in my final report which includes details of how I reached the PLC classes for the Peach Road Island site (pages 25-27 of my report).

3.45 In paragraph 1, page 124 – Attachment 6, Ms Langford notes that historic photographs suggest that horticulture had been established on the Peach Island Road site, and further notes that this poses the question whether the rooting depth limitation is major enough to reduce the productive potential of the soil to a degree that might make it acceptable for gravel extraction.

3.46 I have examined aerial photographs for the site following establishment and based on my visual assessment of the aerial photograph in 2011, the growth of the horticultural crop does look to be highly variable, and most likely affected by soil depth and variability (see **Appendix 3**).

3.47 Email correspondence provided in Mr Nelson's evidence (paragraph 3.2) from a previous owner noted 'that soil conditions where challenging with silty loam being the main but large areas where very sandy and the gravel layer was close to surface. Plants took three times longer to become established and replanting was ongoing.'

3.48 Also, of note from my assessment of the aerial photography is that the LUC unit 6s1 mapped by LandVision (LandVision, 2021) was not in productive use until 2020, and still only looks to be used for low intensity grazing. Therefore, the PLC classification of this area as 'H' or 'F' at best is appropriate.

3.49 Ms Langford refers to a new PLC criteria (PLC 2021) which I was contracted to develop. Applying the new PLC criteria for the Peach Island Road site results in the land on the site being classified as PLC land class 'B1' as opposed to PLC land class 'A' when applying the PLC 1994. There are some important points to note.

3.50 Both applications of the PLC (1994 and 2021) and resulting land classes for the site use regional scale map information which is being applied beyond its intended scale. Although useful as a regional broad-brush assessment, the criteria need to be applied based on property scale (finer scale) soil and land map information for property scale manamgent and decision making.

3.51 My assessment for PLC 2021 is provided in Appendix 4 of my evidence.

3.52 It should also be noted that the PLC 2021 is still in development and ground truthing has recently been completed. The findings of the ground truthing may result in adjustments to the PLC 2021. However, at this point in time it is not possible to determine the implications of any such changes on the conclusions reached in my report.

3.53 On page 125 of Attachment 6, Ms Langford refers to three management plans. Only one Soil Management Plan was provided, with recommended mitigations summarised in tables for soil properties, dust, and soil loss to water. The applicant has since engaged PDP to provide a specific dust assessment, and they have provided a separate draft Dust Management Plan. As a result I have removed the dust recommendations from the draft Soil Management Plan. I have reviewed the draft Dust Management Plan and confirm it is consistent with the draft Soil Management Plan.

3.54 Ms Langford refers to the Ranzau report (McQueen, 1983) and notes that the soil should only be handled in dry conditions. The Soil Management Plan I have provided includes the requirement that the soil should only be removed and replaced when in dry condition.

3.55 Ms Langford comments that the 'general uncertain wording' of the draft Soil Management Plan reduces confidence in that the land can be reinstated, and its production potential restored.

3.56 The revised Soil Management Plan report includes more directive wording and additional specific mitigations. The specific mitigations form the basis for Standard Operating Procedures (SOPs) that the Applicant will apply for activities on the site. Collectively, these provide assurance that soil management effects can be minimised, and that reinstatement of the soil profile and its productive potential restored.

3.57 Ms Langford has requested further detail on the impacts on soil properties including the scales of short term and long term. I have included additional comment in the finalised report provided in Appendix 1.

Residual effects after reinstatement

3.58 I acknowledge the concerns on the lack of clarity on residual effects after reinstatement.

3.59 In response, the Soil Management Plan acknowledges that the anticipated soil disturbance (as part of any activity) is likely to result in disruption to soil properties (paragraph 2, page 20). It further comments that soil disturbance or disruption can occur with any land use practice (e.g. cultivation for cropping). Anticipated soil property effects are described (last paragraph, page 21), and mitigations to avoid these potential effects (leading to residual effects following soi reinstatement) are provided in Table 5 on page 22. These measures ensure the residual effects are minimised and are no more than the soil disturbance effects resulting from land use practices such as cultivation for cropping, forest harvesting and intensive pastoral use.

Loss of productive value

3.60 I acknowledge the concerns that the proposal is inconsistent with objectives requiring that loss of potential productive value is avoided.

3.61 In response, the Soil Management Plan includes the reinstatement of the soil profile (subsoil and topsoil) following gravel extraction and post placement management to return the reinstated soil to productive use. This means that although there will be a temporary loss of productive land (during and immediately following gravel extraction), the soil and land will be restored and no loss of potential productive value will result. In my opinion, the productive capacity of the soil will be restored, and potentially enhanced, within 0-3 years of restoration. As a result, the potential of land productivity to provide for future generations is not compromised. This is in contrast to land that is subdivide for rural residential or urban residential use.

4. CONCLUSION

4.1 The property scale soil and LUC assessment undertaken by LandVision (2021) provides the best soil and LUC map information for the Peach Island Road Site.

4.2 The Peach Island Road Site land outside the stop bank is not suitable for agricultural land development due to soil and land limitations of an inherent seasonally high water table, flood risk, and variable or shallow soil depth.

4.3 The Peach Island Road Site land inside the stop bank has soil limitations that restrict production and the range of land uses that it is suitable for over the long term.

4.4 Applying the Tasman Resource Management Plan definition of high productive value for land, the Peach Island Road site is in my opinion not classed as land of high productive value as it fails to meet the requirements in the last sentence of the definition.

4.5 Following gravel extraction, the reinstated soil profile will have a deeper and less variable fine soil matrix which will allow for increased production across a wider range of land uses than the current soils present on the site.

4.6 Adherence to the Soil Management Plan will ensure that the removal, management and placement of soil avoids or minimises impacts on the soil properties prior to and following placement.

4.7 Reduced site productivity and impacts on soil physical properties following reinstatement of the soil profile are anticipated. However, careful soil management throughout the operation and following reinstatement of the soil will reduce impacts on soil properties. Any impacts are likely to only be short term (0-3 years) while the pasture establishes and restores soil structure and soil biology.

4.8 Key to the effective re-establishment of the soil on the gravel extraction site are careful pre-planning, adherence to the guidance provided in the Soil Management Plan.

4.9 Potential for soil loss to water is associated with soil storage, transport, preparation of the receiving surface, soil placement, and post placement management. Provided the guidance in the Soil Management Plan is followed, the risk of soil loss to water from soil related activities is considered minimal.

Reece Hill

15 July 2022

REFERENCES

Campbell, I (2017) Report on soil restoration at Staplegrove Farm gravel extraction site, Waimea West, Nelson Land & Soil Consultancy Services, Nelson.

LandVision. 2021. Peach Island LUC & Soil Survey, Peach Island Road Motueka Valley. Prepared for CJ Industries.

McQueen DJ. 1983. Land reclamation following gravel extraction on Ranzau soils, Nelson. New Zealand Soil Bureau Scientific Report 58. Government Printer, Wellington. 46p.

APPENDIX 1

Soil Management Plan and assessment of soil related effects for 134 Peach Island Road, Motueka (attached separately).

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DRAFT SOIL MANAGEMENT PLAN AND ASSESSMENT OF SOIL RELATED EFFECTS

FOR 134 PEACH ISLAND ROAD, MOTUEKA

Contents

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SUMMARY

A site covering approximately 13.5 hectares (134 Peach Island Road, Motueka) will be used for gravel extraction over a period of 15 years. The gravel extraction area will be refilled with fill and subsoil from stockpiled onsite sources and various other off-site locations before the original topsoil from the site is replaced. This report includes a soil management plan to guide the removal of topsoil from the gravel extraction area, methods for topsoil storage, methods for backfilling of the gravel extraction pit placement of the topsoil, vegetation rehabilitation requirements following rehabilitation, and soil monitoring. The report also includes an assessment of effects relating to soil properties, soil and land versatility and productive land, and the risk of soil loss to waterways.

INTRODUCTION

CONSENT APPLICATION BACKGROUND

C J Industries Limited ('the Applicant') seeks resource consent from the Tasman District Council ('the consent authority') to authorise the extraction of gravel, stockpiling of topsoil, and reinstatement of quarried land as well as the establishment of amenity planting, on-site health and safety signage, and access on an unformed legal road and marginal strip ('the proposal') at 134 Peach Island Road, Motueka ('the site'). The Peach Island Road site is shown in **Figure 1**.

Figure 1. Peach Island Road site, 134 Peach Island Road, Motueka.

The application site is zoned Rural 1 and Conservation, is within Land Disturbance Area 1, and is subject to a Flood Hazard. The proposal is as a controlled activity under Rule 16.1.5.3, a restricted discretionary activity under Rules 16.2.2.6, 16.10.2.2 and 18.5.2.4, and a discretionary activity under Rule 17.5.2.9. Overall, the proposal is deemed to be a discretionary activity.

CJ Industries Ltd is an established family business (directed by Desmond Corrie-Johnston and Arne Corrie-Johnston) which is located in Motueka and specialises in manufacturing and supplying certified ready-mix concrete, aggregates, construction works and landscaping supplies for the commercial and residential sectors.

C J Industries currently holds consents RM150901 and RM150896 to extract gravel from the banks of the Motueka River at 83 Douglas Road. CJ Industries has been undertaking gravel extraction in this location since 2002 (under NN020167). Past aerial photographs of the site demonstrate the staging of works and progress of excavation areas over this time, as well as identify the quality of site rehabilitation and environmental outcomes that CJ Industries has achieved. Gravel is in high demand and has a high value because of regional growth and limited supply throughout the region, however, the majority of the available gravel material from Douglas Road is near to being exhausted. Accordingly, the Applicant wishes to apply for further resource consents in order to extract gravel material for high end use such as concrete, seal chip and roading projects in the Tasman region.

Because of the site's Rural 1 zoning, it is important to ensure that the soil resource will be protected through the extraction and restoration process.

PURPOSE OF THE REPORT

Landsystems Limited has been commissioned by CJ Industries Limited to:

Provide a report including a summary of the **soil and Land Use Capability units** on the Peach Island Road site, a draft **soil management plan** for the rehabilitation of soils on the gravel extraction site following gravel extraction, and an **assessment of effects relating to soil management** for the proposed activity.

The purpose of this report is to provide the advice and draft Soil Management Plan requested by the Applicant. The Soil Management Plan (once certified by Council) will provide the basis for Standard Operating Procedures (SOPs) for specific activities.

PROPOSED GRAVEL EXTRACTION AND SITE REHABILITATION

OVERVIEW

The Applicant proposes to undertake gravel extraction on the property in three stages, within an area of approximately 73,500 m^2 (~7.4 ha), and over a 15 year period (**Figure 2**).

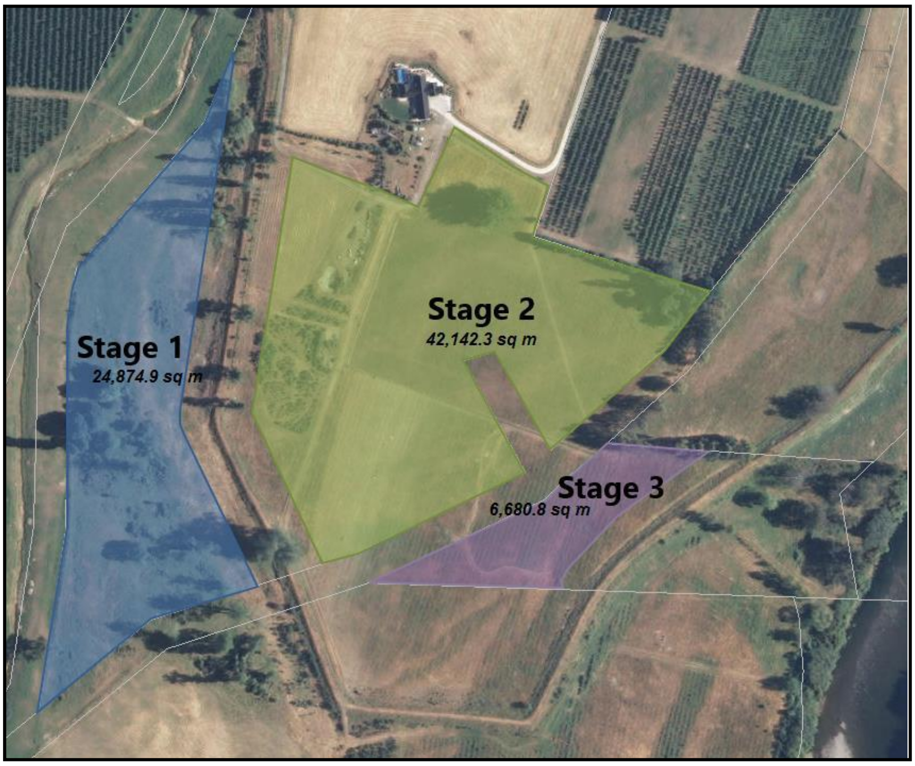


Figure 2. Proposed gravel extraction staging for the Peach Island Road site (from the Application for Resource Consent – Planscapes, 2020).

No processing or crushing of gravel will occur on site. Test pit excavations on the site indicate that on average, the gravel surface is between 0.5 m to 1 m below ground surface and up to 5 m of gravel was encountered before reaching groundwater. No excavation will occur below the groundwater level at the time of extraction. In addition:

- No excavation will occur within 20 m of stop banks, on the Motueka River side of the stop bank within Lot 2 DP 2357, nor within the land surrounding the dwelling and sheds.
- Any excavation which approaches property boundaries will have a batter of material which will remain unexcavated.
- Gravel will be extracted progressively in an upstream direction starting at the downstream end of the property, and all excavation will occur in strips (20 m wide x 80 m long) which are aligned parallel to the general direction of flood flow.

Topsoil will be removed from extraction area for the day, this will be stockpiled. Aggregates will then be extracted and carted from the site using an excavator and 30-ton dump trucks.

The material will be stockpiled in an area behind the stop bank. The base of the stockpile will be 1 metre below ground level. As the truck returns to the extraction site from the stockpile, it will bring fill with it to be used for reinstatement of the extraction site. At the end of each day, clean fill will replace extracted material so that by the end of each day the pit size will be no greater than 1600m^2 (i.e. 20 m x 80 m), though shape may vary from time to time. In this way the extraction site will move daily.

Backfilling will be undertaken at every possible opportunity even when no new excavation is occurring. Fill material will be clean and substantially inorganic.

The ground will be reinstated to the original levels as far as practicable and the finished ground levels will not result in the obstruction or deflection of flood flows.

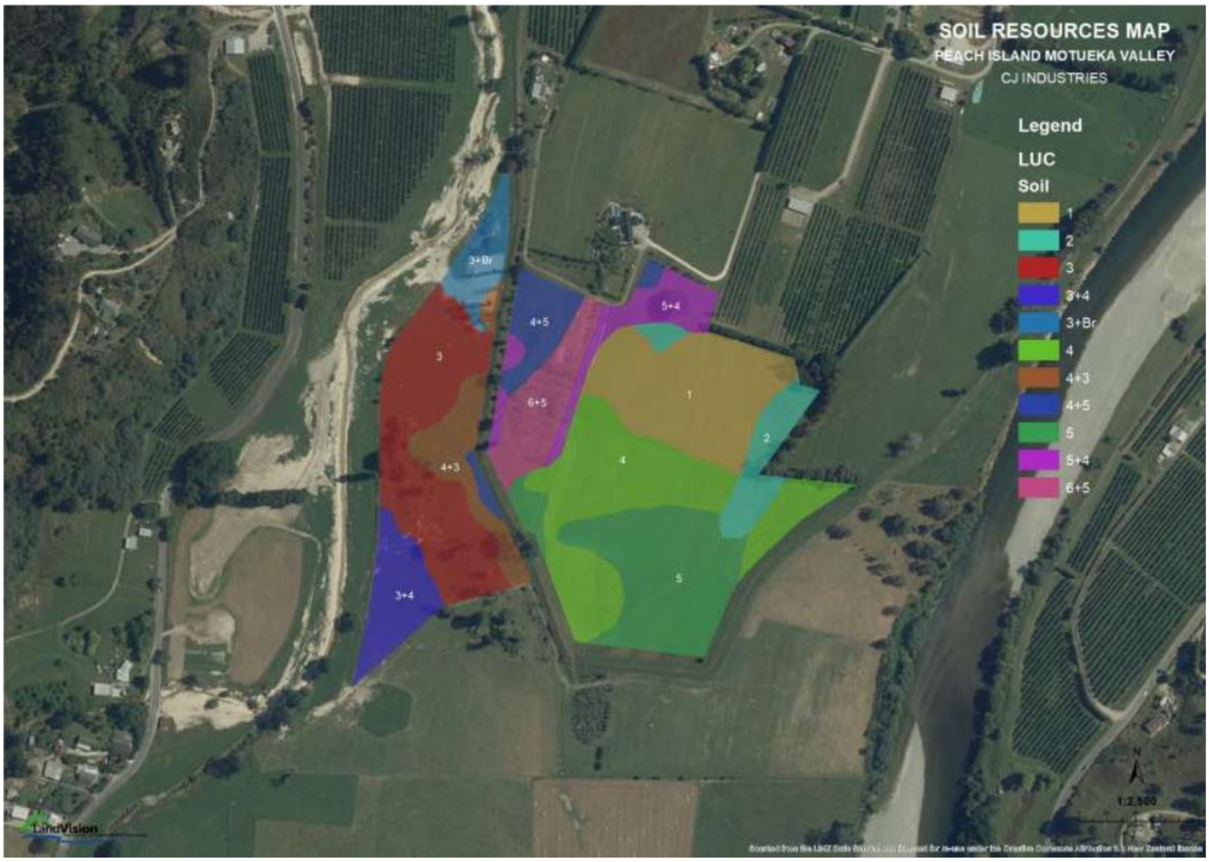
SOIL AND LAND USE CAPABILITY INFORMATION

CHARACTERISTICS OF THE SOILS ON THE SITE

A soil and LUC survey was undertaken by LandVision (LandVision, 2021)[1] on Peach Island Road, Motueka at 1:6000 scale for the purpose of consenting for gravel extraction[2]. The total area mapped was 9.98 ha.

To add certainty to the survey, an EM (electromagnetic) sensor was run over the survey area sampling about 2000 points per hectare at two depths (1.5 m and 0.5 m). The results from this were used to determine where soil pits or auger holes were investigated.

The LandVision report identified six dominant soil types on the property. The soils were all formed from alluvium derived from greywacke sands, gravels and finer material. Some soil types were more dominant than others and some were derivatives of others (**Figure 3**), varying only in depth of fine soil matrix over gravel, dominance of sandy versus silt textures and soil drainage. No soil series or Smap sibling names were assigned to these soils. However, based on the available regional scale soil map information, they are likely to be Riwaka soil variants. Note that the soils identified have been allocated numbers for reference (1-6; Br indicates bedrock) rather than soil type names. These numbers do not have any reference to LUC classes.



[1] LandVision. 2021. Peach Island LUC & Soil Survey, Peach Island Road Motueka Valley. Prepared for CJ Industries.

Figure 3. Soil map units for the Peach Island Road site based on the property scale soil assessment undertaken by LandVision (2021).

LAND USE CAPABILITY OF THE SITE

In general, for those soils formed on gravels it was the depth to the gravels that differentiated them. This depth also differentiated the LUC unit present.

The Land Use Capability (LUC) classification is the most commonly used classification nationally to assess the long term sustainable capability of land to support production for cropping, pastoral farming, forestry and soil/water conservation. Additionally, the classification indicates the versatility of the land and its given limitations for use (**Figure 4**).

Increasing Limitations to Use ↓ | Decreasing Versatility of Use ↓

LUC class	Arable Cropping Suitability†	Pastoral Suitability	Production Forestry Suitability *	General Suitability
1	High ↓	High ↓	High ↓	Multiple Use Land
2				
3				
4	Low			
5	Unsuitable			Pastoral or Forestry Land
6				
7		Low	Low	
8		Unsuitable	Unsuitable	Catchment Protection

Figure 4. Relationship between LUC classes and versatility of use (from Lynn et al., 2009).

A detailed description of the system is provided in the Land Use Capability Survey Handbook, a 3rd edition of which was published in 2009 (Lynn et al., 2009). The LUC classification is based on five inventory factors including rock type, soil type, slope, erosion and vegetation.

The LUC mapping unit is in three parts:

- <u>The LUC class</u>
  The LUC class is the broadest grouping in the classification, identifying the general degree of limitation to arable use. It comprises eight classes. Classes 1 to 4 are classified on their suitability for cultivation for cropping, with class 1 being the most versatile with few limitations to use, through to LUC class 4 which has limitations so severe it is marginal for cultivation for cropping. Classes 5 to 7 are not suitable for cropping but are suitable for non-cropping uses such as pastoral farming, tree crops or forestry. Physical limitations increase from LUC class 5 to 7. LUC class 8 has such severe physical limitations it is not suited for any commercial farming system and is considered suitable only for retirement and protection use.
- <u>The LUC subclass</u>
  The LUC class is subdivided into one of four subclasses, depending on the major physical limitation to use. There are four limitations; erodibility (e), wetness (w), soil (s), and climate (c). They are denoted by the small letter e, w, s or c after the LUC class number. For

example, an area of land suitable for pastoral farming but limited by moderate erosion is shown as Class 6e.

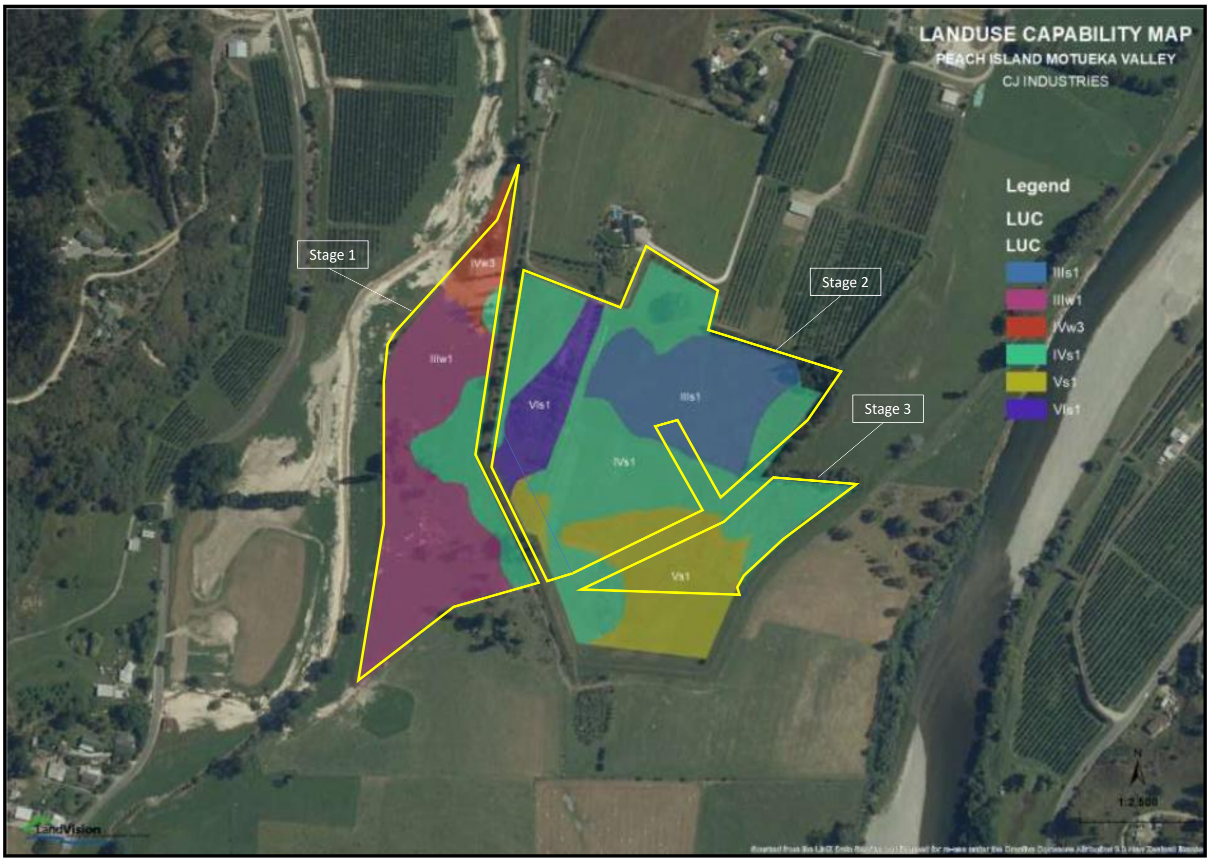
i. <u>The LUC unit</u>

The third and most detailed level of classification is the LUC unit. The unit groups areas that require the same kind of management, the same kind and intensity of soil conservation treatment, and are suited to the same kinds of crops, pasture or forestry species which require specific conservation measures and management practices to achieve similar yields. For example, LUC class 6e becomes 6e1, or 6e2, and so on depending on the detailed management requirements needed.

Note that historically Roman numerals were used to denote LUC classes. However, Arabic numerals are recommended (and more commonly used) over traditional Roman numerals (i.e. LUC I, II, III… VIII) to promote consistency and ease of database management (e.g. IIIw1 equates to 3w1)[3]. In this report I have adopted the use of Arabic numerals for LUC classes.

For this survey, slope, erosion and vegetation were considered consistent across the site and were not assessed[4]. In total there were six different LUC units present ranging from LUC class 3 to LUC class LUC 6 land. Based on the LandVision report, 36% is LUC 3 land, 23% LUC 4 land, 15% LUC 5 land, and the remaining area is LUC 6 land. However, the area of the assessment extended beyond the Stage 1, Stage2 and Stage 3 areas.

A map showing the distribution of LUC units based on the 1:6000 scale soil map and in relation to the staged excavation areas is provided in **Figure 5**.



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[3] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3rd ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163p.

[4] LandVision. 2021. Peach Island LUC & Soil Survey, Peach Island Road Motueka Valley, CJ Industries.

Figure 5. Property scale (1:6000 scale) LUC map for the Peach Island Road site.

Based on the LUC map provided in **Figure 5**, the distribution of LUC units across the proposed gravel extraction stages (Stage 1, Stage 2 and Stage 3) is summarised as follows:

- Stage 1 – Predominantly 3w1, with lesser sized areas of 4s1and 4w1.
- Stage 2 – Predominantly 4s1 and 3s1 with lesser sized areas of 6s1 and 5s1.
- Stage 3 – Similar sized areas of 4s1 and 5s1.

Table 1 provides a summary of the LUC units mapped for the site, the soils within each LUC unit and the limitations for each map unit.

Table 1. Summary of the LUC units and limitations mapped for the site (from LandVision, 2021)

LUC unit	Description	Soil parent material	Soil map units	Comments
3w1	Flat to undulating floodplains and low terraces with moderately deep sandy loam to clay loam soils. Depth to low chroma colours and mottling is >45 cm. Moderately high water table for part of the year.	Finer alluvium and alluvial sands.	3, 3+4	The soils are moderately developed finer materials with good structure. The soils have a moderate wetness (w) limitation during winter and spring and are prone to pugging.
3s1	Flat to undulating floodplains with shallow[5] (30-45 cm) and stony silt loam or sandy loam textures.	Alluvial sands over gravels.	1	Well drained soils with gravels below the plough layer. Weakly developed structure that will not handle repeated cultivation. Prone to wind (sheet) erosion if cultivated. Moderate soil (s) limitations for arable use.
4w3	Flat to undulating floodplains and low terraces with moderately deep sandy loam to clay loam soils. Depth to low chroma colours and mottling is <45 cm. Moderately high water table for part of the year.	Finer alluvium and alluvial sands.	3+Br	Similar to 3w1 but more prone to flooding and deposition. Prone to pugging when wet. Severe wetness (w) limitation.
4s1	Flat to undulating floodplains, low terraces and fans with shallow[6] (15-30 cm) stony silt loam to sandy loam soils.	Alluvial gravels.	2, 4, 4+3, 4+5	The shallow depth to gravels and stones is a severe soil (s) limitation for arable use. The very weakly developed topsoil not suited to repeat cultivation and prone to wind (sheet) erosion if cultivated.
5s1	Flat to gently rolling floodplains and fans with	Alluvial gravels.	5	Low natural fertility and prone to drying out in summer

[5] Newsome PFJ, R H Wilde RH, Willoughby EJ. 2008. Land Resource Information System Spatial Data Layers Data Dictionary. Landcare Research New Zealand Ltd, Palmerston North.

[6] Newsome PFJ, R H Wilde RH, Willoughby EJ. 2008. Land Resource Information System Spatial Data Layers Data Dictionary. Landcare Research New Zealand Ltd, Palmerston North.

	very shallow[7] silt loam to sandy loam textured soils with surface boulders.			months. Reasonably resistant to pugging but near surface gravels makes them unsuitable for cultivation. Severe soil (s) limitation.
6s1	Flat to gently rolling floodplains and fans with very shallow[8] silt loam to sandy loam textured soils with surface boulders.	Alluvial gravels and boulders.	6, 6+5	Surface boulders inhibit cultivation.

CURRENT SOIL LIMITATIONS AND PRODUCTIVE POTENTIAL

The site includes land both inside and outside the stopbank. The area outside the stop bank has the potential for occasional flooding and this limits the land use opportunities. Only about 2.0 ha of land inside the stop bank is classified as LUC class 3 land. This land has soil limitations (shallow depth to gravel) that limits the versatility of the land. The report concludes that none of the soils or land should be classified as highly versatile. Some soil or land could be marginally highly productive but the range of crops this applies to is very limited.

DRAFT SOIL MANAGEMENT PLAN

PURPOSE OF SOIL MANAGEMENT PLAN

The purpose of the Soil Management Plan is to:

a) Ensure that the removal, management and placement of soil avoids or minimises impacts on the soil properties prior to and following placement, and that the re-established soil retains or exceeds the soil versatility of the original soil on the site, and
b) minimise potential for soil loss to water.

KEY CONCEPTS FOR RESTORATION

Key to the effective reestablishment of the soil on the gravel extraction site are careful pre-planning, adherence to the guidance provided in the Soil Management Plan, and the training of all staff involved.

The main on-ground factors that achieve successful land restoration and retain productive value of the land are preparation of the existing surface to ensure it has the appropriate contour, and careful removal storage and placement of the fill and soil material so they are not degraded or compacted.

Much of the guidance for these activities is provided by the publication *Bulk soil handling for quarry restoration* (Ramsey, 1986)[9].

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[7] Newsome PFJ, R H Wilde RH, Willoughby EJ. 2008. Land Resource Information System Spatial Data Layers Data Dictionary. Landcare Research New Zealand Ltd, Palmerston North.

[8] Newsome PFJ, R H Wilde RH, Willoughby EJ. 2008. Land Resource Information System Spatial Data Layers Data Dictionary. Landcare Research New Zealand Ltd, Palmerston North.

[9] Ramsay WJH. 1986. Bulk soil handling for quarry restoration. Soil and land use management Volume 2, No. 1. Pp30-39.

For the reinstated soil an ideal topsoil depth of 300-400 mm and an underlying 700 mm thickness of subsoil material should provide a soil profile depth of at least 1000 mm with no significant barriers to plant roots, provided the soil materials used are stone free. If this is achieved, and slopes are less than five degrees, then the land will be LUC class 2 with slight limitations to arable use (Lynn et al., 2009)[10].

Pasture is the best vegetation for preparing the soil for cropping and horticulture. The fine roots of pasture create soil structure and grow into the new subsoil to coat cracks and pores. Generally, after three years in pasture and with careful stock management to avoid compaction, the new soil is suitable for cropping and horticulture.

GRAVEL EXTRACTION STAGING

The gravel extraction will occur in three stages over a period of up to 15 years with removal of topsoil and overburden undertaken incrementally. Staging the gravel extraction reduces the short term loss of productive land on the site and reduces the volume of soil requiring stockpiling and the time the soil is stockpiled. This in turn reduces the potential for soil degradation and soil loss (by overland flow runoff or wind).

SOIL REMOVAL AND PLACEMENT

Before any soil removal (also referred to as lifting or stripping) activities are carried out all existing vegetation must be killed and/or removed. This will avoid green vegetative materials being incorporated into the replaced soil at the site.

All soil material must be removed from all affected land prior to the commencement of any trafficking of the area and stockpiled in a secure predesignated area.

As an overarching principle, the handling of the topsoil material should only be undertaken in dry soil condition[11] to avoid soil compaction. Compaction restricts root growth and drainage and is the main risk to being able to return the soil to a usable condition.

Topsoil may only be removed using an excavator and extreme care must be taken to avoid shearing and compressive force on the soil (i.e. the inherent structure of the topsoil should be maintained as much as possible). This is best achieved by only removing soil when the soil is in a dry condition with single continuous bucket movements.

Light track-driven machinery (e.g. tracked excavators and dozers) or flotation tyred machines must be used for the soil removal and placement to avoid the considerable compaction and shearing of soil by large heavy rubber tyred machines (this does not preclude the use of cropping machinery, as long as any machinery does not have a detrimental compacting effect on the soil).

All areas that are not being actively quarried will be maintained in vegetation.

SOIL STORAGE

[10] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3rd ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163p.

[11] A useful field method of deciding whether a soil is sufficiently dry to be moved safely is the spade test: plasticity is determined by hand-rolling a sample from the relevant horizon on the back of a spade to see if a thread of 3 mm diameter can be formed without crumbling. If a thread can be formed the soil is too wet for working (Ramsay, 1986).

All trees and vegetation including large root systems, old fences, rock, debris, and all obstructions of whatever kind, whether natural or artificial, encountered within the area of the works must be removed and disposed of in an appropriate approved manner.

Appropriate sediment control measures are required to prevent the discharge of soil into watercourses, or onto, or through downstream properties. Existing sediment traps may be useful, but additional sediment capture ponds or barriers may be required during removal, placement, and following placement at the property until vegetation is established.

A designated centralised storage area on the landward side of the stop bank will be used for stockpiling soil. Use of a centralised storage area will ensure the potential for soil loss to water from the stockpiled soil is well managed and minimised. No stockpiling of soil will occur outside the landward side of the of the stop bank, other than topsoil that will be used in that day's rehabilitation. Some topsoil may be used for the purpose of creating a noise bund if required.

Soil stockpiles must be protected from compaction, degradation and soil loss (to water). Stockpiles must not exceed three metres in height and should be kept for as short a period as possible to minimise loss of soil structure. Soil stockpiling should be included in pre-planning and scheduling to (as much is as practicable) minimise the time topsoil is stockpiled. For any soil stockpiles stored for greater than one month, the stockpile should be covered or vegetated with grass to reduce soil damage and loss caused by rain.

TRANSPORT

For transport of topsoil and other soil material, the main consideration is the degradation of soil aggregates caused by the vibration during transport. Given the size of the site, the degradation of soil aggregates caused by the vibration is considered a low risk. Reducing the transport distances and vehicle speed on site will reduce any potential for degradation of soil aggregates. This will be achieved using a centralised designated storage area to minimise transport distances on site and restricting vehicle speed on site to 15 km/hour.

PREPARATION OF THE RECEIVING SURFACE

The receiving soil surface must cultivated to provide as even surface as is possible. Light track-driven machinery (e.g. tracked excavators and dozers) or flotation tyred machinery must be used to prepare the receiving surface to minimise soil compaction.

Cultivation must avoid creating concentrated areas of compaction (e.g. wheel track lines up and down the slope) and must minimise the number of passes over the site.

Where possible, cultivation and levelling of the soil surface should be along the contour.

SUBSOIL PROPERTIES

In addition to meeting the requirements for the fill material, the following applies to subsoil:

The subsoil is permitted up to 300-400 mm of the final land surface but a minimum subsoil thickness of 700 mm is required. This is to ensure the final re-established soil profile (of approximately 1000 mm) comprises predominantly fine matrix soil materials, free of rocks and other coarse materials.

The following properties are required for the subsoil material:

- Only acceptable Clean Fill Material as defined in the Peach Island Proposed Quarry: Groundwater and Clean Fill Management Strategy be used.

- Coarse organic materials are not permitted in the subsoil material.
- The subsoil material may include fine organic materials as permitted by the Peach Island Proposed Quarry: Groundwater and Clean Fill Management Strategy.
- The subsoil material will not contain rocks or inert materials such as concrete.
- The subsoil can contain clay, silt and sand textured soil materials. Sand and silt rich subsoil materials should be used in preference to clay texture dominated soil materials.
- The subsoil material can include up to 35% by volume of gravels (moderately gravelly)[12] of 6-20 mm diameter[13] with fine soil matrix materials.
- Overburden soil material removed from the extraction site and stockpiled can be used.

TOPSOIL PROPERTIES

In addition to meeting the requirements for the fill material, the following applies to topsoil:

The topsoil must occupy the upper 300-400 mm of the final re-established soil profile. This is to ensure the final re-established soil profile has a topsoil that has organic matter, nutrients and fine matrix soil materials similar to the original soil profile.

The following properties are required for the topsoil material:

- Topsoil removed from the extraction site and stockpiled should be used.
- Other clean topsoil sourced offsite can be used.
- Coarse organic materials are not permitted in the topsoil.
- The topsoil may include up to 10% (by volume) of fully decomposed organic material provided it is thoroughly mixed with the other soil material.
- The topsoil material cannot contain rocks or inert materials such as concrete.
- The topsoil material can include up to 5% (by volume) of gravels (slightly gravelly) with fine soil matrix materials.

SEQUENCE OF SOIL PLACEMENT

Soil placement is the single most important operation in the restoration process. The soil must be placed under optimal conditions to specified depths on a platform graded to design levels.

The platform design determines the future landform and must take into account materials available, groundwater levels, erosion hazard, slope criteria for restored land use, aspect, microclimate, aesthetics, and most importantly, drainage (Ramsay, 1986). Final slopes of five or less degrees are considered optimal for cropping and horticultural purposes.

Once the shape of the existing land surface has been attained, the soil materials must be placed using light track-driven machinery or flotation tyred machinery.

Between the placed subsoil and topsoil, the surface must be ripped along the contour (if any) or otherwise treated to reduce any subsurface compaction and eliminate slippage surfaces and root restricting or water perching layers. Sharp interfaces between texturally contrasting materials must be avoided.

Topsoil placement operations need to be carried out when the soil materials are in a dry condition – soil conditions similar to cultivation of cropland. A useful field method of deciding whether a

[12] Milne JDG, Clayden B, Singleton PL, Wilson AD. 1995. Soil Description Handbook. Lincoln, New Zealand, Manaaki Whenua Press. 157p. (p46).

[13] Milne JDG, Clayden B, Singleton PL, Wilson AD. 1995. Soil Description Handbook. Lincoln, New Zealand, Manaaki Whenua Press. 157p. (p45).

soil is sufficiently dry to be moved safely is the spade test: plasticity is determined by hand-rolling a sample from the relevant horizon on the back of a spade to see if a thread of 3 mm diameter can be formed without crumbling. If a thread can be formed the soil is too wet for working (Ramsay, 1986). Vehicular traffic and soil handling should be kept to a minimum and all soil compaction must be rectified by appropriate tillage/ripping treatments prior to establishment of a plant cover. Special care is required to avoid continually using the same vehicle tracks when redistributing the soil materials, or if this is not possible then the excessively tracked areas should be ripped.

The topsoil material must be distributed in such a way as to achieve an approximately uniform stable thickness over the whole area.

Any exposed soil surfaces require protection from wind erosion. Light surface wetting of the soil topsoil via irrigation is an acceptable method. All areas that are not being actively quarried will be maintained in vegetation.

The site is to be progressively stabilised i.e. each active stage must be remediated prior to excavation commencing on the next stage.

OVERVIEW OF RESTORED SOIL

The objective of restoration is for the restored soil to reach the following outcomes:

i. A minimum of 800 mm[14] of plant growth medium with little or no limitations to root penetration.
ii. Soil strength to be such that there is no serious limitation to cultivation and movement of machinery, i.e. no visually obvious contrasting compacted layers within the restored soil profile, especially between the subsoil and the topsoil, and no visually obvious compaction within the upper 300–400 mm of topsoil.
iii. Be at least imperfectly drained, preferably moderately well or well drained[15] where the inherent soil drainage characteristics of the land allow.

Figure 6 and **Figure 7** indicate the placement sequence to achieve the above conditions.

[14] TRMP requirement d).

[15] TRMP requirement c).

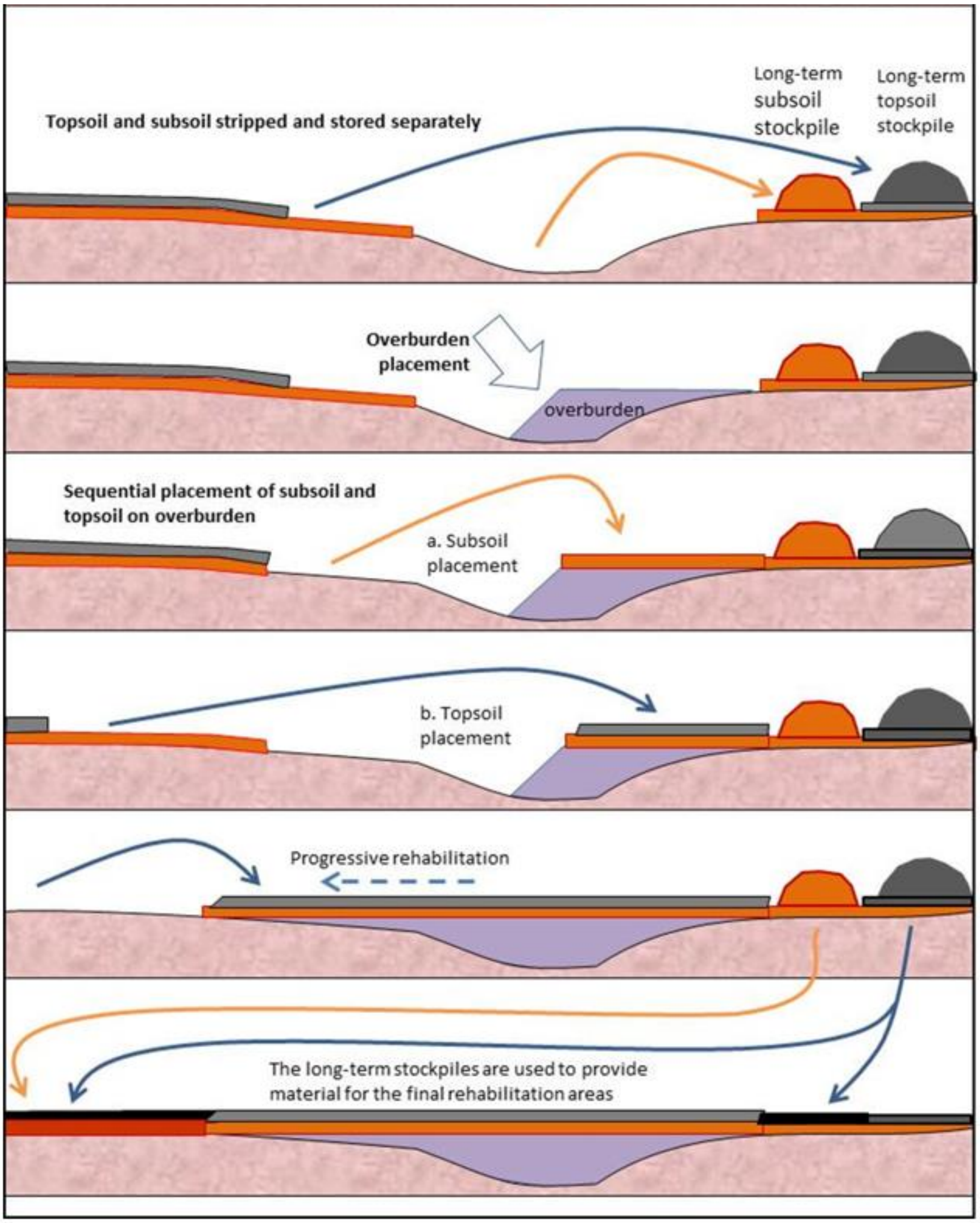

Figure 6. Sequence of topsoil and subsoil removal and replacement on fill (overburden).

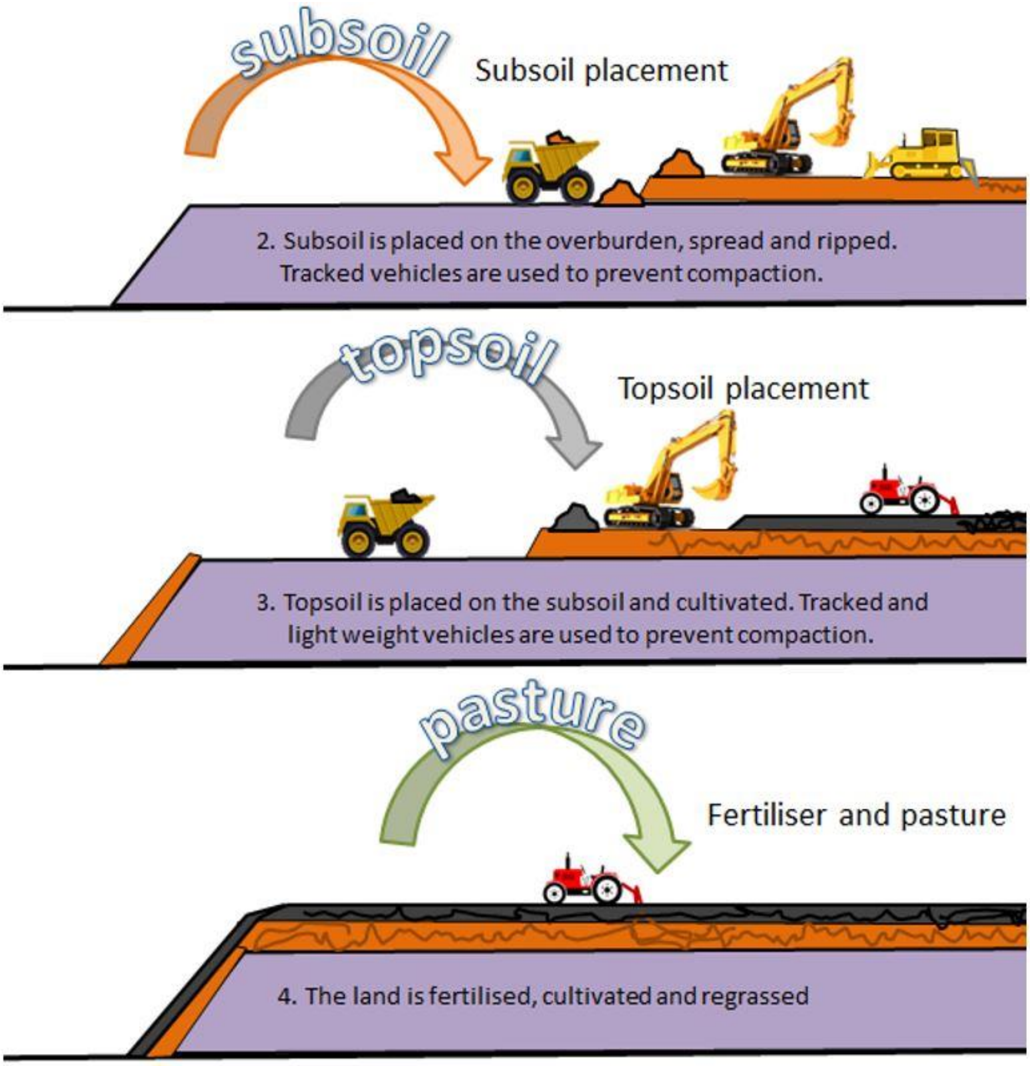

Figure 7. Sequence of soil replacement and preparation.

REHABILITATION AFTER PLACEMENT

The primary purpose of rehabilitation (soil reinstatement) is to:

- Maximise favourable environmental conditions for plant growth and hasten revegetation processes by managing those factors that are able to be controlled. This also involves, monitoring results of progress, and where necessary, progressively adapting activities to improve results.
- Ensure that the life supporting capacity of the soil is retained following extraction activities, in a way that retains or enhances the range of potential land uses provided by productive land.
- Minimise exposed areas (bare soil areas) and achieve soil stabilisation as soon as is practical after soil placement

Following the placement of the new soil profile, the consent holder must obtain advice from a qualified agronomist on fertiliser application and other soil treatments, as determined by soil test, to encourage effective re-vegetation. Suitable pasture species for the local conditions should also be selected.

Pasture is the best vegetation for restoring the soils to a condition suitable for intensive land uses such as cropping and horticulture. Pasture roots help create soil structure and penetrate the subsoil. This helps ensure the cracks needed for drainage and air supply in the soil are kept open.

Re-vegetation to pasture must be undertaken as soon as practicable after topsoil placement. This will minimise possible deterioration of soil structure and development of erosion problems on bare cultivated soils. Ideally and weather permitting, seeding should occur within two weeks following topsoil placement. On any cut-bank batters the use of mulches or hydro-seeding may be necessary to control erosion, promote germination of seeds and increase the moisture retention capacity of the soil.

To encourage the rapid recovery of the soil structure, stocking rates will need to be kept to a minimum for at least three years with only light weight stock such as yearling cattle and sheep being allowed on the pastures. This helps prevent recompacting the soil. Deer, bulls and pigs should not be allowed under any circumstances during the recovery period. The number of grazing animals should be strictly controlled during wet periods, with total withdrawal of stock if the soils are above field capacity, and a management system which promotes grass harvesting (hay and/or silage) over the initial years is to be encouraged. Cultivation should also be avoided for at least three years to facilitate recovery of soil structure and allow the stabilisation and development of soil aggregates. Any repairs to pasture should be made by under-sowing techniques rather than recultivation.

Areas of obviously impeded drainage which show by way of surface ponding should be examined to establish if any moisture restricting layer exists and appropriate ripping or subsurface aeration undertaken to shatter such compacted layers. If such ripping is unsuccessful then drainage will need to be considered.

RECOMMENDATIONS FOR REDUCING RISK OF SOIL LOSS TO WATER

Soil management related potential for soil loss to water is associated with soil storage, transport, preparation of the receiving surface, soil placement, and post placement management. Relevant recommendations for reducing soil loss to water from the Soil Management Plan are summarised in **Table 3**.

Table 3. Summary of Soil Management Plan recommendations relevant to soil loss to water.

Section in Soil Management Plan
Soil storage
Soil stockpiles (other than topsoil that will be used in that day's rehabilitation) be located on the landward side of the stop bank to increase protection from flooding (and soil loss to water).
A centralised storage area is designated and used for soil stockpiles to ensure the potential for soil loss to water is well managed.
Placement of sediment control measures. Existing sediment traps may be useful, but additional sediment capture ponds or barriers may be required during removal, placement, and following placement at the property until vegetation is established.
Stockpiles do not exceed three metres in height and should be kept for as short a period as possible.
For soil stockpiles stored for greater than one month, the stockpiles are covered or vegetated with grass to reduce soil loss caused by rain.
Transport
Deep sided trucks (dump trucks) are used onsite to reduce spill and if possible, the soil should be covered.
Deep sided trucks with covers are used for the transport of soil material offsite.
Tracking of soil onto public roads from vehicle wheels is avoided. Procedures are in place to check for and remove any soil spill.
Preparation of receiving surface
Use of light track-driven machinery or flotation tyred machinery to minimise soil compaction.
Cultivation avoids creating concentrated areas of compaction (e.g. wheel track lines up and down the slope).
Cultivation minimises the number of passes over the site to avoid soil compaction.
If applicable, cultivation and levelling of the soil surface should be along the contour.
Soil placement
Use of light track-driven machinery for soil placement to minimise soil compaction.
Post placement management
Revegetation using suitable grass species to develop soil structure.
Addition of nutrients (fertiliser) to increase fertility and promote and maintain even revegetation.

Soil moisture management via irrigation (if available) to promote and maintain even revegetation.

In addition to the recommendations summarised in **Table 3**, soil removal and placement activities on site shall only be undertaken in dry weather (no rainfall) providing soil moisture conditions are suitable and cease ahead of forecast heavy rainfall.

SOIL MANAGEMENT TRAINING, MONITORING AND REPORTING

Soil management training of all staff involved and activities monitoring is included to ensure the effective reestablishment of the soil on the gravel extraction site. The consent holder must consult a Soil Scientist or Restoration Manager for the initial training of relevant staff.

Soil management training for staff will be undertaken as part of the site induction programme. The induction programme will include the following information specific to soil management:

- Information about soil management and the activities that may cause soil loss to water within the site with the potential to impact neighbouring areas,
- consent requirements,
- soil management procedures,
- description of soil management monitoring for the site, and
- complaints management procedures.

Staff training records will be maintained on site. The records will include:

- Who was trained,
- when the person was trained, and
- general description of training content and whether follow up/refresher courses are required at a later date.

The following are required as part of the Soil Management Plan:

SOIL REMOVAL

Operator performance in the lifting phase is crucial, and on-site guidance on soil horizon recognition and on machine routing is required to be provided to the operator in consultation with a Soil Scientist or Restoration Manager. This guidance can be provided to all relevant staff as part of the site induction programme. Additionally, an excavator with GPS depth control is recommended to ensure the correct soil horizon is being removed.

SOIL PLACEMENT

Operator performance in the placement phase is crucial, and on-site guidance on correct placement and on machine routing, is required to be provided to the operator by a Soil Scientist or Restoration Manager. This guidance can be provided to all relevant staff as part of the site induction programme.

POST PLACEMENT

The staged and incremental reinstatement of the excavated area allows for iterative checking and refinement of placement procedures to ensure the quality of the replaced soil profile. Annual inspection of the in-situ placed fill and soil materials (the reinstated soil profile) by a Soil Scientist or Restoration Manager is required as specified by a detailed soil monitoring plan.

Assessment should include the following matters, plus any additional matters identified by the Soil Scientist or Restoration Manager:

- Visual assessment of the placed soil profile, examining for abrupt horizon boundaries, compacted layers, smeared layers, visual evidence of restricted water movement.
- Confirmation of the presence and % content of gravels and soil colour (using a Munsell soil colour chart) should be recorded for the subsoil, and topsoil.
- Topsoil and subsoil samples for soil chemical analysis as specified by a detailed soil monitoring plan.

Immediately following full establishment of the pasture vegetation, the soil should be capable of production similar to land that has been cultivated for cropping and re-grassed. As the pasture establishes over the first year, soil properties will improve due to the positive impacts of the pasture cover. These will include development of soil aggregates and soil biological activity.

In general, soil properties are likely to change more rapidly in the first few years following re-establishment, and then slow as the soil settles towards longer term equilibrium conditions.

Under established land use, soil quality changes commonly occur over decades depending on the intensity of land use, at which point contemporary land management practices are likely to have a greater impact on the soil rather than the soil property changes associated with the reestablishment of the soil.

A precautionary approach will be taken for reinstating land uses to allow the soil to re-establish and prevent any damage from land management activities.

An indicative timeframe for productive uses:

- 0-2 months – pasture establishment (no grazing),
- 3 years – available for low intensity grazing (no cropping),
- >3 years – available for intensive land uses including cropping and orchards.

The consent holder must undertake annual soil quality (soil condition) monitoring for rehabilited soil areas for the first three years following the completion of the rehabilitation of each gravel extraction stage, to ensure soil quality is restoring as intended.

SOIL MONITORING PLAN

A detailed soil monitoring plan must be developed for post placement soil monitoring and the assessment undertaken by a Soil Scientist.

The results of the monitoring shall be recorded and made available to Tasman District Council.

The following provides guidance for the contents of a soil monitoring plan.

To allow comparative assessment of the soil quality of the re-established soil following extraction, soil monitoring should include baseline sampling and analysis of the original soils on the site. Additionally, a control site in an adjoining undisturbed site (on a similar original soil) should be included in ongoing soil monitoring to differentiate between the effects of contemporary land use management and effects associated with the reestablishment of the soil.

The soil monitoring plan will include the sampling approach (location of point samples or sampling transects). All sampling locations will be recorded using a handheld GPS.

Potential soil properties (soil indicators) to monitor are provided in **Table 4**. The suggested soil properties are commonly used to assess the impacts of land management on soils under a given land use. These are soil quality indicator soil properties used by regional authorities (including Tasman District Council) for regional and national reporting. They should not be considered definitive (i.e. alternative soil properties for monitoring can be considered) but do provide a research based representation of soil chemical, biological and physical condition (soil quality).

Table 4. Suggested soil properties to monitor.

Term	Definition
pH	A measure of the acidity or alkalinity of a soil.
Total carbon	A measure of the total amount of all forms (organic and inorganic) of carbon in the soil.
Total nitrogen	A measure of the total amount of all forms of nitrogen in the soil.
Anaerobically mineralisable nitrogen	A laboratory measure of the amount of nitrogen that can readily be supplied to plants through the decomposition of soil organic matter. An indicator of soil biological activity.
Olsen phosphorus	A measure of the amount of phosphorus available for plant and microbial uptake.
Bulk density (fine dry bulk density)	The weight of soil in a given volume. This is a measure of how densely soil particles are packed in situ in the field.
Air-filled porosity (at -10 kPa)	The proportion of soil volume drained between the pressure levels of 0 and -10 kPa on the soil-water desorption curve (i.e. pores >30 um equivalent cylindrical diameter). The terms air-filled porosity (at -10 kPa) and macroporosity (at -10 kPa) are often used interchangeably.
Aggregate stability	A measure of the ability of soil aggregates to resist disruption when outside forces are applied.

ASSESSMENT OF EFFECTS

INTRODUCTION

This part of the report provides an assessment of the effects of the proposal on soil properties productivity.

EFFECTS OF DISTURBANCE ON SOIL PROPERTIES AND PRODUCTIVITY

The consent application[16] stated (in Annexure G) that Council's Resource Scientist – Land, Dr Bernard Simmonds, was consulted in regard to this proposal, and he advised that disturbance and removal of the topsoil disrupts:

1. *Air and water flow pathways that control soil biological respiration,*

[16] Planscapes. 2020. CJ Industries Application for Resource Consent (Annexure A), June 2020.

2. *moisture movement and storage, and*
3. *structural changes to the soil profile increasing the risk of compaction.*

These soil property changes can lead to discontinuous drainage patterns across a site, affecting root growth and overall productive potential and soil versatility.

I agree that soil disturbance (as part of any activity) is likely to result in disruption to soil properties as described by Dr Simmonds. Soil disturbance or disruption can occur with any land use practice (e.g. cultivation for cropping).

Establishing pasture vegetative cover (in contrast to cropping or horticultural uses) following reinstatement of the soil profile is the most effective way to prevent soil loss from erosion, improve soil structure and promote organic matter through soil biological activity.

A precautionary approach of increasing land use intensity over several years will allow the soil to re-establish and prevents any damage from more intensive land management activities. An indicative timeframe for reintroducing productive land uses is:

- 0-2 months – pasture establishment (no grazing),
- 3 years – available for low intensity grazing (no cropping),
- >3 years – available for intensive land uses including cropping and orchards.

Adherence to the Soil Management Plan (most importantly during the removal and placement of the subsoil and topsoil materials, and post placement management) will ensure the effects are minimised and are no more than the soil disturbance effects that would result from land use practices such as cultivation for cropping, forest harvesting and intensive pastoral use.

A report on land reclamation following gravel extraction on Ranzau soils, Nelson[17] indicated reduced production on gravelly soils similar to soils on the Peach Island Road site. The main changes were related to soil physical properties, and included increased soil moisture content, aggregate density, bulk density, air-dry penetrometer resistance, decreased infiltration hydraulic conductivity, and aggregate stability. The changes resulted in trafficability and plant growth issues. The issues were attributed to soil compaction and loss of soil structure, which occurred while respreading when the soil was not dry.

Soil properties improved over the 18 month monitoring period. The report also stated that the soil degradation observed could have been largely avoided by following better soil management practices. The suggested practices included:

- Soil should be moved and spread during comparatively dry soil conditions.
- Spreading of dump mounds should be carried out by a back acting excavator to minimise subsequent passes by spreading vehicles.
- Spreading should be carried out by tracked, not tyred spreading vehicles.
- Complete ripping of the soil should be carried out to a depth sufficient to break up the subsoil.
- Surface contouring of the site to encourage drainage from the site to prevent creating ponding areas.
- Sowing of a deep rooted crop in rotation with pasture to breakup subsoil compaction and restore topsoil structure.

[17] McQueen DJ. 1983. Land reclamation following gravel extraction on Ranzau soils, Nelson. New Zealand Soil Bureau Scientific Report 58. Government Printer, Wellington. 46p.

These practices have been incorporated into the Soil Management Plan in this report.

Another example of the soil properties following soil restoration at Staplegrove Farm gravel extraction site, Waimea West, Nelson[18] indicated poor soil condition following reinstatement of the soil. The report highlighted a number of soil profile features including:

- No A horizon present,
- stone content >35%,
- abrupt boundary between fill and subsoil,
- presence of coarse foreign debris,
- soil drainage impairment,
- subsoil compaction,
- presence of soil contaminants, and
- severely diminished potential productive capacity.

These observed features do not necessarily mean that reinstatement of the soil following gravel extraction cannot be successfully achieved, but do highlight the importance of good soil management including:

- Sequential replacement of the subsoil and a sufficiently deep topsoil,
- minimising the stone content of soil materials, especially in the topsoil,
- ripping the surface of the cleanfill and subsoil to prevent abrupt boundaries,
- ripping of the topsoil to create soil structure for air and water movement,
- minimising soil compaction from machinery,
- removal of coarse foreign debris,
- post placement soil and land management,
- subsoil compaction,
- use of contaminant free cleanfill and soil materials.

These practices have been incorporated into the Soil Management Plan in this report.

Discussion with a local grower with experience establishing a pear orchard on rehabilitated soil, indicated impeded soil drainage on the site prior to orchard establishment. In response, the site was established with pears, rather than apples, as pears were more likely to tolerate poorer drained soils. Impeded drainage and observed pugging continued in the first year following orchard establishment. Subsequent improvements to orchard management including establishment of rye grass/clover pasture and avoiding heavy machinery during the wet spring remedied this, and in recent years the soils have improved. General observations indicate no obvious reduction in production on the site compared with other undisturbed sites.

The effects on soil properties are likely to be predominantly soil physical effects related to soil compaction, loss of soil structure and degradation of soil aggregates during removal, transport and storage, and compaction of the soil material during placement. In turn, these can lead to impeded soil drainage (reducing air and water flow pathways in the soil), reduced soil water storage capacity, and reduced soil pores for biological activity. Soil fertility is not considered to be of primary concern as this can be remedied with the addition of fertiliser. Guidance from the Soil Management Plan specific to avoiding or minimising the potential for soil physical degradation is summarised in **Table 5.** If the steps set out in the Soil Management Plan are followed, I expect effects on soil properties following restoration to be short term (0-3 years), and less than minor, or positive, in the longer term.

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[18] Campbell, I (2017) Report on soil restoration at Staplegrove Farm gravel extraction site, Waimea west, Nelson Land & Soil Consultancy Services, Nelson.

Table 5. Summary of Soil Management Plan recommendations to mitigate the potential effects on soil properties.

Management practice in the Soil Management Plan
Soil placement
Sequential replacement of the soil material to approximate the original soil profile; regolith (fill), subsoil and topsoil. This will maintain air and water flow pathways similar to an undisturbed soil profile.
Handle soil in dry condition.
Soil storage
Vegetation of stockpiles stored for greater than one month with shallow rooting grass to protect from water (rain).
Transport
Handling of the soil material in dry condition. This helps maintain soil aggregates and avoid soil smearing and compaction.
A centralised storage area is designated and used for soil stockpiles to minimise the transport of soil onsite.
Preparation of receiving surface
The receiving soil surface should be cultivated to provide as even surface as is possible. This avoids sharp interfaces between texturally contrasting materials, reduces compaction, and creates air and water pathways.
Use of light track-driven machinery or flotation tyred machinery should be used to minimise soil compaction.
Cultivation should avoid creating concentrated areas of compaction (e.g. wheel track lines up and down the slope).
Cultivation should aim to minimise the number of passes over the site to avoid soil compaction.
If possible, cultivation and levelling of the soil surface should be along the contour.
Fill and soil properties
Coarse organic materials should be avoided or removed from the soil material before placement.
Minimise the inclusion of organic material (<10% by volume) to minimise anaerobic conditions in the soil from decomposition.
Soil placement
Sequential placement of fill, subsoil and topsoil to approximate an undisturbed soil profile
Use of light track-driven machinery for soil placement to minimise soil compaction and degradation of soil aggregates.
Post placement management
Revegetation using grass to develop soil structure. This will increase the ability of the soil to store air and water, improve moisture movement and improve soil biological activity.
Addition of nutrients (fertiliser) to increase fertility and promote and maintain even revegetation.
Soil moisture management via irrigation to promote and maintain even revegetation.

The applicant intends to return the land to productive use. In the long term, the aim is that the land is suitable for cropping and horticulture (i.e. is versatile land with high productive value). The land will be returned to productive use incrementally as works progress so to have as little impact on the productivity of the site's soil as possible. Based on the guidance provided in the Soil Management Plan, the method of extraction has been designed to achieve this goal.

Following post extraction rehabilitation (including establishment of the pasture vegetation) the soil resource will be capable of supporting at least the same range of land uses as the current soil resource and the life supporting capacity of the soil will be retained. Therefore, I consider long term productivity related impairments will be less than minor.

Soil and land versatility and land productivity for the Peach Island Road site can be assessed using the following:

- TRMP definition for land with high productive value,
- Productive Land Classification

An assessment using these for the site pre and post gravel extraction is presented in the following sections.

LAND OF "HIGH PRODUCTIVE VALUE"

The definition for land with high productive value is defined in Chapter 2 'Meaning of words" in the Operative Tasman Resource Management Plan:

High productive value – in relation to land, means land which has a combination of at least two of the following features, one of which must be (a):

(a) a climate with sufficient sunshine that supports sufficient soil temperature;

(b) a slope of up to 15 degrees;

(c) imperfectly-drained to well-drained soils;

(d) soil with a potential rooting depth of more than 0.8 metres and adequate available moisture;

(e) soil with no major fertility requirements that could not be practicably remedied;

(f) water available for irrigation;

where that combination is to such a degree that it makes the land capable of producing crops at a high rate or across a wide range.

NOTE: This meaning is adapted from "Classification System for Productive Land in the Tasman District", Agriculture New Zealand, December 1994 and is equivalent to land under classes A, B, and C.

The *high productive value* definition although based on the PLC only requires the land to have two of the features listed, rather than classifying the land based on the greatest limitation as used by the PLC. This means that land that is poorly drained, has shallow soils, or has slopes of >15 degrees (all of which make the land unsuitable for cropping and horticulture) could be classified as land with high productive value, although they must also meet the requirements of the last sentence in the definition: i.e. "that combination is to such a degree that it makes the land capable of producing crops at a high rate or across a wide range".

An assessment of the LUC units on the site (pre gravel extraction) against these features in the definition is provided in Table 6.For the assessment I have included both the land on the site outside the stop bank (Stage 1) and the land inside the stop bank (Stage 2 and Stage 3). It should be noted that the land outside the stop bank is not considered land with high productive value due to the inherent flooding risk.

Table 6. Assessment of the LUC units on the site (pre gravel extraction) against high productive value definition features.

High productive value *feature*	LUC unit					
	3w1	3s1	4w3	4s1	5s1	6s1
(a) climate	yes	yes	yes	yes	yes	yes
(b) slope	yes	yes	yes	yes	yes	yes
(c) soil drainage	no	yes	no	yes	yes	yes
(d) rooting depth	yes	no	yes	no	no	no
(e) fertility	yes	yes	yes	yes	yes	yes
(f) irrigation	yes	yes	yes	yes	yes	yes

Applying the definition as stated requires the land to meet the climate feature (a), and one other feature. Although I have not reviewed climate data, the site is assumed to meet the climate (a) feature for the definition, given the presence of cropping and horticulture in the area. The soils on the site range in fertility from high to low soil fertility. However, fertility can be rectified by the addition of nutrients and trace elements with the addition of fertiliser. Additionally, water is available for irrigation. Therefore, applying the definition all land on the site is classed as high productive value, irrespective of poor drainage (3w1 and 4w3) and soil depth limitations (LUC 3s1, 4s1, 5s1 and 6s1).

However, when assessed against the last part of the definition 'where that combination is to such a degree that it makes the land capable of producing crops at a high rate or across a wide range', LUC units 3w1 and 3s1 are likely to meet the requirements of land capable of producing crops at a high rate or across a wide range and LUC units 4w3, 4s1, 5s1 and 6s1 are unlikely to meet these requirements.

Assessment of the estimated LUC units on the site (post gravel extraction) against the features in (a) to (f) is provided in **Table 7**.

Table 7. Assessment of the LUC units on the site (post gravel extraction) against high productive value definition features.

High productive value *feature*	LUC unit		
	3w1	2s1	4w3
(a) climate	yes	yes	yes
(b) slope	yes	yes	yes
(c) soil drainage	no	yes	no
(d) rooting depth	yes	yes	yes
(e) fertility	yes	yes	yes
(f) irrigation	yes	yes	yes

Following gravel extraction and the reinstatement of the soil, the LUC units with an existing wetness (w) limitation (LUC 3w1 and 4w3) are unlikely to be improved, given the inherent soil drainage and flooding risk. However, if the Soil Management Plan guidance is followed, rooting depth for LUC units 3s1, 4s1, 5s1 and 6s1 will be increased, and the soil limitation (soil rooting depth) will be improved. If the soil profile remains well drained or is moderately well drained, the likely resulting LUC class will be 2s[19] with an improved soil limitation (s) due to a soil depth >45 cm. If the reinstated soil does not remain well drained (i.e. is imperfectly drained), the likely resulting LUC class will be 2w with an increased wetness (w) limitation.

[19] Note that based on the NZLRI (1:50,000 scale) LUC map information, the majority of the intensive horticulture soils on the eastern side of the Motueka River are Riwaka soils and LUC units 1s2 and 2s2, compared with LUC 3s2 on the Peach Island Road site. This high LUC classification is due to the soils having a deeper fine soil matrix.

As a result of the increased soil depth and reduced variability of soils across the site, it is possible that production could be at a higher rate and the site potentially suitable for a wider range of land uses including cropping and horticulture. Therefore, following gravel extraction and the reinstatement of the soil the site is likely to meet the requirements of the last sentence in the definition and be considered land with high productive value.

PRODUCTIVE LAND CLASSIFICATION

The Productive Land Classification (PLC 1994) has been used by Tasman District Council to identify productive land suitable for cropping and horticulture. Cropping and horticulture land includes land classed as PLC land class A, B or C[20].

The PLC 1994 provides a better indication of land versatility than the Operative Tasman Resource Management Plan definition for land of high productive value, which is focussed more on the productive potential of the land rather than the range of land uses suitable for the land.

The PLC 1994 criteria scores for the LUC units on the Peach Island Road Site pre gravel extraction and post gravel extraction are presented in **Table 8** and **Table 9** respectively. LUC units have been used as these best represent the overall soil and land limitations for the given area and is most useful where soil map units are a complex of soils (e.g. soil map units 3+Br, 3+4, 4+5, 6+5).

Where data was not available from the property scale soil and LUC assessment (e.g. water holding capacity), estimates were sourced from the available regional scale soil data, the New Zealand Fundamental Soil Layer data[21] (NZFSL). It is important to note the limitations of this data. New Zealand Fundamental Soil Layer data applies the same soil data to all LUC units which are said to have Riwaka soils irrespective of the LUC limitation. The soil depth data in the NZFSL is sourced from a single soil profile provided in the Waimea County soil survey[22] which has a fine soil matrix depth of 0.9m-1.19m.

For example, LUC units 3s1, 2s1 and 1s1 all have the same soil depth and water holding capacity values, however, applying the LUC class criteria from Lynn et al. (2009) clearly shows that the soil depth (and therefore the water holding capacity) differs for these LUC units, and is less than 0.9m – 1.19m, which only apply to the LUC unit 1s1.

[20] Agriculture New Zealand. 1994. Classification system of productive land in Tasman District. Contract report prepared for Tasman District Council by Agriculture New Zealand, MAF, Richmond, Nelson.

[21] New Zealand Fundamental Soil Layer data from https://lris.scinfo.org.nz/layer/48137-fsl-south-island-all-attributes/.

[22] Chittenden ET, Hodgson L, Dodson KJ. 1966. Soils and agriculture of Waimea County, New Zealand. Soil Bureau Bulletin No 30. Department of Scientific and Industrial Research, Wellington.

Table 8. PLC 1994 criteria scores for pre gravel extraction LUC units on the Peach Island Road site (highest possible PLC class for each criteria, bolded score indicates limiting score).

LUC unit	Criteria													PLC Land class
	Climate qualities					Topography		Soil						
	Altitude	Length of growing season	Heat over summer	Rainfall	Wind	Slope (degrees)	Orientation (North/ South)	Fertility	Water Holding Capacity*	Rooting depth (m)	Erosion (including flooding)	Structure/ texture	Drainage & Permeability	
3w1	A	A	A	A	A	A	A	A	A	**B**	A	**B**	A	**B**
3s1	A	A	A	A	A	A	A	A	A	**F**	B	A	A	**F**
4w3	A	A	A	A	A	A	A	A	A	B	**E**	B	**E**	**E**
4s1	A	A	A	A	A	A	A	A	A	**F**	B	A	A	**F**
5s1	A	A	A	A	A	B	C	D	A	F	B	A	**H****	**H**
6s1	A	A	A	A	A	B	C	D	A	**F**	B	A	**H****	**H**

* Based on New Zealand Fundamental Soil Layer data from https://lris.scinfo.org.nz/layer/48137-fsl-south-island-all-attributes/.
** Excessive soil drainage.

Table 9. PLC 1994 criteria scores for estimated post gravel extraction LUC units on the Peach Island Road site (highest possible PLC class for each criteria, bolded score indicates limiting score).

LUC unit	Criteria													PLC Land class
	Climate qualities					Topography		Soil						
	Altitude	Length of growing season	Heat over summer	Rainfall	Wind	Slope (degrees)	Orientation (North/ South)	Fertility	Water Holding Capacity	Rooting depth (m)	Erosion	Structure/ texture	Drainage & Permeability	
3w1	A	A	A	A	A	A	A	A	A	**B**	A	**B**	A	**B**
2s	A	A	A	A	A	A	A	A	A	**B**	**B**	A	A	**B**
4w3	A	A	A	A	A	A	A	A	A	B	**E**	B	**E**	**E**

Based on the assessment of pre gravel extraction LUC units against the PLC 1994 criteria, only LUC 3w1 would be classed as highly productive land (PLC class B, with rooting depth and structure/texture limitations) suitable for cropping and horticulture. The next best land is LUC 4w3 (PLC class E), which based on the PLC 1994 is most suited to dairy, other intensive and extensive pastoral and production forestry. LUC units 3s1, 4s1 are all classified as PLC class F (soil depth limitation). This land is most suited to extensive sheep and beef and production forestry. LUC 5s1 and LUC 6s1 are classified as PLC class H due to their excessive drainage. The soils in these LUC class are prone to drought (drainage and permeability limitation) and based on the PLC, are most suited to retirement or recreation. Although irrigation water is available the excessive drainage characteristics of these soils is likely to mean that even with irrigation their use for intensive cropping and horticulture will be marginal as large volumes of irrigation water will be required to ensure plant survival.

The PLC 1994 report does note (page 12) that:

No single factor can be taken in isolation. A number of factors are considered when deciding on the classification of a particular land unit. The final assessment is made using professional judgement.

In my opinion, the soil depth and excessive drainage limitations of the soils in LUC 5s1 and 6s1 are severe enough to render the land unsuitable for intensive cropping or horticulture, and that the land is most suited to extensive sheep and beef and production at best. This would imply that a PLC class of 'F' is most appropriate.

Based on the assessment of estimated post gravel extraction LUC units against the PLC criteria, LUC 3w1 and LUC 2s would be classed as highly productive land (PLC class B, with rooting depth and structure/texture limitations) suitable for cropping and horticulture. The remaining land would likely still have inherent soil drainage and inundation limitations and be classed as LUC 4w3 (PLC class E). Based on the PLC, this land would be most suited to dairy, other intensive and extensive pastoral and production forestry.

Using the LUC units provided by the LandVision property scale soil and LUC assessment (LandVision, 2021), and applying the PLC, the land suitable for cropping and horticulture within the stop banks could potentially increase post gravel extraction. The suitability of the land for cropping and horticulture outside the stop banks is unlikely to increase given the inherent high water table and potential for flooding.

Overall, I conclude that the proposal will have positive effects on productive land as assessed using the LUC classes, following restoration.

RISK OF SOIL LOSS TO WATER

The main risk of soil loss to water is associated with overland flow when the soil is bare. This is most likely to occur during heavy or prolonged rainfall. The main periods of high soil loss risk from overland flow are during topsoil and overburden removal from the extraction site, during storage (stockpiling), and following final placement of the soil during vegetation establishment. The procedures for minimising the risk of soil loss to water are provided in the Soil Management Plan (**Table 3**) are summarised in **Table 11**.

Table 11. Summary of Soil Management Plan recommendations to mitigate the risk of soil loss from overland flow.

Process	Mitigation
Topsoil and overburden removal	• Avoid removing or placing soil during or ahead of heavy rainfall and flood conditions.
Soil storage	• Minimise the period the soil is stockpiled. • Soil stockpiles should be no more than 3 m in height. • Locate stockpiles in a sheltered area, away from watercourses, or obvious pathways to watercourses. • Have sediment control measures to prevent the discharge of soil into watercourses. • Cover or vegetate stockpiles with grass to minimise bare soil exposure.
Post activity vegetation establishment	• Ensure soil moisture is sufficient for vegetation establishment. • Maintain soil moisture during early vegetation establishment.

Provided the guidance in the Soil Management Plan is followed, the risk of soil loss to water from overland flow is considered minimal, and the effects less than minor.

CONCLUSIONS

The property scale soil and LUC assessment undertaken by LandVision (2021) provides the best soil and LUC map information for the Peach Island Road site.

The recommended measures for inclusion in a Soil Management Plan will ensure that the removal, management and placement of soil avoids or minimises impacts on the soil properties prior and following placement, and that the re-established soil can over the long term retain or exceed the soil versatility of the original soil on the site.

If the soils are re-established over the area by following the guidance provided in the Soil Management Plan, then:

i. Soil ripping during placement of the soil layers will provide a friable soil state which promotes normal soil infiltration and good crop/pasture establishment and growth.
ii. Plant roots will be able to extend themselves through the total volume of the restored materials to seek nutrients and moisture.
iii. The amount of plant available moisture that can be held within the soil profile should approximate, or even increase, what was originally present.
iv. Provided large rocks are removed prior to placement and the relocated topsoil is rock free, the resulting land should provide improved soil for cropping and horticulture.

As with any land use activity involving soil disturbance, reduced site productivity and impacts on soil physical properties immediately following reinstatement of the soil post gravel extraction are anticipated. However, careful soil management throughout the operation, in conjunction with post placement pasture establishment will minimise the impacts on soil properties, to a level comparable with general land use management practices. The establishment of pasture and avoidance of intensive stocking or cropping is the best method to restore the soil structure and soil biology and return the land to productive use.

Following pasture establishment land use is restricted to low intensity grazing to allow topsoil organic matter to build up and development of the soil structure. Following three years the soil organic matter and soil structure should be developed sufficiently to support more intensive land uses including cropping and orchards. Annual soil monitoring can be used to check and confirm this.

An indicative timeframe for productive uses:

- 0-2 months – pasture establishment (no grazing),
- 3 years – available for low intensity grazing (no cropping),
- >3 years – available for intensive land uses including cropping and orchards.

Post establishment soil and vegetation monitoring will provide additional assurances that the soil and land productivity are maintained, as well as the on-going opportunity for additional remedial soil practices such as ripping.

Irrespective of any soil disturbance impacts, the land will be retained for productive use, will have soil profile characteristics that meet the TRMP criteria in (a) to (f) of the definition and is likely to meet the last part of land of high productive value.

Key to the effective reestablishment of the soil on the gravel extraction site are careful pre-planning, adherence to the guidance provided in the soil management plan, and the training of all staff involved.

Staging the gravel extraction reduces the area of land not in productive use on the site and reduces the volume of soil requiring stockpiling and the time the soil is stockpiled.

Provided these points are met, the re-established soil is likely to over the long term to remain productive at a similar level as the original soil and will have similar, or potentially have greater soil versatility than the original soil pre-gravel extraction.

Applying the Tasman Resource Management Plan definition of *high productive value* for land, the Peach Island Road site is in my opinion not classed as land of high productive value as it fails to meet the requirements in the last sentence of the definition.

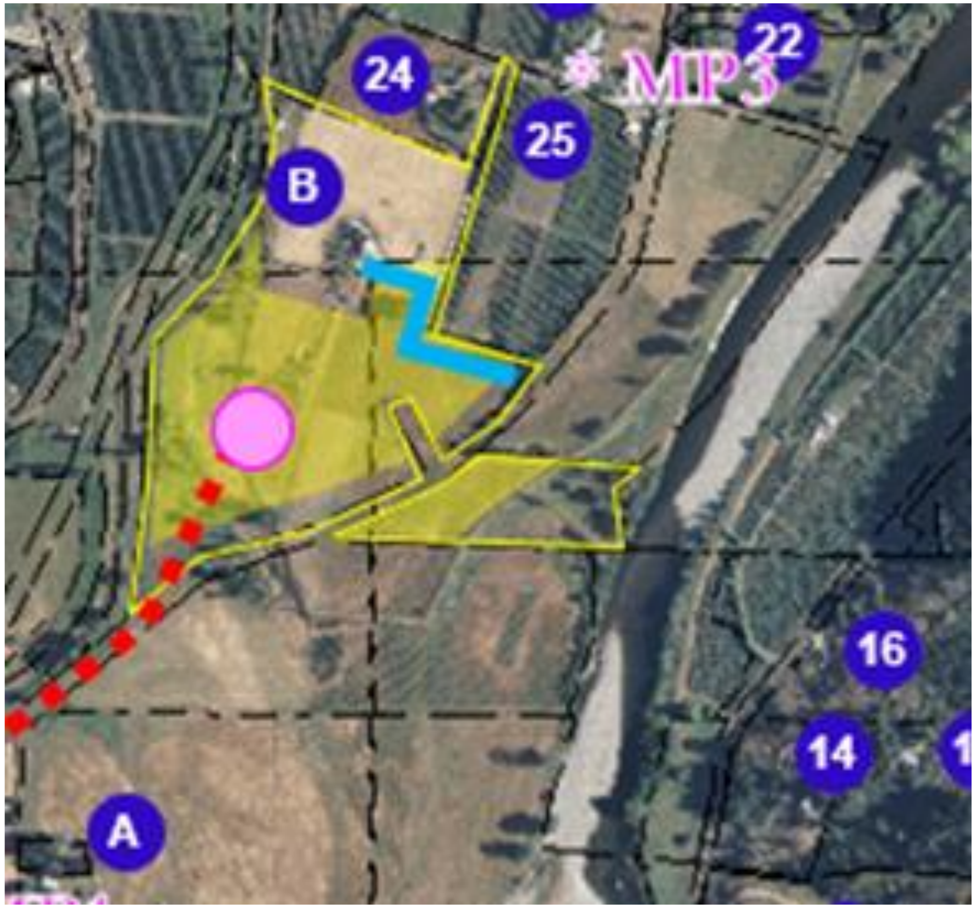
Following gravel extraction and reinstalment of the soil the resulting soil profile will be less variable with greater soil depth and the land may be classed as land of high productive value.

Applying Tasman District's Productive Land Classification pre gravel extraction, only the LUC 3w1 land on the Peach Island Road site is classed as land suitable for cropping and horticulture. This is in agreement with the LandVision report.

Applying Tasman District's Productive Land Classification post gravel extraction, the land suitable for cropping and horticulture could potentially increase post gravel extraction.

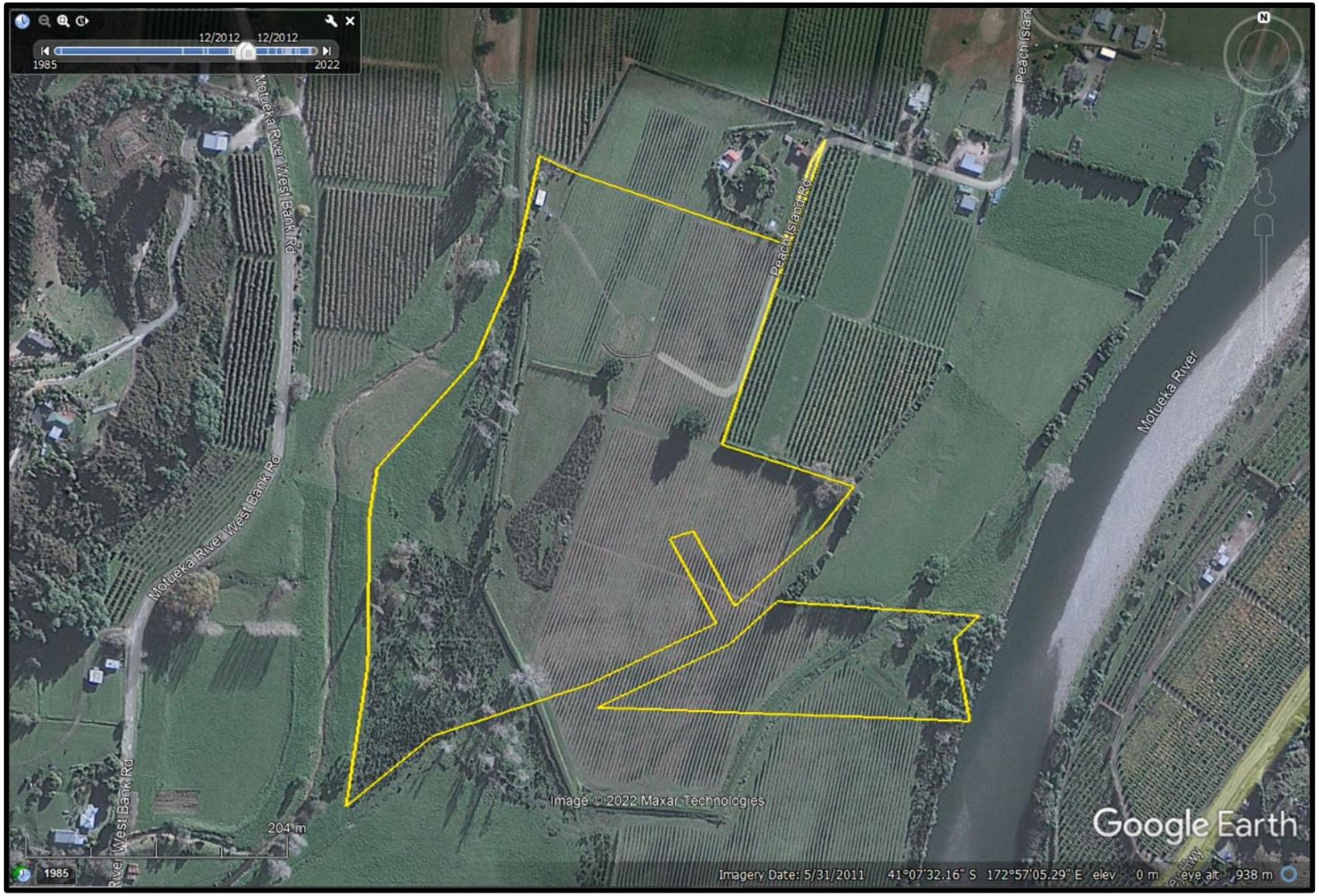
Potential for soil loss to water is associated with soil storage, transport, preparation of the receiving surface, soil placement, and post placement management. Provided the guidance in the Soil Management Plan is followed, the risk of soil loss to water from soil related activities is considered minimal, and the effects less than minor.

APPENDIX 2



Proposed noise bund location (indicated by the blue line).

APPENDIX 3



12/2012
12/2012
1985
2022
Motueka River West Bank Rd
Peach Island Rd
Motueka River
Motueka River West Bank Rd
River West Bank Rd
Image © 2022 Maxar Technologies
204 m
Google Earth
1985
Imagery Date: 5/31/2011 41°07'32.16" S 172°57'05.29" E elev 0 m eye alt 938 m

APPENDIX 4

PLC 2021 criteria scores for pre gravel extraction LUC units on the Peach Island Road site (highest possible PLC class for each criteria, bolded score indicates limiting score).

LUC unit	Criteria												
	Climate qualities					Land qualities							
	Altitude AMSL (m)	Mean Annual Soil Temperature (°C)	Frost Free Period	Mean Annual Rainfall (mm/yr)	Growing Degree Days (10° C)	Low Fertility Soil "Series"	Potential Rooting Depth (m) *	Profile Readily Available Water **	Soil Drainage Class	Salinity Class	Slope (degrees)	Erosion risk #	Flood frequency in years ##
3w1	A	A	A	A	A	A	A	A	A	A	A	**B1**	A
3s1	A	A	A	A	A	A	**C or D**	A	A	A	A	B1	A
4w3	A	A	A	A	A	A	**B1**	A	A	A	A	**B1**	A
4s1	A	A	A	A	A	A	**C or D**	A	A	A	A	B1	A
5s1	A	A	A	A	A	A	**C or D**	A	A	A	A	B1	A
6s1	A	A	A	A	A	A	**C or D**	A	A	A	A	B1	A

PLC 2021 criteria scores for estimated post gravel extraction LUC units on the Peach Island Road site (highest possible PLC class for each criteria, bolded score indicates limiting score).

LUC unit	Criteria												
	Climate qualities					Land qualities							

	Altitude AMSL (m)	Mean Annual Soil Temperature (°C)	Frost Free Period	Mean Annual Rainfall (mm/yr)	Growing Degree Days (10° C)	Low Fertility Soil "Series"	Potential Rooting Depth (m)	Profile Readily Available Water *	Soil Drainage Class	Salinity Class	Slope (degrees)	Erosion risk**	Flood frequency in years #
3w1	A	A	A	A	A	A	A	A	A	A	A	**B1**	A
2s	A	A	A	A	A	A	A	A	A	A	A	**B1**	A
4w3	A	A	A	A	A	A	**B1**	A	A	A	A	**B1**	A

* C if local climate is suitable for viticulture, otherwise D.
** Based on New Zealand Fundamental Soil Layer data from https://lris.scinfo.org.nz/layer/48137-fsl-south-island-all-attributes/. LUC units 3s1, 4s1, 5s1 and 6s1 will have increasingly reduced Profile Readily Available Water.
# Assumes increased erosion risk associated with likely cultivation (Webb et al., 2011).
Based on New Zealand Fundamental Soil Layer data from https://lris.scinfo.org.nz/layer/48137-fsl-south-island-all-attributes/.