BEFORE AN EXPERT PANEL **FTAA-2508-1097**

HALDON SOLAR

Under the	FAST-TRACK APPROVALS ACT 2024
In the matter of	an application for resource consent approvals for the Haldon Solar project

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STATEMENT OF EVIDENCE OF NICHOLAS JOHN HEAD

TERRESTRIAL ECOLOGY

Royal Forest and Bird Protection Society of New Zealand Inc
Solicitor Acting:
T C T Williams
[redacted]

INTRODUCTION

1. My full name is Nicholas John Head.

2. I have been asked by the Royal Forest and Bird Protection Society to provide expert evidence on the terrestrial ecology values that are potentially affected by the Haldon Solar fast-track application, in particular:

   - Provide an ecological Overview of the Mackenzie Basin, including its biogeographic context, characteristic ecosystems, climatic influences, and the distribution of indigenous habitats and species across the Basin.

   - Outline the ecological significance of the Mackenzie Basin at regional and national scales, including its importance for dryland ecosystems, and threatened indigenous flora and fauna.

   - Document historical and ongoing loss, fragmentation, and degradation of ecological values within the Mackenzie Basin, with particular emphasis on land-use intensification, irrigation, infrastructure development, and cumulative effects on indigenous biodiversity.

   - Provide a detailed description of the Tekapo–Haldon outwash plain, including its geomorphology, soils, hydrology, and indigenous vegetation patterns, and an assessment of its ecological values, significance, and vulnerability.

   - Critique the applicant's ecological reports, including the adequacy of survey methodologies, the identification and assessment of ecological values, the application of significance criteria, and the assessment of actual and potential ecological effects.

   - Comment on the findings from subsequent field surveys undertaken after the initial assessments, including the implications of newly recorded species or habitats for ecological significance, impact assessment, and uncertainty.

- Respond to the Applicant's Replies to Panel Minute Questions, including whether those responses adequately address identified gaps, uncertainties, and deficiencies in the original ecological assessments.

QUALIFICATIONS AND EXPERIENCE

3. I have a Master of Science (Hons) degree in plant ecology from Lincoln University and a BSc with a double major in plant ecology and physical geography from the University of Canterbury.

4. Since 2017 I have been employed as the Senior Ecologist for the Christchurch City Council. For the previous 23 years I worked as plant ecologist for Department of Conservation (DOC) where I had responsibilities across the Eastern South Island. Prior to that I worked for Landcare Research New Zealand Ltd as a field botanist for the Rabbit and Land Management Programme and Semi-Arid Lands Programme, based in Alexandra.

5. I have over three decades experience working in Canterbury and throughout New Zealand undertaking ecological and botanical assessments. From a practical perspective, I have extensive field experience assessing, recording, monitoring and reporting on botanical matters throughout New Zealand, with a particular focus on threatened and rare ecosystems and plants in the eastern South Island.

6. I have substantial experience assessing and determining ecological significance. I participated in three Protected Natural Area Programme (PNAP) surveys in Canterbury and Marlborough that used a standard scientific approach to assess significant ecological values across large areas. I was part of Environment Canterbury ecologists' working party to develop ecological criteria for the Canterbury Regional Policy Statement (CRPS). I was also responsible for the preparation of DOC's best practice guidelines for assessing significant ecological values[1] which I co-authored.

[1] Davis, M.; Head, N. J.; Myers, S. C.; Moore, S. H. 2016. Department of Conservation guidelines for assessing significant ecological values. Department of Conservation, Wellington, 71p.

7. I have undertaken many botanical assessments across a wide range of scales, from areas exceeding 40,000 hectares to less than one hectare. I have surveyed many sites that form the basis of Significant Natural Areas (SNAs) in district plans, and I have oversight of those proposed for inclusion in the Christchurch City Council's district plan.

8. During the Tenure Review process under the Crown Pastoral Land Act 1998 (CPLA), I have undertaken extensive ecological assessments across large areas of the Canterbury high country, collectively encompassing many hundreds of thousands of hectares. From this I have obtained a high level of familiarity with the ecological values, patterns, and processes of the Mackenzie Basin and the wider Mackenzie District. Within the Mackenzie Basin alone, I completed detailed ecological assessments of at least 23 pastoral leases, which together exceed 200,000 hectares and comprise a substantial proportion of the Basin floor. These assessments included, but were not limited to, Sawdon, Mt Hay, Balmoral, Holbrook, Irishmans Creek, Glenmore, Braemar, The Wolds, Maryburn, Simons Pass, Mt Dalgety, Mt Gerald, Grampians, Black Forest, Gurragmore, Streamlands, Stony Creek, Kirkliston, Omahau Hill, Ferintosh, Quailburn, and Twin Peaks Stations. I have also surveyed most pastoral leases and University endowment land within the Hakatere Basin (Ashburton Lakes) and the Waimakariri Basin. In addition, while employed by Landcare Research, I undertook vegetation monitoring across most pastoral properties adjoining Lakes Hāwea and Wānaka.

9. In addition to my work associated with Tenure Review, I have undertaken a wide range of ecological assessments across the Mackenzie Basin properties for statutory and planning purposes, including Significant Natural Area (SNA) identification, CPLA processes, and Overseas Investment (OIA) related work. These assessments have included parts of Haldon, Ōhau Downs, Lake Ōhau, Guide Hill, Omarama, Totara Peaks, Killermont, Ribbonwood, Birdwood, Mt Cook, Godley Peaks, Rostriever, Rugged Ridges, and all land administered by the New Zealand Defence Force.

10. I have presented expert evidence on ecological matters at numerous hearings at both district and regional levels, as well as in the Environment Court, including most recently at the Mackenzie District Plan Change 18 hearing in 2024. I have also

prepared a substantial number of successful proposals for land protection across Canterbury. This includes the ecological assessment reports that supported successful Nature Heritage Fund (NHF) land purchases within the Mackenzie Basin at Ōhau Downs Station and Tarnbrae, and Hakatere Station within the Hakatere Basin (Ashburton Lakes).

11. I have a long involvement with research on the management of threatened plant species and rare dryland ecosystems, such as that undertaken in the Tekapo Scientific Reserve[2], and I currently oversee a dryland restoration project at McLeans Island on the Canterbury Plains, and at Kaitorete. This research involves rigorous studies on threatened species populations and ecosystem health, which includes assessing responses to various management actions over time, including sheep grazing.

12. I provide a wide range of botanical and ecological advice to colleagues and the public generally. I have published numerous articles on threatened plant species and ecosystems, some of which are included in the references section of this evidence.

13. The evidence I have prepared for this hearing draws on evidence I prepared for the Environment Court hearing on Plan Change 13 (PC13) and PC 18 to the Mackenzie District Plan.

CODE OF CONDUCT

14. I understand that this is not a hearing under the Resource Management Act, however, I note that I have read the code of conduct for expert witnesses contained in the Environment Court's Practice Note 2023 (the Code). I have complied with the Code when preparing this written statement of evidence. The data, information, facts, and assumptions I have considered in forming my opinions are set out in my evidence. Unless I state otherwise, this evidence is within my sphere of expertise, and I have not

[2] Walker, S.; Comrie, J.; Head, N.; Ladley, K. J.; Clarke, D.; Monks, A, 2016b. Sampling method and sample size affect diversity and indigenous dominance estimates in a mixed grassland community. New Zealand Journal of Ecology, 40(1) 150-159.

omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SUMMARY

15. The Mackenzie Basin, situated in South Canterbury, is New Zealand's largest and most ecologically significant inter-montane basin. It comprises glacially derived landforms, including moraines, alluvial outwash plains, ephemeral wetlands, inland sand dunes, and braided rivers. These ecosystems are nationally rare, supporting a unique assemblage of flora and fauna adapted to the basin's extreme climatic conditions—cold winters, hot dry summers, strong winds, and semi-arid rainfall. Indigenous species exhibit adaptations such as cushion and mat growth forms, short stature, and seasonal dormancy, creating a mosaic of microhabitats critical for rare and endemic taxa.

16. The basin's outwash ecosystems are a nationally important stronghold for threatened and at-risk species, including at least 109 plant taxa, 28 endemic invertebrates such as the robust grasshopper (*Sigaus robustus*) and Tekapo ground wētā (*Hemiandrus furoviarius*), ground-nesting birds like the kakī/black stilt (*Himantopus novaezelandiae*), banded dotterel (*Charadrius bicinctus bicinctus*), black-fronted tern (*Chlidonias albostriatus*), and lizards.

17. The Tekapo–Haldon outwash ecosystem on which the solar farm is proposed to be located on the bottom end of the sequence represents one the largest and most intact fluvio-glacial sequences remaining in New Zealand. It is nationally significant for both plants and fauna, including numerous threatened species, including many that are dependent on sparsely vegetated, stony outwash habitats. Its size and connectively across intact environmental gradients is a major ecological attribute of the site that is unparalleled elsewhere in New Zealand.

18. The Haldon section of the outwash sequence plays a key role in maintaining ecological connectivity and landscape-scale resilience for indigenous biodiversity. It supports characteristic species and communities typically depleted across the Basin. Conservation of Haldon is therefore necessary to prevent further irreversible loss of

nationally significant ecosystems, and its loss would represent a substantial reduction in both the extent and ecological integrity of critically endangered outwash gravels.

19. The ecological assessments for the Haldon site are fundamentally deficient, failing to provide reliable information on biodiversity or potential impacts. Bird surveys were limited, spatially restricted, and failed to account for seasonal and nocturnal variations. Key threatened species such as banded dotterel, black-fronted tern, and South Island pied oystercatcher were not recorded despite their known presence, while misidentifications suggest lack of ornithological expertise.

20. No Invertebrate survey was conducted despite the almost certain presence of nationally threatened and endemic species such as robust grasshopper, short-horned grasshopper (*Sigaus minutus*), and Tekapo ground wētā. This omission prevents evaluation of ecological effects or mitigation strategies of the proposal.

21. Surveys for lizards used inappropriate sized pitfall traps and non-standard detection methods. DOC Herpetofauna records were not consulted, and permit requirements were inadequately addressed. The survey cannot reliably determine lizard presence, distribution, or conservation status.

22. The plot-based botanical design sampled only a fraction of the 320ha site. It failed to capture the heterogeneity of the outwash ecosystem and consequently many cryptic or sparsely distributed threatened plants were most probably missed.

23. The conclusion that the Haldon outwash site is not ecologically significant is scientifically indefensible and reflects a fundamental misapplication of the accepted criteria for representativeness, rarity/distinctiveness, and ecological context in the Canterbury Regional Policy Statement. The site is clearly representative of the Basin's outwash ecosystem, retaining characteristic dryland vegetation. It also meets the criterion for rarity, supporting at least 4 at-risk plant species, and glacial outwash ecosystems are listed as "originally rare". In terms of ecological context, the Haldon outwash forms a vital ecological corridor linking the Tekapo River with the wider Basin floor and Lake Benmore, maintaining connectivity for fauna and the integrity of regional ecological processes.

24. A limited site visit by DOC and Environment Canterbury in November 2025 recorded threatened indigenous plants, and indigenous invertebrates, and banded dotterel. Despite its constrained scope, the detection of species of conservation concern demonstrates that the site supports higher ecological values than identified in the applicant's assessment and confirms that significant uncertainty remains due to inadequate baseline surveys.

25. By failing to properly consider these criteria, the assessment's dismissal of significance is inconsistent with statutory and scientific frameworks and contradicts multiple Environment Court findings confirming the national importance of Mackenzie Basin outwash ecosystems.

26. Correctly assessed, the site clearly qualifies as a Significant Natural Area (SNA), and its loss would represent a major and irreversible adverse effect on the biodiversity and ecological integrity of the Mackenzie Basin.

27. The proposed solar development would result in largely irreversible loss of nationally rare ecosystem and habitats for threatened and rara taxa, compromise the ecological connectivity of the most 'intact' outwash ecosystem remaining, and threaten the persistence of multiple threatened, at-risk and endemic taxa. Empirical evidence from overseas dryland solar farms shows substantial reductions in native plant richness, and invertebrate diversity under and around solar panels. The claim that vegetation and fauna will "recover" is speculative and contradicted by experience in comparable semi-arid environments. The proposal would result in a major and largely irreversible loss of habitat.

28. The restoration opportunities proposed by the applicant along the margins of the site do not adequately address the scale or nature of the habitat loss and associated indigenous biodiversity values affected by the development. Marginal planting of native species such as tussocks and shrubs, even if successfully established, fails to replicate the ecological integrity, functional complexity, or compositional authenticity of the dryland ecosystem that would be displaced by the solar farm. Such measures amount to partial landscaping rather than true ecological compensation or

restoration. Furthermore, the proposal to establish podocarp forest within this dryland outwash environment (a suggestion made at the expert panel overview conference) is ecologically incongruous and lacks scientific credibility, given the site's soil, climate, and historical vegetation context.

ECOLOGICAL OVERVIEW OF THE MACKENZIE BASIN

29. The Mackenzie Basin[3] is in South Canterbury occurring between the main ranges of the Southern Alps, and the Dalgety, Grampians, Ben Ohau and Kirkliston ranges. The basin floor largely comprises glacial landforms of moraines and low-lying alluvial outwash ecosystems (variously called depositional or dryland ecosystems) formed by successive glacial advance and retreat. Braided rivers and associated alluvial surfaces are also notable components of the Basin's ecological character.

30. On the national scale, inter-montane basins are uncommon[4]. In New Zealand, there are four that are broadly similar to the Mackenzie Basin, being the Hakatere, Upper Clutha, and to a lesser extent Waimakariri[5]. The Mackenzie Basin is by far the largest and most complex of them all[6].

31. Outside the Mackenzie, the Hakatere Basin is the only inter-montane basin that still supports relatively intact glacial derived ecosystems to any large extent, especially those that comprise the basin floors. However, the Hakatere Basin has a different

[3] For the purposes of this evidence the Mackenzie Basin also encompasses the Waitaki District council jurisdiction which is sometimes referred to as the Waitaki Basin

[4] Speight (1914) identified 8 inter-montane basins, but he included Hanmer, Culverden, Mid–Waimakariri and upper Pareora Basin, but these all occur at low altitude and have almost entirely lost their indigenous cover.

[5] The Waimakariri Basin does not have extensive fluvio-glacial alluvial outwash surfaces that are a feature of the Mackenzie Basin especially.

[6] Kitson A. E.; Thiele E. O. 1910. The Geography of the Upper Waitaki Basin, New Zealand. The Geographical Journal Vol. 36, No. 5 (Nov. 1910), pp.537-551 Published by: geographicalj DOI:10.2307/1777341 Stable URL: http://www.jstor.org/stable/1777341;

Speight, R. 1914. The Intermontane Basins of Canterbury. Art XXXVI— Transactions and Proceedings of the New Zealand Institute for the Year 1914, Volume 47. Alexander Turnbull Library, Wellington, New Zealand. http://natlib.govt.nz/records/1034542 ecological character (wetter, lower altitude and smaller) to the Mackenzie, and this is reflected in the absence of many threatened and rare 'desert' species that are not found in the Hakatere Basin.

32. Biogeographically, the Mackenzie Basin is encompassed within the Mackenzie Ecological Region (ER)[7]. This includes the immediately contiguous western and eastern ranges that enclose the inter-montane basin floor. The basin floor is largely contained within three Ecological Districts (ED) (Tekapo, Pukaki, Omarama) that are delineated by finer scale environmental gradients primarily associated with altitude changes and different ages of glacial deposition (Map 1; Appendix 2).

33. Climatic extremes are a feature of the Mackenzie Basin, with cold winters, strong winds, hot dry summers, and semi-arid annual precipitation, especially in the east. These climatic conditions give the Mackenzie Basin its distinctive ecological (desert) character[8] that supports a distinctive biota not represented to the same extent elsewhere in New Zealand (or the world).

34. Adaptations in the Mackenzie basin flora to cope with hot, dry, windy conditions are expressed by high levels of dormancy, seasonality in growth (such as spring annual lifecycle), short stature, leaflessness, cushion and mat form, and spikey forms, etc., and for some species a combination of ephemeral/spring growth and mobility i.e. short lifespans and random patchiness across the landscape in any one year. Some of these species are shown Appendix 3, photos 1-4.

[7] The ecological character of New Zealand has been divided into areas of similar ecological character called Ecological Regions ("**ER**") by a scientific panel. ERs are further subdivided into ecological districts ("**ED**") that differentiate finer scale patterns of climate, geology, and landforms. There are 85 ERs and 268 EDs in New Zealand (McEwen 1987). The ED scale is the accepted framework that underpins ecological significance assessment criteria that are used to determine ecologically significant sites, such as the criteria outlined in the Canterbury RPS and the DOC assessment guidelines. These ecological districts are shown I Map 1 in Appendix 2.

[8] Cockayne, A. H. 1915. Some economic considerations concerning montane tussock grasslands. *Transactions and Proceedings of the Royal Society of New Zealand 1868-1961*, 48: 154-165.

35. Analysis of pollen from soil cores[9] shows that from the end of the last ice age around 17000 ago[10], the vegetation of the Mackenzie Basin was dominated by short tussock grasslands and associated herbaceous species. Those species were the primary colonisers of new land surfaces exposed as ice melted and retreated. Over time a complex mosaic of low 'open forest', shrublands and grasslands developed across the basin floor reflecting broad patterns of altitude, climate, soils, and rainfall.

36. Immediately prior to human arrival, vegetation across the Mackenzie Basin is understood to have comprised mixed conifer associations, with Hall's tōtara, celery pine, and bog pine occupying moist fertile sites through to leached, infertile substrates respectively. In contrast, small-leaved angiosperm scrub (including *Olearia*, *Coprosma*, and matagouri) and short-tussock grasslands (fescue and silver tussock) dominated landscapes characterised by excessive drainage or very low rainfall, particularly on younger alluvial outwash surfaces and in the drier eastern parts of the basin. The Haldon site is representative of these dryland outwash environments, where short tussock and shrubland communities would have predominated. Beech forest (mountain and silver beech) was largely confined to the wetter western ranges, while higher elevations supported a mosaic of subalpine shrublands, tussock grasslands, and alpine herbfields broadly comparable to those present today.

37. Studies of buried charcoal and pollen suggest that natural fires were infrequent and had a localised influence on vegetation patterns. Nonetheless, disturbance was part of the natural ecology of the Mackenzie Basin; it was certainly exacerbated with the arrival of humans. The pattern of disturbance was due to harsh climatic extremes, such as drought, frost, cold, heat and wind, which are all important influences on plant growth. Widespread disturbance by large birds (moa etc.) is also thought to have had

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[9] McGlone, M.S. 2001. The origin of the indigenous grasslands of southeastern South Island in relation to pre-human woody ecosystems. *New Zealand Journal of Ecology 25*: 1-15.

[10] Barrell, D. J. A.; Read, S. A. L. 2014. The deglaciation of Lake Pukaki, South Island, New Zealand—a review. New Zealand Journal of Geology and Geophysics, Vol. 57(1), 86–101, http://dx.doi.org/10.1080/00288306.2013.847469

a major influence on the evolution of the native species characteristic of dryland ecosystems[11].

38. With the arrival of Māori around 800 years ago came increased and repeated burning[12]. This resulted in the widespread loss of low forest and conifer scrub across the Mackenzie basin floor and surrounding slopes[13]. It caused a corresponding increase in short tussock grasslands, red tussock grasslands, and dry scrub communities, which expanded across the basin floor. Snow tussock descended down-slope to occupy previously forested and/or scrubby lower slopes below the treeline (~1200m).

39. When the first Europeans arrived in the Mackenzie Basin around 1850, they encountered an extensive plain of tussock and shrublands. Thomson, New Zealand's Surveyor-General, described the area as "extensive plains, covered with grass of generally scanty growth"[14]. Von Haast, in 1862, commented that the basin floor was a "great tawny expanse of low tussock grassland", which merged into snow grass at higher altitudes. Dense thickets of matagouri and spear-grass occurred among tussock and along riverbanks. Matagouri was common and increased to the west with increasing rainfall. Fescue tussock was the dominant grassland community, as it still is today, with blue tussock, plume grass and blue wheat grass common[15]. Extensive dune-lands were also apparent; they were described by the Surveyor- General as a

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[11] Rogers G., Walker, S. 2002. Taxonomic profiles of rarity in the New Zealand vascular flora. *New Zealand Journal of Botany* 40: 73-93.

[12] Wilmshurst, J.; Hunt, T.; Lipo, C.; Anderson, A. 2012. High-precision radiocarbon dating shows recent and rapid initial human colonization of East Polynesia. *Proceedings of the National Academy of Sciences* 108: 1815-1820

[13] There is no oral history from local Māori that there was ever extensive woody cover in the Mackenzie Basin (Gillespie 1958), indicating that the predicted extensive cover of low forest and shrublands was eliminated very early on probably by Māori burning.

[14] Thomson, J. T. 1858. Lecture on the Province of Otago: its description, resources, and capabilities. Otago Witness, July 1858.

[15] von Haast, J. 1879. Geology of the Provinces Canterbury and Westland, New Zealand. A report compiling the results of official explorations. Times Office, Christchurch, New Zealand.

Wilson, R. K. 1949. The Mackenzie Basin. A regional study in the South Island High country. Unpublished MSc thesis. University Canterbury.

"desert of sand", and Chapman (1884)[16] noted the presence of moa bones that had been exposed by wind erosion.

40. European settlement has resulted in continuing ecosystem modification of the Basin. Pastoralism, in combination with the introduction of rabbits in the 1860s and exotic plant species, caused widespread depletion of native dryland ecosystems throughout the Mackenzie Basin (and across all rain shadow regions of New Zealand). Nevertheless, ecological resilience has been a feature of the Mackenzie Basin's ecology; descriptions of the denuding of the land, along with anecdotal reports of phases of recovery occurring in between periods of depletion, can be found in several early accounts[17].

41. Ecological recovery from over-grazing and weed invasion is most clearly demonstrated from a study in the Tekapo Scientific Reserve[18]. This study documents the recovery of short tussock grasslands and associated native species (including many that are classified as threatened and at-risk) that occurred after the removal of stock grazing, rabbit control and wilding pine control, on what were very depleted moraine and alluvial outwash ecosystems[19]. This study also demonstrated, contrary to widespread belief, that mouse-ear hawkweed (*Pilosella officinarum*) is not an intractable threat to indigenous biodiversity as it was shown to succumb to recovering native species given sympathetic management. Figure 11 in Appendix 3 depicts some of the recovery that has occurred in the Tekapo Scientific Reserve.

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[16] Thomson, J. T. 1873. On the Glacial Action and Terrace Formations of South New Zealand. Transactions and Proceedings of the New Zealand Institute for the Year 1914, Volume 6, 301-332. Alexander Turnbull Library, Wellington, New Zealand. http://rsnz.natlib.govt.nz/volume/rsnz_06/rsnz_06_00_004760.html.

Chapman, F. 1884. Notes on Moa Remains in the Mackenzie Country and other Localities. ART. XVII - Transactions and Proceedings of the Royal Society of New Zealand 17: 172-178. Alexander Turnbull Library, Wellington, New Zealand. http://rsnz.natlib.govt.nz/volume/rsnz_17/rsnz_17_00_003540.html

[17] Appendix to the Journals of the House of Representatives. 1910. Canterbury Pastoral Runs Classification. National Library of New Zealand. https://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&cl=seach&d=AJHR1910-I.2.1.4.25&sr...

[18] Walker, S.; Comrie, J.; Head, N.; Ladley, K. J.; Clarke, D. 2016. Hawkweed invasion does not prevent indigenous non-forest vegetation recovery following grazing removal. *New Zealand Journal of Ecology,* 40(1) 137 - 149.

[19] Prior to becoming the Scientific Reserve, the land was part of the Sawdon Station that was retired from the pastoral lease.

42. More recently, especially since about 2000, intensive agricultural practices of cultivation and irrigation have caused widespread and permanent loss of natural ecosystems and indigenous biodiversity across the Mackenzie Basin. The extent of those losses is discussed in paragraphs 52.

ECOLOGICAL SIGNIFICANCE OF THE MACKENZIE BASIN

42. In my experience, areas of the Mackenzie Basin that have not been intensively developed typically retain significant ecological values, consistent with the assessment criteria of the *Canterbury Regional Policy Statement (CRPS)* [20].

43. The Basin's characteristic dryland ecosystems comprise fescue tussock grasslands, native shrublands, and herbfield–stonefield mosaics (Figure 6 & 8; Appendix 3) [21]. Although typically depleted and containing exotic species such as mouse-ear hawkweed, these communities remain representative [22] of the Basin's natural vegetation patterns and ecological composition.

44. What is broadly termed "tussock grassland" in the Mackenzie Basin is, in reality, a mosaic of plant communities reflecting subtle variations in substrate, drainage, and microclimate. Sparsely vegetated environments, including stonefields, mossfields, and herbfields, support diverse assemblages of native herbs, grasses, subshrubs, and mosses, including many threatened and at-risk species that contribute substantially to

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[20] https://www.ecan.govt.nz/document/download?uri=2075337

[21] McGlone, M.S. 2001. The origin of the indigenous grasslands of southeastern South Island in relation to pre-human woody ecosystems. *New Zealand Journal of Ecology 25*: 1-15

Walker S., Lee, W.G. 2000: Alluvial grasslands in south-eastern New Zealand: vegetation patterns, long-term and post-pastoral change. Journal of The Royal Society of New Zealand 30 (1): 69-103.

Walker, S., Lee, W.G., Rogers, G.M. 2003: Post-pastoral succession in inter-montane values and basin of eastern South Island, New Zealand. Science for Conservation 227. Department of Conservation, New Zealand.

[22] Representativeness is a key criterion for determining ecological significance in New Zealand. Significant indigenous vegetation is generally where native plant communities broadly 'reflect' the vegetation that was present at around 1840 (European arrival). In highly modified EDs, however, the 1840 benchmark is not fit for purpose.

the Basin's ecological significance. The Haldon site is representative of these dryland outwash conditions, where such mosaics are expressed at fine spatial scales.

45. Even highly modified and severely depleted habitats can retain high ecological significance, frequently supporting threatened and at-risk species. Many of these taxa are endemic or persist as remnant strongholds within the Mackenzie Basin, highlighting the conservation importance of sites such as Haldon despite their modified appearance.

46. The Basin's large scale and ecological connectivity are fundamental to its significance (although I acknowledge in some parts have been significantly reduced). The Mackenzie's extensive, interconnected depositional ecosystems provide for a greater diversity of habitats and associated species assemblages. These attributes are important for ecological resilience and long-term biodiversity persistence[23], but have been severely diminished in most other New Zealand dryland regions[24].

47. In view of this context, the Haldon site is ecologically significant not only because it retains key elements of the dryland outwash ecosystems of the eastern Mackenzie Basin, but also because it forms part of the Basin's broader network of interconnected habitats that support metapopulations of mobile fauna important for ecological resilience. While depleted, Haldon retains the defining environmental features and species mosaics, such as sparsely vegetated stonefields, tussock grasslands, and associated subshrubs. These habitats continue to support threatened and at-risk species, serving as important refugia and contributing to the persistence of regional biodiversity. In combination with the Basin's extensive depositional landscapes and remaining connectivity, the Haldon site forms an inherent part of the rare and irreplaceable ecological values of the Mackenzie's dryland ecosystems, and its loss would represent a reduction of both local and landscape-scale ecological integrity.

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[23] O'Connor, K. K.; Overmars, F. B.; Ralston, M. M. 1990. Land Evaluation for nature conservation. A scientific review compiled for application in New Zealand. *Conservation Sciences Publication Number 3.* Department of Conservation, Wellington.

[24] Walker, S., Price, R., Rutledge, D., Stephens, R., T; Lee, W.G. 2006: Recent loss of indigenous cover in New Zealand. New Zealand Journal of Ecology 30: 169-177.

NATIONAL PRIORITIES AND HABITAT PROTECTION

48. The Mackenzie Basin is widely recognised as a national stronghold for some of New Zealand's most distinctive and vulnerable ecosystems. Its ecological significance arises not only from the diversity and rarity of these habitats, but also from the degree to which they remain relatively intact compared with other dryland regions of the country.

49. The Basin is dominated by "Originally Rare"[25] ecosystems, including inland outwash surfaces, moraines, ephemeral wetlands (kettleholes), inland sand dunes, and braided rivers[26]. These ecosystems are unparalleled elsewhere in New Zealand in terms of their extent, ecological diversity, and connectivity (Figures 6, 7, 9; Appendix 3). Collectively, they form extensive and relatively intact ecological sequences across the basin floor, supporting a disproportionately high number of threatened plant species and other indigenous taxa of national conservation significance. Haldon contributes directly to these national conservation values as part of the critically endangered outwash gravels ecosystem. The Haldon site is representative of the Basin's dry eastern outwash gravels, an ecosystem type that is both naturally rare and critically endangered at a national scale.

50. Under *IUCN* criteria, the Basin's principal ecosystem types are classified as follows:

- Outwash gravels – Critically Endangered
- Moraines – Vulnerable
- Inland sand dunes – Critically Endangered
- Ephemeral wetlands – Critically Endangered
- Braided rivers – Endangered

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[25] Originally rare ecosystems are environmentally distinct areas that comprised less than 5% of New Zealand's land area prior to human settlement. They often have highly specialised and distinctive assemblages of species including relatively high proportions that are endemic, rare, and threatened.

[26] Ministry for the Environment 2007. Protecting our Places. Introducing the national priorities for protecting rare and threatened native biodiversity on private land. Ministry for the Environment, Wellington.

51. The Mackenzie Basin supports an exceptional concentration of threatened and at-risk species across multiple taxonomic groups, including plants, birds, invertebrates, and lizards. Some of these species are endemics confined entirely to the Basin and many persist here as population strongholds. At least 109 threatened or at-risk plant species have been recorded[27], alongside numerous endemic invertebrates (e.g., ground beetles, grasshoppers, and moths), with approximately 23% of the 3,052 identified taxa yet to be formally described, and at least 28 invertebrate species are restricted to the Basin[28]. The Basin also sustains several threatened and at-risk lizard species and key bird populations, including kakī/black stilt (Nationally Critical) (Figure 6, Appendix 3), tarapirohe/black fronted tern (Nationally Endangered), and banded dotterel (Declining) [29],[30]. Many species are either absent from, or occur in much lower abundance outside, the Basin. Notable examples include the endemic kakī/black stilt and the robust grasshopper (*Sigaus robustus*, Nationally Endangered[31]).

52. Since around 2000, intensive agricultural development, including irrigation, cultivation, over-sowing, and fertiliser application (OSTD), has caused widespread and largely irreversible loss of dryland ecosystems across the Basin, particularly affecting outwash and moraine surfaces. While some degradation from pastoralism and invasive species can be partially reversed, conversion to exotic pasture or crops has typically resulted in permanent ecosystem loss, with significant declines already documented in the southern Basin (47% outwash loss) and northern Basin (21%). The extent of this loss between 2000

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[27] de Lange, P.J.; Gosden, J.; Courtney, S.P.; Fergus, A.J.; Barkla, J.W.; Beadel, S.M.; Champion, P.D.; Hindmarsh-Walls, R.; Makan, T.; Michel, P. 2024: Conservation status of vascular plants in Aotearoa New Zealand, 2023. New Zealand Threat Classification Series 43. Department of Conservation, Wellington. 105 p.

[28] Wakelin, M. Tweed, J., Murray, T. (2023). A list of the invertebrates of the Mackenzie area, New Zealand. *New Zealand Journal of Zoology*, DOI: 10.1080/03014223.2023.2214370.

[29] Robertson, H.A., Baird, K.A., Elliott, G.P., Hitchmough, R.A., McArthur, N.J., Makan, T.D., Miskelly, C.M., O'Donnell, C.F.J., Sagar, P.M., Scofield, R.P., Taylor, G.A., & Michel, P. (2021). Conservation status of birds in Aotearoa New Zealand 2021. New Zealand Threat Classification Series 36. Department of Conservation, Wellington

[30] O'Donnell, C.F.J.; Monks, J.M. 2020. Distribution, long term population trends and conservation status of banded dotterels (*Charadrius bicinctus bicinctus*) on braided rivers in New Zealand. Notornis 67(4): 733–753.

31 Funnell, G., Gordon, D., Leduc, D., Makan, T., Marshall, B.A., Mills, S., Michel, P., Read, G., Schnabel, K., Tracey, D., & Wing, S. (2023). Conservation status of indigenous marine invertebrates in Aotearoa New Zealand, 2021. New Zealand Threat Classification Series 40. Department of Conservation, Wellington.

and 2016 is shown in Maps 3 and 4 in Appendix 2[32]. Although the pace and scale of losses caused by agricultural conversion has slowed since this analysis was undertaken, ongoing losses and degradation have continued[33].

53. In addition to direct habitat loss, pervasive edge effects from neighbouring agricultural activities further degrade remaining dryland ecosystems. Water, nutrients, soil, and seeds can disperse long distances (measured to over 300m[34]), facilitating exotic plant invasion, altering natural processes, and threatening native species. Edge effects from increased irrigation adjoining dryland ecosystems across central Otago is one of the key factors that caused the population collapse of inland cress that is now all but extinct[35]. Other compounding pressures include wilding conifer spread, ambiguous clearance regulations, and insufficient recognition of ecological values of the Mackenzie's depleted dryland ecosystems.

54. Large-scale solar farm developments proposed in the Mackenzie Basin represent an emerging and significant threat to dryland ecosystems and indigenous biodiversity. Solar arrays cast shade and alter microclimates, reducing light, modifying temperature and moisture regimes, which can suppress or eliminate low-growing native plants, impede seedling recruitment, and fundamentally change the sparsely vegetated habitats required by many rare and threatened species. Many of these species are small, poor competitors with taller, denser exotic vegetation, and rely on open, high-light habitats that are highly vulnerable to invasion.

55. Solar installations also involve clearing, grading, and compaction of land, and the construction of panel supports, roads, fencing, and transmission lines. This infrastructure alters hydrology, surface conditions, and soil integrity. During both construction and

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32 This comes from evidence I presented at the PC13 hearing.

33 Evidence from Mr Harding for PC18 Council hearing showed that the loss of significant ecological values has continued between 2016 -202033.

[34] Walker, S. 2020. Measured edge effects on indigenous grassland and shrubland vegetation on low-relief topography in Canterbury. Contract report LC3866. Manaaki Whenua-Landcare Research.

[35] Walker, S.; Harding, M, A. C.; Loh, G. 2023. The pattern of declines and local extinctions of endemic inland *Lepidium* species I the eastern South Island. New Zealand Journal of Ecology 47(1):3547

operation, noise, human presence, and vehicle traffic can disturb or displace fauna, while birds may be exposed to collision risks or behavioural changes from reflection effects ("lake effect") off the panels[36] that is discussed in more detail in the evidence of Dr McClelland. Adverse effects of solar farms are discussed further in paragraphs 99 -106.

56. Collectively, these pressures of agricultural intensification, edge effects, invasive species, and large-scale infrastructure such as solar farms, increase the need to protect and manage the remaining dryland habitats, including Haldon.

TEKAPO–HALDON OUTWASH

57. The proposed Haldon solar farm is proposed to be constructed on the bottom end of the extensive glacial outwash plain that begins at the terminal moraine of Tekapo Village to Lake Benmore, called the "the Tekapo outwash" for the purpose of this assessment. The Tekapo outwash ecosystem is nationally significant. It is the largest fluvio-glacial ecosystem that remains largely undeveloped in New Zealand, classified as an originally rare and threatened ecosystem. It comprises a sequence of glacial outwash surfaces of varying age and deposition, forming a nationally important continuum from the terminal moraines of Lake Tekapo to the terraces above Lake Benmore where the proposed solar farm is located on Haldon Station.

58. The large scale and relative intactness of the sequence from Tekapo to Benmore is an outstanding ecological attribute that is unparalleled nationally. The upper part of the Tekapo outwash, adjoining the glacial moraine near Lake Tekapo township, represents the oldest and most dissected section of the sequence. It contains deeper soils interspersed with numerous pronounced melt-water channels and deflation hollows[37], which become progressively less pronounced downslope toward Lake Benmore, where it becomes a stony outwash terrace associated with the Tekapo glacial advance[38].

[36] O'Donnell, Dr C. 2025. Evidence on Glorit Solar Farm. Department of Conservation, 28 July 2025, DOC-10389586.

[37] Hollows and stony channels are a natural part of glacial outwash ecosystems. They were formed when the landform was deposited among melting ice. They are not the result of 'recent' soil erosion as some mistakenly assume.

[38] Cox, S.C; Barrell, D. J. A (compilers) 2007. Geology of the Aoraki area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 15. Institute of Geological and Nuclear Sciences Ltd, Lower Hutt.

59. Despite a long history of pastoral use and the presence of widespread weeds and pests (particularly mouse-ear hawkweed and rabbits) that has depleted the vegetation, the Tekapo outwash retains representative[39] native plant communities and high species diversity associated with channels, subtle topographical and substrate variation, and surface ages.

60. The contrasting geomorphic and edaphic conditions across the sequence give rise to distinct vegetation assemblages. The deeper silty soils that form low dunes, banks and bars, support sparse fescue tussock and stunted matagouri as the main native cover (typically <10%, occasionally exceeding 20%), interspersed with exotic herbs such as mouse-ear hawkweed and browntop, which often comprise more than 25% cover. In contrast, the rocky channels, depressions and terraces are dominated by lichen, rock, and bare ground, with tussock generally absent, likely reflecting intolerance to frost-prone and periodically saturated microhabitats. These habitats support a distinctive flora of cushion and mat-forming species, dryland herbs and mosses, including multiple threatened species.

61. The intact habitat sequences across the Tekapo outwash provides important habitats for multiple threatened and at-risk species across taxonomic groups. This includes a notable assemblage of threatened and at-risk plant species, with 10 threatened and 27 at-risk species recorded. The list of threatened plant species known to occur in the Mackenzie Basin is shown in Appendix 1.

62. The Tekapo outwash is also a critical habitat for dryland birds, supporting nationally important breeding and foraging grounds for species reliant on open stony surfaces and shallow depressions. It supports some of the largest remaining population strongholds of the endangered black-fronted tern (*Chlidonias albostriatus*). Other species typical of these habitats include banded dotterel, South Island pied oystercatcher, black-billed gull,

[39] Representativeness is a key criterion for assessing ecological significance in New Zealand. Areas of significant indigenous vegetation are typically sites where native plant communities reflect the characteristic vegetation types in the ecological district in which they occur. In highly modified ecological districts, historical benchmarks such as 1840 (European arrival) are no longer appropriate owing to widespread ecosystem loss and modification that has occurred. In such contexts, representativeness is more appropriately evaluated in relation to the best remaining examples of indigenous ecosystems within the present-day landscape.

and New Zealand pipit, all classified as At Risk – Declining. These ground-nesting birds rely on the structural simplicity and openness of the outwash for predator detection and successful nesting. The combination of stony expanses, and herbfield mosaics provides important foraging and breeding habitats, now largely absent to any similar extent elsewhere in New Zealand.

63. The Tekapo outwash is a 'centre' of endemism for dryland invertebrates, including the critically endangered Tekapo ground wētā (*Hemiandrus furoviarius*), and the nationally endangered robust grasshopper (*Sigaus robustus*) that are confined to the Mackenzie Basin, and short-horned grasshopper (*Sigaus minutus*) (Figures 4 and 5, Appendix 3), that are wholly dependent on undisturbed outwash surfaces. Other specialist taxa include ground beetles, wolf spiders, and flightless moths, many of which are regionally restricted. Threatened lizard species, including locally endemic skinks and geckos, also persist in these habitats.

64. The Haldon section is an integral part of the Tekapo outwash ecosystem[40]. It represents the lowest-altitude portion of the outwash sequence serving as a critical ecological link within this nationally rare dryland ecosystem to where it adjoins Lake Benmore. The area retains the characteristic stony, sparsely vegetated surfaces and subtle microtopography typical of the Basin's glacially derived outwash ecosystems, supporting a comparable suite of specialist dryland species.

65. The ecological value of the Haldon section of the Tekapo outwash is further elevated by the near-total loss of comparable lower-altitude outwash ecosystems elsewhere in the Pukaki Ecological District, largely due to development and agricultural intensification, (illustrated in Figure 9, Appendix 3). Furthermore, the proposed Ōhau Point solar farm development on the terrace between the Twizel and Ōhau rivers would further diminish any remaining ecological values, by introducing industrial-scale infrastructure across approximately 600 ha.

[40] Despite being squeezed by the Mary Range and Grays Hills, the Haldon section of the outwash is an integral component of the outwash sequence that is contiguous with the Tekapo River.

CRITIQUE OF ECOLOGICAL ASSESSEMENTS

66. The following critique evaluates the adequacy and reliability of the ecological assessments undertaken for the Haldon outwash site, including the subsequent assessment of ecological significance based on those results. The review examines the methodological design, sampling intensity, taxonomic accuracy, and the survey's capacity to detect and represent the indigenous biodiversity and ecological values of this nationally important outwash ecosystem. Attention is given to whether the methods employed were appropriate for the heterogeneous nature of outwash plains and sufficient to provide a defensible basis for determining ecological significance, especially in relation to the threatened plant species known to occur in comparable habitats within the Mackenzie Basin.

BOTANICAL ASSESSMENT

67. The botanical survey methods were fundamentally inadequate for assessing the plant biodiversity and ecological significance of the Haldon outwash site. Only a fraction of the 320ha area was sampled—four transects[41] with six 10 × 10 m plots (total 2400 m^2, or 0.00075% of the site), plus 28 × 1 m^2 plots (0.00006% of the site). This is an exceptionally small and spatially restricted sampling effort that could not possibly capture the natural heterogeneity of the outwash landscape. I also note what appears to be a surprising taxonomic error where slender fescue (*Festuca filiformis*) has been mistaken for Chewing's fescue (*Festuca rubra*)[42]. Slender fescue is a much smaller distinctive 'tussock' forming species that has a more limited distribution compared to Chewing's fescue, which is larger and less tolerant of very dry sites.

68. The survey results are correspondingly poor recording a surprisingly low diversity of species and failing to detect any of the numerous threatened species known to occur elsewhere on the Tekapo outwash. Only four At Risk vascular plant species were recorded, with three mat daisies, *Raoulia australis, R. parkii,* and *R. beauverdii,* being relatively large and obvious species, whereas desert poa (*Poa manitoto*) is typically a common

[41] Although 8 transects were established, only 4 were in undeveloped outwash relevant to where the solar farm is proposed.
[42] Figure 7 applicant's AEE

species locally. The apparent absence of the many other small, cryptic and sparsely located threatened and at-risk taxa characteristic of these habitats, and in my experience certainly reflects the inadequate methodology rather than genuine absence.

69. The use of a small number of fixed plots represents an overly reductionist design that ignores the spatial complexity of outwash ecosystems. These surfaces are highly heterogeneous at fine scales, with subtle topographic and edaphic variations supporting a mosaic of microhabitats. Many threatened species occur only in small, discrete patches—on stony pavements, low terraces, or ephemeral drainage channels—that would easily be missed by rigidly located plots. Such an approach severely underrepresents species richness and fails to identify populations of conservation concern.

70. This methodological inadequacy has been well documented. Studies by Walker et al. (2003, Landcare Research Science Series No. 24) and Walker et al. (2007, Science for Conservation 285) demonstrate that fixed-plot designs consistently under-detect threatened species on outwash plains, while adaptive, habitat-based surveys record substantially higher species richness. Lloyd et al. (2003, DOC Science Internal Series 111) similarly emphasised the need for repeated, seasonally timed, habitat-targeted searches by experienced botanists.

71. To detect small, sparsely distributed plants, surveys must be designed to maximise detection probability across heterogeneous terrain. The standard practice is a stratified adaptive search, combining (i) targeted searches based on habitat and microtopography, and (ii) flexible expansion of search effort around any detections. Equally important is seasonal timing, surveys must coincide with the short phenological window when ephemeral rare taxa are visible (typically flowering or fruiting). Single-visit surveys undertaken outside this period have very low detection power.

72. For the Tekapo–Haldon outwash, these issues are particularly critical. The area forms part of the larger Tekapo outwash system, known to support numerous threatened plants occurring at low densities and confined to microhabitats that are both spatially

and temporally variable. Plot-based surveys such as the one undertaken are unsuitable for detecting such taxa and should not be relied upon to evaluate ecological significance.

BIRD SURVEY

73. The avifaunal assessment undertaken for the proposed Haldon solar development is seriously deficient and cannot be regarded as a credible evaluation of the bird values or ecological risks associated with the site.

74. The survey consisted of short (3–5 minute) early morning and late evening point counts at 10 fixed stations along a 6.2 km route (transects T3 and T6; Figure 10), undertaken by paired observers using binoculars and listening for calls. Birds were also incidentally noted during vegetation surveys and when driving through the site. In total, it appears that only two short surveys (each 30–50 minutes in duration) were completed, representing an extremely limited survey effort across a large landscape.

75. Such an approach is wholly inadequate for assessing bird populations on an extensive open-country system such as the Haldon outwash. Effective avifaunal surveys in these environments require systematic, landscape-scale coverage designed to detect territorial and mobile species, especially ground-nesting birds. Surveys should have involved active searches across the entire area to locate and map territorial banded dotterels and other open-habitat species, especially during the breeding season.

76. Furthermore, avifaunal use of these dryland and outwash habitats varies seasonally, with significant shifts between breeding, post-breeding, and migratory periods. A scientifically credible assessment therefore requires multiple seasonal surveys, including spring and summer breeding periods and autumn–winter foraging surveys, to capture this temporal variation.

77. The complete absence of banded dotterel records is ecologically implausible and strongly indicative of methodological failure. Outwash ecosystems within the Mackenzie Basin support one of the largest and most important remaining habitat strongholds for banded

dotterels in New Zealand[43]. Stony pavements and sparsely vegetated terraces provide prime nesting and foraging habitat for banded dotterels and other open-country species such as black-fronted tern (*Chlidonias albostriatus*), black-billed gull *(Larus bulleri*), and South Island pied oystercatcher (*Haematopus finschi*).

78. Given this ecological context, the failure to record even a single banded dotterel is not credible. Equally concerning is the report of a variable oystercatcher (*Haematopus unicolor*), a coastal species rarely recorded inland, suggesting possible misidentification, especially given that South Island pied oystercatcher, a common and conspicuous species of this habitat, was inexplicably not detected. These inconsistencies suggest a lack of ornithological expertise and undermine confidence in the accuracy of the data.

79. The survey also completely neglected nocturnal observations, a critical omission. Many threatened and at-risk wetland and open-country bird species undertake nocturnal movements or display nocturnal flight behaviour, making them particularly vulnerable to collision with solar infrastructure. The absence of night-time monitoring precludes any meaningful assessment of this significant potential impact.

80. For comparison, the adjacent Ōhau Point solar farm, the following threatened species have been identified as potentially affected by both construction and operational phases of solar developments in Mackenzie Basin outwash systems[44].

Table 1. Threatened species at risk from construction and operation of the proposed Ōhau Point solar farm.

[43] O'Donnell CFJ 2013. The significance of Ohau Downs alluvial outwash plain, Mackenzie Basin, for banded dotterel and other bird species. Department of Conservation File Report DOCDM-130975. Department of Conservation, Christchurch.
[44] Per com Dr Colin O'Donnell, Principal Science Advisor. Department of Conservation.

Scientific name	Common name	Primary habitat type	Threat category	Loss of breeding habitat	Loss of feeding habitat	Potential collision	Mortality of equivalent species in overseas studies
Ardea modesta	Kōtuku/white heron	Lake/Wetland/Riverine	Nationally Critical			Y	Y
Botaurus poiciloptilus	Matuku/Australasian bittern	Wetland/Riverine	Nationally Critical			Y	Y
Himantopus novaezelandiae	Kakī/black stilt	Lake/Wetland/Riverine	Nationally Critical			Y	Y
Chlidonias albostriatus	Tarapirohe/black-fronted tern	Lake/Wetland/Riverine /Dryland	Nationally Endangered		Y	Y	Y
Anas superciliosa	Pārera/grey duck	Lake/Wetland/Riverine	Nationally Vulnerable			Y	Y
Falco novaeseelandiae novaeseelandiae	Kārearea/eastern falcon	Dryland	Nationally Vulnerable			Y	Y
Hydroprogne caspia	Taranui/Caspian tern	Lake/Riverine	Nationally Vulnerable			Y	Y
Podiceps cristatus australis	Pūteketeke/Australasian crested grebe	Lake/Wetland/Riverine	Nationally Vulnerable			Y	Y
Anarhynchus frontalis	Ngutu parore/wrybill	Riverine	Nationally Increasing			Y	Y
Anthus novaeseelandiae novaeseelandiae	Pīhoihoi/NZ pipit	Dryland	Declining	Y	Y	Y	Y
Charadrius bicinctus bicinctus	Tūturiwhatu/banded dotterel	Riverine/Dryland	Declining	Y	Y	Y	Y
Haematopus finschi	Tōrea/South Island pied oystercatcher	Riverine/Dryland	Declining	Y	Y	Y	Y
Larus bulleri	Tarāpuka/black-billed gull	Lake/Wetland/Riverine /Dryland	Declining		Y	Y	Y
Porzana pusilla affinis	Koitereke/marsh crake	Wetland/Riverine	Declining			Y	Y
Porzana tabuensis	Pūweto/spotless crake	Wetland/Riverine	Declining			Y	Y
Phalacrocorax carbo	Māpunga/black shag	Lake/Wetland/Riverine	Relict			y	y
Microcarbo melanoleucos	Kawaupaka/little shag	Lake/Wetland/Riverine	Relict			y	y
Fulica atra	Australian coot	Lake/Wetland/Riverine	Naturally uncommon			Y	Y

81. A competent survey would require:

- Landscape-scale searches to identify territorial and mobile species.
- Multiple seasonal surveys to capture changing patterns of habitat use.
- Targeted breeding surveys for ground-nesting birds.
- Nocturnal monitoring to assess collision risk and night-time use.

82. The current assessment fails to meet these basic standards and, as a result, underestimates both the ecological significance and the potential risks posed by the proposed development to indigenous avifauna of the Tekapo–Haldon outwash system.

INVERTEBRATE ASSESSMENT

83. Given the well-documented ecological significance of the Mackenzie Basin's outwash ecosystems for invertebrates, the complete omission of an invertebrate survey from the assessment represents a major deficiency in the applicant's ecological evaluation. The failure to assess invertebrates disregards a key component of the ecosystem's

biodiversity and conservation value, particularly in an environment known to support nationally threatened and endemic taxa.

84. The Haldon outwash provides good habitat for the Tekapo ground wētā (Nationally Critical), the endangered robust grasshopper and short horned grasshopper, and other dryland specialists. It provides the same physical and vegetative characteristics to areas where these species have been confirmed. It is therefore scientifically untenable to assume their absence without targeted investigation. Standard ecological assessment protocols for inland drylands, particularly in the Mackenzie Basin, require at least reconnaissance-level invertebrate surveys where suitable habitat is present. The lack of such work prevents any credible assessment of potential effects, or the adequacy of mitigation measures and directly undermines the comprehensiveness of the ecological evaluation.

85. This omission also indicates a lack of specialist ecological input. A competent assessment team with appropriate expertise in the Basin's ecology would have recognised the high likelihood of threatened invertebrate occurrence and the need for targeted sampling. The failure to include even a preliminary survey suggests that the ecological investigation was incomplete and does not meet best-practice standards for environmental assessment in a nationally significant ecosystem.

LIZARD ASSESSMENT

86. The lizard assessment has several methodological limitations and does not fully align with accepted best-practice standards for herpetofauna survey and evaluation. No reference was made to the Department of Conservation (DOC) Herpetofauna Database, which is the largest repository of herpetofaunal records nationally, available on request and generally considered a key component of the desktop assessment phase. The absence of this information limits the contextual understanding of likely species presence, conservation status, and the potential ecological significance of the site. A more thorough desktop review would likely have identified the presence of Threatened and At-Risk lizard taxa in the wider area, information that should have informed the evaluation of ecological values and significance

87. The field methods applied also appear to depart from recommended survey protocols[45]. The pitfall traps used were undersize and are unlikely to be effective for detecting skinks or geckos[46]. In addition, it is unclear whether a wildlife permit was held, which raises questions regarding compliance with the Wildlife Act 1953. While it is stated that a permit was unnecessary because surveyors were not "handling" lizards, the removal of animals from traps would necessitate handling and therefore requires a wildlife permit.

88. The assessment also employs outdated taxonomic terminology. For example, the term "common skink" is no longer a valid species name following taxonomic revisions made more than a decade ago[47].

89. The use of "sand strips" to detect animal tracks is not a recognised or reliable method for lizard surveys. If the intent was to determine lizard presence rather than species-level identification, established techniques such as tracking tunnels or artificial refuges would have provided more reliable data and could have been implemented in a cost-effective manner, subject to appropriate permitting[48].

90. Taken together, these issues mean that the assessment provides a limited basis for evaluating lizard diversity, distribution, and ecological values at the site. Further work consistent with accepted professional standards would be required to provide a more robust and defensible assessment.

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[45] Lettink & Whitaker 2004; DOC 2019

[46] Hare, KM. 2012. Herpetofauna: pitfall trapping (version 1.0). In Greene T & McNutt K (editors) 2012. Biodiversity Inventory and Monitoring Toolbox. Department of Conservation, Wellington, New Zealand. http://www.doc.govt.nz/biodiversitymonitoring/

[47] Chapple, D.G.; Bell, T, P; Chapple, S, N, J; Miller, K, A; Daugherty, C. H; Patterson, g. B. 2011. Phylogeography and taxonomic revision of the New Zealand cryptic skink (*Oligosoma inconspicuum*; Reptilia: Scincidae) species complex. Zootaxa 2782:1-33.

Hitchmough, R.A., et al. (2023). Conservation status of New Zealand reptiles, 2021. New Zealand Threat Classification Series. DOC, Wellington.

[48] Lettink M, Young J, Monks JM. Comparison of footprint tracking and pitfall trapping for detecting skinks. New Zealand Journal of Ecology. 2022 Jan 1;46(2):1-5.

SIGNIFICANCE ASSESSMENT

91. The assessment presented is fundamentally flawed, both methodologically and conceptually, and is inconsistent with contemporary ecological understanding and the established Environment Court findings relating to the exceptional ecological values of the Mackenzie Basin. Its conclusions that the site is not a Significant Natural Area (SNA) and that effects of the proposed solar farm will be "very low", are unsound, unsupported by evidence, and contrary to accepted professional and statutory approaches to ecological significance assessment in New Zealand.

92. The assessment incorrectly cites the exemption in the National Policy Statement for Indigenous Biodiversity[49] as a rationale for not assessing significance. The NPS-IB clause relating to renewable electricity generation activities do not nullify the need to assess significance under the Resource Management Act 1991 (RMA) or district and regional plans. Section 6(c) of the RMA imposes a mandatory obligation to recognise and provide for the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna, irrespective of the proposed activity type. The failure to undertake a full significance evaluation under standard criteria (representativeness, rarity/distinctiveness, diversity/pattern, and ecological context) is therefore a serious technical omission.

93. The report's claim that the Mackenzie Basin's dryland outwash vegetation has "low ecological value" is demonstrably out of step with the last two decades of peer-reviewed research and multiple Environment Court determinations (e.g. PC13,[50] Environmental Defence Society Inc v Mackenzie District Council,[51] and the recent interim decision in PC18[52]). These decisions consistently recognise the ecological significance of the Basin's semi-arid outwash ecosystems owing to their national rarity, providing strongholds for multiple threatened taxa including Basin endemic species, and the wider context of the ongoing decline of indigenous biota.

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[49] https://environment.govt.nz/assets/publications/NPSIB-amended-october-2024.

[50] *Federated Farmers of New Zealand Inc v Mackenzie District Council* [2017] NZEnvC 53

[51] *Environmental Defence Society Inc v Mackenzie District Council* [2016] NZEnvC 253

[52] *The Royal Forest and Bird Protection Society of New Zealand Inc and others v Mackenzie District Council* [2025] NZEnvC 125

94. The vegetation and fauna assessments are methodologically inadequate for detecting cryptic or sparsely distributed threatened species. Surveys were undertaken over limited seasonal windows, with no targeted searches or habitat-specific stratification for At -Risk taxa known from similar habitats (e.g., *Carmichaelia nana, Lepidium sisymbrioides, Myosurus minimus, Raoulia monro*i etc). The conclusion that threatened species are "widespread elsewhere" is ecologically meaningless without quantitative regional abundance or occupancy data, nor is it relevant to the significance assessment of the Haldon site. As a result, the survey is likely to have significantly under-detected threatened and characteristic dryland flora, leading to a substantial underestimation of significance.

95. The report's reasoning that the site "no longer comprises a natural indigenous community" is ecologically incorrect. Modification by grazing or the presence of exotic species does not negate ecological significance under either the Canterbury Regional Policy Statement or the Mackenzie District Plan. Both frameworks recognise that even highly modified dryland ecosystems can retain significant representativeness, rarity, distinctiveness and ecological context, particularly where they occur on originally rare ecosystems such as glacial outwash surfaces. By dismissing significance solely on "naturalness" based on an unrealistic historical baseline the assessment ignores these critical and legally established principles.

96. Assertions that indigenous values are "adequately represented" in nearby conservation areas are factually and conceptually flawed. The extent of legally protected outwash ecosystems remains relatively small and fragmented; the presence of similar landforms elsewhere does not mitigate the loss of habitat at this site. Moreover, the Haldon outwash forms the lower component of a contiguous ecological corridor connecting the Tekapo River system to the wider Basin floor, and for which similar examples have been lost to development, a context that substantially elevates its ecological significance of the Haldon site.

97. Large sections of the assessment introduce irrelevant debates, such as proposed definitional changes in the Mackenzie District Plan and speculative commentary on the validity of At-Risk classifications, which have no bearing on the actual ecological

significance of the site. These diversions obscure the central fact that the site, on its ecological merits, meets multiple established criteria for significance. Extended focus on mouse-ear hawkweed (*Pilosella officinarum*) is also misplaced. The claim that hawkweed is the key driver of indigenous species loss has been clearly disproven.[53] Evidence shows that mouse-ear hawkweed is not a major driver of indigenous species loss, including post-grazing recovery studies that show indigenous vegetation recovery regardless of hawkweed cover.[54]

98. In summary, the assessment's dismissal of the Haldon solar site's significance and its minimisation of effects are scientifically wrong, procedurally deficient, and inconsistent with both statutory obligations and Environment Court precedent. Despite flawed methodology likely to have under-recorded threatened species, the site clearly meets multiple significance criteria, particularly representativeness, rarity, and ecological context for semi-arid outwash ecosystems. It supports at least four At Risk – Declining plant species and forms part of a nationally rare and threatened ecosystem type of very limited extent. The proposed solar development would therefore cause a major loss of indigenous dryland habitat and significantly compromise the ecological integrity and connectivity of the Tekapo outwash system.

COMMENTS ON EFFECTS

99. The conclusion that the proposed solar development will have "very low" or "temporary" ecological effects is indefensible. The construction and operation of solar infrastructure across several hundred hectares of fragile dryland habitat will cause extensive and enduring modification to the physical environment, vegetation, and fauna. These dryland ecosystems are inherently vulnerable to disturbance, being characterised by low

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[53] Walker, S. 2024, Rebuttal evidence for PC 18, showed that the applicants' conclusions regarding mouse-ear hawkweed are erroneous. They rely on selective, incomplete, and methodologically unreliable data. Key data, such as the MBGT, that showed opposite trends were omitted, historical survey plots were misattributed, and unpublished or unverifiable numbers were presented without context. Many cited surveys (Connor 1960s, PNAP 1980s) were unreplicated, imprecisely located, and too few to generalise across the Mackenzie Basin outwash plains. Consequently, claims about hawkweed impacts are misleading, unsubstantiated, and contradicted by replicated, verifiable studies such as those at Lake Tekapo Scientific Reserve that clearly show the recovery of native species.

[54] Walker S, Comrie J; Head N, Ladley KJ, Clarke D, Monks A 2016. Hawkweed invasion does not prevent indigenous non-forest vegetation recovery following grazing removal. NZ Journal of Ecology 40: 137–149

productivity, sparse vegetation, and highly specialised flora and fauna adapted to open, high-light, and low-moisture conditions.

100. Ground disturbance during site preparation and construction, such as grading, piling, trenching, and the movement of heavy machinery, will compact soils. The installation of panel foundations, cable trenches, and access tracks will fragment the ecosystem, destroy existing indigenous biota, and disrupt natural soil processes and habitats that support native vegetation, birds, invertebrates and lizards.

101. The introduction of extensive panel arrays will substantially modify surface microclimates. Shading reduces solar radiation at ground level, altering diurnal temperature cycles and soil moisture dynamics. In arid and semi-arid systems, these changes suppress native dryland (xerophytic) plants adapted to full sunlight and promote disturbance-tolerant or exotic species[55]. Reduced ground temperatures and altered evapotranspiration rates beneath panels have been shown in comparable dryland solar installations to result in major declines in native plant cover, richness, and recruitment[56].

102. Empirical evidence from international studies in Mediterranean and desert ecosystems consistently demonstrates that solar developments in drylands cause lasting reductions in native plant and invertebrate diversity[57]. Vegetation recovery beneath and adjacent to arrays is typically poor, even decades after installation, due to loss of seed banks, soil compaction, and the establishment of competitive exotic grasses or herbs. Invertebrate communities, particularly ground-dwelling taxa

[55] Hernandez, R.R., Easter, S.B., Murphy-Mariscal, M.L., Maestre, F.T., Tavassoli, M., Allen, E.B., et al. (2014). Environmental impacts of utility-scale solar energy. Renewable and Sustainable Energy Reviews, 29, 766–779.

[56] Lovich, J.E., & Ennen, J.R. (2011). Wildlife conservation and solar energy development in the desert Southwest, United States. BioScience, 61(12), 982–992. & Hernandez, R.R., Hoffacker, M.K., & Field, C.B. (2015). Land-use efficiency of big solar. Environmental Science & Technology, 49, 12587–12594

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dependent on open, sunlit conditions, are displaced or eliminated[58]. These effects in turn adversely affect insectivorous birds and reptiles that rely on open-ground prey availability and thermoregulatory basking habitats.

103. The proposed solar arrays would create a substantial physical and ecological barriers within a formerly continuous dryland landscape. The dense configuration of panels, and service roads, would sever linkages between adjacent patches of remnant habitat, impeding movement and species habitat use and dispersal. The resulting loss of connectivity would further isolate remaining habitat fragments, undermining metapopulation viability and ecological function across the wider landscape. Once established, these barriers would be effectively permanent for the lifespan of the infrastructure and would represent a significant fragmentation of an already rare and threatened ecosystem.

104. The assertion that vegetation will “recover” (limited in the Ecological Assessment to “introduced resident vegetation”)[59] following construction does not apply to indigenous vegetation. Natural recovery in these ecosystems is extremely slow and dependent on intact natural habitats, including undisturbed soil and seed banks, both of which would be destroyed[60]. The proposed development would therefore result in a major and largely irreversible loss of habitat, compromising both the structure and functioning of the dryland ecosystem and the ecological connectivity of the wider landscape.

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[58] Carabid beetles in solar parks: assemblages under solar panels are severely impoverished compared to gaps between panel rows and edge areas. (2024). *Journal of Insect Conservation.* Springer Nature. https://doi.org/10.1007/s10841-024-00597-w

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[59] AEE Appendix 7 – Ecological Assessment at pp 43-44

[60] Hernandez, R.R., Easter, S.B., Murphy-Mariscal, M.L., Maestre, F.T., Tavassoli, M., Allen, E.B., et al. (2014). Environmental impacts of utility-scale solar energy. Renewable and Sustainable Energy Reviews, 29, 766–779. & Lovich, J.E., & Ennen, J.R. (2011). Wildlife conservation and solar energy development in the desert Southwest, United States. BioScience, 61(12), 982–992.

105. In summary, the assessment's dismissal of the Haldon solar site's significance and its minimisation of effects are scientifically wrong, procedurally deficient, and inconsistent with both statutory obligations and Environment Court findings. Despite flawed methodology likely to have under-recorded threatened species, the site clearly meets multiple significance criteria, particularly representativeness, rarity, and ecological context for semi-arid outwash ecosystems. It supports at least four At-Risk (Declining) plant species and forms part of a nationally rare and threatened ecosystem type of very limited extent. The proposed solar development would therefore cause a major loss of indigenous dryland habitat and significantly compromise the ecological integrity and connectivity of the nationally significant Tekapo outwash ecosystem.

SUBSEQUENT INDEPENDENT FIELD SURVEY FINDINGS

106. Since the preparation of the applicant's ecological assessment and its critique above, a field visit of the site was undertaken representatives from DOC and ECan in November 2025. Although this visit was limited in scope and not intended to be a comprehensive or seasonally representative survey, it nonetheless recorded the presence of threatened indigenous plant species and indigenous invertebrates, as well as observations of banded dotterels utilising the site, including nesting. The detection of threatened and at-risk species during a relatively constrained survey effort indicates that the site supports greater ecological values and biodiversity than has been recognised in the applicant's assessment. These findings reinforce concerns raised above regarding the adequacy of the baseline ecological assessments, particularly in relation to cryptic and seasonal species that are easily overlooked without appropriately timed and methodologically robust survey efforts. While further survey work would be required to fully characterise species presence, abundance, and habitat use, the results of this recent survey demonstrate that ecological values of conservation significance are present and that uncertainty remains.

COMMENTS ON APPLICANT'S RESPONSE TO PANEL MINUTE

[19] There is an adjacent solar farm fast-track application, and at least one other possible nearby. Have cumulative effects been considered?

107. I do not agree with the applicant's conclusion that cumulative ecological effects will be negligible. The assessment of ecological values at the Haldon site is inadequate and, when combined with an apparent understatement of the site's ecological significance, materially constrains the applicant's ability to provide an objective and robust evaluation of the full extent of adverse effects. In particular, the failure to properly characterise baseline ecological values undermines subsequent conclusions regarding both scale and significance of effects.

108. It is my view that the establishment of solar panel infrastructure across dryland habitats represents a substantial net loss of indigenous habitat area. This includes the direct loss of known habitats for nationally threatened and at-risk taxa, the degradation and displacement of habitat utilised by indigenous fauna, including dryland-adapted bird species such as banded dotterel. Habitat loss in this context is not limited to the physical footprint of panel arrays, but also includes functional habitat degradation associated with shading, altered microclimates, access tracks, fencing, and increased human activity.

109. The proximal Ohau Point site occurs within the same broad ecological envelope as the Haldon site. Ecologically it is comparable, except that much of the Ohau Point site has been more heavily modified by attempted agricultural intensification through cultivation and/or direct drilling. Nevertheless, it retains residual ecological values for dryland indigenous biodiversity, including supporting large considerable numbers of banded dotterels[61]. These residual values are ecologically significant given the context of ecological rarity and loss of dryland habitats.

110. When considered collectively, the development of two large-scale solar farms near each other and on similar dryland habitats, and adjoining prime bird habitats of braided rivers, wetlands and a lake of high bird usage, results in a considerable cumulative loss of habitat, both in terms of area and ecological function. The combined effects of the loss of hundreds of hectares of habitat, ecological fragmentation and reduced connectivity, and disturbance, will further diminish the availability of suitable

[61] Pers Com Mr Harding, ecologist for DOC.

habitat for threatened and at-risk species within an already constrained ecological setting. In my view, these cumulative effects are significant and have not been adequately identified, assessed, or addressed in the applicant's ecological assessment.

Ecology Issues

[23] Please provide further information on the suite of nationally threatened or at-risk flora or fauna that are potentially present but that were not detected.

[24] Please provide additional commentary on the adequacy of survey methodology and level of effort and the corresponding likelihood that the full suite of notable flora or fauna was detected – noting that many species are cryptic and/or only present seasonal.

111. I disagree with the applicant's claim that their baseline ecological survey was "one of the most comprehensive surveys undertaken" and that, given the degraded condition of the terrace and the combined AgScience and DOC effort, "the likelihood that a material population within the footprint was overlooked is very low."

112. The applicant's survey methodology was inadequate for the reasons outlined earlier in my evidence. Consequently, there is a high likelihood that a substantial proportion of indigenous species present at the Haldon site were not detected. This conclusion is reinforced by a subsequent Department of Conservation field visit, which, although limited to a brief reconnaissance and not intended to be comprehensive or seasonally representative, nonetheless recorded additional threatened taxa not identified by the applicant, including the nationally critical inland cress (*Lepidium solandri*) and a notable population of the endemic and endangered short-horned grasshopper (*Sigaus minutus)*. The detection of these species during such a constrained survey underscores both the uncertainty inherent in the applicant's assessment and the very high likelihood that the full extent of indigenous biodiversity at the site has not been adequately identified or accounted for.

113. The applicant's reliance on the "degraded condition" of the Haldon terrace as an indicator of limited ecological value is ecologically unsound. Many Threatened and

At-Risk dryland species characteristically occupy sparsely vegetated, disturbed, or open habitats, and their presence is often independent of conventional measures of vegetation integrity. Accordingly, habitat modification and apparent degradation cannot be used as a reliable proxy for the absence of conservation-significant species, as evidenced by the subsequent recording of threatened taxa overlooked by the applicant.

114. Further undermining confidence in the ecological assessment, there are instances of species misidentification within the applicant's field survey. These errors raise additional concern that both species richness and conservation significance have been systematically underestimated, and that the assessment cannot be relied upon to accurately characterise the ecological values of the site.

[25] Please comment on the assessment of effects methodology and how conclusions on the level of effect were reached in relation to impacts on nationally threatened or at risk flora and fauna, with particular focus on: a) How the assessment factored in the likely or potential presence of nationally threatened or at risk species; b) How the interplay between threat status and magnitude of effects was addressed to arrive at a level of effect;

115. The applicant's assertion that the overall ecological effects of the project will be "Very Low" is fundamentally flawed, as it is based on an incomplete and understated assessment of baseline ecological values and an inadequate consideration of cumulative effects. The applicant does not remedy the fundamental deficiencies in their ecological assessment. Their conclusions regarding ecological value and magnitude of effects are not supported by adequate field data, misapply accepted ecological assessment frameworks, and fail to consider the correct ecological context within which the site must be assessed.

116. Furthermore, recent reconnaissance-level surveys undertaken independently of the applicant have already demonstrated that threatened and at-risk species were present but previously undetected, directly confirming that the applicant's survey effort was insufficient and that their conclusions are unreliable.

117. The loss or degradation of habitat for nationally Threatened or At-Risk species cannot be characterised as a negligible effect simply because those species occur at low density. Low density is typically a defining characteristic of threatened taxa. The applicant's supporting arguments for negligible magnitude are flawed for the following reasons:

"Highly modified vegetation"

118. Vegetation modification does not equate to low ecological value. The Mackenzie Basisn's modified dryland and outwash ecosystems are nationally significant for indigenous species, especially threatened plants, and endemic invertebrates. The presence of threatened taxa demonstrates that the site retains functional ecological value irrespective of vegetation cover metrics.

"Small footprint relative to extensive surrounding habitat"

119. This assertion lacks evidential support. The applicant has failed to assess the correct ecological context. The applicant's narrow focus on local vegetation condition and footprint size ignores the broader pattern of ongoing habitat loss and degradation in the basin and regionally, leading to systematic undervaluation of residual ecological values. The applicant also has not demonstrated that "thousands of hectares of similar or better habitat" are available, secure, or functionally equivalent. In the national context and regional context, lowland and terrace dryland ecosystems have been disproportionately lost and fragmented, making the 'protection' of those remaining a national priority. Ecosystem rarity, significant habitats and species present, and cumulative loss, are central considerations that the applicant has failed to address.

"Very low densities of At-Risk species"

120. Low densities increase, rather than diminish, ecological sensitivity. Small populations are inherently vulnerable to incremental habitat loss, and even modest developments can result in disproportionate adverse effects at the population scale.

Incorrect application of the EIANZ effects framework

121. The conclusion that a "negligible magnitude" acting on "negligible–moderate ecological value" results in a "Very Low" effect is not supported by the evidence. Where ecological value has been underestimated due to inadequate survey data, the resulting effects rating is inherently invalid. Under the EIANZ framework, uncertainty and data deficiency should lead to more conservative effect ratings, not lower ones.

[26] In broad terms please provide comment on how the application has demonstrated best endeavours to ensure the protection and maintenance of habitat that meets criteria for ecological significance in accordance with the relevant policies and objectives in the Canterbury Regional Policy Statement.

122. Collectively, the measures advanced by the applicant do not demonstrate best endeavours to protect and maintain ecologically significant habitat in accordance with the Canterbury Regional Policy Statement (CRPS). They are founded on an incomplete understanding of ecological values, prioritise development outcomes over avoidance, and rely on mitigation and enhancement measures that do not account nor compensate for the loss of significant indigenous biodiversity. As such, the application does not meet the intent or requirements of the relevant CRPS objectives and policies.

123. While the applicant cites avoidance, footprint refinement, targeted protection, and enhancement, these measures are largely reactive, conditional, or reliant on incomplete ecological information, and do not satisfy the CRPS requirement to first accurately identify, then avoid and protect, ecologically significant indigenous biodiversity.

124. **Avoidance** - The claim that the solar farm avoids ecologically significant habitat by locating development on a "highly modified outwash terrace" is incorrect. As addressed elsewhere, the ecological assessment underpinning this conclusion is inadequate and has demonstrably failed to detect threatened indigenous species and invertebrates known to occupy modified dryland and outwash systems. The presence of such species confirms that the site retains ecological significance irrespective of its modified condition. Avoidance cannot be credibly claimed where the extent, distribution, and function of significant habitat have not been properly identified.

125. **Footprint refinement-** Measures such as limiting panel coverage, retaining a panel-free transmission corridor, and applying setbacks do not constitute protection or maintenance of ecologically significant habitat. These design responses were developed without a reliable understanding of ecological values and therefore cannot be assumed to avoid or safeguard significant ecosystems. Fragmentation, shading, altered microclimates, and disturbance effects extend well beyond the physical footprint of panels and are not addressed by partial coverage or spatial exclusions.

126. **Targeted protection** - The proposed avoidance, management, or translocation of Threatened and At-Risk plants identified through limited DOC survey work does not represent best endeavours. Reliance on post-hoc discovery and mitigation of threatened species is inconsistent with CRPS policy direction, which prioritises avoidance of adverse effects on significant indigenous biodiversity. Seed collection or translocation is a last-resort measure and has a high probability of failure. It does not maintain the integrity, function, or ecological context of indigenous habitat in-situ.

127. The assertion that ecological values would otherwise continue to be lost in the absence of the solar farm is speculative and not supported by evidence. It does not justify the permanent loss or degradation of significant indigenous biodiversity and is not a substitute for policy-compliant protection. I have outlined the recovery of dryland ecosystems in my evidence.

128. **Enhancement** - Proposed enhancement within transmission corridors, road setbacks, or through contributions to off-site wetland restoration does not offset the loss or degradation of ecologically significant dryland ecosystems at the site. Enhancement measures are ancillary and discretionary, lack detailed design and long-term security, and do not address the CRPS requirement to protect representative and at-risk ecosystems where they currently exist.

[27] In addition, please outline potential options for addressing ecological effects, including (but not limited to) trade-up compensation, should this be considered necessary.

129. The approach described by the applicant underestimates ecological risk, misapplies evidence, and does not demonstrate compliance with the CRPS requirement to protect significant indigenous biodiversity. Avoidance and protection, rather than speculative adaptive responses, are required.

130. The applicant's proposed "monitor - respond" framework is inadequate and inconsistent with best-practice ecological management for several reasons. First, the premise that ecological effects are poorly documented in New Zealand and that overseas studies show only modest or positive impacts misrepresents the evidence. Overseas studies also document clear negative effects on dryland ecosystems, including loss of native herbs, altered soil microclimates, reduced invertebrate diversity, and habitat fragmentation, such effects that are highly relevant to New Zealand dryland systems.

131. Second, adaptive management frameworks cannot substitute for avoidance or protection where baseline surveys are incomplete. The applicant's surveys are insufficient to detect cryptic or low-density native species, meaning that any post hoc monitoring is unlikely to prevent permanent loss. Under the Canterbury Regional Policy Statement (CRPS, Objective 5.3.1; Policy 5.3.2), ecologically significant indigenous biodiversity must be protected and maintained in-situ, with avoidance prioritised over mitigation or enhancement. Reliance on later interventions, such as supplemental seeding, predator exclosures, or offsite contributions, does not meet this obligation.

132. Finally, the claim that compensation is unnecessary because predicted effects are "Very Low" is untenable, as the effect rating itself is based on incomplete and flawed ecological data. Permanent coverage by solar panels will result in the loss of habitats for threatened species that cannot be offset by the proposed measures. Enhancement or monitoring cannot restore the integrity, connectivity, or ecological function of dryland terraces once lost.

[redacted]

Nicholas Head

22 January 2026

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Appendix 1: Current threatened plant list for the Mackenzie Basin

Species 2023 Revision	Threat Rank	2018 rank	Primary Habitat	Mackenzie stronghold
Cardamine mutabilis	Nationally Critical		kettleholes	stronghold
Carex albula	Nationally Critical	N. Vulnerable	moraine and outwash	stronghold
Carmichaelia curta	Nationally Critical		moraine erratics	stronghold
Ceratocephala pungens	Nationally Critical		outwash	stronghold
Chenopodium detestans	Nationally Critical		kettleholes	stronghold
Crassula peduncularis	Nationally Critical		kettleholes	
Epilobium pictum	Nationally Critical		moraine erratics	
Lagenophora schmidiae	Nationally Critical		kettleholes	
Lepidium solandri	Nationally Critical		outwash	stronghold
Leptinella conjuncta	Nationally Critical		outwash	stronghold
Carex cirrhosa	Nationally Endangered		kettleholes	
Chaerophyllum colensoi var. delicatulum	Nationally Endangered		kettleholes	
Crassula multicaulis	Nationally Endangered		kettleholes	
Dysphania pusilla	Nationally Endangered		outwash	stronghold
Hypericum rubicundulum	Nationally Endangered		kettleholes	
Pachycladon cheesemanii	Nationally Endangered		moraine erratics	
Ranunculus brevis	Nationally Endangered		kettleholes	
Senecio dunedinensis	Nationally Endangered		moraine erratics	
Sonchus aff. novae-zelandiae (a) (CHR 517718; "grassland")	Nationally Endangered	N. Vulnerable	moraine and outwash	stronghold
Triglochin palustris	Nationally Endangered	N. Critical	wetlands	stronghold
Veronica cupressoides	Nationally Endangered		shrublands	stronghold
Wurmbea novae-zelandiae	Nationally Endangered		kettleholes	stronghold
Achnatherum petriei	Nationally Vulnerable		moraine and outwash	stronghold
Carex capillacea	Nationally Vulnerable	New record for Basin	wetlands	

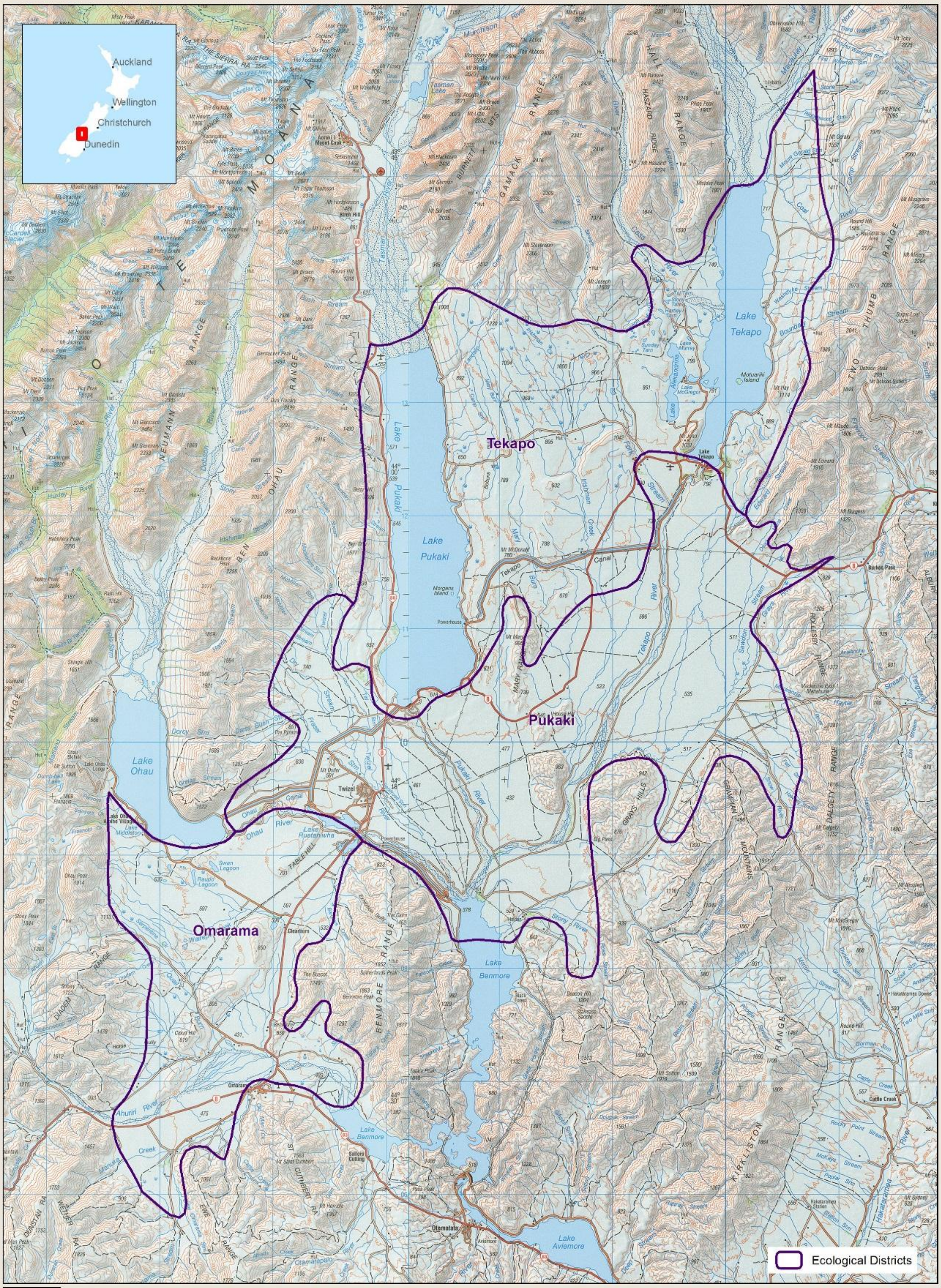
Carmichaelia corrugata	Nationally Vulnerable		outwash	
Carmichaelia crassicaulis subsp. crassicaulis	Nationally Vulnerable	Declining	moraine and outwash	stronghold
Carmichaelia kirkii	Nationally Vulnerable		shrublands	stronghold
Carmichaelia nana	Nationally Vulnerable		outwash	stronghold
Centrolepis glabra	Nationally Vulnerable	New record for Basin, was naturally uncommon	kettleholes	
Luzula celata	Nationally Vulnerable		kettleholes	stronghold
Myosotis brevis	Nationally Vulnerable		outwash	stronghold
Myosotis uniflora	Nationally Vulnerable		outwash	stronghold
Olearia fimbriata	Nationally Vulnerable		shrublands	
Pimelea sericeovillosa subsp. pulvinaris	Nationally Vulnerable		outwash	stronghold
Rytidosperma telmaticum	Nationally Vulnerable	Declining	kettleholes	stronghold
Aceana buchananii	Declining		moraines and outwash	stronghold
Aciphylla subflabellata	Declining		wetlands	
Amphibromus fluitans	Declining	N. Vulnerable	kettleholes	stronghold
Anthosachne falcis	Declining		outwash	stronghold
Asplenium subglandulosum	Declining	N. uncommon	moraine erratics	
Botrychium australe	Declining		moraine and outwash	
Carex buchananii	Declining		wetlands	
Carex decurtata	Declining	Data Def.	outwash	stronghold
Carex kaloides	Declining	Missed 2018	wetlands	
Carex muelleri	Declining	New ranking	moraines	stronghold
Carex resectans	Declining	New ranking	outwash	stronghold
Carex rubicunda	Declining	N. Vulnerable	kettleholes	
Carex talbotii	Declining		kettleholes	stronghold
Carex tenuiculmis	Declining		wetlands	

Carmichaelia australis	Declining	New ranking	shrublands	
Carmichaelia monroi	Declining	Could be C. vexillata	moraines	
Carmichaelia petriei	Declining		shrublands	stronghold
Carmichaelia uniflora	Declining		outwash	stronghold
Carmichaelia vexillata	Declining		moraine and outwash	stronghold
Chenopodium allanii	Declining	N.Uncommon	shrublands	
Colobanthus brevisepalus	Declining	Data def.	outwash	stronghold
Connorochloa tenuis	Declining		moraine and outwash	
Convolvulus verecundus f. verecundus	Declining	N. Vulnerable	outwash	stronghold
Coprosma brunnea	Declining	new record in basin	outwash	
Coprosma intertexta	Declining		shrublands	stronghold
Coprosma virescens	Declining		moraine	
Deschampsia cespitosa	Declining		wetlands	stronghold
Echinopogon ovatus	Declining	New ranking	moraine	
Epilobium angustum	Declining	N. uncommon	kettleholes	stronghold
Epilobium billardiereanum	Declining	New ranking	kettleholes	
Epilobium chionanthum	Declining	New ranking	wetlands	
Hypericum involutum	Declining		moraine	
Korthalsella clavata	Declining		shrublands	
Leptinella maniototo	Declining	Relict	kettleholes	stronghold
Leptinella pusilla	Declining	Added to basin list	outwash	
Leptinella serrulata	Declining		outwash	
Leucopogon nanum	Declining		outwash	stronghold
Lobelia ionantha	Declining		kettleholes	stronghold
Luzula ulophylla	Declining		outwash	stronghold

Mentha cunninghamii	Declining	Added to basin list	wetlands	
Montia angustifolia	Declining		kettleholes	stronghold
Muehlenbeckia ephedroides	Declining	N. Vulnerable	outwash	
Myosurus minimus subsp. novae-zelandiae	Declining	N. Vulnerable	kettleholes	stronghold
Olearia lineata	Declining		shrublands	
Olearia odorata	Declining	New ranking	shrublands	stronghold
Poa maniototo	Declining	New ranking	kettleholes	stronghold
Pterostylis tanypoda	Declining		moraine and outwash	stronghold
Pterostylis tristis	Declining		moraine and outwash	stronghold
Raoulia australis	Declining		outwash	stronghold
Raoulia beauverdii	Declining		outwash	stronghold
Raoulia monroi	Declining	N. Vulnerable	outwash	stronghold
Raoulia parkii	Declining		outwash	stronghold
Rytidosperma buchananii	Declining		moraine and outwash	
Rytidosperma exiguum	Declining		moraine and outwash	stronghold
Rytidosperma merum	Declining		moraine and outwash	
Rytidosperma thomsonii	Declining		moraine and outwash	
Sophora prostrata	Declining		moraine	
Taraxacum zealandicum	Declining	New ranking	moraine and outwash	
Veronica lilliputiana	Declining		kettleholes	stronghold
Agrostis imbecilla	Data deficient		moraines erratics	
Brachyscome longiscapa	Naturally Uncommon		kettleholes	
Centrolepis minima	Naturally Uncommon	Not listed in latest revision?	kettleholes	
Clematis quadribracteolata	Naturally Uncommon	New ranking	shrublands	
Convolvulus fractosaxosus	Naturally Uncommon		moraine	
Euchiton delicatus	Naturally Uncommon	New ranking	kettleholes	

Euchiton paludosus	Data deficient		kettleholes	
Isolepis basilaris	Naturally Uncommon	N. Vulnerable	kettleholes	stronghold
Juncus pusillus	Naturally Uncommon	Missed 2018	kettleholes	
Luzula leptophylla	Naturally Uncommon	New record for Basin	wetlands	
Pelargonium inodorum	Naturally Uncommon	New ranking	moraine and outwash	
Plantago obconica	Naturally Uncommon		kettleholes	
Ranunculus maculatus	Naturally Uncommon		wetlands	
Veronica pimeleoides subsp. faucicola	Naturally Uncommon		moraine and outwash	

Appendix 2: Maps 1 - 4



5 Kilometres

Scale at A4 = 1:300,000
NZGD 2000 New Zealand Transverse Mercator
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Map 1: Mackenzie Basin Ecological Districts

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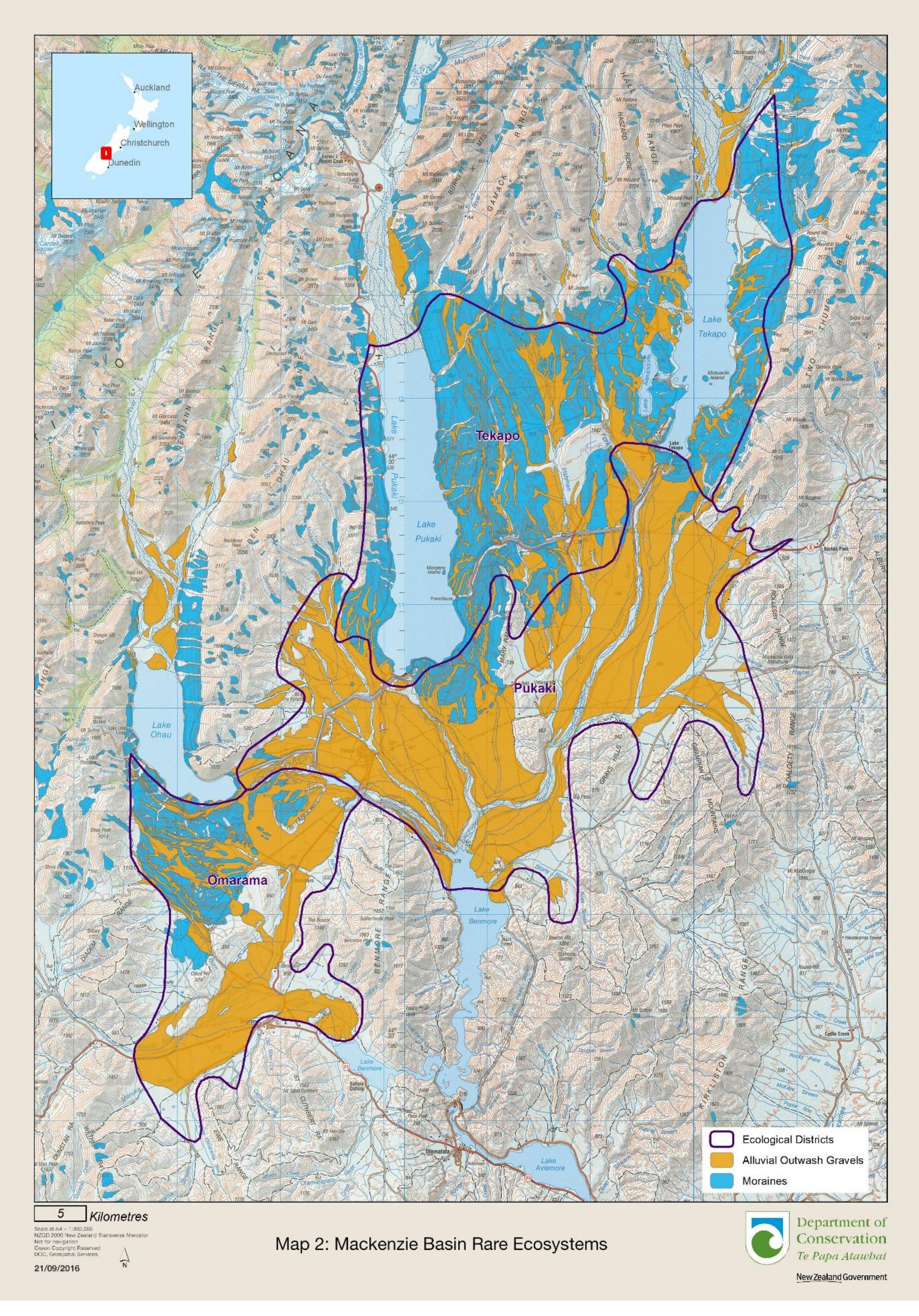
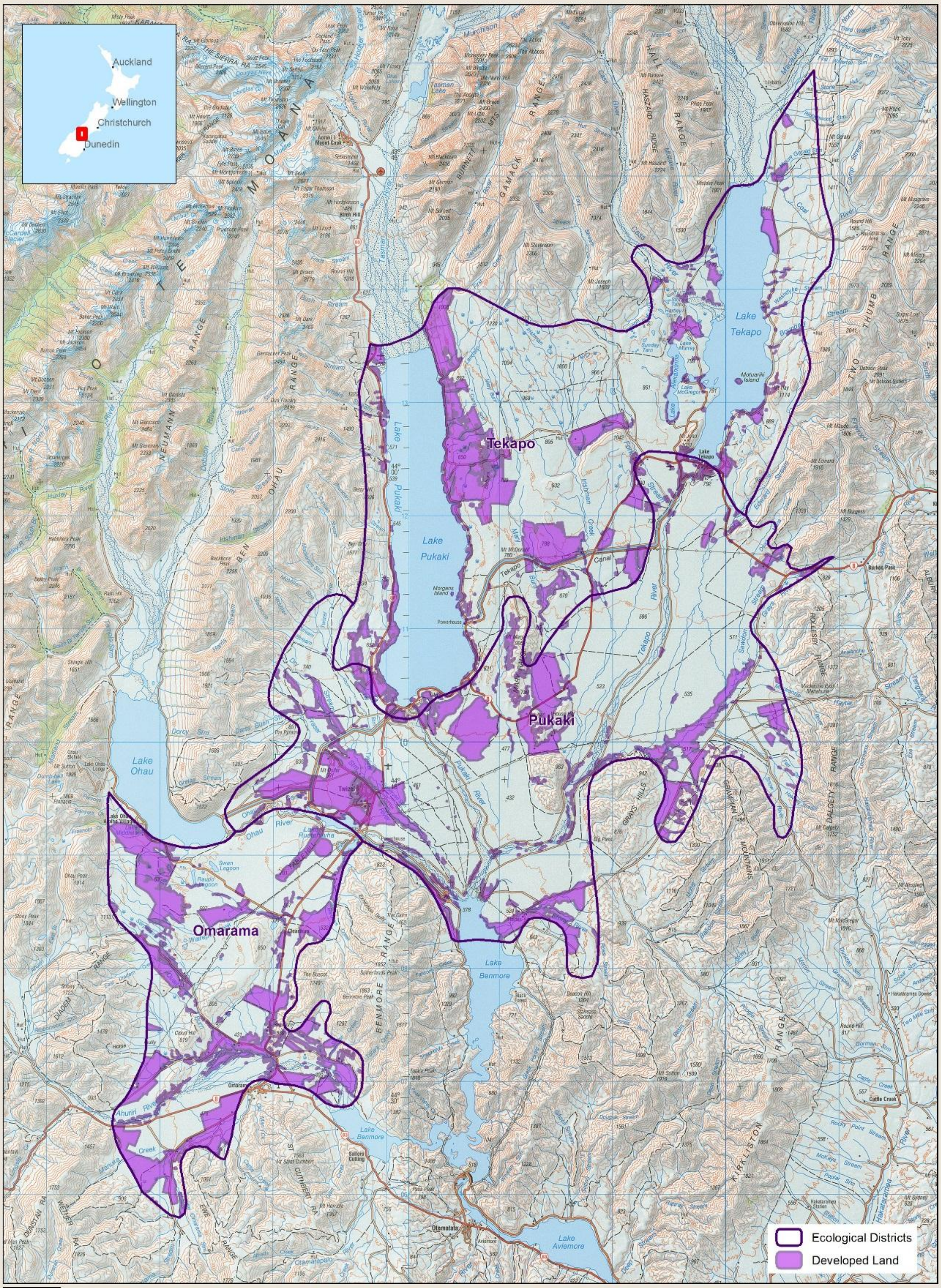
New Zealand Government



Map 2: Mackenzie Basin Rare Ecosystems



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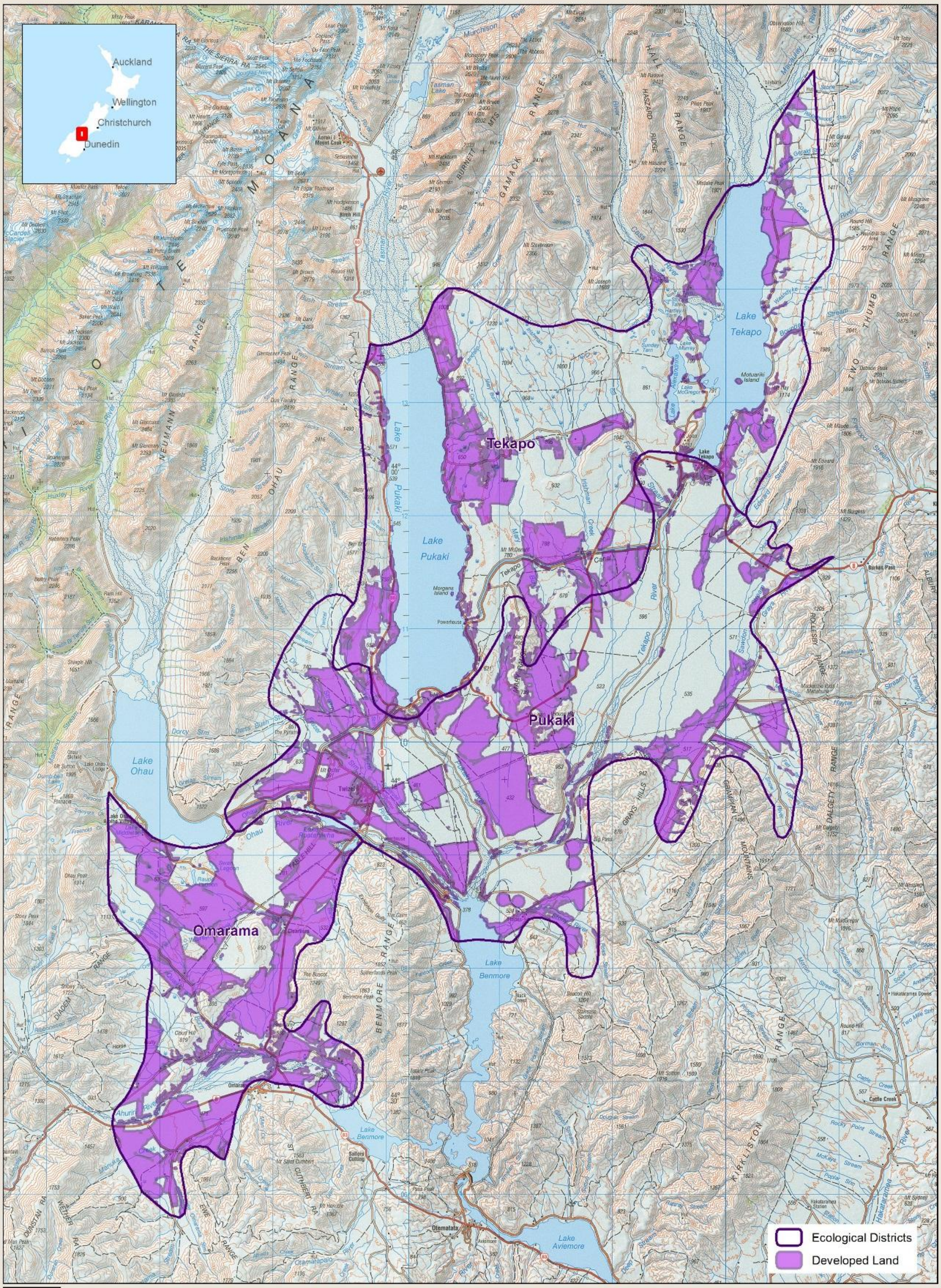
Map 3: Ecosystem Loss 2000

Department of Conservation
Te Papa Atawhai

New Zealand Government



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Map 4: Ecosystem Loss 2016

Department of Conservation
Te Papa Atawhai

New Zealand Government

Appendix 3: Images

Figure 1: Cushion Pimelea *(Pimelea sericeovillosa subsp pulvinaris)*

Figure 2: Dwarf broom (leafless) *(Carmichaelia vexillata)*

Figure 3: Inland cress *Lepidium solandri*

Figure 4: Robust grasshopper *(Sigaus robustus).*

Figure 1: Short horned grasshopper (Sigaus minutus), nationally endangered

Figure 6: Black stilt (*Himantopus novaezelandiae)* (Nationally Critical).

Figure 7: Tekapo outwash showing complex patterns of silt bars (dunes) and outwash channels (interfluves)

Figure 8: Glenmore moraines complex with multiple tarns and ephemeral wetlands (kettleholes).

Figure 9: Typical vegetation of the upper Tekapo outwash showing 'dunelands and depleted' channels' with contrasting vegetation of fescue tussock and mat plants respectively.

Figure 10: Tekapo outwash, stretching from Lake Tekapo to Lake Benmore is the largest fluvio-glacial outwash surface in New Zealand that remains largely undeveloped.

Figure 11: Tekapo Scientific Reserve vegetation study - comparison of monitoring plots in the Tekapo Scientific Reserve from 1992 – 2011 showing recovery of tussock grassland ecosystem after severe depletion.

Figure 1: Inland cress Lepidium solandri (nationally critical) growing among scabweed (Raoulia australis) at -risk declining.

Figure 2: Cushion Pimelea (Pimelea sericeovillosa subsp pulvinaris)-nationally vulnerable

Figure 3: Dwarf broom (leafless) (Carmichaelia vexillata) -nationally vulnerable

Figure 2: Robust grasshopper (Sigaus robustus). Nationally endangered endemic to the Basin

Figure 3: short horned grasshopper (Sigaus minutus), nationally endangered

Figure 4: Black stilt (Himantopus novaezelandiae) (Nationally Critical), 'endemic' to the Basin.

Figure 5 Tekapo outwash showing complex patterns of silt bars (dunes) and outwash channels (interfluves)

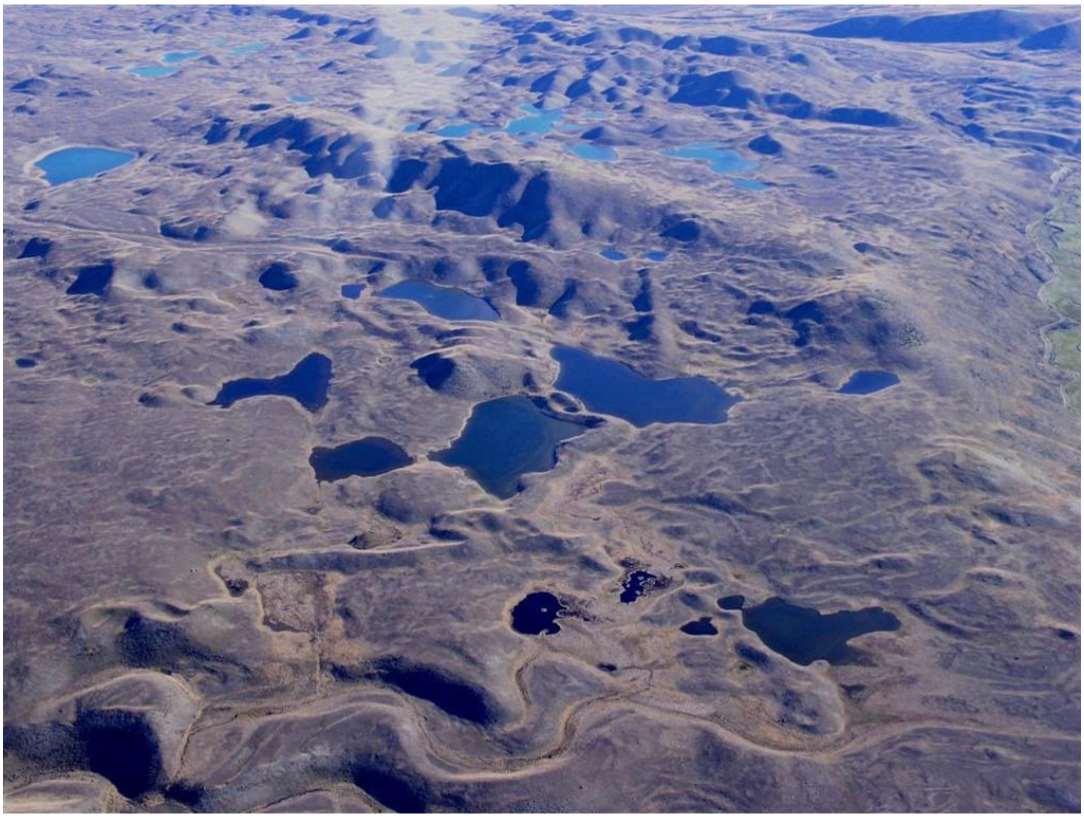

Figure 6: Glenmore moraines complex with multiple tarns and ephemeral wetlands (kettleholes) .

Figure 7: Tekapo outwash showing 'dunelands and depleted' channels' with contrasting vegetation of fescue tussock and mat plants respectively. N. Head ~2012

Figure 8: Tekapo outwash, stretching from Lake Tekapo to Lake Benmore is the largest fluvio-glacial outwash surface in New Zealand that remains largely undeveloped. (either side of the Tekapo River, in the Pukaki ED). Other similar outwash terraces south showing numerous circles from recent developments. (photo taken from ECan satellite mapping)

Figure 9: comparison of monitoring plots in the Tekapo Scientific Reserve from 1992 – 2011 showing recovery of tussock grassland ecosystem after severe depletion.