

Natural Solutions for Nature Ltd

Arrow South Special Zone – Plan Change

Ecological Assessment of Indigenous Plantings



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Prepared for:
Arrowsouth Properties Limited

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1 Introduction

1.1 Overview

Arrowsouth Properties Limited is pursuing a private plan change to the Operative District Plan Arrow South Special Zone in order to enable the subdivision and residential development of Lots 102 and 103 of DP 535793 on the eastern side of McDonnell Road (**Stage 2 Development**), adjacent to earlier subdivision (RM161093) to the north (**Stage 1 Development**).

The Stage 1 Development required the remainder of the McDonnell Road property be secured as Private Open Space (**POS**). At that time a Private Open Space Management Plan and Overarching Open Space Management Plan were prepared by Rough and Milne Landscape Architects for the Stage 1 Development (refer to Appendices 1 and 2) these provided an outline strategy for revegetation planting and ongoing maintenance of the POS.

In accordance with the relevant conditions of consent for the Stage 1 Development, following the subdivision and development of the 20 residential lots (RM161093) and the third growing season after the establishment of planting, (Condition 24g), the residents of Brodie Avenue and Patton Place (Owners Group) have taken on the responsibility for ongoing maintenance of the northern Escarpment (Lot 104) and Roadside Planting Strip, refer to Appendix 2.

The balance of the land, being Lots 100 – 103 has been managed and maintained by Arrowsouth Properties Ltd under the Open Space Management Plan. Lot 100 was reserved for future roading, Lot 101 was a stormwater asset being a wetland (stream), Lot 102 was a private open space, Lot 103 included a public trail, and POS areas on the escarpment (POS-E1), along the water course (POS-W1) and a schist outcrop (POS-E5).

Natural Solutions for Nature Ltd (NSN) has been engaged to assess the establishing plantings in the Private Open Space Management Plan areas and provide advice regarding their “ecological appropriateness”, anticipated benefits arising from the maturing plantings, and with those learnings and observations made, to provide recommendations for landscape planning and urban design of the proposed Stage 2 subdivision via a Private Plan Change.

Documents reviewed and considered in undertaking this assessment were:

- RM161093 Decision, re-issued and dated 31/10/2016.
- Rough & Milne Landscape Architects (September 2017): Arrowtown South Special Zone Overarching Open Space Management Plan. Prepared in collaboration with Lane Neave and CHA Surveyors Limited. For Arrowsouth Properties Limited.
- Rough & Milne Landscape Architects (September 2017): Arrowsouth Properties Ltd Private Open Space Management Plan. Prepared in collaboration with Lane Neave and CHA Surveyors Limited. For Arrowsouth Properties Limited.
- Indicative Subdivision of Lots 102 and 103 of DP 535793 – Concept Plan; prepared by C Hughes and Associates Ltd. Dated 30/6/2023.

- Arrowtown South Private Plan Change. Ecological Assessment and Recommendations. Contract Report NSN92/09 Prepared by Natural Solutions for Nature Ltd on behalf of John Edmonds and Associates Ltd. Dated 14/9/2009.

1.2 Limitations

The services provided by NSN have been performed with the level of care and expertise exercised by professional ecological practitioners.

The site assessment for this report was undertaken in May 2025 at a time when some species are less conspicuous or the lack of seeds, flowers and fruit may make them more difficult to identify. The instruction for this report required that NSN undertake a qualitative assessment rather than a quantitative assessment of the establishing vegetation. While care was taken to record the full suite of species planted, some may have been overlooked.

Normal assessments of data reliability have been made, however NSN assumes no responsibility or liability for errors in any data obtained from regulatory agencies, and information and statements obtained from third party sources relied upon, developments outside the scope of this assessment or amendments to the proposal following the completion of this report. Therefore, no warranties, express or implied, are made.

2 Methodology

2.1 Site Visit and Office Based Assessments

For the purposes of this assessment, site visits were undertaken on 27th and 28th of May 2025. The planted areas were divided into sample areas, refer to Figure 1. A walkover survey through Lots 100 – 104 DP 535793 was undertaken; the shortest and tallest specimen of each species present in each area was recorded. Height was estimated against a 1500mm fibreglass pole with increments of 500mm, 1000mm and 1200mm marked. No attempt was made to count the number of plants present, conversely, an estimate of planting gaps was made based on the stated planting density of 1m spacing specified in the Open Space Management Plan and judged by the layout of plants on site. Empty plant guards and dead plants provided confirmation of losses.

Browsing damage was noted, and rabbit holes - both active and inactive - were recorded using a handheld GPS.

Notes were also made regarding the condition of plants; site factors influencing the condition observed were recorded. Observations were informed by extensive in-house knowledge and experience with revegetation projects across the Whakatipu Basin.

A track of the route followed through each Open Space area was recorded using a handheld GPS, the track indicates that the width and length of each planted area was sampled by the

survey, refer to Figure 2. The POS areas surveyed are described below and shown in Figures 1 and 2.

Sample Areas

RPS | Roadside Planting Strip

The Roadside Planting Strip has been incorporated into Lots 20, 1, 4, 5 and 6 of Stage 1, fronting McDonnell Road. It is about 6 metres wide.

POS – E1 | Escarpment

- E1_1 The upper slope wedge, above the trail crossing the escarpment from the trail fork to the top of the escarpment.
- E1_2 The small wedge between the fork in the trail at the southern margin of the escarpment.
- E1_3 The band of the escarpment above/ east of the trail and north of the fork in the trail.
- E1_4 The band of the escarpment below the trail.
- E1_5 Lower slope; the lower portion of the escarpment north of the trail in Lot 104.
- E1_5 Upper slope; the upper portion of the escarpment north of the trail in Lot 104.

POS – W1 | Waterway

- W1_1 The true left side of the waterway upstream of a culvert crossing. The walking trail is east of the stream, and a large stormwater basin has also been formed east of the trail.
- W1_3 The true right of the stream, upstream of a culvert crossing.
- W1_5 The true right of the stream from the culvert crossing to the southern boundary.
- W1_7 The true left of the stream from the culvert crossing to the southern boundary.

POS – E5 | Outcrop

- Above the outcrop.
- Below (east of) the outcrop.

Above the schist outcrop, the soils are thin over bedrock; east of the outcrop the soils are deeper.

Office based assessments involved curation of data and photographs; analysis of results, web-based assessments, review of the RM161093 decision and comparison of results with the approved Private Open Space Management Plan.

The species recorded in each area were entered into an excel spreadsheet with the maximum and minimum heights (the height range) measured for each species (i.e. not each individual plant) within each area. The average of the maximum and average of minimum measurements for each species was calculated from aggregated data for all transects, refer Table 1. These do not represent true averages of all the establishing plants, rather they are averages of the range of maxima and the range of minima for each species in each area

surveyed. The measurements, combined with site observations provide a summary indication of the sort of growth achieved at the site thus far, refer Tables 2A and 2B.

The anticipated growth rates were analysed based on the assumption that plants were supplied at the grades specified in the Private Open Space Management Plan. The height at time of planting was estimated based on in-house knowledge of height usually supplied for the grades specified. NSN understands that planting was completed by Autumn 2020, about 5 years ago.

The estimated height at 5 years relied on in-house knowledge of annual incremental growth (growth rate) experienced in local conditions which are reasonably consistent with the guidelines provided in the Wakatipu Reforestation Trust (WRT) publication, "Growing Native Plants in the Wakatipu". The WRT 5-year heights were therefore used as a published local reference to compare establishment success at this site, refer to Table 1.

The estimated growth rate is variable depending on site conditions with wind exposure, drought and frost prone sites, and sites with poorly developed, or shallow soils achieving slower growth rates than sites with moist, fertile, free draining soil in sheltered, warm sites. There is variability within the Arrow South Special Zone with drought and frost prone areas and moderately fertile soil on the escarpment; the shallow soil of the outcrop, and the more fertile, moist and frost prone soils along the stream¹.

The estimated growth at 5 years was compared to the mature height of the species so that species capable of reaching mature height within 5 years at the site could be identified (e.g. tussocks and sedges).

From survey data, an overall indication of establishment success of each area was assessed with a traffic light system allocated. This data has been summarised in Table 1 attached.

- Green indicates species that are generally at or tracking reasonably towards an anticipated height at 5 years.
- Yellow indicates there have been some setbacks, plants appear to be growing slowly, acknowledging the usual growth rate for the species.
- Orange indicates plants are under stress, performing poorly putting on weak growth, and/ or have suffered rabbit browse.

3 Arrowsouth Overarching and Private Open Space Management Plan Visions

The information described above provides the basis for an assessment of how successfully the Stage 1 planting has achieved the vision and objectives of the Arrowsouth Overarching and Private Open Space Management Plans.

¹ S-Map Online, Manaaki Whenua Landcare Research, accessed 28/6/2025; Hewitt (2010)
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The key vision statements and objectives have been copied from those documents and inserted below.

Overarching Open Space Management Plan Vision Statement:

Arrowsouth will be a unique neighbourhood and open space defining the edge of Arrowtown that provides new living opportunities within an ecologically enhanced and protected environment. A major native revegetation project will see the existing stock damaged waterway and weed infested escarpment, become a lush, enriched ecosystem for wildlife and human communities to share and enjoy. This band of vegetation will create a 'green buffer' on the urban edge of Arrowtown and will assist in blending existing and proposed residential development with the surrounding landscape. A series of tracks will enable public access through the reserve areas and connect to the wider pedestrian/cycle network of Arrowtown. Through implementing a unique development scheme of dividing the revegetated escarpment into privately owned lots, residents of Arrowsouth will become stewards of their own ecologically enhanced open space.

OOSMP Weed and Pest Management Strategy: *For the site to be successfully revegetated, it must first be cleared of any weed and pest species present.*

OOSMP Restoration Philosophy: *The goal for all areas of restoration planting will be to create a self-sustaining native shrub and forest areas, free from the pressures of stock, pest browse and weed competition. Particular focus will be on restoring habitats and food sources for native wildlife, including the rare and endangered NZ Eastern Falcon.*

Private Open Space Management Plan Objectives:

The objectives of the POSMP which were set within the context of a staged residential development were²:

- *“... to outline a strategy for establishing, re-vegetating and maintaining Private Open Space (POS) areas within land owned by Arrowsouth Properties Ltd, within the Arrowtown South Special Zone.”*
- *“It is intended that the POSMP will inform the current landowner and future residents of the vision and strategy for regenerating and managing each area of POS.”*
- *... “the intention of the Land owned by Arrowsouth Properties Ltd plan is to protect and enhance visual amenity of the site, while introducing ecological values at the same time.”*
- *“The vision for the escarpment is to create a self-sustaining native shrubland. Plants selected for revegetation are typical to the Wakatipu Basin and hardy to local conditions to ensure the best success rate of planting. In time, the shrubland will attract*

² Arrowtown South Private Open Space Management Plan
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native fauna and provide enhanced visual, ecological and recreational amenity for nearby residents. The escarpment shall be cleared and kept free of invasive weed species such as broom, gorse and briar, as well as being free from animal pests such as rabbits and hares.”

- “The schist outcrop on the lower plane has potential to be an attractive feature of the site (on[c]e visible from McDonnell Road), but is presently obscured with broom and gorse, and infested with rabbits. The long-term enhancement goal for the outcrop is to remove the gorse and broom to reveal the schist formations and revegetate the area surrounding it with native vegetation that will encourage native birds, lizards and invertebrates to habitate there.”
- “A spring-fed stream (approx 1m wide) flows in a south-eastern direction from a culvert outlet beneath McDonnell Road near the northwest corner of the site across the lower plane. The stream is currently unfenced to stock and suffers from pugging and erosion within the flood zone leaving it in poor ecological health. The long-term enhancement goal is to revegetate the stream margin with native riparian planting that will improve the ecological health and amenity of the stream. Riparian planting will assist with water quality, provide habitat for wildlife and reintroduce a native seed source to the area.”

The presence of the established and maturing vegetation communities surveyed for this assessment provides evidence of progress made towards the achievement of the overarching vision and objectives of the OOSMP and the POSMP.

4 Description of Arrow South Environment

The Arrow South pre-development environment was previously described in the NSN Ecological Assessment prepared in 2009 and summarised in the Overarching Open Space Management Plan (2017). The site has since been retired from grazing, and riparian and planted areas have been fenced off. Trails have been established across the escarpment and along the true left of the stream. Stage 1 of a residential subdivision has occurred, and a Owners Group established. The current environment can now be summarised as having four ecological zones established by the implementation of the OOSMP and POSMP:

- 1) The escarpment has been planted with red and silver tussocks (*Chionochloa rubra*, *Poa cita*), sedges (*Carex secta* and *C. buchananii*), shrubland (*Olearia*, *Coprosma*, *Ozothamnus*, *Veronica*) and mountain ribbonwoods (*Plagianthus regius*), kohuhu (*Pittosporum tenuifolium*), cabbage trees (*Cordyline australis*), kowhai (*Sophora microphylla*) and beech trees (*Fuscospora cliffortioides*, *F. fusca*).
- 2) The waterway has been enhanced and protected by the removal of stock, fencing and riparian planting which is established and maturing along the margins the stream. Plants included tussocks, rushes, flax, toetoe, shrubland (e.g. *Olearia* and *Coprosma*), and trees (mountain ribbonwoods, kowhai and cabbage trees). Introduced wetland obligate species within the wet channel continue to include soft rush (*Juncus effusus*), watercress (*Nasturtium* spp.), water starwort (*Callitriche stagnalis*), floating sweetgrass (*Glyceria fluitans*), creeping buttercups (*Ranunculus repens*) and pasture species.

- 3) The schist outcrop in the southwest corner of Stage 2 has been planted with tussocks, Coprosma and Olearia shrubland, kohuhu, and mountain ribbonwood.
- 4) Mown pasture grass, retired from grazing.

More detailed descriptions of these establishing communities are provided below.

This report focuses on the Stage 1 Development landscape plantings in the areas highlight in Figure 1, with consideration of their ecological appropriateness, and establishment success. Outcomes of this assessment will inform considerations for a proposed Stage 2 development. Learning from Stage 1 will inform recommendations for continuing ecological enhancement, and the extension of support for the achievements of the POSMP under the proposed Stage 2 Development.



Figure 1: Private Open Space Management Plan Planting Zones
Source Map: Google Earth Pro, © Airbus 2025, accessed 23/6/2025.



Figure 2: Survey track through Open Space Management Plan Planting Zones on 27th and 28th May 2025. Source Map: Google Earth Pro, © Airbus 2025, accessed 23/6/2025.



Figure 3: Distribution of rabbit holes and warrens. Yellow sites were inactive, grey sites were active holes. Rabbits were also gaining access to the site through the southern fence (on the right margin of the site).

4 Results

Using the indicative range of growth, combined with observations made during the site visit, an assessment of species performance in the POS, and those best suited (ecologically) to each POS have been made. This information will be used to inform ecological outcomes and continued management of vegetation under Stage 2.

An overview of ecological fit or appropriateness has also been undertaken for each of the Private Open Spaces (POS). A summary for each of the Private Open Spaces is provided below.

Table 1 provides a summary of growth and establishment for each species with notes regarding whether plants have been eco-sourced and appropriately matched with the site's environment

Table 2A provides a summary of the minimum heights recorded for each species in each sample area.

Table 2B provides a summary of the maximum heights recorded for each species in each sample area

Table 3 provides a summary of gaps in each survey area and recommended species for supplemental planting for each area as part of a Stage 2 development

Field sheets for each sampled area can be supplied on request.

Ecologically “appropriate” is defined in this context as meaning, the species naturally occurs in similar habitats within the Shotover Ecological District and adjoining Ecological Districts in the Lakes Ecological Region (being the “Whakatipu area”). It is acknowledged that some species have a broad range of tolerances, however, ensuring species are well matched within suitable environmental conditions is also important, providing a good fit with the site. For example, planting species associated with wetlands on dry hill slopes is less ecologically appropriate than planting obligate or facultative wetland species within wetland ecosystems and habitats³, conversely grey shrubland species are better suited to drier sites.

An understanding of local conditions is also important in interpreting a species “appropriateness”. For example, whether the species are likely to establish under *current* local site conditions (with initial maintenance support) and whether the species and plantings buffer, extend, support, reinstate or contribute to local diversity, or not.

To assist in this consideration, it is noted that the Land Environments of the site are classified using a suite of abiotic drivers that relate to indigenous biodiversity as N5.1c (the flat ground of Lot 103) and N4.1d (the Escarpment land in Lot 103 and 104). Less than 10 percent of the indigenous vegetation associated with the N5.1c Environment and less than 20 percent in the N4.1d Environments remains.

³ <https://environment.govt.nz/assets/publications/Wetland-delineation-protocols.pdf> page 12 Glossary.

The vegetation in N1.5c Environments would historically have included short tussock grassland with hard and silver tussocks and *Elymus* (*Anthosachne*) species at the time of European settlement (c 1860s). Kanuka, common to other N5 environments did not naturally extend into the Kawarau catchment (Burrell, 1965). Large swamps within N5 environments in central and eastern Otago are classified as N7 environments with the species present varying with drainage with “silver tussocks on rises, red tussocks on the damper ground, *Carex sinclairii* and *Carex coriacea* in wet hollows and *C. secta* in deeper water” (Leathwick, et.al., 2003). Species associated with dry short tussock grassland communities include tall and dwarf shrubs (*Carmichaelia*, *Melicytus*), tall forbs (*Aciphylla* and *Celmisia*), sedges, flax (*Phormium*), toetoe (*Austroderia richardii*), herbs (*Gentians*, *Wahlenbergia*, *Geraniums*, *Viola*), mat forming species (*Raoulia*).⁴ The riparian habitat of this site has been channelised by historic farming and was likely an N7 Environment.

Indigenous vegetation associated with N4.1d Environments in the Shotover Ecological District includes small-leaved *Coprosma*s, *Olearia*, Matagouri, native brooms and Kowhai along with lianes such as *Muehlenbeckia* (pohuehue) and *Rubus* (bush lawyer), (Leathwick, et.al., 2003).

Singers and Rogers (2014) building on previously established classification systems including Leathwick, et.al. (2003), published a more comprehensive system of classification of New Zealand’s terrestrial ecosystems and potential ecosystems. The Singers and Rogers (2014) classification indicates pre-colonisation ecosystems. This system also relies on the abiotic drivers, particularly temperature and moisture gradients, along with gravity, wind, landform, geological (lithological), edaphic (soil) conditions and biological responses to extremes along with patterns of spatial distribution. They described climatic zones and azonal areas recognising 152 ecosystems including 78 zones and 74 predominantly non-forest azonal ecosystems. Most of the Whakatipu Basin, including the Arrowsouth Properties Ltd land is classified as Cold Forest and Scrub (CDF3): Mountain Beech Forest. However, this is a very widespread modelled ecosystem unit described as generally supporting mountain beech with small-leaved *Coprosma*s, weeping matipo, mountain celery pine, snow totara, broadleaf, three-finger and putaputaweta and locally Hall’s totara. Scattered pockets of red and silver beech may be present in humid locations⁵. Today, the closest examples of these ecosystems are fragments in Bush Creek, near Arrowtown, the Coronet Faces on the northern slopes of the Whakatipu Basin, fragments on the northern and western flanks of the Remarkables Range.

Species from all these ecosystems have been incorporated into the Arrow South Special Zone and the POSMP planting schedules.

Species from outside the Ecological Region or not known to have naturally occurred within the Shotover Ecological District or Kawarau River catchment are less “ecologically appropriate”. Planting of such species could in my opinion be considered amenity plantings in much the same way as exotic trees may be introduced to plantings as a feature or expression of cultural values. However, the purpose of the plantings and the potential for introduced species to spread into natural ecosystems or potentially hybridise with indigenous species contributes to

⁴ Wardle, P. (1991): Short tussock and related grasslands of inland districts; page 244 of Chapter 9, Vegetation of NZ

⁵ Singers and Rogers (2014): Appendix 3: A classification of New Zealand terrestrial ecosystems.

the determination of “ecological appropriateness” at this site. I assess that the risk of escapee infestations of non-eco-sourced plants and hybridisation with local species is low due to the small numbers, their isolated distribution within the plantings reducing the potential for fertilisation and seed production and the presence of actively managed landscapes surrounding the Arrow South Special Zone

4.1 Summary of Stage 1 POS Community Establishment

RPS – Roadside Planting Strip

The roadside planting strip contributes elements of indigenous biodiversity, amenity and a low level of screening between McDonnell Road and the private residences. The strip is about 6 metres wide. The diversity of planting (15 species) is greater than was indicated in the Private Open Space Management Plan schedule (7 species). The planted area includes a mixture of *Coprosma* (4 species), *Olearia* (3 species), flaxes, *Corokia*, a *Pittosporum* cultivar; a smaller variety than the wild *Pittosporum tenuifolium*. No lemonwoods were recorded which I consider appropriate as this species is a forest associate with a mature height of about 12 metres and a spread of about 3 metres in good conditions. This species would have overwhelmed the roadside strip where planted. Use of the *Pittosporum tenuifolium* cultivar also moderated a similar impact that this species would have had with a mature height of about 6 to 8 metres, also with a spread of about 3 metres. Maturing plants in this area are establishing but have yet to put on width to infill the planted area and provide the anticipated visual screening, about 58 gaps were recorded.

Muehlenbeckia astonii (shrubby tororaro) was recorded in the RPS area, a Threatened, Nationally Endangered species popular in cultivation and often used in hedges and wind breaks has a natural range in Canterbury and Marlborough. This species was also recorded in the Outcrop plantings. The RPS is more of a cultivated setting than the Outcrop plantings where its inclusion is less ecologically appropriate than the Roadside Planting Strip, but contributes to the amenity values of the plantings

POS – E1 | Escarpment

The indicative plant schedule for the escarpment listed 15,825 plants with 46 percent of these comprised of silver tussocks (*Poa cita*), red tussock (*Chionochloa rubra*), Buchanan's sedge (*Carex buechananii*), and narrow-leaved snow tussock (*Chionochloa rigida*). The latter is difficult to source despite being abundant in the surrounding hill country. Additionally, *Carex secta* (*purei*) was also scattered within the escarpment plantings but was not in the primary schedule for this area.

Sedges such as *Carex secta* and *Carex buechananii* are commonly associated with damp hollows, ponds, lakes, streams, wetlands and their margins. While it is present throughout the escarpment plantings, *Carex buechananii* has failed to put on vigorous growth. Most plants seen had attained mature height but with only a few leaves present so have not developed the erect form or biomass of a mature plant in the appropriate habitat. As such, it is competing with and being overwhelmed by the vigorous pasture grass sward. I do not consider either of

these *Carex* species to be ecologically appropriate for the escarpment habitat. Similarly, red tussocks are only scarcely present in natural wetlands of the Lakes Ecological Region and are more common in lowland wetland complexes although they are a popular species incorporated into landscape planting throughout the Whakatipu Basin. At this site, they are more appropriately planted on the flats adjacent to the stream than the escarpment habitat. They require control of competing pasture grasses to flourish and provide the intended landscape amenity impact.

The plant schedule also indicated a mix of five *Coprosma* species accounting for 12% of the schedule which also included four species of *Olearia*, manuka, mountain ribbonwoods, red and mountain beech trees and beech forest associates including broadleaf, and kohuhu (*Pittosporums*).

Coprosma rigida (572) were identified in the planting mix. This is another species that is not usually available in high numbers from eco-sourcing nurseries servicing the Lakes Ecological Region. It appears that *Plagianthus divaricatus* (makaka/ salt marsh ribbonwood), a coastal species has been substituted into the schedule. It is thriving at the site and has been incorporated into most of the planting schedules across the site but as a coastal species. It seems to be providing functional habitat and is contributing to the aesthetic values of the plantings.

Manuka (*Leptospermum scoparium*) were scattered across the site, but some well-established plants carrying seed capsules appeared to have died recently. A few Kanuka (*Kunzea* spp.), a species not naturally distributed within the Kawarau River catchment were noted to be well established in Lot 104.

No mountain toatoa (*Phyllocladus alpinus*) or wineberry (*Aristotelia serrata*) was recorded on site. The former is a slow growing species difficult to access in the numbers indicated in the schedule without significant advanced notice, and the latter is frost prone and would be challenging to establish in an open site such as this one. Other substitutions included a few *Coprosma dumosa*, a species well suited to this site, *Veronica cupressoides*, *V. odora*, a grey *V. odora* variant, *Phormium tenax* (swamp flax) and a few *Myrsine australis* (red matipo) a beech forest understory species. All are found locally.

Despite the open appearance of the escarpment, losses/ gaps of only about a 5% (851 plants) were recorded. The dominance of tussocks and sedges within the plantings and the stunted growth of many shrubs creates the appearance of higher losses. Most of the losses were concentrated in the areas identified as E1_3 (73) and E1_4 (425), above and below the track across the escarpment where rabbit pressure is greatest. Figure 3 illustrates the distribution of active rabbit burrows. Browsing pressure in the vicinity of these sites is significant with many *Coprosmas*, and other species pruned by browsing, some not yet emerging from their guards or in the case of the well-established *Ozothamnus* (Cottonwood), having damaged root systems exposed by burrowing.

Plants that have been top pruned by browsing should have well developed root systems so release from browsing pressure should enable the plants to put on good growth and recover well. Holes underneath plants should be filled in where possible when control is undertaken.

Overall, the shrub and tree communities on the escarpment are establishing, they are making progress towards achieving the vision and objectives of the POSMP. The removal of rabbits should allow trees and shrubs to improve their coverage of the site reasonably quickly.



Figure 4: Escarpment E1_1 and E1_2 view southeast at fork in trail, many plants have not yet grown out of their guards. D Palmer 20250528_094608



Figure 5: Kowhai about 30cm tall in rank fescue grass on Escarpment E1_2.



Figure 6: Escarpment E1_3, view southeast. *Pittosporum* on higher slope doing better than small plants adjacent to the trail. *Veronica cupressoides* and cottonwood shrubs on the mid slope are maturing. D Palmer, 20250528_094427



Figure 7: Escarpment E1_3 left of trail, E1_4 right of the trail, view southeast. Flax, *Chionochloa rigida*, *Poa cita*; beech trees just visible on the mid slope left of trail. D Palmer, 20250528_093926



Figure 8: Escarpment E1_4 below the trail from about halfway along; view south. Losses and stunted plants where rabbit browse is severe. Flax, toetoe, Olearias, scattered ribbonwoods near trail retention wall. D Palmer, 20250528_094451



Figure 9: Escarpment E1_4 view northwest from the southeast corner. Mountain ribbonwoods are damaged by browse and stunted. Gaps where rabbit browse is severe. D Palmer, 20250528_094628



Figure 10: Escarpment E1_4 view north from southwest corner. Oak trees staked along the western fence line. Tussocks and toetoe between mountain flax. D Palmer 20250528_142518



Figure 11: Escarpment E1_3 northern half view northwest towards small gully. Maturing shrubs interspersed with tussocks, areas of rabbit browse and gaps. D Palmer, 20250528_115236



Figure 12: Escarpment E1_5 upper slope. View into Lot 104 from northeast corner of E1_3. Open gaps where tussocks and sedges planted on upper margin.
D Palmer, 20250528_122336



Figure 13: Escarpment E1_5 Lower slope, view from southwest corner. Bands of flax and Coprosma with a band of tussock and sedges along the top of the slope.
D Palmer, 20250528_144200 Esc1_5A SW cnr view N



Figure 14: Escarpment E1_5 from northeast corner above old track bench. View southeast.
D Palmer, 20250528_153559

POS-W1 | Waterway

Diverse riparian plantings of sedges, rushes, trees and shrubs are establishing along the waterway. A total of 2633 plants were listed in the indicative schedule, 47% of these were sedges, red tussocks and toetoe (*Austroderia richardii*). Of these 17% were *Carex sinclairii* (Sinclair's sedge) and *Carex buehneri*. Sinclair's sedges were not prominent along the waterway; none were recorded, while *Carex buehneri* were present, they were struggling to compete with rank pasture grasses and have only sparse growth similar to that noted on the escarpment above.

The waterway is choked with exotic watercress, some *Glyceria fluitans* (floating sweet grass), and *Callitriche stagnalis* (water starwort) but has scattered *Carex secta* sedges, *Juncus edgariae* (wiwi) and naturally occurring, introduced *Juncus effusus* (soft rush) along the margins of the stream bank.

The sedges, tussocks, toetoe and trees and shrubs along the waterway recorded a range of growth with heights taller than the overall site average maximum and taller than the site's overall average minimum for these and most other species.

This indicates that the waterway conditions are favourable for most of the establishing plants. Species added to the waterway planting schedule include *Corokia cotoneaster*, *Phormium cookianum* (mountain flax), *Plagianthus regius* (mountain ribbonwood), *Plagianthus divericatus* (makaka/ salt marsh ribbonwood); a single *Astelia nervosa* and a single *Coprosma lucida* (shining karamu) were also recorded. These species may have been substituted for manuka and *Phyllocladus alpinus* (mountain toatoa) which were not recorded. Many of these tended to be present on the higher, drier banks. As previously noted, the salt marsh ribbonwood/ makaka, is a coastal species not ecologically appropriate for this site but is establishing well where planted.

The stormwater retention basin adjacent to the walking trail, in Lot 101 is vegetated by pasture grass with silver tussock around the embankment. Cluster planting along the east side of the waterway walking trail has matured well but there have been some losses along the planted margins.

The eastern bank of the stream appears to have more densely established plantings compared to the western side. An estimated 386 planting gaps were recorded with 345 along the western side of the stream: 73 in W1_3, and 272 in W1_5. The landscape plans also indicate that the western side was not as extensively planted, this was considered in estimating the planting gaps.

The species in the planting schedule are ecologically appropriate for the site. However, *Carex secta* are likely to have competed more favourably in this site than *Carex sinclairii* and *Carex buehneri*.



Figure 15: Waterway W1_2 View of stormwater basin from east of stream crossing in Lot 103.
D Palmer 20250527_161638



Figure 16: Waterway W1_1 View southeast downstream from margin of Lot 103. Watercress choking creek with flax and red tussock forming the prominent cover along the stream.
D Palmer, 20250527_133506



Figure 17: Waterway W1_5 view southeast towards southern boundary fence. Stream flow may be either backed up upstream of the fence due to a long-term build-up of debris, vegetation and soil impeding flow, or may in a less channelised natural state. D Palmer, 20250527_153039



Figure 18: Waterway W1_5 view north along the true right side of the stream. Planting is spaced with scattered remaining *Carex secta*. Competition with rank grass is hindering establishment of planted vegetation. D Palmer, 20250527_153555



Figure 19: Waterway viewed from Lot 103 near fence gate and crossing along trail to escarpment. D Palmer, 20250528_093746

POS-E5 | Outcrop

Active rabbit burrows were present within this small area including large warrens under the fence on and near the southern boundary. Competition with pasture grass and tall weeds was also evident east of the rock outcrop. Dry, shallow soils and browsing pressure are impacting plant establishment across the top of the outcrop. Trees, shrubs and tussocks were the densest and most established in the northwest corner of this area.

The indicative planting schedule listed 1447 plants with 13% of those a mix of hard tussock, narrow-leaved snow tussock and red tussock. Desert broom and porcupine shrub accounted for almost a third of the schedule but neither species was found, although both are ecologically suited to the habitat. Coprosma and matagouri made up about 20% and Olearias just over 10% the indicative schedule. Broadleaf, *Myrsine australis*, *Olearia bullata*, kowhai and lemonwood were listed in the indicative schedule but not recorded in the Outcrop plantings. Substitutions included *Carex secta*, makaka/ salt marsh ribbonwood, toetoe, snow totara (*Podocarpus nivalis*), *Veronica cupressoides*, *Veronica salicifolia*, *Muehlenbeckia astonii*, *Myrsine divaricata*, *Plagianthus regius* and a species of *Brachyglottis*. *Olearia odorata* was substituted providing a much better fit for the site than the tree daisy (*Olearia arborescens*) a beech forest understory species which was not found. There were at least 217 gaps in the planted area (15%) of the plantings.

Less ecologically appropriate species not eco-sourced from this area included a species of *Brachyglottis*, *Muehlenbeckia astonii*, and makaka although the latter two were among the most vigorously growing species present. A smaller *Pittosporum tenuifolium* cultivar was also establishing well.



Figure 20: Outcrop, view from northeast corner. D Palmer 20250527_114943 Outcrop A NE



Figure 21: Outcrop, view from southeast corner. D Palmer, 20250527_120232 Outcrop B SE

5 Summary of Findings

Based on the assessment undertaken, the maturing plantings are likely to meet the vision and objectives of the OOSMP and POSMP for Stage 1 of the Arrowtown South Special Zone; not all plantings have reached a self-sustaining condition, but they are making progress towards this. The continuing maturation of the plantings will enhance the amenity values established and envisioned by the implementation of the POS Management Plan.

An incidental conversation with a resident of Stage 1 and a contractor undertaking maintenance work during the survey confirmed that replacement planting had been undertaken on the northern portion of the Escarpment (E1_5) at least twice since the primary planting. An ongoing rabbit control issue was also identified; this was confirmed by the NSN survey. These two factors have influenced the plant heights recorded.

Rabbits pose one of the most significant impediments to the maturation of establishing plantings. Release from rabbits is likely to result in rapid growth and regeneration of seed-bearing plants given the maturity of the plants present.

Gaps identified are consistent with a reasonable range of loss at this stage of a planting project at a site prone to frost. Rabbit damage could result in much higher losses if left unmanaged.

The use of substitutions including some species not eco-sourced for the Whakatipu Basin habitats was less ecologically appropriate for restoration or reinstatement planting but may be more acceptable in terms of their contribution to landscape amenity values and their provision of functional habitat. The reliance on sedges in the escarpment plantings was unfortunate; the escarpment plantings would likely be more prominent if shrubs had been a more dominant component of the planting schedule.

Overall, the establishment of the plantings is at or under the expected heights for the plantings in the escarpment area.

The range of heights recorded indicated that the wetland areas, the northwest corner of the outcrop, the northern portion of the escarpment E1_5 (Lot 104), and the shallow gully area identified in E1_3 (the escarpment above the track) have the most favourable growth conditions for the species planted. These areas are the least impacted by rabbits. However, while the *Ozothamnus*/ cottonwood shrubland interspersed with *Veronica cupressoides* area on the escarpment (E1_3) are well established they are currently being undermined by rabbit burrowing damaging roots. If rabbits are not controlled and holes filled, these large plants may suffer dieback or death.

NSN recorded evidence of irrigation on Lot 104 on the northern portion of the escarpment. The establishing plants no longer require irrigation although water would ensure smaller plants do not succumb to heat stress, mulch application may be a more cost-effective means of supporting these plants.

Aesthetically, the layout of the bands of flax, Coprosmas, and tussocks on the escarpment do not look particularly natural.

Except for the species discussed above, the plantings were generally ecologically appropriate and the vision and objectives of the Stage 1 POSMP and OOSMP are being achieved.

6 Ecological Effects of POS Plantings

As the plantings mature, they will increasingly provide an area of habitat that will contribute to the expanding pockets of indigenous vegetation across the Whakatipu Basin including the recent Coronet Forest plantings and establishing planting within Sawpit Gully and hills surrounding Arrowtown. Fragmented plantings contribute to the pattern of connectivity between these and larger areas of indigenous habitat. While NSN does not have a measure of the current extent of indigenous vegetation cover for Arrowtown, the maturing plantings will contribute to the target of 10% indigenous vegetation cover for the local urban and non-urban environments along the western side of Arrowtown⁶.

Endemic and native bird species recorded during the survey included New Zealand fantail/ Pīwakawaka (*Rhipidura f. fuliginosa*) (black phase), Tūī (*Prosthemadera novaeseelandiae*), Paradise shelduck/ Pūtangitangi (*Tadorna variegata*), Silvereyes/ Tauhou), (*Zosterops lateralis*) Pūkeko (*Porphyrio melanotus*) and Spur-winged plovers (*Vanellus miles novaehollandiae*), none are regionally or nationally threatened or at risk. In addition, introduced species dunnoek, song thrush, blackbird, and magpies were present.

At least one pair of New Zealand falcon (eastern) (*Falco novaeseelandiae*), nationally and regionally threatened – vulnerable is known to be present around Arrowtown, this site will be within the home range of that pair. Enhancing habitat within the territory of this pair was an objective of the POSMP that has been initiated by Stage 1 planting and will accrue as the plantings mature through their support of bird populations which are the prey of falcon.

South Island pied oystercatcher/ Tōrea (*Haematopus finschi*), nationally at risk – declining, and regionally vulnerable is a seasonal migrant to the District. Tōrea nest on short, spring farm paddocks throughout the Whakatipu Basin; this species and may forage on the damp pasture of this site. Pied stilts / Poaka (*Himantopus Himantopus*) are another seasonal migrant. Poaka breed in inland wetlands, they are not threatened. Poaka may forage on the margins of the stream particularly where it is slightly impounded by debris strained on the fence at the southern boundary. It is possible that this species uses this site in combination with other wetlands in the surrounding area.

A more detailed list of species known to be in the area at least seasonally and likely to be present at the site, or able to benefit as plantings mature are listed in Table 4 at the back of this report.

Further development of the flat pasture portion of the site (Lot 103) and encroachment towards the stream habitat is likely to remove or render that habitat less suitable for waders such as oystercatchers and stilts as well as herons. Clearance of vegetation and debris from the fence may also reduce the flooded area of the wetland upstream of the fence, however, it is possible

⁶ National Policy Statement for Indigenous Biodiversity, section 3.22; page 29.
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that the stream character in Lot 103 is in a more natural rather than an impounded state, in which case there is merit in retaining this condition.

A trail along the eastern side of the stream stops at the southern boundary. This trail and the adjacent paddock (Lot 103) are used by local dog walkers and children who were observed using the space during the site visits. Dogs off lead are likely to disturb waterfowl, waders and herons that may visit the site if their presence coincides.

New Zealand Pipits (presence unconfirmed), New Zealand falcon (eastern), South Island pied oystercatcher/ Tōrea, are all identified as specified highly mobile fauna in Appendix 2 of the National Policy Statement for Indigenous Fauna (2023). In my opinion, these species are not likely to nest in the site, but may hunt or forage incidentally as part of a wider network. Given the existing condition and use of the habitat, the site is unlikely to provide significant habitat that these species would rely on as part of their annual lifecycle. Loss of the habitat as part of future subdivision is unlikely to impact the populations of these species inhabiting the surrounding landscape but would contribute to the gradual attrition and loss of these habitats from the wider Whakatipu Basin.

7 Recommended Management Measures for Stage 2

The planting established under Stage 1 has provided a foundation of ecological and amenity enhancement that can be further supported with additional planting under a Stage 2 development of Lot 103. Assessing the establishment and success of the Stage 1 plantings and riparian outcomes has informed the recommendations for Stage 2 set out below.

The recommendations below provide management guidelines to inform landscaping and policy responses for a Plan Change that would provide riparian outcomes, ecological and amenity enhancement for a Stage 2 subdivision and residential development of the Arrowtown South Special Zone.

7.1 Planting

The plantings established by the Implementation of the Stage 1 Arrowtown South Open Space Management Plans will continue to mature, however, supplemental planting that incorporates eco-sourced species would bolster the ecological value of these areas. Table 1A below lists species recommended for incorporation into further planting or landscaping in the Private Open Spaces of the Escarpment, Waterway and Outcrop areas.

The species recommended in Table 1A for each Open Space area should be used to guide the planting schedules. Not all species need to be incorporated into plantings, however, the addition or substitution of species into Open Space areas where not indicated is discouraged.

Table 1B provides an indication of the planting in the Escarpment, Waterway and Outcrop that would further support and supplement the maturing Stage 1 communities by filling gaps within

these areas with ecologically appropriate species that contribute to the maturing habitat and are consistent with the attributes discussed under Section 4 above.

It is recommended that further planting on the southern portion of the escarpment be distributed to soften any linear bands of planting. Flax and shrubland species could be planted to widen and extend the bands of flax so that they merge more naturally into the surrounding establishing community. It is recommended that future planting and maintenance continue to be coordinated with the Owners Group so that continuity across Lot 104 is sustained going forward. This would help support the ongoing OOSMP vision of establishing *“a ‘green buffer’ on the urban edge of Arrowtown and will assist in blending existing and proposed residential development with the surrounding landscape”*.

Irrigation is not necessary; the application of organic mulch would likely provide a more cost-effective means of retaining soil moisture during establishment given the sheltering influence of the Stage 1 plantings. Mulch need only be applied to young plants in Stage 2 where drought stress is likely.

Future planting along the Escarpment and Waterway trail should allow sufficient offset to avoid the need for mowing or trimming on maturity and avoid the creation of hedge effects along the trails. Pittosporums and koromiko should be set back at least 2 to 3 metres from the trail and flax should also be set back at least 2 metres, with other plants at least 1 metre from the trail.

Stage 1 plants that have been affected by browsing or competition should be maintained until they are at least 1 metre in height and/ or able to exert some canopy control and suppression over competing grasses. This work can be coordinated with ongoing management of the Stage 1 areas and maintenance of Stage 2 plantings.

Planting along the Waterway is recommended to support the variable density plantings allowing for areas of both open margins and dense cover. As the existing Stage 1 plantings mature, it is recommended that any Stage 2 planting be dominated with *Carex secta* and clusters of shrubland with emergent trees distributed along the Waterway, this is in keeping with the landscape vision of Stage 1. Planting should maintain unobstructed flow. Consideration should be given to the southern boundary management with the potential for a broader wetland, pond or stormwater attenuation feature being incorporated into the stream at this point.

Further channelisation and bunding should be avoided where possible to retain the natural elements of the stream.

Table 1A Recommended Species for use in Stage 2 Planting

Scientific Name	Common Name	Escarpment	Waterway	Outcrop
<i>Carmichaelia petriei</i>	Desert broom	Y		Y
<i>Carex secta</i>	Purei		Y	
<i>Chionochloa rubra</i>	red tussock		Y	
<i>Coprosma crassifolia</i>		Y		
<i>Coprosma dumosa</i> *		Y		Y
<i>Coprosma lucida</i> *	shining karamu	Y		
<i>Coprosma propinqua</i>	Mingimingi	Y	Y	Y
<i>Coprosma rugosa</i>		Y	Y	Y
<i>Coprosma virescens</i>		Y		Y
<i>Cordyline australis</i>	Cabbage tree/ tī kōuka	Y	Y	Y
<i>Corokia cotoneaster</i>	Korokio	Y		Y
<i>Austroderia richardii</i>	toetoe	Y	Y	Y
<i>Discaria toumatou</i>	Matagouri	Y		Y
<i>Fuscospora cliffortioides</i>	Mountain beech	Y		
<i>Fuscospora fusca</i>	Red beech	Y		
<i>Griselinia littoralis</i>	broadleaf	Y		
<i>Halocarpus bidwillii</i>	bog pine		Y	
<i>Juncus edgariae</i>	Edgar's rush		Y	
<i>Leptospermum scoparium</i>	manuka	Y		
<i>Myrsine divaricata</i>	Weeping matipo	Y		Y
<i>Olearia bullata</i>	Shrub daisy		Y	
<i>Olearia fragrantissima</i>	fragrant tree daisy	Y		Y
<i>Olearia lineata</i>		Y	Y	Y
<i>Olearia odorata</i>	Scented tree daisy	Y		Y
<i>Ozothamnus vauvilliersii</i>	Mountain tauhinu	Y		Y
<i>Phormium cookianum</i>	Mountain flax	Y		Y
<i>Phormium tenax</i>	NZ flax		Y	
<i>Pittosporum tenuifolium</i>	kohuhu / black matipo	Y		
<i>Plagianthus regius</i>	ribbonwood	Y	Y	Y
<i>Poa cita</i>	Silver tussock	Y		Y
<i>Poa colensoi</i>	Blue tussock			Y
<i>Pseudopanax ferox</i> *	fierce lancewood	Y		Y
<i>Sophora microphylla</i>	kowhai	Y	Y	Y
<i>Veronica cupressoides</i>	cypress hebe	Y		
<i>Veronica odora</i> *	boxleaf hebe	Y	Y	Y
<i>Veronica salicifolia</i>	koromiko	Y	Y	

Table 1B Summary of Stage 2 Plant Numbers to support Stage 1 Planting

POS	Stage 2 Planting
Escarpment	746
Waterway	386
Outcrop	217

7.2 Pest Management

The Stage 1 plantings are generally well established and maturing, however there is evidence that browsing damage to roots and foliage are hindering the development of form and height in places impacted by rabbits.

Given the small area concerned, rabbit control should be undertaken using dog and ferret or Magtoxin (Magnesium phosphide) applied by a suitably certified and experienced contractor. Magtox can be administered directly into the holes which must be immediately filled in and monitored for reopening. This will avoid the hazards associated with shooting or laying of poison and will not result in residual toxicity (including the rabbits) along an urban boundary after the underground chemical reaction of Magtox is complete⁷. The location of most of the rabbit holes is provided in Figure 3 above, the .gpx file with grid references can be provided on request.

Holes underneath plants should be filled in where possible when control is undertaken.

Boundary and enclosure rabbit netting should be repaired where damaged or rabbits have burrowed under them to maintain the Stage 1 and any future Stage 2 plantings.

The northern escarpment has vertical holes which may not be rabbit damage it is recommended that this be drawn to the attention of the Owners Group to ensure subsurface erosion caused by irrigation piping is not occurring, these are currently identified as rabbit holes in Figure 3.

The burden of plant pests is reasonably low; however, some gorse regeneration was noted in areas E1_1, E1_4, localised areas of the northern escarpment (E1_5) lower slope and the outcrop area (refer Figure 1). Broom regeneration was noted across the escarpment, and outcrop open spaces. Given the longevity of broom and gorse seed in the soil bank, it is recommended that ongoing maintenance to control and remove these species form a part of Stage 2 landscape Open Space management planning.

7.3 Sediment

In the event of future subdivision and development, it is recommended that an environmental management plan ensures sedimentation impacts on the stream and riparian habitat are avoided.

8 Conclusions

The vision and objectives of the OOSMP and POSMP relating to Stage 1 of the Arrowtown South Special Zone subdivision are being achieved and with the continuing maturation of the plantings the amenity values established and envisioned by the implementation of the OOSMP and POSMP will continue to accrue.

⁷ Ms Palmer holds a Controlled Substances Licence for Magnesium phosphide. Worksafe Licence Number: CSL012210; issued 18/3/2024

Ongoing maintenance of plantings and follow up removal of woody weeds and rabbits will sustain the ecological benefits that these plantings are creating.

The incorporation of a large proportion of sedges and red tussocks into the escarpment planting schedule, has resulted in a more open appearance, the recommended planting for the Stage 2 development will infill and support the maturing Stage 1 plantings. The plant numbers recommended in Table 1B would equate to approximately 7 percent of the original schedule across all POS areas, they will increase the site density, improving the integrity and quality of the habitat.

The stream environment runs through the lowest ground of the site and continues to provide a small local foraging opportunity for waders, herons and waterfowl all of which are highly mobile within the Basin's wetland habitats. However, proximity to the residential area and the potential for disturbance by unsupervised or off-lead pets does create risk for waterfowl, waders and herons that may use the habitat. Encroachment onto the riparian area by Stage 2 development is recommended to maintain a buffer. None the less, the conversion of open space to residential activity will likely displace foraging wetland and pasture birds from this site.

The Stage 2 planting as recommended above, will enhance the POS plantings, improve habitat complexity and compete more favourably with the pasture grass ground cover. The work required to achieve this enhancement and sustain the accruing benefits is not substantial and would complement and support the achievements of Stage 1.

The Stage 1 plantings are and will continue to provide habitat for indigenous songbirds and honeyeaters. As they mature, they will create an extension fragment to the existing network of habitats in the eastern area of the Whakatipu Basin and fringes of Arrowtown. This will benefit the local falcon which prey upon these birds as intended by the OOSMP and POSMP.

The maturing Open Space plantings would be supported by recommended ongoing maintenance under Stage 2 with continuing control of rabbits, woody weeds and some additional planting. Gaps in the POS areas should be filled with species from Table 1 where the gap would not otherwise be taken over by an adjacent maturing plant.

The establishment of many plants in the POS-Outcrop area has been hindered by rabbits and competition with pasture grasses in this area with many still quite small. The establishment of large Lots in the POS-Outcrop area would require a reconfiguration of planting but Stage 2 planting plans could enable the ecological enhancements in those areas to be supported by the Lot owners in that area.

I therefore conclude that with the incorporation of the recommendations above, the proposed Stage 2 extension of subdivision and residential development over Lot 103 will be able to sustain and support the ecological benefits achieved under the Open Space Management Plan implemented under Stage 1 for POS-E1 (Escarpment) and POS-Outcrop. While there may be some displacement and encroachment into the riparian zone of the POS-W1 (Waterway) area, the impacts of encroachment can be managed and minimised by

supplemental planting and measures to ensure healthy flow and the avoidance of contamination by sediments and pollutants.

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Table 1 Summary of growth and establishment for each species.

Species not on the POSMP Schedules indicated with *

Species not eco-sourced for the Whakatipu Basin indicated with +

Scientific Name	Common Name	Wetland Plant List	WRT Height @ 5 yr (m)	Mature Height (m)	Ave max height (m)	Ave min height (m)	Notes on indicative establishment success
<i>Astelia nervosa</i> *	Mountain astelia/ kakaha	FACU	0.5	1.5	1.0	0.9	A few specimens along the Waterway in area W1_7
<i>Brachyglottis spp?</i> + *	daisy				0.6	0.6	A few specimens on the schist outcrop, not eco-sourced for this area.
<i>Carex buechananii</i>	shining sedge, Buchanan's sedge	FAC	0.5	0.5	0.8	0.4	Good height but poor growth form with almost uniformly poor/ sparse foliage development.
<i>Carmichaelia petriei</i>	Desert broom		1.5	2	1.3	0.9	Planting schedules indicate this species should have been more abundant within the plantings.
<i>Carex secta</i>	Purei	OBL	1	1.5	1.1	0.8	Good growth in the waterway areas; poorer results on the Escarpment
<i>Chionochloa rigida</i>	Narrow-leaved snow tussock	FACU	1	1.25	1.4	1.2	Establishing well, reasonably rapid growth, planting schedules indicate this species should have been more abundant within the plantings.
<i>Chionochloa rubra</i>	red tussock	FAC	1	1.25	1.5	1.1	Establishing well where planted.
<i>Coprosma crassifolia</i>			1.8	4	0.8	0.5	Impacted by rabbit browse and competition with rank grass.

<i>Coprosma dumosa</i> *		FAC		3	1.1	1.1	Ecologically appropriate species, substituted in low numbers, establishing well.
Scientific Name	Common Name	Wetland Plant List	WRT Height @ 5 yr (m)	Mature Height (m)	Ave max height (m)	Ave min height (m)	Notes on indicative establishment success
<i>Coprosma lucida</i> *	shining karamu	FACU	2 to 3	3	1.8	1.6	Only a few seen in the waterway plantings W1_1. A, not in the plant schedule.
<i>Coprosma propinqua</i>	Mingimingi	FAC	1.5	3	1.4	0.8	Variable due to impacts of rabbit browse.
<i>Coprosma rugosa</i>		FACU	1.5 to 2	3	1.3	1.0	Variable due to impacts of rabbit browse.
<i>Coprosma virescens</i>		UPL	2 to 3	5	1.7	0.9	Variable due to impacts of rabbit browse.
<i>Cordyline australis</i>	Cabbage tree/ tī kōuka	FAC	2	10	1.8	0.8	Variable due to impacts of rabbit browse.
<i>Corokia cotoneaster</i>	Korokio	UPL	1 to 1.5	3	1.0	0.6	Scattered through Roadside Strip, waterway (W1_7) and Escarpment plantings. Smaller where browsed.
<i>Austroderia richardii</i>	toetoe	FAC		2	1.8	1.3	Variable but mostly good where planted, smallest plants in E1_1 and E1_3 on escarpment.
<i>Discaria toumatou</i>	Matagouri	UPL	1.5	5	1.1	0.7	Generally slow growth, doing best near the waterway but few seen compared to the indicative schedules.
<i>Fuscospora cliffortioides</i>	Mountain beech	FAC	3 to 5	20	5.6	0.9	Variable but good growth with average minimums likely to have been reduced by replanting in the Owners Group maintenance area, indicating some losses.
<i>Fuscospora fusca</i>	Red beech	FAC	3 to 5	25	4.0	1.4	As for mountain beech.
<i>Griselinia littoralis</i>	broadleaf, kāpuka, papauma	FACU	1 to 2	10	0.8	0.5	Few seen compared to the indicative schedules, variable to poor growth, browse damage; possible frost damage stunting growth.
<i>Halocarpus bidwillii</i>	bog pine	FAC	.5 to 1	2.5	1.3	0.8	Growing well in a single cluster next to stream. Planted as larger specimens? However fewer than indicated in schedule indicating substitutions/ losses.

<i>Juncus edgariae</i>	Edgar's rush	FACW		1.5	1.6	1.1	mature height reached
Scientific Name	Common Name	Wetland Plant List	WRT Height @ 5 yr (m)	Mature Height (m)	Ave max height (m)	Ave min height (m)	Notes on indicative establishment success
<i>Kunzea spp.</i> + *	kānuka			10	2.4	1.7	Large plants planted? Or thriving ; not eco-sourced for this area.
<i>Leptospermum scoparium</i>	manuka	FAC	1.5 to 2	4	1.2	0.6	Losses including maturing plants with seed capsules.
<i>Muehlenbeckia astonii</i> + *	shrubby tororaro			4	1.1	0.9	Not eco-sourced for this area; planted in RPS and outcrop areas. Tallest in the RPS away from rabbits.
<i>Myrsine australis</i>	red matipo	FACU	1.5	4	0.7	0.6	slower growing than indicated, browse damage; they were only in the outcrop schedule (101 plants) but were recorded in small numbers on the escarpment and RPS areas.
<i>Myrsine divaricata</i>	Weeping matipo, weeping mapou	FAC	1	3	0.4	0.4	poor, under, rabbit pressure, only one seen in the outcrop area; not on the schedule.
<i>Olearia bullata</i>	Shrub daisy	FACW	2	4	1.7	1.1	Growing best near the stream; habitat best suited to this species; incorporation into escarpment areas less suitable. In lower numbers than indicated on schedule indicating losses/ substitutions.
<i>Olearia fragrantissima</i>	fragrant tree daisy		2.5	8	1.1	0.6	Competing with rank grass and impacted by rabbits; the tallest specimens were in the Owners Group escarpment where rabbits are better controlled. Only a few seen, less than indicated on schedule.
<i>Olearia lineata</i>		FACU	3 to 4	8	2.6	2.2	Growing best near the stream; habitat best suited to this species; okay elsewhere. In lower numbers than indicated on schedule indicating losses/ substitutions.

Scientific Name	Common Name	Wetland Plant List	WRT Height @ 5 yr (m)	Mature Height (m)	Ave max height (m)	Ave min height (m)	Notes on indicative establishment success
<i>Olearia odorata</i>	Scented tree daisy		2 to 3	3.5	1.9	1.1	Growing well, the average reduced by damaged plants in the outcrop area; and rabbit browse on the escarpment in E1_4.
<i>Ozothamnus vauvilliersii</i>	Mountain tauhinu /cottonwood	FACU	1	3	1.5	1.0	Growing well, but root damage caused by rabbits on the escarpment will undermine this. Smaller plants in rabbit damaged areas.
<i>Pachystegia minor</i> + *	Marlborough daisy			0	0.0	0.0	Streetscape amenity
<i>Phormium cookianum</i>	Mountain flax	FACU	1 to 1.5	2	1.4	0.7	Growing well but not in numbers indicated on schedule for Outcrop indicating losses/ substitutions.
<i>Phormium red cultivar</i> + *	red flax			0	0.0	0.0	Streetscape amenity
<i>Phormium tenax</i>	NZ flax	FACW	2	2	2.3	1.5	Growing well.
<i>Pittosporum eugenioides</i>	lemonwood/ tarata		2 to 3	10	1.2	0.7	Planted on the escarpment, damaged and poor condition, often next to the trail.
<i>Pittosporum tenuifolium</i>	kohuhu / black matipo	FACU	2 to 3	8	2.1	0.9	Variable, doing best in the waterway plantings, with many in guards, rabbit damaged on the escarpment interspersed with healthy plants.
<i>Plagianthus divaricatus</i> + *	Makaka/ salt marsh ribbonwood	FACW		3	1.6	1.1	Establishing well but this is a coastal marsh shrub not eco-sourced for this area.
<i>Plagianthus regius</i>	ribbonwood	FACU	4 to 5	15	4.2	1.2	Establishing well with average heights reduced by browsing damage on the escarpment and outcrops.
<i>Poa cita</i>	Silver tussock	FACU	0.5	0.75	0.8	0.7	Growing well, thriving; good match for this site.
<i>Poa colensoi</i> *	blue tussock		0.4	0.3	0.6	0.6	Growing well, thriving; good match for this site.
<i>Podocarpus nivalis</i> *	Snow totara		0.8	2	0.3	0.3	Slow growing, not on the schedules for this site.
<i>Pseudopanax ferox</i> *	fierce lancewood	UPL	1.5	5	0.9	0.9	Only 1 seen alive
<i>Sophora microphylla</i>	kowhai	FACU	2 to 3	10	1.8	0.8	Damaged by rabbit browse.
<i>Veronica cupressoides</i>	cypress hebe		1 to 1.3	2	0.7	0.5	Poor growth, competition with rank growth.

<i>Veronica odora</i> *	boxleaf hebe		1	1.5	0.4	0.4	Poor growth, competition with rank growth.
<i>Veronica salicifolia</i>	koromiko	FACU	2	3.5	1.1	0.9	Poor growth, competition with rank growth, rabbits in E1_4.
<i>Veronica topiaria</i> ?+*	hebe			0.5	0.5	0.3	near / at mature height; variant of <i>Veronica odora</i> / eco-sourced?

Wetland Plant List - Information derived from the revised national wetland plant list prepared to assist councils in delineating and monitoring wetlands (Clarkson et al., 2021 Manaaki Whenua – Landcare Research Contract Report LC3975 for Hawke’s Bay Regional Council). The national plant list categorises plants by the extent to which they are found in wetlands and not ‘drylands’. The indicator status ratings are:

- OBL: Obligate Wetland. Almost always is a hydrophyte, rarely in uplands (non-wetlands)
- FACW: Facultative Wetland. Usually is a hydrophyte but occasionally found in uplands
- FAC: Facultative. Commonly occurs as either a hydrophyte or non-hydrophyte
- FACU: Facultative Upland. Occasionally is a hydrophyte but usually occurs in uplands
- UPL: Obligate Upland. Rarely is a hydrophyte, almost always in uplands.

“A hydrophyte is a plant that grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; plants typically found in wetland habitats”. (Clarkson, et.al., 2003);

Table 2A Maximum Height Measured per Species in each POS Area

Scientific Name	RPS	W1_1	W1_3	W1-5	W1_7	E1_1	E1_2	E1_3	E1_4	E1_5 Lwr Slope	E1_5 Upr Slope	E5 Lwr / East Outcrop	E5 Upr Outcrop
<i>Astelia nervosa</i> *					1000								
<i>Brachyglottis spp?</i> + *													600
<i>Carex buchananii</i>				800	850	800		800	700	700			
<i>Carmichaelia petriei</i>		1500	1200		1800			1100	1050				
<i>Carex secta</i>	800	1100	1200	1500	1900				725	500		1200	700
<i>Chionochloa rigida</i>						1500		950			1600	1500	1500
<i>Chionochloa rubra</i>		1400	1700	1800	2000	1200		1800	1510	1500	1100	1100	1100
<i>Coprosma crassifolia</i>			800	700	950		750	450	750	300	1750		
<i>Coprosma dumosa</i> *								1100					
<i>Coprosma lucida</i> *		1800											
<i>Coprosma propinqua</i>	1800		1300	1500	1600	1100		1600		1800	1200	1200	800
<i>Coprosma rugosa</i>	1700	1900	1500	1000	1250	700		1500	750	2000	1100		900
<i>Coprosma virescens</i>	2500	1900	1900	1800	2300		300	1850	900	1700	1400		
<i>Cordyline australis</i>		1800	2500	2500	3500	800	700	3000	250	750	1900		
<i>Corokia cotoneaster</i>	750				2400			150	700		1150		
<i>Austroderia richardii</i>		2000	1800	2250		1500		1500	1600	2000		1400	
<i>Discaria toumatou</i>			1555	1000				1200				800	1000
<i>Fuscospora cliffortioides</i>								8000		3250	5500		
<i>Fuscospora fusca</i>								5500			2500		
<i>Griselinia littoralis</i>	300							1000	850	950	950		
<i>Halocarpus bidwillii</i>					1300								
<i>Juncus edgariae</i>				1400	1700								
<i>Kunzea spp.</i> + *										2250	2500		

<i>Leptospermum scoparium</i>						800	800	2500	1200	400	1200		
Scientific Name	RPS	W1_1	W1_3	W1-5	W1_7	E1_1	E1_2	E1_3	E1_4	E1_5 Lwr	E1_5 Upr	E5 East Outcrop	E5 Upr Outcrop
<i>Muehlenbeckia astonii</i> + *	1800											800	750
<i>Myrsine australis</i>	600								750		800		
<i>Myrsine divaricata</i>													400
<i>Olearia bullata</i>	1800			1250	2600			1300			1350		
<i>Olearia fragrantissima</i>						1150		300	850	2225			
<i>Olearia lineata</i>				3200	3500					2000	1800		
<i>Olearia odorata</i>	2000			2500	2250			2250	1300		2600		550
<i>Ozothamnus vauvilliersii</i>								1350	1350	1500	1800		
<i>Pachystegia minor</i> + *													
<i>Phormium cookianum</i>	1500	1900		1200	800	1000	1100	1000	1400	2000	2000		
<i>Phormium red cultivar</i>													
<i>Phormium tenax</i>		2800	2500	2800	2350			1850	2000	2500		1800	
<i>Pittosporum eugenoides</i>							700	2000	750				
<i>Pittosporum tenuifolium</i>	2600	2500	1900		2000	4000	350	2500	2800	2000	2000	950	1100
<i>Plagianthus divaricatus</i> + *		2000	1700	1800							1550		1000
<i>Plagianthus regius</i>		6000	5000	6000	4500		3500	1700	5000	3200	5000	3400	2500
<i>Poa cita</i>	500	700		900		700		1000	1200	900			
<i>Poa colensoi</i> *						600							
<i>Podocarpus nivalis</i> *												300	300
<i>Pseudopanax ferox</i> *										900			
<i>Sophora microphylla</i>		3100			2200	800		1900	600	3250	850		
<i>Veronica cupressoides</i>	800		400	700	1000			1100				400	300
<i>Veronica odora</i> *			400	350				450		500	500		
<i>Veronica salicifolia</i>		1700				750			250		1550	1200	
<i>Veronica topiaria</i> ?+ *	500			350					500				

Table 2B Minimum Height Measured per Species in each POS Area

Scientific Name	RPS	W1_1	W1_3	W1_5	W1_7	E1_1	E1_2	E1_3	E1_4	E1_5 Lwr Slope	E1_5 Upr Slope	E5 Lwr / East Outcrop	E5 Upr Outcrop
<i>Astelia nervosa</i> *					900								
<i>Brachyglottis spp?</i> + *													600
<i>Carex buchananii</i>				600	400	300		300	300	700			
<i>Carmichaelia petriei</i>		1000	1000		1200			700	750				
<i>Carex secta</i>	750	900	1000	800	700				725	500		800	700
<i>Chionochloa rigida</i>						1500		800			1100	1500	900
<i>Chionochloa rubra</i>		1100	1200	1100	1300	1200		1100	1000	1200	1100	1100	800
<i>Coprosma crassifolia</i>			800	700	800		250	250	300	300	850		
<i>Coprosma dumosa</i> *								1100					
<i>Coprosma lucida</i> *		1600											
<i>Coprosma propinqua</i>	1800		1300	600	1200	250		250		300	700	300	800
<i>Coprosma rugosa</i>	1500	1900	1100	1000	1250	350		500	250	1200	1100		900
<i>Coprosma virescens</i>	1500	1900	700	700	800		300	250	300	1650	800		
<i>Cordyline australis</i>		1800	1300	500	1800	800	250	400	250	500	650		
<i>Corokia cotoneaster</i>	500				1400			150	250		700		
<i>Austroderia richardii</i>		1800	1500	1300		700		800	1000	2000		1400	
<i>Discaria toumatou</i>			1000	800				500				300	1000
<i>Fuscospora cliffortioides</i>								2000		300	350		
<i>Fuscospora fusca</i>								250			2500		
<i>Griselinia littoralis</i>	300							300	350		950		
<i>Halocarpus bidwillii</i>					800								
<i>Juncus edgariae</i>				1400	800								
<i>Kunzea spp.</i> + *										1750	1700		

<i>Leptospermum scoparium</i>						800	700	800	700	300	500		
Scientific Name	RPS	W1_1	W1_3	W1-5	W1_7	E1_1	E1_2	E1_3	E1_4	E1_5 Lwr	E1_5 Upr	E5 East Outcrop	E5 Upr Outcrop
<i>Muehlenbeckia astonii</i> + *	1400											600	550
<i>Myrsine australis</i>	600								400		800		
<i>Myrsine divaricata</i>													400
<i>Olearia bullata</i>	1450			1250	1100			800			700		
<i>Olearia fragrantissima</i>						700		300	550	725			
<i>Olearia lineata</i>				1800	3500					2000	1500		
<i>Olearia odorata</i>	950			1500	2250			1000	350		1400		300
<i>Ozothamnus vauvilliersii</i>								1000	700	1000	1100		
<i>Pachystegia minor</i> + *													
<i>Phormium cookianum</i>	1200	1200		900	800	700	400	300	400	400	450		
<i>Phormium red cultivar</i> + *													
<i>Phormium tenax</i>		1800	1200	800	2200			1250	1200	2500		1200	
<i>Pittosporum eugenioides</i>							700	750	750				
<i>Pittosporum tenuifolium</i>	1100	1700	1200		800	3500	350	250	250	300	400	600	800
<i>Plagianthus divaricatus</i> + *		1500	1700	350							1100		1000
<i>Plagianthus regius</i>		2000	2200	600	2100		800	400	1200	1300	1600	800	600
<i>Poa cita</i>	500	700		700		700		700	950	600			
<i>Poa colensoi</i> *						600							
<i>Podocarpus nivalis</i> *												200	300
<i>Pseudopanax ferox</i> *										900			
<i>Sophora microphylla</i>		2500			700	550		700	300	300	700		
<i>Veronica cupressoides</i>	800		400	350	600			700				400	300
<i>Veronica odora</i> *			400	350				350		500	500		
<i>Veronica salicifolia</i>		1000				750			250		1100	1200	
<i>Veronica topiaria</i> ?+ *	200			350					400				

Table 4: Bird Species Present or Likely to be present in the immediate area

*Species confirmed to be present in or immediately surrounding the site on comparable habitat **

Species present in the surrounding landscape that may benefit as plantings mature+

Scientific Name	Common Name	Māori Name	National Conservation Status	Regional Conservation Status
<i>Alauda arvensis</i> *	Eurasian skylark	kairaka	Introduced and Naturalised	Introduced and Naturalised
<i>Anas platyrhynchos</i>	mallard duck	rakiraki	Introduced and Naturalised	Introduced and Naturalised
<i>Anthornis melanura</i> *	bellbird	kōparapara	Not Threatened	Not Threatened
<i>Anthus novaeseelandiae</i>	New Zealand pipit	pihoihoi	At Risk Declining	Not Threatened
<i>Athene noctua</i>	little owl	ruru nohinohi	Introduced and Naturalised	Introduced and Naturalised
<i>Callipepla californica</i> *	California quail	tikaokao	Introduced and Naturalised	Introduced and Naturalised
<i>Carduelis carduelis</i> *	European goldfinch	kōurarini	Introduced and Naturalised	Introduced and Naturalised
<i>Carduelis chloris</i>	European greenfinch		Introduced and Naturalised	Introduced and Naturalised
<i>Carduelis flammea</i> *	common redpoll		Introduced and Naturalised	Introduced and Naturalised
<i>Circus approximans</i> *	Australasian harrier	kāhu	Not Threatened	Not Threatened
<i>Egretta novaehollandiae</i>	white-faced heron	matuku moana	Not Threatened	Not Threatened
<i>Emberiza citrinella</i>	yellowhammer	hurukōwhai	Introduced and Naturalised	Introduced and Naturalised
<i>Falco novaeseelandiae</i> *	eastern falcon	kārearea	Nationally Vulnerable	Regionally Vulnerable
<i>Fringilla coelebs</i> *	chaffinch	pahirini	Introduced and Naturalised	Introduced and Naturalised
<i>Gerygone igata</i> +	grey warbler	riroriro	Not Threatened	Not Threatened
<i>Gymnorhina tibicen</i> *	Australian magpie	makipai	Introduced and Naturalised	Introduced and Naturalised
<i>Haematopus finschi</i> *	South Island pied oystercatcher	tōrea	At Risk Declining	Regionally Vulnerable
<i>Himantopus h. leucocephalus</i> *	pied stilt	poaka	Not Threatened	Not Threatened
<i>Hirundo neoxena</i> +	welcome swallow	warou	Not Threatened	Not Threatened
<i>Larus dominicanus</i>	southern black-backed gull	karoro	Not Threatened	Not Threatened
<i>Passer domesticus</i> *	house sparrow	tiu	Introduced and Naturalised	Introduced and Naturalised
<i>Petroica macrocephala</i> +	South Island tomtit	ngirungiru	Not Threatened	Not Threatened
<i>Porphyrio melanotus</i> *	pukeko	pukeko	Not Threatened	Not Threatened

<i>Prothemadera novaeseelandiae</i> *	tūi	tūi	Not Threatened	Not Threatened
<i>Prunella modularis</i> *	dunnock		Introduced and Naturalised	Introduced and Naturalised
<i>Rhipidura fuliginosa</i> *	South Island fantail	pīwakawaka	Not Threatened	Not Threatened
<i>Sturnus vulgaris</i> *	common starling	tāringi	Introduced and Naturalised	Introduced and Naturalised
<i>Tadorna variegata</i> *	paradise shelduck	pūtakitaki	Not Threatened	Not Threatened
<i>Todiramphus sanctus</i>	New Zealand kingfisher	kōtare	Not Threatened	Not Threatened
<i>Turdus merula</i> *	Eurasian blackbird	manu pango	Introduced and Naturalised	Introduced and Naturalised
<i>Turdus philomelos</i> *	song thrush	manu-kai-hua-rakau	Introduced and Naturalised	Introduced and Naturalised
<i>Vanellus miles</i> *	spur-winged plover		Not Threatened	Not Threatened
<i>Zosterops lateralis</i> *	silveryeye	tauhou	Not Threatened	Regionally Declining