In the matter	of the Resource Management Act 1991
And	
In the matter	of an application for Resource Consents by Road Metals Company Limited to extend quarry operations onto adjoining land and operate an aggregate processing activity.

STATEMENT OF EVIDENCE OF VICTOR MTHAMO FOR ROAD METALS COMPANY LIMITED

15 March 2018

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INTRODUCTION

1 My full name is Victor Mkurutsi Mthamo.

2 I am a Principal Consultant for the environmental science, engineering and project management consultancy Reeftide Environmental and Projects Limited (Reeftide). I have been in this role for over 5 years. Prior to this I was a Senior Associate with the surveying, environmental science and engineering, and resource management consulting firm CPG New Zealand Limited (now rebranded to Calibre Consulting Limited), where I was also the South Island Environmental Sciences Manager. I have worked in the area of environmental science and engineering for over 25 years.

3 I have the following qualifications: Bachelor of Agricultural Engineering (Honours) with a major in Soil Science and Water Resources (University of Zimbabwe); Master of Engineering Science in Water Resources (University of Melbourne); Master of Business Administration (University of Zimbabwe). I hold an Advanced Certificate in Overseer Nutrient Management modelling qualification. I am a member of the Institute of Professional Engineers NZ (CMEngNZ) and am a Chartered Professional Engineer (CPEng) and an International Professional Engineer (IntPE). I am a past National Technical Committee Member of (i) Water New Zealand and (ii) New Zealand Land Treatment Collective (NZLTC).

4 I have been involved in the design and implementation of numerous on-farm irrigation schemes, soil investigations, landuse assessments in New Zealand. Prior to this I was involved in irrigation scheme development projects and water resource investigations in most southern African countries and parts of Asia. As a Consultant for the Food and Agricultural Organisation (FAO), I have worked on landuse projects in Papua New Guinea and The Maldives. I was also involved in the preparation of an irrigation design and management manual for FAO. While working as a Senior Consultant for the audit and consulting firm PricewaterhouseCoopers (Harare Office), I was involved in the preparation of feasibility studies for large scale irrigation/landuse projects, conceptual and detailed designs, environmental impact assessments, capacity building, cost-benefit analyses and providing sustainable management expertise to the beneficiary communities. Some of the infrastructure development projects and assessment of environmental effects/environmental impact assessments, I have been involved in in New Zealand include Hunter Downs Irrigation Scheme, North Bank Hydro Project, Mararoa-Waiau Rivers

Irrigation Feasibility Study, North Canterbury Lower Waiau Irrigation Feasibility Assessment.

CODE OF CONDUCT

5 While this is a Council Hearing, I acknowledge that I have read and am familiar with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014, and agree to comply with it. I confirm that this evidence is within my area of expertise, except where I state that this evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions I express in this evidence.

SCOPE OF EVIDENCE

6 In my evidence I have been asked by Road Metals Company Limited (Road Metals) to review the Quarry Rehabilitation Plan required by Standard 17.8.3.14 of the Christchurch District Plan, and whether the rehabilitation proposed in this document would return the land to a 'stable and free-draining landform capable of supporting light pastoral farming or an alternative permitted or consented activity'.

7 In doing so, I have:

7.1 Addressed the type and intensity of productive activities that will be able to be undertaken on the rehabilitated land, taking into account soil depth and quality/versatility, proposed grass cover, landform and depth to groundwater.

7.2 Reviewed the already rehabilitated site at the Yaldhurst Quarry, and provide comment on what type and intensity of land use this rehabilitated land can support.

7.3 Responded to any issues raised in the s42A Officer's Report, including the proposed rehabilitation conditions.

7.4 Commented on concerns expressed by submitters.

8 I have reviewed:

8.1 Various submissions by the affected parties.

8.2 The Rehabilitation Plan prepared by Golder, Report Number RMA/2017/2111.

8.3 The original consent application and the assessment of environmental effects.

8.4 Other publications referenced in various parts of my evidence.

9 I have structured my evidence as follows:

9.1 Executive Summary.

9.2 Outline of the rehabilitation measures proposed in the Rehabilitation Plan.

9.3 Type and intensity of post-rehabilitation productive activities suitable over the proposed site.

9.4 Existing rehabilitation on the adjacent land.

9.5 Responses to submitters.

9.6 Summary and conclusions.

EXECUTIVE SUMMARY

10 The draft suite of conditions proposed in the s42A report has proposed that 350mm of topsoil is spread during rehabilitation, to allow for a minimum compacted depth of 300 mm. I have therefore assessed whether or not the proposed rehabilitation depth of 300 mm can sustain plant growth. The following is a summary of my review and assessment:

10.1 The proposed 300 mm topsoil depth will be equivalent to a Land Class 3 soil. These soils are widely used for sustainable pasture production in Canterbury.

10.2 There are many species of grass that can thrive when grown in the proposed topsoil depth conditions. To enhance the benefits of the different types of grasses, I recommend the planting of one of the several grass mixes (i.e. a mixture of several grasses planted together) on the market to be grown on the rehabilitated site.

10.3 With this soil depth of soils, it is possible to achieve unirrigated Dry Matter yields of 4,000-9,000 kg DM/ha/year with minimal inputs on a sustained basis. These yields would comfortably support stock grazing of smaller animals, for example sheep and goats. This is a good yield when compared to irrigated Dry Matter Yields of 14,000-15,000 kg DM/ha/Year.

10.4 I have also looked at the rehabilitation carried out for a previous stage of the quarry, referred to as “RM1”. The grass is in a healthy state and there is good coverage across the planted areas. This indicates that the rehabilitation strategy (which included a 300 mm topsoil) and the current management of the rehabilitated land are both effective.

11 In my evidence, I also reviewed the submissions by various affected parties. I have offered comments on the concerns relating to groundwater contamination resulting from the reduced distance between the groundwater and the final rehabilitated surface. In summary:

11.1 The activities over these areas post rehabilitation are unlikely to introduce new risk of contamination.

11.2 Landuse over these areas will be limited to rural residential and any intentions to intensify would require various consents under the Canterbury Regional Council Land and Water Plan. The plan has rules around what is and is not permissible e.g. rules around the quantities of fuel and hazardous substances that can be stored.

12 It is my conclusion that the proposed 300 mm topsoil post-quarrying will be able to sustain pasture growth for cut and carry (for hay or silage elsewhere) purposes or for small animal (e.g. sheep) grazing onsite. I understand that this is what these areas have traditionally been used for, and that these uses align with rural residential use.

MEASURES PROPOSED IN THE REHABILITATION PLAN

13 Post-quarrying the applicant will progressively rehabilitate the site as outlined in the Rehabilitation Plan. According to the plan, the rehabilitation will be based on the following principles:

13.1 Development of a free draining landform. This will involve re-spreading and contouring of stored overburden materials, stabilisation of quarry faces and grassing of completed and restored extracting areas to create a free draining and stable landform. The finished floor level will be the original ground level and 4 m below ground level.

13.2 Re-grassing after spreading stored topsoil and subsoil. This will involve replanting with suitable grass species as soon as practicable. If necessary topsoil will be brought in from offsite.

13.3 Ensure any areas where works have been completed are left in a safe and stable condition. This is achieved by contouring of the site to integrate the site into the surrounding depressed landform created through the existing quarry extensions.

13.4 Establish stable grassed areas to a slope of no more than 1v:3h to reduce erosion. Slope stability is important as part of mitigating effects on the stability of adjoining land and susceptibility to subsidence and erosion.

13.5 Control weeds. This will ensure that that planted grass will grow with minimal weeds.

13.6 Monitor and maintain rehabilitated areas to ensure they are functioning appropriately post-closure.

14 On completion of quarrying and rehabilitation activities, the applicant will remove all mobile machinery from the site and secure the site in a manner suitable for its ongoing use.

15 I understand that the target topsoil depth post rehabilitation will be 300 mm.

16 The effect of the final landform is a matter addressed in the landscape evidence – but purely from a rehabilitation aspect, I suggest the floor rehabilitated area would be best kept largely flat to avoid any issues with run-off or potential soil saturation which may affect pasture establishment or growth rates. This also mirrors the largely flat nature of the terrain at present.

TYPE AND INTENSITY OF PRODUCTIVE ACTIVITIES

Sustainable Post Quarrying Rehabilitation

Requirements for Successful Rehabilitation

17 Successful rehabilitation after any quarrying development will depend on a number of factors. These include:

17.1 Reconstruction of the soil profile, including:

17.1.1 Removal and management of the topsoil during excavation of the aggregate.

17.1.2 Soil profile reconstruction to support the desired landuse post-quarrying.

17.2 Species selection.

17.3 Plant establishment including:

17.3.1 Seeding strategies.

17.3.2 Plant management in the early stages.

18 I will now give a brief discussion of the relevance of these factors to Road Metals' proposal.

Soil Properties

19 The soil is the medium that sustains plant growth. Topsoil is the upper most layer that is commonly characterised by dark-coloured, organically-enriched materials. The topsoil is typically 100-300 mm deep. It normally includes the surface layer of plant litter. The majority of plant roots are usually in the topsoil layer. I understand that the current soil depth at the RM4 site is approximately 100 mm. In **Appendix A** I have appended some photographs I took in early March. These show that the soil depth at the RM3 land at the boundary with the RM4 site. The soil depth shown in these photographs is 100-150 mm.

20 Below the topsoil is usually the subsoil. This is less structured than the topsoil. The subsoil contains some plant roots and is the maximum depth of rooting. Deeper soils are generally more favourable for plant growth. For larger crops and trees, deeper soils also provide anchorage.

21 The topsoil is a very important factor in the success of sustainable vegetation establishment or re-vegetation. The topsoil's biological, chemical and physical characteristics determine the soil fertility.

22 The key chemical properties are pH, electrical conductivity, phosphorus and exchangeable sodium percentage (ESP). Physical properties include permeability, water holding capacity, soil density and drainage characteristics. Soil profile characteristics such as soil

structure, soil texture, stoniness, soil depth, depth to rock, observed root depth, colour and mottling provide an indication of the soil fertility and usefulness for plant growth.

23 The soil properties I have highlighted in Paragraph 22 are all very important to the successful growth of vegetation. Below I discuss some of the important aspects of these properties:

23.1 The chemical and physical properties of the soils are closely related to the soil texture.

23.2 Soil bulk density describes the degree of compaction of a soil. For example, values for sandy soils are 1.4-1.6 g/cm^3. Compacted soils have values in the order of 1.7-2.2 g/cm^3. Vehicular traffic can result in bulk densities >2 g/cm^3. High bulk densities limit root growth. Consequently, for good plant growth it is important to maintain bulk density at low levels (1.1-1.5 g/cm^3).

23.3 Available soil water storage is a measure of water that crops can extract from the soil and is directly related to the soil texture. Use of silty loamy soils as proposed (Paragraph 25) means that the soil what holding capacity will be considerably higher (twice that of sandy soils) and will ensure readily available water for plant abstraction as these do not dry out as fast as the coarser textured soils do.

24 Usually only one to three of the soil physical and chemical factors will limit plant growth. Thus, while there is a temptation to consider the 300 mm soil depth as the limiting factor for this rehabilitation it is important to recognise that other factors such as water holding capacity and soil fertility may take precedence. What this means is that deeper soils that are limited by other soil characteristics might be less conducive to grass growth than shallower soils where the other soil characteristics are favourable.

25 The Environment Canterbury GIS (ECan GIS) system provides information on the soil type over the proposed quarry area. The ECan GIS shows the dominant soil type to be the Waimakariri deep silty loam. These soils are well drained and moderately deep (45-100 cm) with a silty texture. There is no data on current soil chemical and physical properties.

26 In **Attachment A** I have appended a typical soil profile of a Waimakariri deep silty loam soil. The plant roots are generally within the top 300 mm and the organic matter only extends as far as 400 mm below the ground level. I have also included photographs

taken at the quarry during the site visit. These show the existing soil profile and the topsoil depth.

27 As I noted in Paragraph 15, the applicant is proposing to add 350mm of topsoil, which will provide a compacted depth of 300 mm. The soil that will be used for the rehabilitation will be taken from the topsoil stockpiled at the start of the quarrying, with additional topsoil to be imported to the site should this be required.

28 Use of the stockpiled soil for rehabilitation would be similar to reconstructing the topsoil pre-quarrying. If the stored soil is reused for rehabilitation, I would recommend that the work be carried out when the soil materials are friable. Wet or damp soils are easily compacted and will be much less able to grow plants than if they were handled when friable (Paragraph 23.2).

29 Thorough site preparation will be important to ensure that the soil will support the plantings. For example, if the soil gets compacted during placement this can be addressed by ripping the soil to break the pans and ensure good root aeration, water movement through the soil etc.

30 Landcare Research provides the broadest grouping of the land capability classifications called Landuse Classes[1] (LUC). The LUC provides an assessment of the land's capability for use while taking into account its physical limitations. There are 8 LUC Classes. The proposed 300 mm topsoil rehabilitation falls under LUC Class 3. Figure 1 below summarises LUC Class 3 properties:

3.2.3 *LUC Class 3*

Class 3 land has moderate physical limitations to arable use. These limitations restrict the choice of crops and the intensity of cultivation, and/or make special soil conservation practices necessary. Class 3 land is suitable for cultivated crops, vineyards and berry fields, pasture, tree crops or production forestry. The most common limitations that may occur include:

- Moderate susceptibility to erosion under cultivation.
- Rolling slopes (8-15°).
- Shallow (20-45 cm) or stony soils.
- Wetness or waterlogging after drainage.
- Occasional damaging overflow.
- Low moisture holding capacity.
- Moderate structural impediments to cultivation.
- Low natural fertility.
- Weak salinity.
- Moderate climatic limitations.

Figure 1 – Landuse Classification Class 3 Properties

31 Based on the LU Classes presented in Figure 1, it is clear that the proposed rehabilitation produces a soil profile that is not uncommon in Canterbury and in New Zealand in terms of

[1] https://www.landcareresearch.co.nz/__data/assets/pdf_file/0017/50048/luc_handbook.pdf

the soil depth. An advantage that the proposed rehabilitation has over the soils that are in the LUC Class 3 is that slopes will only be on the sides of the rehabilitated quarry and most of the areas will be flat as shown in **Attachment B** (examples of rehabilitated land) unlike the LUC Class 3 soils which are found on rolling slopes. Thus, while the depth of the soils on rehabilitated land is similar to that of LUC Class 3 soils, the rehabilitated land will not have the same limitations to plant growth as the LUC Class 3 (refer to Figure 1 above). Thus, I would expect productivity over the rehabilitated areas to be higher the LUC Class 3.

32 The soil fertility over the rehabilitated land can be enhanced by the use of organic and inorganic fertilisers. Inorganic fertiliser application rates need to be carefully management as these are more leachable than the organic fertilisers. If inorganic fertilisers are applied in accordance with Good Farm Management Practice they should not cause any adverse effects or groundwater contamination. Given Road Metals plan to employ a farming contractor to sow the pasture, I would regard the sowing of pasture with fertilizer to be a standard practice, which would aid pasture establishment. After that point, it is generally the case that rural lifestyle blocks, do not use heavy fertilizer application rates, as the land is not the primary form of income of these small blocks. This has been the case from my observations of the current farming practices on the land. I am also aware that Ecan rules (relating to the discharge of nutrients to land), will also govern future farming practices on this land.

33 I should also note that revegetation can improve soil plant growth conditions through extensive root systems development, increased soil organic matter, lower bulk density and moderate soil pH, thereby improving soil nutrient availability. Thus, over time I would expect the topsoil used for rehabilitation to continue to improve.

34 Before I provide further comments on whether or not the 300 mm will be able to sustain plant growth, it is important to give a brief discussion on the proposed plantings. Thus, in the next section I discuss the plant selection, taking into account the soil rooting depth and soil physical and chemical properties that I have outlined in the preceding sections (Paragraphs 23.1-23.3).

Plant Selection

35 Fundamental to successful rehabilitation is the selection of suitable plant species to be used on the site. The species selection must reflect the future use(s) of the site and its

goals. For example, if the site is to be rehabilitated for livestock grazing, then the species selected should be useful as a forage crop.

36 The consent application proposes to regrass the rehabilitated areas by replanting with suitable grass species as soon possible (Paragraph 13.2).

37 The applicant's choice for planting grass is based on the following considerations:

37.1 The proposed topsoil depth of 300 mm precludes other plant species that require deep soils for optimal root growth.

37.2 Perennial grasses have unimpeded rooting depths that range from 300-800[2] mm with most of the roots within the top 300 mm.

37.3 Several studies[3,4] have reported a depth of between 300-800 mm for soil water extraction by perennial ryegrass root system. Around 80% of the root mass was found to be in the top 150 mm of the soil. **Attachment C** shows the root distribution with depth for a variety of plants.

37.4 Crush et al (2002)[5] have investigated inherited differences in root depth distribution in perennial ryegrass and tall fescue. They demonstrated that depending on crop management re-sown pastures and ryegrass roots were predominately found in the top 50 mm of soil, with no roots below 200 mm. Another study found that the penetration resistance of a soil can determine variations in root development and the study concluded that increased penetration resistance in compacted soil can reduce the downward growth of roots (Crush & Thom, 2011; Becel *et al.*, 2012).

37.5 Perennial ryegrass and white clover pastures have been extremely successful as a production base in pastoral agriculture in NZ. Both species have shallow roots, which make them ideal for shallower soils (Holmes et al. 2002)[6] and this also reflects their tolerance of a wide range of environments and managements.

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[2] Source: NZS 5103 :1973) / pg G39 Lincoln Technical Manual
Brock, J.L. (1983). Grassland Roa tall fescue: a review. Proceedings of the New Zealand Grassland Association 44, 74-80.
Broughman, R.W. (1957). Pasture growth rate studies in relation to grazing management. Proceedings of the New Zealand Society of Animal Production 17, 46-55.
Garwood, E.A & Sinclair, J. (1979). Use of water by six grass species. 2. Root distribution and use of soil water. Journal of Agricultural Science, Cambridge 93, 25-35.
Garwood, E.A & Sinclair, J. (1979). Use of water by six grass species. 1. Dry matter yields and responses to irrigation. Journal of Agricultural Science, Cambridge 93, 25-35.
[4] Crush, J. R., Ouyang, L., Eerens, J. P. J., & Stewart, A. V. (2002). The growth of roots of perennial, Italian, hybrid and annual ryegrasses through a high-strength root medium. Grass and Forage Science, 57(4), 322-328. doi:10.1046/j.1365-2494.2002.00332.
Crush, J. R., & Thom, E. R. (2011). The effects of soil compaction on root penetration, pasture growth and persistence. Grasslands Research and Practice Series, 15, 73-78.
[6] Holmes, C.W.; Brookes, I.M.; Garrick, D.J.; MacKenzie, D.D.S.; Parkinson, T.J.; Wilson, G.F. 2002. Milk production from pasture, principles and practices. Massey University.

37.6 Grasses are the current plant found on the site, and are consistent with the rural character of the area, and of the dryland pasture found in wider rural Canterbury. This will help it blend in with the neighbouring properties. I have provided visuals of previously rehabilitated stages in **Attachment B**.

37.7 Grasses will provide full cover in a short time.

37.8 Fescues have the advantage in that they are suited to poorer quality soil, and require less energy input than other grasses do.

37.9 Grasses mixed with clover will fix nitrogen to the soil, which will help to improve soil fertility and reduce the need for nitrogenous fertilisers.

37.10 Timing of planting – grasses can be planted at any time of the year unlike some plant species that can only be propagated at certain times of the year.

38 As can be seen from my comments in Paragraph 37 various grasses provide different benefits. To enhance the benefits of the different types of grasses, I recommend the planting of one of the several grass mixes (i.e. a mixture of several grasses planted together) on the market to be grown on the rehabilitated site. Such grass mixes will produce many of the benefits I have outlined in Paragraph 37 above.

39 The planting should be done as soon as possible after topsoil is spread to minimise risk of erosion and to quickly supress weed seeds.

Management Requirements to Support the Selected Species

40 From the preceding paragraphs, it is proposed to plant a mixture of grasses. In this section I will highlight the conditions necessary for the grass to be grown sustainably.

41 There are a number of strategies that are available to Road Metals, following normal farming best practice, to ensure successful and sustainable pasture growth over a topsoil layer of 300 mm. I note that Road Metals contracts out the seeding to a farming contractor with extensive experience in crop and pasture establishment. The good practice measures that would be used include:

41.1 Selecting the best time for seeding depending on the type of seeds selected e.g. when soil moisture is high and the weather is cooler. However, this is not a limiting factor as I have noted in Paragraph 37, grasses can be grown at any time of the year.

41.2 Ensuring that the selected seeding method for the site e.g. direct drilling, broadcasting (e.g. hydroseeding) is carried out effectively i.e. ensuring the seed is applied evenly across the planting area.

41.3 Applying the supplier's recommended seeding rate for the earliest establishment possible.

41.4 Maintaining and monitoring the progress of the plants and reseeding if necessary i.e. if the germination rate is not satisfactory.

EXISTING REHABILTATION ON THE ADJACENT LAND

42 As I noted in Paragraph 7, I have been asked by Road Metals to comment on the rehabilitation that has been undertaken on previous quarrying stages.

43 As discussed in the preceding paragraphs, I expect grass to be able to grow over the proposed topsoil layer albeit with good management as recommended by the seed supplier and general farming practices.

44 The previously rehabilitated land seems to confirm the conclusions I have drawn (Paragraph 43) regarding sustainably growing grass over the proposed topsoil. **Attachment B** includes Figures B1 and B2 which show good grass growth over rehabilitated areas. The grass cover looks good and the grass is in a healthy state. It looks no different from the grass on areas that have not been quarried.

45 I have also appended Figure B3 in **Attachment B**. This shows the newly rehabilitated areas that I sighted when I visited the quarry in early March 2018. The picture demonstrates good practices in terms of rehabilitation and management of the surface post topsoiling.

RESPONSES TO SUBMITTERS

46 I have also been asked to comment on specific issues that have been raised by various submitters. Below I address these specific issues.

47 **Ross & Julianne Blanks**

48 As part their submission Mr & Mrs Blanks wrote "*In fact proposing to rehab the ground with less groundwater cover leaves the environment degraded because less shingles, less depth to water table*"

49 The consent application addressed potential effects on the groundwater arising from the proposed excavation and backfilling. The application provided the following assessment:

49.1 "*The excavation and backfilling will not intercept groundwater as a buffer of at least 1 m above the highest recorded groundwater level from the base of the quarry and thus from where backfill activities will occur.*

50 I understand that Mr Eric Van Nieuwkerk will address groundwater issues in his evidence, but I offer comment here from a rehabilitation perspective. I note that post rehabilitation the land will be used for rural urban fringe purposes.

51 Chemical contamination of groundwater can only occur if liquids are spilled on the ground, or if solids that are disposed of on the property are leached by surface or groundwater flows. A variety of rules in the Canterbury Land and Water Plan govern the use and storage of potential contaminants such as fuels, lubricants and fertilisers. Compliance with these rules will prevent adverse impacts to groundwater and surface quality from occurring.

52 I would say the highest risk rural activity would be dairying which is well known for its potential adverse effects on groundwater due to nitrate leaching. Dairying will not be a feasible landuse option on this land for the following reasons:

52.1 The stock carrying capacity will be very low based on the soil pasture yield. Based on experience in other places in Canterbury and my knowledge of the Overseer software I would accept the estimates by Cichita et al (2014)[7] that the Dry Matter yield (DM) will be in the order of 4,000-9,000 kg DM/ha/yr under dryland conditions in these soils. This is a good yield when compared to irrigated Dry Matter Yields of 14,000-15,000 kg DM/ha/Year.

[7] *Cichota, R., Vogeler, I., Li F.Y., Beautrais J. 2014. Deriving pasture growth patterns for Land Use Capability Classes in different regions of New Zealand. Proceedings of the New Zealand Grassland Association 76: 203-210*

52.2 If the carrying capacity is 600 kg DM per year per stock unit then the carrying capacity would be 6-15 stock units/ha or a maximum of 2 dairy cows/ha. The only time the rate would be increased was if supplementary feed was provided. As far as I am aware the applicant is not proposing dairying.

52.3 The total land area is small and dairying would make dairy economically unfeasible. It is highly unlikely that any person would adopt this farming practice in this area, even if this were permitted.

52.4 It is also unlikely that dairying would comply with the Land and Water Plan rules given the quarrying and rehabilitation proposed.

53 I envisage the most likely land use will be as lifestyle blocks. These are typically accompanied by small animal (e.g. sheep, goats and pigs) rearing and possibly horticultural activities via glasshouses etc. Again, from my experience and knowledge of farming systems in the area, these activities will not have the kind of adverse effects on groundwater that Mr & Mrs Blanks are concerned about.

54 **Derek & Jessica Vallance**

55 Mr & Mrs Vallance's highlighted concerns over water and water table height. The submission reads "*There are major concerns regarding pollution to the water table (we all use well water in this area so pollution of the water table is a great concern). If the water gets polluted it is unfixable i.e. the water table would be permanently polluted and the consequences would last for many many years*"

56 My comments in Paragraphs 48-53 also relate to Mr & Mrs Vallance's submission.

57 Alison Merchant & Martin Toan

58 Ms Merchant & Mr Toan expressed concerns regarding groundwater contamination. My comments in Paragraphs 48-53 also relate to this submission.

59 **Craig James & Annell Judith McDonagh**

60 Mr & Mrs McDonagh expressed concerns regarding aquifers, groundwater contamination and wells. My comments in Paragraphs 48-53 also relate to Mr & Mrs McDonagh's submission.

COMMENTS ON THE CHRISTCHURCH CITY COUNCIL S42A REPORT

61 I have reviewed officer s42A report. The following are my comments.

62 Paragraph 152 of the officer's report states that "*I note that the procedure does not specify the minimum depth of topsoil which Ms Dray considers should be 350mm for a minimum compacted or settled depth of 300mm*".

63 I agreed with the Officer's comments in Paragraph 153 that the land can be used for sheep grazing (refer to my Paragraph 53) and that it will not be suitable for dairying as I noted in Paragraphs 52.1- 52.4.

64 I also agree with the Officer's comments in Paragraph 154 of their report. As I have outlined in the preceding sections of my statement of evidence, a minimum topsoil depth of 300 mm will be able to sustain pasture growth at levels sufficiently economical for small animal rearing (Paragraph 53).

65 I have reviewed the proposed conditions of consent relating to rehabilitation. As noted above I generally agree with the officer.

SUMMARY AND CONCLUSIONS

66 I have assessed whether or not the proposed rehabilitation depth of 300 mm can sustain plant growth. The following is a summary of my review and assessment:

66.1 The proposed 300 mm topsoil depth will be equivalent to a Land Class 3 which used widely for pasture production in Canterbury and around New Zealand.

66.2 To enhance the benefits of the different types of grasses, I recommend the planting of one of the several grass mixes (i.e. a mixture of several grasses planted together) on the market to be grown on the rehabilitated site.

66.3 It is possible to achieve Dry Matter yields of 4,000-9,000 kg DM/ha/year under dryland conditions and with minimal inputs on a sustained basis. These are good yields compared to approximately 16,000 kg DM/ha/year under irrigation.

67 I have also looked at the rehabilitation on the previous stage. The grass is in a healthy state and there is good coverage across the planted areas.

68 In my evidence, I also reviewed the submissions by various affected parties. I have offered comments on the concerns relating to groundwater contamination resulting from the reduced distance between the groundwater and the final rehabilitated surface. In summary:

68.1 The activities over these areas post rehabilitation are unlikely to introduce new risk of contamination.

68.2 Landuse over these areas will be limited to rural residential and any intentions to intensify would require various consents under the Canterbury Regional Council Land and Water Plan. The plan has rules around what is and is not permissible e.g. rules around the quantities of fuel and hazardous substances that can be stored.

69 It is my conclusion that the proposed 300 mm topsoil post-quarrying will be able to sustain pasture grown which can be used for small animal (e.g. sheep) grazing.

____

Victor Mthamo
Environmental Consultant

15 March 2018

ATTACHMENT A - WAIMAKARIRI SOIL PROFILE

Figure A1 – Typical Waimakariri Soil Profile

Figure A2 – Photograph of the Existing Topsoil at the Boundary between RM3 and RM4 (Taken during a site visit in early March 2018)

Figure A3 – Photograph of the Existing Topsoil at the Boundary between RM3 and RM4 (Taken During a site visit in early March 2018)

ATTACHMENT B - EXAMPLES OF REHABILATED AREAS

Figure B1 - View of the Partially Rehabilitated RM2 Quarry Extension (Taken during a site visit in early March 2018)

Figure B2 - Existing Rehabilitated Road Metals Site (Taken during a site visit in early March 2018)

Figure B3 – Newly Rehabilitated RM3 Land (Taken during a site visit in early March 2018)

ATTACHMENT C - PLANT ROOTING PROFILE

(Extracted from "M.B. DODD, J.R. CRUSH, A.D. MACKAY and D.J. BARKER (2011)- "The "root" to more soil carbon under pastures")

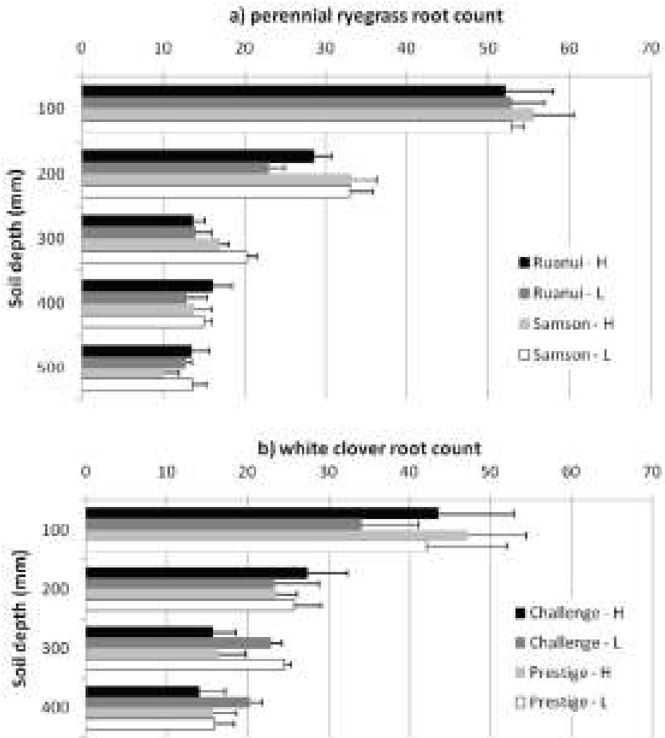

Figure C1 - Root counts (per 100 mm of horizontal minirhizotron tube length) of a) two perennial ryegrass cultivars at five soil depths and b) two white clover cultivars at four soil depths, grown in constructed soil profiles at high (H) and low (L) P fertility. Bars represent SEM **(**)

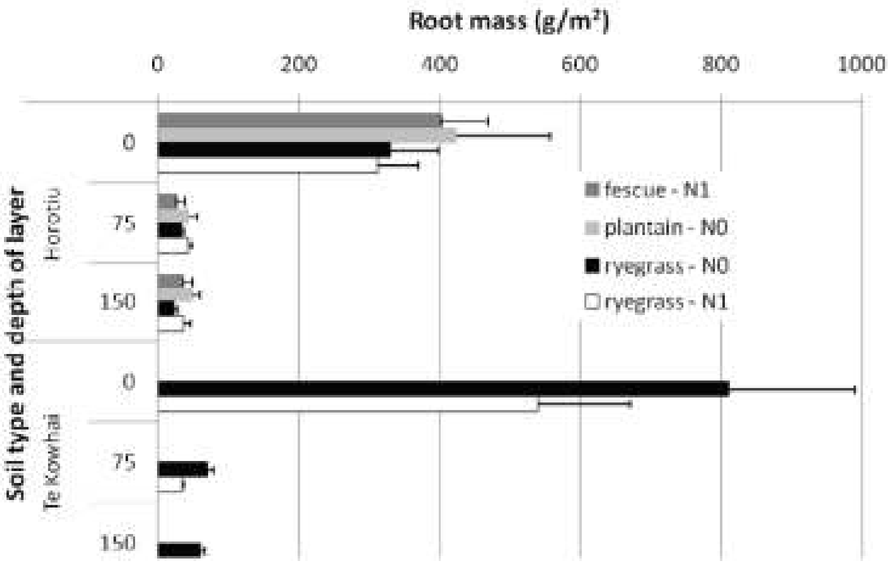

Figure C2 - Root mass (g DM m-2) in three soil layers from tall fescue-white clover (with N fertiliser), plantain (without N fertiliser) and perennial ryegrass-white clover (with and without N fertiliser) paddocks on two different soil types at Scott farm, Hamilton. Bars represent SED.