

Monday 14 September 2026

RFI 11 Question 11 Ecology measures of success for rehabilitation of cushionfields and spring annuals: High level feed back to CODC from Mr Mike Harding and Statement of Dr Geoffrey Rogers on Behalf of Sustainable Tarras 7 September 2026

Mr Harding and Mr Rogers raised a number of concerns relating to 2026 survey extent, likelihood of finding additional populations and changes to the success criteria which are collectively addressed below. The proposed criteria focus on increasing the number and extent of spring annual sub-populations within areas managed by MGL, developing propagation methods for *Ceratocephala pungens*, and increasing the area and condition of cushionfield communities through rehabilitation and ecological management.

1. Spring annuals

The proposed success criteria were developed based on outcomes from 2024 and 2025 spring annual surveys, and the extent of the contracted 2026 spring annual survey scheduled for later September/October (depending on emergence times). The 2025 and 2026 surveys will be comparable, as the same methods are used and many of the same areas will be resurveyed, including all those within the DDF (confirmed by Matakanui). The 2026 survey will include areas of the DDF unable to be surveyed in 2025 due to lambing – this means all probable spring annual habitats within the DDF will have been surveyed by a team including spring annual specialists at a time of year when these plants are present. The 2026 spring annual survey team includes 2 specialists from the 2024 and 2025 surveys supported by suitably qualified botanists/ecologists.

With regard to changing the Success measure: 'net increase in number of subpopulations' (replacing a 50% increase) the proposed change is based on the following factors.

- Large numbers of sub populations and plants identified inside and outside DDF in the 2025 spring annual survey. Many more plants and populations were found than in the 2024 survey (which was done at the end of the growing season).
- High probability that significant additional sub-populations and plants are present across the wider landscape in suitable habitat. The high probability is based on 2024 and 2025 survey results and habitat assessment of surveyed areas. Dr Rogers proposed some survey areas based on his expectation such populations may be present.

The initial success criteria, as documented in the Cushionfield Applied Research Plan (ARP), prepared prior to the 2025 spring annual survey, were developed based on the understanding of population sizes and areal extent at that time. The large numbers found in the 2025 survey within the DDF greatly increased the numbers needing to be identified or established outside DDF to enable mining of the CIT pit. The increased numbers and extent of habitat outside the DDF also increases their resilience, i.e. providing increased certainty that viable populations of these species exist and are maintained despite the proposed mining, and despite surveys potentially resulting in a higher proportion of these plants within the DDF. This is because there are many more plants

(thousands to 10s of thousands) in many more populations both inside and outside the pit than known before the 2025 survey. Success criteria were therefore adjusted based on this increased knowledge.

Techniques for propagation of spring annuals will still be developed as outlined in the Cushionfield ARP, and rate of potential progress and success enhanced by certainty of access to large numbers of plants and seed, which was not known at the time the Cushionfield ARP was written. The understanding of these species' biology has and will occur concurrently with spring annual surveys and will continue alongside habitat interventions – these do not need to occur sequentially as suggested by Dr Rogers (para 21). Detail of interventions will be developed when the Cushionfield ARP is activated and will incorporate additional information and observations gained from the spring 2026 survey.

I note the 'net increase in number of subpopulations' condition means that *Ceracephala pungens* plants are likely to need to be established in the ESA unless extremely large numbers are found in future surveys. The nursery specification is included to complement on-site propagation techniques. I therefore propose no change to condition C124 in D.03.

I also note that in sites where larger numbers of *C. pungens* have been monitored over years, some plants have emerged in nearly all years, while the number of plants in any one year fluctuates. The spring 2025 survey identified larger numbers and more subpopulations of *C. pungens*, providing confidence that statistically robust trials to enhance plant establishment and to expand subpopulations can be done every year for the duration of the Cushionfield ARP despite variability in numbers of plants emerging at individual sites (i.e. I do not agree with para 22 and 23 of Dr Rogers' statement).

I confirm the number of 200 nursery-raised *C. pungens* plants reaching maturity over two successive seasons as a suitable condition. This is a conservative number that I consider adequate to confirm successful propagation methods have been developed. While acknowledging the number is not related to seed quantities used, I do not consider specifying a minimum success rate to be practical or feasible given the lack of knowledge of propagation to date.

I also confirm my recommendation to delete the criterion requiring establishment of spring annuals on DDF. This should remain optional. I further note that '500 ha of engineered bare pavement' (para 27 Dr Rogers) is not what is proposed, and that description is completely inconsistent with the LERMP and Mine Closure Plan.

Dr Rogers considers *Daucus glochidiatus* and *Myosotis glauca* should be included in the definition of spring annuals (Condition C4) and the spring annuals success criteria (c) in Condition C124. *D. glochidiatus* has not been found in the DDF. The surveys by Matakanui have recorded one observation of this species on Ardgour Station. This large herb (30 to 80 cm height) is associated with cushionfield but noted as readily confused with non-native carrot species (especially in harsh environments). Given the single record outside the DDF I suggest focus is maintained on the spring annuals listed in the current condition, and that this species is not added.

With respect to *M. glauca*, Dr Rogers has raised his doubts around the identity of the non-*Myosotis brevis* taxa, and that it is possible *M. glauca* is present within the DDF, missed in the surveys and/or been misidentified as the much less threatened *M. antarctica* subsp. *antarctica*.

This topic is addressed by Z. Milner in his S53 response evidence of 17 April 2026, who provides detail on the 2023-2024 survey and concludes 'it is likely that *Myosotis glauca* is absent or present only at very low density'. During the 2025 survey there was considerable discussion about *Myosotis* species identification, and specifically *M. glauca*. Photos and specimens of the surveyed native *Myosotis* were taken and confirmed not to be *M. glauca*. However, it remains possible that *M. glauca* is present within the DDF. I therefore recommend an addition to C124 as follows.

That a spring annual herb survey collects at least 25 geo-referenced individuals considered to be *M. antarctica* from within DDF and sends these to the Allan Herbarium¹, Lincoln, New Zealand. If *M. glauca* plants are confirmed within the DDF or MRZ, those georeferenced plants (up to a maximum of 25 individuals) are also sent to the Allan Herbarium to assist resolution of species identification and seed is collected.

The rationale for this condition is that it would contribute to resolving the taxonomy which will be useful for the rehabilitation of *M. antarctica*. Marking of sites to enable relocation of plants is facilitated by plant being recorded as perennial (NZ Plant Conservation Network).

2. Cushionfields

The success criteria for cushionfield are separated into mined areas (which are within the DDF) and managed areas (including Mine Regeneration Zones and Ardour Restoration Area²). The first success measure for mined areas is establishment of a minimum 19 ha of cushionfield (Condition C125 in D.03). This is based on the area proposed to be removed. The 19 ha is conservative because that mapping included cushionfields with depleted grasslands. *Raoulia* is the defining native species in cushionfield. The second success measure therefore requires a minimum *Raoulia* cover to be established in mined areas (Condition C125(a)(ii) in D.03). The covers proposed are based on analysis of 2 by 2 m plots that contain *Raoulia*. I consider the focus on *Raoulia* component of cushionfields is sensible and pragmatic. *Raoulia* are both the dominant native species of cushionfield by area and define it visually along with a high proportion of bare ground or rock. Two of the three *Raoulia* species present also have potential to be identified using drone imagery which could allow characterisation across areas outside plots (using reference plot data). The LERMP and conditions also require a specific additional cushionfield species to be established in rehabilitated areas to achieve closure³. It is not therefore impossible, and is not proposed to rehabilitate 'homogeneous, monospecific cushionfield removed from its wider community content' (para33 G Rogers).

The LERMP describes the core rehabilitation locations and topography for cushionfields on mined areas (Western ELF, Shepherds and Come in Time), describes slopes and aspects and notes the importance of rock cover with the Western ELF. The CIT pit, if mined, is specifically required to

¹ The Allan Herbarium proposed based on their taxonomists' work on these species, e.g., Prebble et al 2022 'Taxonomic revision of the southern hemisphere pygmy forget-me-not group (*Myosotis*; Boraginaceae) based on morphological, population genetic and climate-edaphic niche modelling data'.

² RFI 11 Question 10 Response – Measures of success for rehabilitation of cushionfields and spring annuals, Bioeconomy Science Institute, June 26.

³ For example, D.03 Schedule One – Common Conditions C52 'The Consent Holder must establish the Nationally or Regionally At-Risk and Threatened plant species in the DDF and / or MRZ Management Units in accordance with the rehabilitation management approach provided in Attachment 3 of these conditions (specified in Appendix E.7 of the LERMP)'

have topography mimicking stable features of the original topography⁴. This detail has been overlooked by G Rogers para 34 comment on topographic relief.

The managed areas also have two success criteria. The first is aerial extent. This is based on ESA-wide mapping (not changes in area within permanent plots as indicated by Mr Harding). The initial vegetation mapping of the broader landscape combined cushionfields with depleted grasslands. The first step of the Cushionfield ARP is therefore to separately map the cushionfields to define their extent. I do not consider this needs to occur before success measures or consent conditions are finalised (i.e. I disagree with Mr Harding).

The second success criterion for managed areas is achievement of minimum cushionfield condition scores, which is proposed to be based on the permanent plots that are located within cushionfields. This substantive work is proposed to occur post consenting. I disagree with Mr Harding that the cushionfield condition score should be developed in advance of consenting. As with other actions in the Cushionfield ARP, results of the cushionfield survey and the condition score will be peer reviewed to ensure appropriateness and are expected to have value for assessment of cushionfields beyond this project (D.03 Schedule One – Common conditions to the CODC and ORC Resource Consents Condition C125).

The expansion of Raoulia area and condition in managed areas is most likely to occur at the expense of non-native species and of bare ground. This is expected because Raoulia occurs primarily in a mosaic with degraded non-native grasslands (pasture) and where cushionfields have a low cover of Raoulia, the vegetated cover is most often dominated by non-native herbs and grasses. The expansion of cushionfield area and of Raoulia is therefore unlikely to adversely impact other native species found in cushionfield as Rogers postulates (G Rogers para 43).

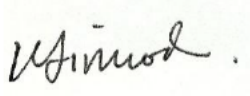
Summary

I consider the following summary extracted from one of the Santana Minerals Ltd responses to RFI 11 in August 2026 captures my views concisely. I have added a new point 2 (*italicised*):

- suitable and measurable success criteria can be established for both spring annuals and cushionfields;
- *it is appropriate to map the extent of cushionfields and develop a cushionfield condition score as part of the Cushionfield ARP (as proposed) and not in advance of consenting;*
- progress towards those outcomes can be assessed through monitoring, review and adaptive management processes;
- the growing understanding of spring annual distribution, habitat requirements and propagation opportunities provides an increasingly robust basis for management and rehabilitation efforts; the proposed survey, research and management programme will continue to improve understanding of spring annual ecology and inform future conservation actions.

⁴ D.03 Schedule One – Common Conditions C44 Objectives for Mine Components part e(i) To backfill the CIT Open Pit to resemble the pre-mining landforms to the extent possible and support the permanent reestablishment of native vegetation mosaic that includes native spring annual herbs and cushionfields (through the implementation of the Applied Research Plan for the Conservation, Management, Rehabilitation and Expansion of Cushionfield (“Cushionfield ARP”))

I note that the Cushionfield ARP and associated success criteria will be overseen by the Central Otago Regional Council and Otago Regional Council as part of the ARP and compliance reporting requirements with further input from the Peer Review Panel.



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Daucus glochidiatus

Daucus glochidiatus has not been found in the DDF. The surveys by Matakanui have recorded one observation of this species on Ardour Station. This large herb (30 to 80 cm height) is associated with cushionfield but noted as readily confused with non-native carrot species (especially in harsh environments). Give just one record outside the DDF, I suggest focus is maintained on the spring annuals listed in the current condition, and that this species is not added.

Instead I suggest a condition that if *Daucus glochidiatus* is recorded in Ardour or MRZ, the location is marked and seed is collected to be made available to DOC (the seed heads being bagged post flowering). An alternative or addition being Matakanui growing some plants in the nursery (shows viability of the collected seed). NZPCN notes it is easily propagated. Despite Threatened – Regionally Critical status, it is not endemic and recorded throughout New Zealand.

Myosotis glauca

JWS Ecology – Terrestrial vegetation 25 May 2026 records (19) GR has considerable doubts around the identity of the non-*Myosotis brevis* taxa. There is debate regarding the taxonomy of *Myosotis* species and that it is possible that *Myosotis glauca* is present within the DDF. GR firmly believes that *M. glauca* is present in the DDF. In other correspondence GR considers “*M. glauca* Threatened – Nationally Vulnerable, has been missed in survey and/or misidentified as the much less threatened *M. antarctica* subsp. *antarctica* (which he considers should be referred to as *Myosotis drucei*, having a taxonomically indeterminate threat ranking).

GR has produced no evidence *M. glauca* is present, and the two site surveys by experienced spring annual ecologists did not record this species present. I note that during the 2025 survey there was considerable discussion about *Myosotis* species identification, and specifically *M. glauca*. In addition, photos and specimens of the native *Myosotis* surveyed were taken to allow wider discussion with other botanists. These botanists agreed the species photographed/collected were not *M. glauca*. However, it remains possible that *M. glauca* is present within the DDF.

I therefore recommend an addition to C124. That the 2026 spring annual herb survey collects 25 georeferenced individuals of *M. antarctica* from within DDF and sends these to the Allan Herbarium, Lincoln, New Zealand. If *M. glauca* plants are confirmed within the DDF in the same survey, those georeferenced plants (to a maximum of 25 individuals) are also sent to the Allan Herbarium to assist resolution of species identification. If *M. glauca* is found in the MRZ, the locations are marked and seed is collected to be made available to DOC (i.e. same treatment as *Daucus* above).

The Allan Herbarium proposed based on their taxonomists’ work with these species (Prebble et al 2022)

Reference: Taxonomic revision of the southern hemisphere pygmy forget-me-not group (*Myosotis*; Boraginaceae) based on morphological, population genetic and climate-edaphic niche modelling data. *Aust Syst Bot* (2022) 35 (1): 63–94. [Taxonomic revision of the southern hemisphere pygmy forget-me-not group \(*Myosotis*; Boraginaceae\) based on morphological, population genetic and climate-edaphic niche modelling data | Australian Systematic Botany | ConnectSci](#)

Rationale:

- proposal also helps resolve taxonomy – which will be useful for dealing with *M. antarctica*
- plants are perennial so can mark more accurately. NZPCN notes propagation easy by seed, and seed held on the plant for months allowing efficient collection if plants are located
- unlikely to be found in large numbers