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SOIL MANAGEMENT PLAN
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 reinstated with clean fill from off-site sources before the original subsoil and topsoil from the site is replaced. This Soil Management Plan provides the requirements for 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.

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 deposition of clean fill 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.

It is important to ensure that the soil resource will be protected through the extraction and restoration process.

A Soil Management Plan has been requested by the Applicant for land use consent RM200488 for gravel extraction and associated site rehabilitation at 134 Peach Island Road, Motueka. The Soil Management Plan (once certified by Council) will provide the basis for Standard Operating Procedures (SOPs) for specific activities.

OVERVIEW OF PROPOSED ACTIVITIES

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**).

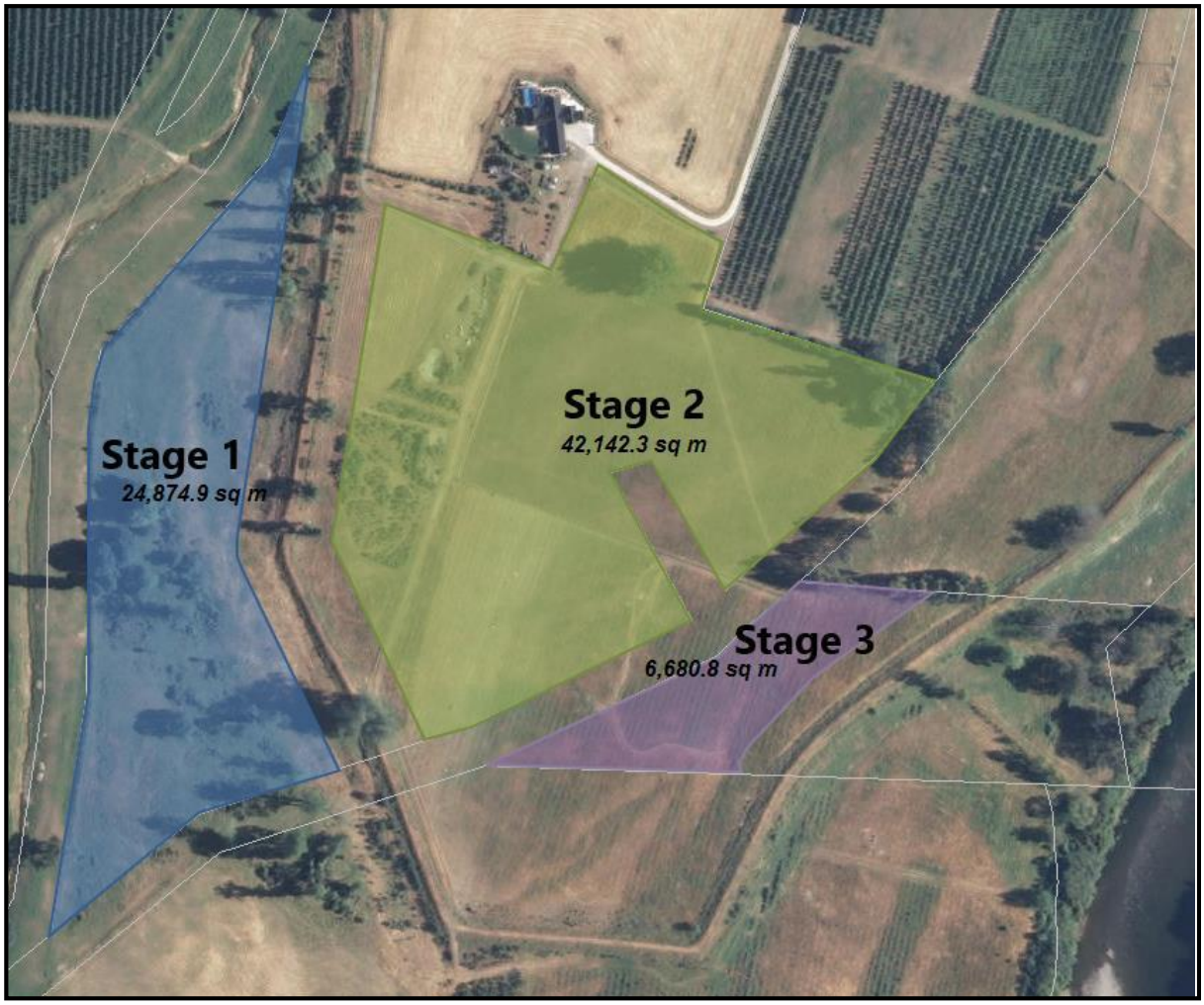

Figure 2. Proposed gravel extraction staging for the Peach Island Road site (from the Application for Resource Consent – Planscapes, 2020).

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.

SOILS AND LAND USE CAPABILITY OF THE SITE

The following information about the site's soil and LUC is included to prove a baseline record which is relevant to the soil restoration measures set out in this Management Plan.

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.

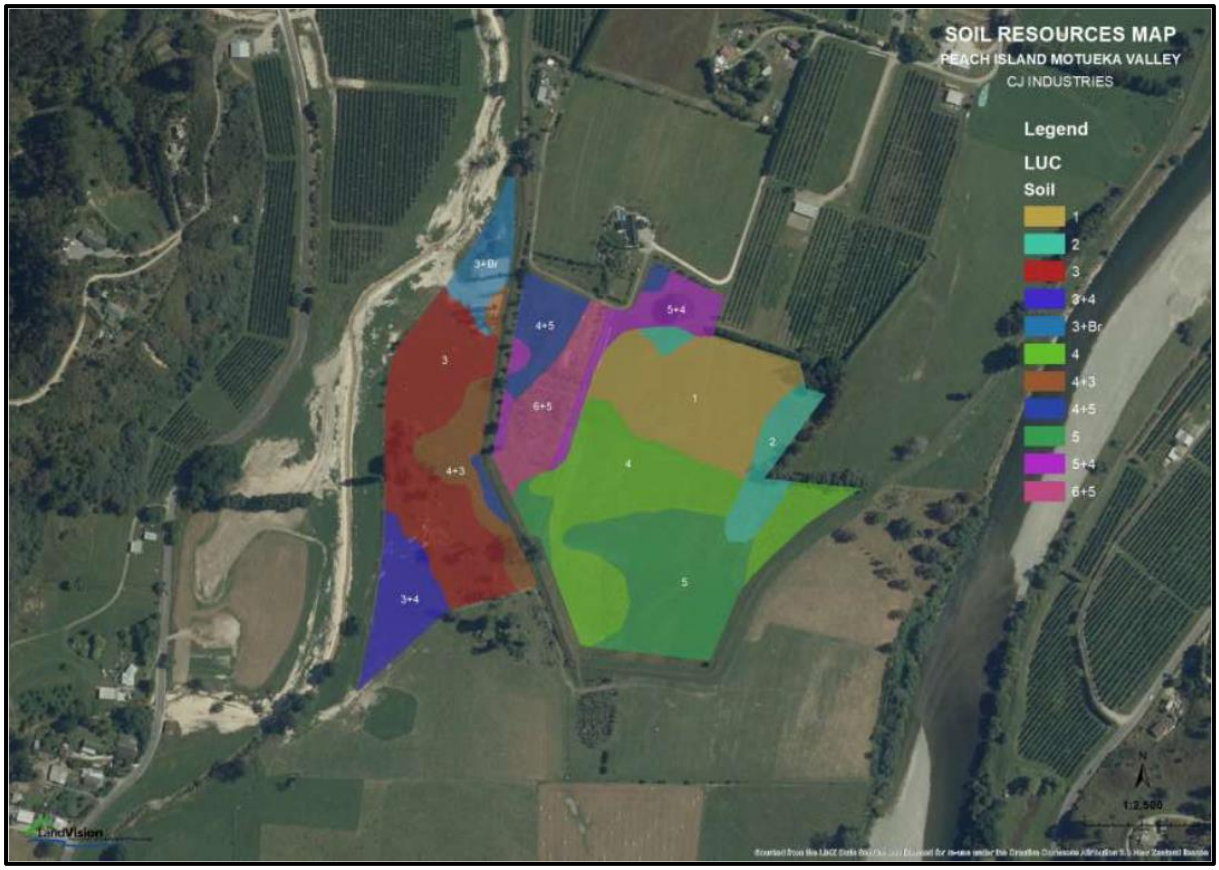

Figure 3. Soil map units for the Peach Island Road site based on the property scale soil assessment undertaken by LandVision (2021).

For this survey, slope, erosion and vegetation were considered consistent across the site and were not assessed[3]. 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. 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 4**.

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

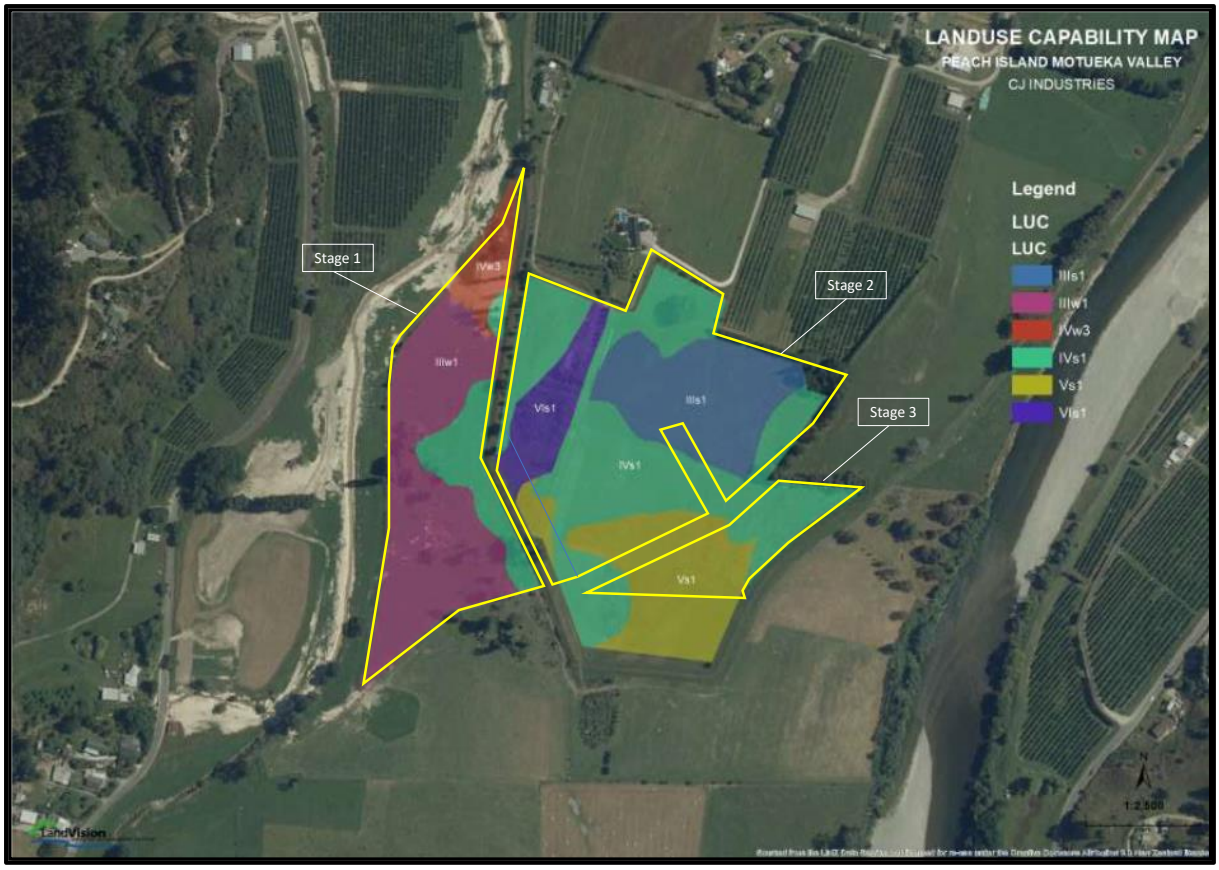

Figure 4. Property scale (1:6000 scale) LUC map for the Peach Island Road site.

Based on the LUC map provided in **Figure 4**, 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[4] (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[5] (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 very shallow[6] silt loam to sandy loam textured soils with surface boulders.	Alluvial gravels.	5	Low natural fertility and prone to drying out in summer 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[7] silt loam to sandy loam textured soils with surface boulders.	Alluvial gravels and boulders.	6, 6+5	Surface boulders inhibit cultivation.

[4] 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.

[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.

[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.

SOIL MANAGEMENT PLAN

PURPOSE

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)[8].

For the reinstated soil an ideal topsoil depth of 300-400 mm and an underlying 700 mm thickness of subsoil material will 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)[9].

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.

BASELINE MONITORING

To allow comparative assessment of the soil quality of the re-established soil following extraction, baseline sampling and analysis of the original soils in the Stage 1, Stage 2 and Stage 3 areas must be undertaken by a suitably qualified and experienced person prior to extraction occurring. Additionally, sampling of a control site in an adjoining undisturbed site (on a similar original soil) is required to be undertaken by a suitably qualified and experienced person. This is to differentiate between the effects of contemporary land use management and effects associated with the reestablishment of the soil.

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

[9] 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.

Details of baseline and control monitoring requirements are set out below in the Soil Monitoring section.

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).

Within Stage 1, additional measures are required to minimise potential for sediment loss as a result of flooding while a pit is active. These additional measures are:

- Stage 1 is to be quarried in 3 tranches, with a maximum of one third of the Stage 1 area to be actively quarried or being remediated at any time. Subsequent tranches within Stage 1 shall only commence when the previous tranche has been rehabilitated to the point that a vegetated cover is established.
- Stage 1 quarrying and placement of cleanfill, subsoil and soil is only to take place during the months of October to March, in order to ensure a vegetated cover is established before winter.

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.

The handling of the topsoil and subsoil material may only be undertaken in “dry” soil condition 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. 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). Light irrigation for dust suppression purposes does not render topsoil too wet for placement.

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 will 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

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 must be installed if 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 must 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).

No machinery is permitted on the soil stockpiles.

Stockpiles must not exceed three metres in height and must be kept for as short a period as possible to minimise loss of soil structure. Depending on the machinery used to deposit the soil, stockpiles of less than three metres may practically be required, to ensure machinery does not drive on or over the stockpiles.

Soil stockpiling provisions are required to 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 must 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.

It is likely that topsoil will be brought onto the site from offsite sources. Should topsoil be brought from off-site, it is not practicable (because of open road speed limits) or necessary (because vibration is considered a low risk) to transport topsoil from offsite sources at less than 15 km/hour.

PREPARATION OF THE RECEIVING SURFACE

The receiving soil surface must be 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 will be along the contour.

SUBSOIL PROPERTIES

The following applies to subsoil:

The subsoil is permitted up to 300-400 mm of the final land surface. 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:

- Where subsoil is brought onto the site from an offsite source, it must meet the clean fill requirements of the Groundwater and Clean Fill Management Plan, except that it may include a higher percentage of fine organic materials and it must not contain rocks.
- Coarse organic materials (e.g. branches) are not permitted in the subsoil material.
- The subsoil may contain clay, silt and sand textured soil materials. Where practicable, 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)[10] of 6-20 mm diameter[11] with fine soil matrix materials.
- Subsoil removed from the extraction site and stockpiled can be used.

TOPSOIL PROPERTIES

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 will be used in preference to topsoil sourced offsite.
- Other clean topsoil sourced offsite can be used if it meets the following requirements:
    - it must meet the clean fill requirements of the Groundwater and Clean Fill Management Plan, except:
        - The exclusion of topsoil in the GCMP does not apply.
        - The topsoil may include up to 10% (by volume) of fully decomposed organic material, provided it is thoroughly mixed with the other soil material.
    - Coarse organic materials (e.g. branches) are not permitted in the topsoil.
    - The topsoil material cannot contain rocks.
    - The topsoil material can include up to 5% (by volume) of gravels (slightly gravelly) with fine soil matrix materials.

SOIL PLACEMENT

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

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

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 consider 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.

Vehicular traffic and soil handling must 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 must 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[12] 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, and preferably moderately well or well drained[13] where the inherent soil drainage characteristics of the land allow.

Figure 5 and **Figure 6** indicate the placement sequence to achieve the above conditions.

[12] TRMP requirement d).

[13] TRMP requirement c).

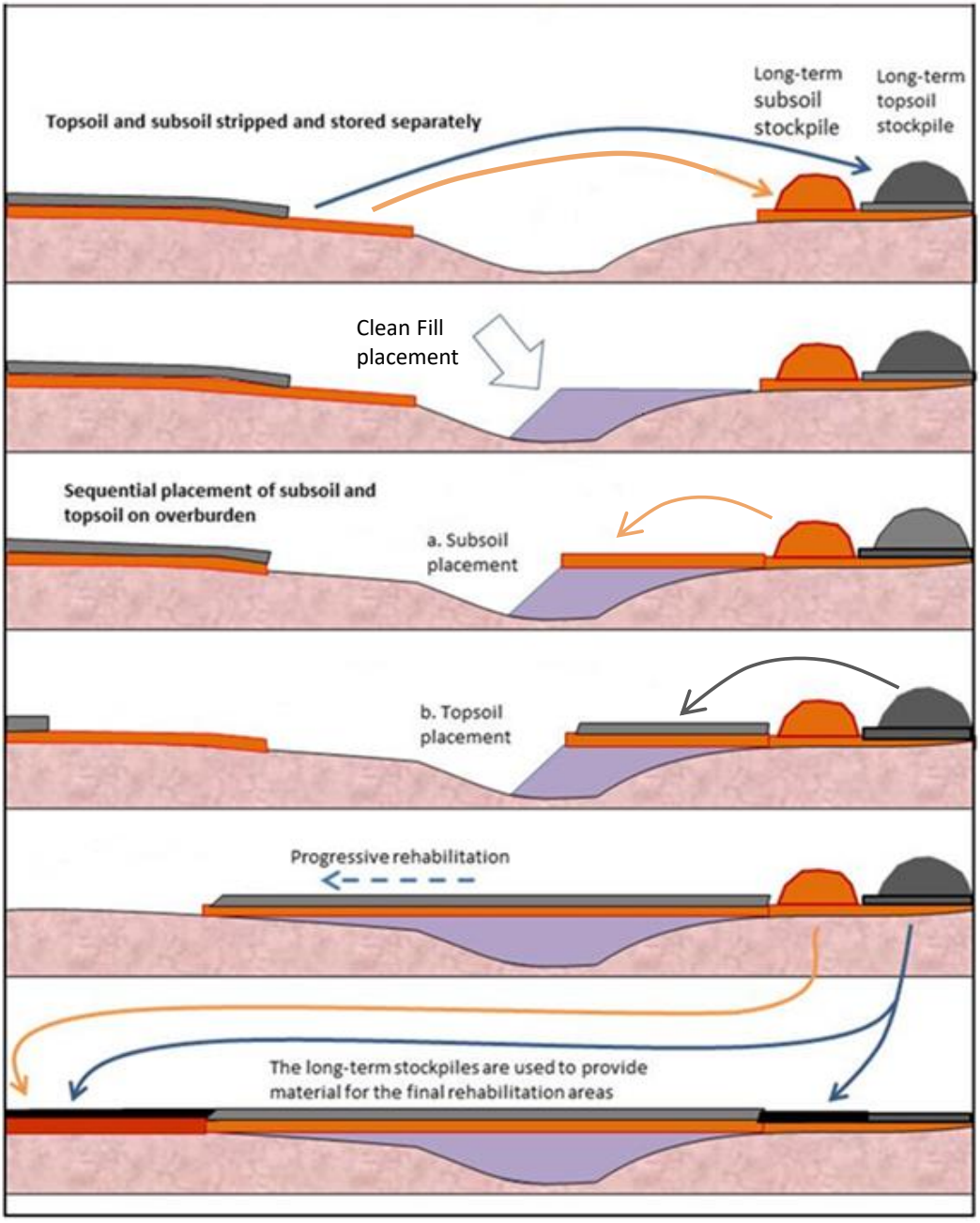

Figure 5. Sequence of topsoil and subsoil removal and replacement on clean fill.

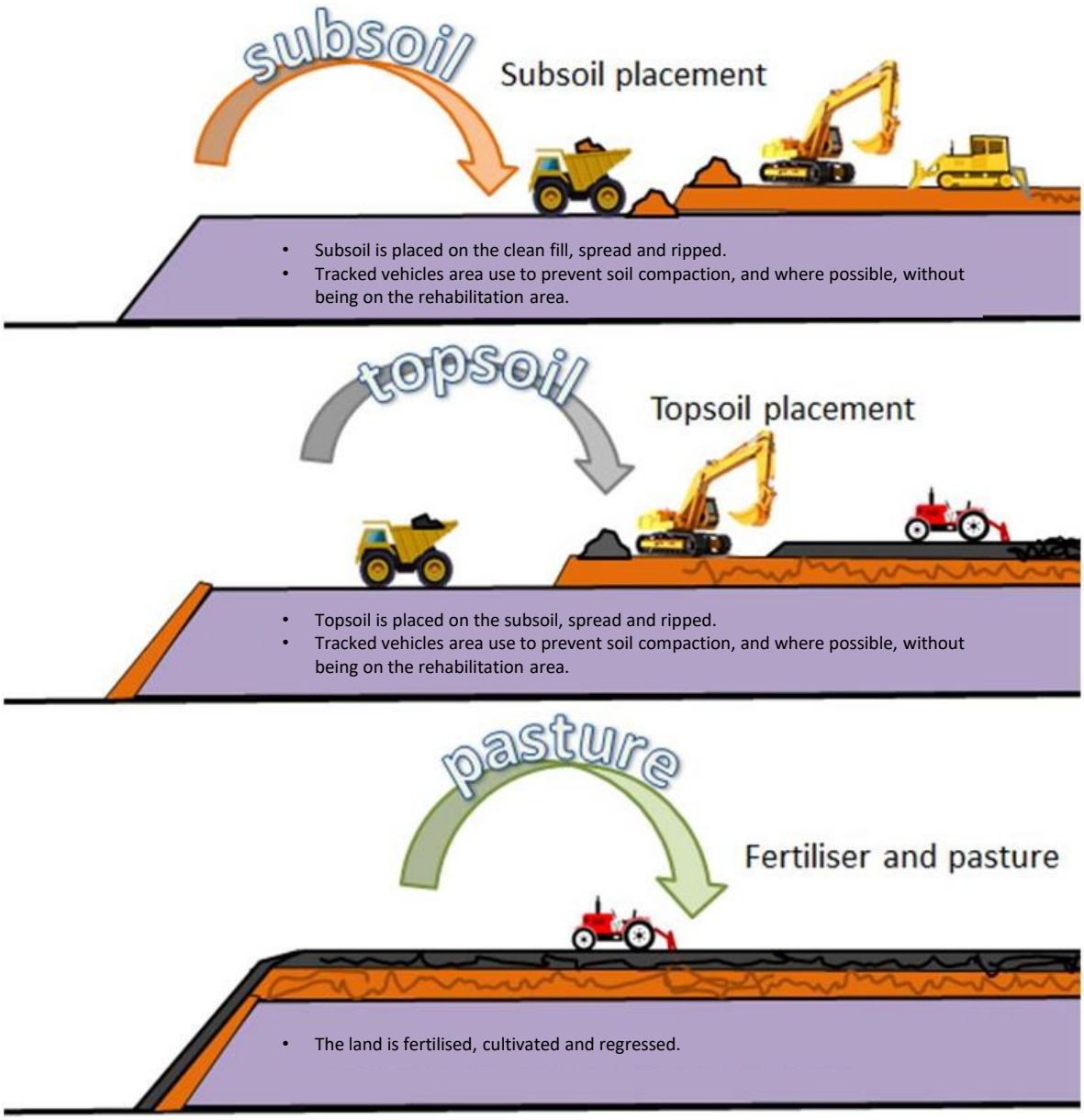

Figure 6. Sequence of soil replacement and preparation.

REHABILITATION AFTER PLACEMENT

INTRODUCTION

The primary purpose of rehabilitation (soil condition 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 the range of potential land uses provided by land with high productive value as defined by the TRMP.
- Minimise exposed areas (bare soil areas) and achieve soil stabilisation as soon as is practical after soil placement

- Mitigate surface depressions resulting from fill and soil settling which show by way of surface ponding.

REVEGETATION AND SOIL STRUCTURE

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 must 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.

LAND USE

To encourage the rapid recovery of the soil structure, stocking rates must 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 are not allowed under any circumstances during the recovery period. The number of grazing animals must be strictly controlled during wet periods, with total withdrawal of stock if the soils are wet (at field capacity[14]), and a management system which promotes grass harvesting (hay and/or silage) over the initial years is to be encouraged. Cultivation must 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 must be made by under-sowing techniques rather than recultivation.

REMEDIATION OF SURFACE DEPRESSIONS

All remediated areas must be assessed annually for up to five years to identify obvious surface depressions.

Remediation of obvious surface depressions, which show by way of surface ponding, must be undertaken annually for up to five years following reinstatement, to allow for full settling of the reinstated fill and soil.

Areas of obviously impeded drainage, which show by way of surface ponding, must 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.

Mitigation of obvious surface depressions must occur by filling depressions with additional topsoil and surface levelling using a laser level or similar, to ensure the surface contour is level and the surface depression removed.

Re-vegetation to pasture must be undertaken as soon as practicable after topsoil placement.

[14] Field capacity is the amount of soil moisture or water content held in soil after excess water has drained away and the rate of downward movement has materially decreased, which usually takes place within 2–3 days after a rain.

MEASURES FOR MINIMISING 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 measures for reducing soil loss to water from the Soil Management Plan are summarised in **Table 2**.

Table 2. Summary of Soil Management Plan measures 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) must be located on the landward side of the stop bank to increase protection from flooding (and soil loss to water).
A centralised storage area must be 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 must not exceed three metres in height and must be kept for as short a period as possible.
No driving of machinery is permitted on the soil stockpiles.
For soil stockpiles stored for greater than one month, the stockpiles must be covered or vegetated with grass to reduce soil loss caused by rain.
Transport
Deep sided trucks (dump trucks) must be used onsite to reduce spill and if possible, the soil should be covered.
Deep sided trucks with covers must be used for the transport soil to the site.
Tracking of soil onto public roads from vehicle wheels must be minimised. Procedures must be in place to check for and remove any soil spill.
Preparation of receiving surface
Light track-driven machinery or flotation tyred machinery must be used to minimise soil compaction.
Cultivation must avoid creating concentrated areas of compaction (e.g. wheel track lines up and down the slope).
Cultivation must minimise the number of passes over the site to avoid soil compaction.
If applicable, cultivation and levelling of the soil surface must be along the contour.
Soil placement
Light track-driven machinery must be used for soil placement to minimise soil compaction.
Post placement management
Revegetation must occur using suitable grass species to develop soil structure.
Nutrients (fertiliser) must be added to increase fertility and promote and maintain even revegetation.
Soil moisture must be managed via irrigation to promote and maintain even revegetation.

In addition to the requirements summarised in **Table 2**, soil removal and placement activities in the Stage 1 area must only occur in summer, and for all of the site (Stages 1, 2 and 3) 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

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 suitably qualified persons for the initial training of relevant staff. The suitably qualified persons must include a soil scientist and an experienced site remediation contractor.

Soil management training for staff must be undertaken as part of the site induction programme. The induction programme must 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 must 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 also required as part of the soil management training:

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 and site remediation contractor. 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 initially provided to the operator by a soil scientist and site remediation contractor. This guidance must 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 site remediation contractor is required.

Assessment must include the following matters, plus any additional matters identified by the soil scientist or site remediation contractor:

- 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) will be recorded for the subsoil, and topsoil.
- Topsoil and subsoil samples for soil analysis.

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 rehabilitated 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

Soil monitoring must be undertaken by a suitably qualified and experienced Soil Scientist.

As a minimum, soil monitoring must include:

- Baseline sampling and analysis.
- Control site sampling and analysis
- Ongoing sampling and analysis of reinstated areas.
- Sampling and analysis of the following:
    - Soil quality properties of the topsoil.
    - Soil profile condition
        - Soil profile description.
        - Visual Soil Assessment of the topsoil.

SOIL PROFILE CONDITION

The objective for the restored soil profile is that there is no serious soil physical limitation to production and water movement in the soil profile, 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.

Monitoring of soil profile condition must include the subsoil and topsoil to ensure there are no visually obvious contrasting compacted layers within the restored soil profile.

Soil profile condition will include a soil profile description of soil morphological characteristics and will be according to Milne et al. 1995[15], including as a minimum: soil horizons and depths, soil boundary shape and distinctness, colour, mottles, soil texture, soil structure, surface stone abundance, gravel abundance, soil consistence, root abundance, the presence of restricting layers, abrupt horizon boundaries, compacted layers, smeared layers, visual evidence of restricted water movement layers, and soil profile drainage class.

Field evaluation of topsoil condition will be carried out using the method outlined in the Visual Soil Assessment Field Guide (2009)[16].

SOIL QUALITY PROPERTIES

The soil quality properties listed in **Table 3** must be monitored

The **Table 3** 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[17]. They provide a research based representation of soil chemical, biological and physical condition (soil quality) and provide comparability with other productive land in the region.

Table 3. Suggested soil properties to monitor.

Term	Definition
Soil 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.

Soil quality sampling and analysis for the topsoil must use methods consistent with the National Environmental Monitoring Standards for Soil Quality and Trace Elements[18].

BASELINE AND CONTROL SITE MONITORING

All sampling locations will be recorded using a handheld GPS.

Baseline and control site sampling and analysis must include the following:

- A soil profile description of the dominant soil for each LUC unit identified in the LandVision report, including as a minimum: soil horizons and depths, soil boundary shape and distinctness, colour, mottles, soil texture, soil structure, surface stone abundance, gravel abundance, soil consistence, root abundance, the presence of restricting layers,

[17] https://www.nems.org.nz/documents/soil-quality-and-trace-element-monitoring/

[18]https://bucketeer-54c224c2-e505-4a32-a387-75720cbeb257.s3.amazonaws.com/public/Documents/Soil-Quality-and-Trace-Elements-v1.0.0.pdf

abrupt horizon boundaries, compacted layers, smeared layers, visual evidence of restricted water movement layers, and soil profile drainage class.

- Soil quality property sampling and analysis for the topsoil using methods consistent with the National Environmental Monitoring Standards for Soil Quality and Trace Elements[19].
- Visual Soil Assessment using the method outlined in the Visual Soil Assessment Field Guide (2009)[20].

POST REINSTATEMENT MONITORING

All sampling locations will be recorded using a handheld GPS.

Post reinstatement sampling and analysis must include the following:

- A soil profile description representative of the soil reinstated area in the past 12 months, including as a minimum: soil horizons and depths, soil boundary shape and distinctness, colour, mottles, soil texture, soil structure, surface stone abundance, gravel abundance, soil consistence, root abundance, the presence of restricting layers, abrupt horizon boundaries, compacted layers, smeared layers, visual evidence of restricted water movement layers, and soil profile drainage class.
- Soil quality property sampling and analysis for the topsoil using methods consistent with the National Environmental Monitoring Standards for Soil Quality and Trace Elements[21].
- Visual Soil Assessment representative of the soil reinstated area in the past 12 months, using the method outlined in the Visual Soil Assessment Field Guide (2009)[22].

REPORTING

A baseline monitoring report including results and interpretation must be completed prior to excavation commencing and must be made available to Tasman District Council on request.

An annual monitoring report including results, interpretation and any mitigation requirements must be completed and made available to Tasman District Council on request.

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[19]https://bucketeer-54c224c2-e505-4a32-a387-75720cbeb257.s3.amazonaws.com/public/Documents/Soil-Quality-and-Trace-Elements-v1.0.0.pdf

[20] Shepherd, T.G. 2009: Visual Soil Assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country. 2nd edition. Horizons Regional Council, Palmerston North. 119p.

[21]https://bucketeer-54c224c2-e505-4a32-a387-75720cbeb257.s3.amazonaws.com/public/Documents/Soil-Quality-and-Trace-Elements-v1.0.0.pdf

[22] Shepherd, T.G. 2009: Visual Soil Assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country. 2nd edition. Horizons Regional Council, Palmerston North. 119p.