1.0 Coronet Forest Revegetation Proposal

For

Queenstown Lakes District Council

February 2017

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Document ID: 16047
Coronet Forest Revegetation Proposal

### Document Status

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<th>Reviewer</th>
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<td>RT</td>
<td>GD</td>
<td>14 December 2016</td>
</tr>
<tr>
<td>B</td>
<td>Draft for client review</td>
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<td>GD</td>
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<tr>
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<tr>
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2.0 INTRODUCTION

2.1 Overview

The Queenstown Lakes District Council (QLDC) is updating the Coronet Forest Management Plan to reflect an early harvest. Coronet Forest is located on the south facing slopes of the Coronet Range, near Arrowtown. The forest contains a plantation of *Pseudotsuga menziesii* (Douglas fir), which covers an area of approximately 172 hectares. The forest is a significant contributor to the spread of wilding trees on neighbouring indigenous tussock grassland and shrubland communities. The council is interested in advancing the harvest to remove the ongoing spread of Douglas fir seed.

Coronet Forest is subject to provisions of the Emissions Trading Scheme (ETS) and the Operating and Proposed District Plans. The ETS and District Plans require the revegetation of the site following the harvest of the plantation. To assist in the determination of the best approach for revegetation of the site and understanding the costs associated with a revegetation project, QLDC commissioned Davis Consulting Group Limited (DCG) to prepare a proposal for the revegetation of the Coronet Forest post-harvest.

The proposal is for the implementation of a landscape level ecological restoration of the site, with a vision of re-establishing indigenous ecosystem values and also providing a recreational space for the local community and visitors.

2.2 Project Objectives

The following provides a list of key project objectives that the revegetation proposal is designed to achieve:

- To revegetate the site as soon as possible after harvesting to ensure landscape values are improved as efficiently as possible;
- To revegetate the site in a manner that promotes the natural regeneration of native vegetation and provides habitat for native wildlife (e.g. birds, lizards and invertebrates);
- To establish native plantings that are self-sustaining within the site;
• To meet the ETS requirements – revegetate 145 of the 172 ha, where each of the 145 hectares will have more than 30% tree crown cover from forest species. These forest species are capable of reaching five metres in height at maturity;
• To promote sustainable use of the site by members of the public via establishment of walkways, biking tracks, horse trekking trails and picnic areas;
• To prevent the establishment of Douglas fir seedlings and other weedy species, e.g. briar, hawthorn, sycamore, rowan, broom and gorse;
• To establish an area of biological diversity to help restore the native biodiversity values within the Wakatipu Basin.

2.3 Proposal Outline

The revegetation proposal is structured as follows:

• Section 2: Provides a set of Governing Principles for the proposal;
• Section 3: Proposed Approach to Revegetation;
• Section 4: Project Oversight;
• Section 5: Cost estimate; and,
• Section 6: Project Summary.
3.0 PROJECT GOVERNING PRINCIPLES

The following lists a set of governing principles that must be achieved in order for the revegetation of Coronet Forest to be successful.

3.1 GP1 – Obligations Under the Emissions Trading Scheme

The ETS requires that each hectare of planted trees, is to have tree crown cover from forest species of more than 30%. These trees are to be capable of reaching five metres in height at maturity, in the place they are growing. The indigenous ecological community that can achieve a height of 5 metres or more within this environment is a community dominated by mountain beech or red beech, mixed with other species such as kowhai (Sophora microphylla), cabbage tree (Cordyline australis), kohuhu (Pittosporum tenuifolium) and ribbonwood (Plagianthus regius). In order for QLDC to meet its obligations under the ETS, 145 of the 172 hectares will have more than 30% tree crown cover from native forest species. This has been adopted as a key governing principle for the revegetation proposal.

3.2 GP2 – Ecological Diversity

As discussed in GP1, at least 30% of 142 hectares on the site will be planted in native forest species. However, to improve the ecological diversity of the site a further 10% of the site is proposed to be planted in grey shrubland and tussock grassland species.

3.3 GP3 – Establishing the Conditions to Support Natural Regeneration Processes

The remainder of the site will be over sown with introduced grass species. Introduced grass species will suppress woody weeds from germinating and promote fast establishment of vegetation cover across the site. Over sowing of grass will be undertaken before any planting is carried out on site. This will give the second rotation crop (native forest species) a higher chance of survival and also reduce the amount of competition from Douglas Fir. Douglas fir seedlings will naturally regenerate on site due to the seed source left on the cutover and viable seed remaining in the soil. In Year 6 and 7, we also propose to introduce bracken fern with the objective of bracken colonising the grassed and unplanted areas over time and providing suitable conditions for indigenous plantings to seed into. Bracken is rhizomatous and has the ability to colonise through grass swards rapidly once it has become established.
3.4 GP4 – Landscape Restoration and Woody Weed Control

The location of Coronet Forest is very prominent within the Wakatipu Basin. It is therefore considered very important that vegetation is restored as efficiently as possible across the entire site. This is proposed by re-grassing the site as soon as operationally possible after each area is harvested, and this will also provide a vegetation cover so that the slopes will provide a natural appearance when viewed from the Wakatipu basin. Post-harvest, the site will be subject to rapid woody weed establishment, particularly from germinating Douglas fir seed, but also a range of other weeds including hawthorn, sycamore, rowan, briar, broom and gorse (among other weed species). Control of the entire site for wilding tree species and woody weeds will be critical to ensure the site can develop on a pathway toward indigenous vegetative cover. Control of wilding tree species and woody weeds can be achieved without affecting the initial grass vegetation on site, which will ensure that a natural look will be achieved and maintained across the slope.
4.0 PROPOSED APPROACH FOR REVEGETATION OF CORONET FOREST

The following sets out a methodology for the revegetation of Coronet Forest. We note that there will need to be a significant programme of work completed in order to engage nurseries for the supply of plants, landscape planting contractors, fencing contractors and weed control contractors. Notwithstanding this body of work, the following details our approach to revegetation of the site based on the guiding principles set out in the previous section of this proposal. A timeline of the key stages discussed below is provided in Section 4 (see Figure 2).

3.1 Site Preparation

Post-harvest site preparation will be critical to maximise the survival rate for all planting work. The proposed key steps in site preparation are oversowing and topdressing, weed control and goat/deer control. This work is described below.

*Plantation Harvest*

QLDC has obtained a harvest strategy for the site which proposes to harvest the forest over a two-year period. The harvest scenario separates the site into four areas, with harvest occurring sequentially (refer to the Harvest Management Plan). Once the harvest is complete, the slash and wood debris will be spread across 84 hectares of the site, with the remaining steeper areas of the site being relatively clear of logging slash, as this will be taken to the skid sites. The slash around the skid sites, will take a long time to degrade and provide a sheltered environment for the ongoing germination and establishment of woody weeds. We note DCG assessed the merits of burning the windrowed material with the Otago Rural Fire Authority. Unfortunately burning of the windrows was not considered appropriate due to the amount of smoke that would be produced, and the nuisance and possible health effects it may have on residents within Arrowtown and its surrounds.

*Oversowing and Topdressing (OSTD)*

Once the harvest is complete, the site will be oversown and topdressed (OSTD). Oversowing with pasture grasses (e.g. Yorkshire fog and brown top) is the first step in restoring landscape values quickly and will help prevent Douglas fir and woody weed establishment. Oversowing and topdressing will occur in the Spring or Autumn immediately after each of the four areas have been harvested. Photographs showing post-harvest clearance of slash and post-harvest cutover and slash left in-situ are provided in Plate 1 and Plate 2. We note that perennial rye and cocksfoot should not be included in the oversowing seed mix as these can be too competitive against native seedlings.
Given the possibility for dust and soil erosion in the period between post-harvest and oversowing and topdressing, consideration of dust and erosion control is advised. If necessary, “Vital Polykelp” or “Vital Bon-Matt Stonewall”, which are non-toxic and non-hazardous polymer chemicals used for dust and soil stabilisation, could be utilised. The Vital Polykelp includes fog grass seed (a variety of Yorkshire fog (*Holcus lanatus*)), which when applied is transparent in colour and will establish within one to two months in Spring. If utilised, these areas of the site would not then need to be oversown and top-dressed. If soil stabilisation is required outside of spring, Vital Bon-Matt Stonewall could be aerially applied where necessary across areas of the site.

Plate 1: Photograph showing post-harvest slash on site, prior to grass establishment on Queenstown Hill.
Weed Control

The pasture grasses are expected to help prevent woody weed species from establishing on site, including Douglas fir seedlings. However, further weed control will be required. The method of weed control across the site is determined by the proximity of neighbouring residents. Aerial application is the most efficient method; however, herbicides would only be applied at a distance of 500 metres or more from the nearest residence. DCG estimates that approximately 65% of the site is outside this chemical application buffer zone.

To ensure the efficient and effective control of Douglas fir and other woody weeds, all areas of the site that are over 500 metres from neighbouring dwellings will be aerially sprayed with metsulfuron or a similar woody weed selective herbicide. The aerial application of herbicide will cover approximately 65% of the site, and will need to be carried out with an upslope wind. We note that pasture grass and native tussock species are resistant to the woody weed selective herbicide. Three herbicide applications are proposed for the site. These applications are proposed soon after the harvest finishes and subsequently two and four years' post-harvest. We note that where native bracken fern has established within this area (as per the Natural Revegetation section below) aerial spraying should not occur. Strategies to reduce spray drift will be used to avoid any damage from aerial spray to the sensitive planting areas.

Weed control within 500-550m of the nearest dwellings will be carried out via hand-pulling and backpack spray units, or a spray unit via hose from a truck or tractor.

Plate 2: Photograph showing post-harvest cutover and slash left in-situ, on Ben Lomond.
**Goat and Deer Browsing Control**

Due to the presence of goats and possibly deer, a deer fence is considered necessary to protect the plantings and maximise the performance of the revegetation work. The most practical fencing approach is to construct a perimeter deer fence around the site, with gates at the top and bottom for contractor access and future public access. Construction of the fence should begin as soon as possible in conjunction with the harvest. An alternate would be to use Plantskydd, a non-toxic animal repellent, that is applied to plants to deter herbivores. However, the effectiveness of Plantskydd on deterring goats is unclear. DCG recommends trialling Plantskydd to determine the effectiveness of this product on managing goat and deer browse. If a trial showed the Plantskydd is effective this may negate the need to construct a deer fence around the perimeter of the site. Notwithstanding this approach, we have included a cost estimate for the installation of the deer fence should Plantskydd not be considered an appropriate grazing deterrent.

**3.2 Landscape Revegetation**

Based on the governing principles set out in Section 2 and the weed control methods discussed above, a revegetation plan has been developed for the site. Figure 1 provides a graphical presentation of the proposed revegetation units and is detailed below.

The aim of the landscape revegetation is to establish a self-sustaining native forest and mixed grey shrubland and tussock grasslands across the site, providing habitat for native wildlife and an outdoor space for members of the public to access and enjoy, as well as ensuring landscape values are improved. To achieve this, a combination of hand planting and natural regeneration will be employed.
Figure 1: Landscape Plan (from LAND Landscape Architects).
**Hand planting**

The Coronet Forest plantation is subject to the ETS, which requires replanting of a forest species capable of reaching five metres in height at maturity and each planted hectare on the site will exceed a tree crown cover of more than 30%. Mountain beech (*Fuscospora clifortioides*) is to be the dominant species planted on the site as it will exceed the requirements of height (approx. 10-15 m at maturity) and historically would have been the vegetation that would have been found on this slope. Other species such as kowhai (*Sophora microphylla*), cabbage tree (*Cordyline australis*), kohuhu (*Pittosporum tenuifolium*), ribbonwood (*Plagianthus regius*), lancewood (*Pseudopanax crassifolius*), broadleaf (*Griselinia littoralis*) and mountain lacebark (*Hoheria lyallii*), will also exceed the requirements of height at maturity and grow well in the Wakatipu. A mixture of these species should therefore be included within the forest plantings for diversity.

Restoration plantings are normally completed at one metre centres, which allows plants to provide shelter to one another and control weeds efficiently. To achieve a coverage of at least 30% of the site, approximately 521,100 native forest species will be planted into the established pasture grass (see Figure 1). In addition to this, 173,700 grey shrubland and tussock species will be planted at one meter centres, in a 12-metre-wide, continuous strip along all the proposed trails. Plate 3 provides an example of beech planted into pasture within the Wakatipu Basin. All native forest, grey shrubland and tussock species will be planted with shelters to protect from rabbit browse and wind exposure in the early growing stages (see Plate 4).

Restoration projects generally use a V150 plant size, but with beech trees grown in one litre pots. To balance cost versus plant survival, a ‘Lannen 35F’ planting size for the beech trees is considered appropriate. While the Lannen 35F is smaller than a one litre pot, it provides a larger root mass to foliage ratio than the V150, which should allow for good establishment (see Plate 5). The beech trees should also be grown in the nursery with duff (i.e. beech soil litter) to inoculate the soil/roots with mycorrhizal fungi which aid plant growth and survival. The remainder of the native forest, grey shrubland and tussock grassland species can be grown to either Lannen 35F or V150 plant size.
Plate 3: Mountain beech that have been hand planted into exotic pasture grass.

Plate 4: Native tree species in protective shelter.
As well as forest tree species, 10% of the site will be hand planted in a mix of grey shrubland and tussock species. This will increase biological diversity and the range of habitats for native wildlife species. Grey shrubland is a key habitat for a number native passerine bird species (e.g. fantail and grey warbler), which in turn provides prey for the ‘At Risk’ New Zealand eastern falcon. To achieve a 10% cover over the site of shrubland and tussock grassland, approximately 173,700 plants will be required to be installed. Species to be planted in the grey shrubland and tussock grassland habitat include, but are not limited to: Coprosma propinqua, Coprosma rugosa, Coprosma rigida, Coprosma virescens, Coprosma intertexta, Leptospermum scoparium, Sophora microphylla, Discaria toumatou, Olearia bullata, Olearia fragrantissima, Olearia fimbriata, Olearia hectorii, Olearia lineata, Olearia odorata, Corokia cotoneaster, Ozoanthus leptophyllus var. vauvilliersii, Pittosporum tenuifolium, Cordyline australis, Leptecophylla juniperina subsp. juniperina, Melicope simplex, Melicytus alpinus, Hoheria lyallii, Hoheria sexstylosa, Plagianthus regius, Chionochloa rubra, Poa cita, Austroderia richardii, Carpodetus serratus, Podocarpus laetus, Veronica cupressoides*, Veronica salicifolia*, Veronica odorata*, Carmichaelia petriei*, Hoheria glabrata*, Coprosma lucida*, Olearia avicennifolia*, Olearia arborescens*, Myrsine divaricata*, Myrsine australis*, Chionochloa rubra*, Festuca nova-zealandia*, Griselinia littoralis*, Aristotelia fruticosa*, Aristotelia serrata* and Pseudopanax crassifolius*. Plants with an asterisk are to be planted in lower numbers and only in suitable

Plate 5: Left: ‘Lannen 35F’ plant size; Right: ‘V150’ plant size.
habitats. This list is to be reviewed once harvesting has been completed and the range of habitats available has been assessed.

The grey shrubland mix will be planted at one metre centres in a 12-metre-wide, continuous strip along all the proposed walking/biking/horse-riding trails (see Figure 1). The location of these plantings is for two reasons. Firstly, to prevent weed species establishing along track edges, where weed species often preferentially establish, and secondly, to enable easy access for the maintenance of the plants.

All the hand planting would occur over seven planting seasons, i.e. spring and autumn over three to four years (Figure 2). The first native plantings will occur two years after harvesting finishes. The delay in the planting will allow for efficient Douglas Fir control as the exotic seedlings will be captured by two aerial sprays before any native planting occurs. This timeframe also allows for the nurseries to supply the native plants and availability of experienced contractors to install the plants and plant shelters.

**Natural Revegetation**

Due to the large-scale landscape level of restoration this project requires, it is not feasible to plant out the whole site. Therefore, providing support for natural regeneration processes is proposed. QLDC are exceeding the requirements of the ETS in regards to the amount of native forest species that are proposed to be planted, and are therefore not dependent on natural regeneration to satisfy the ETS criteria. Natural regeneration is an additional support mechanism to for landscape scale restoration of the site. A limitation to the natural successional processes associated with this site is the lack of early successional species present, notably bracken fern and tutu. Without these species present, it is unlikely that a trajectory toward indigenous vegetation dominance within the unplanted areas, via natural regeneration of the site can be achieved.

Plate 6 below highlights the importance of bracken fern as a nursery crop for the germination and survival of indigenous plants. The important function of bracken fern can be seen in many places, particularly adjacent to Lake Wakatipu.

Given the importance of bracken fern, DCG proposes to assist the colonisation of the site with bracken fern. The best mechanism to achieve colonisation of the site will be determined by trialling a number of methods including the following:

- Transplanting bracken collected from adjacent to the site;
- Collection of bracken vegetative matter, mulching the whole plant (leaves, shoots and roots) and placing the material on the site;
- Collection of rhizomes and planting/placing on site; and,
• Collection of rhizome and coating with flour to mitigate the rate of drying out of the rhizome and placing onto the site.

Colonisation of bracken onto the site, coupled with the planting of indigenous species that can seed into the bracken fern, is critical to ensure the ecological trajectory of the site towards an indigenous ecological community.

Plate 6: Natural regeneration of native species through bracken fern in the Wakatipu Basin.

Public Spaces
The construction of walking, horse trekking and bike tracks could occur once the pasture grasses have established. The upgraded roads post-harvest can be utilised as walking and horse riding trails, with mountain bike trails established off these main routes (see Figure 1). We note future tracks will need to be established in conjunction with the revegetation areas. There is also the potential to link trails up with existing walking networks, for example the Bush Creek track and the ‘Arrowtown to Historic Shotover Bridge’ trail. In addition to the recreation trails, picnic areas could be established on the lower slopes of the site and areas set aside for community planting (see Figure 1).
4.3 Revegetation Maintenance

To maximise the performance of the plantings, a landscape maintenance programme will commence immediately prior to the first round of planting (to remove any weeds that might have established in the interim) and will continue for three years after each planting season (see Figure 2). After each round of hand planting has received three years of maintenance, there needs to be a review to assess if any further wilding/weed control is necessary for each area. The plant maintenance work to be undertaken will include weed control, rabbit and hare control and a check of the fence line (if required). All of which is required to minimise competition from exotic weeds and animal browse.

Within all hand planted areas, weed control will include the application of herbicide immediately adjacent to each plant shelter and hand pulling of weeds that grow within the plant shelter. The remaining areas of the site will be covered in pasture grass. Some weeds will still establish and weed control via hand spraying and cutting will be necessary. Where bracken fern has established within the pasture grass little to no weed control should be required.

Inspection and maintenance of the perimeter deer fence (if required) and plant shelters will be undertaken to ensure all fences and shelters are working effectively.

4.4 Equipment and Facilities

A temporary nursery will need to be constructed on site to keep plants protected prior to planting. During planting seasons, the plants should arrive weekly and will need protection from rabbit/hare browse, as well as irrigation, until planted with shelters.

4.5 Limitations

When dealing with landscape level restoration in the natural environment, there are key aspects to be aware of where there needs to be a level of flexibility. Firstly, that plant growth and survival is dependent on a combination of climatic events, site conditions and animal browse. These factors can interact to slow down or speed up plant growth and in the worst-case lead to a lower survival rate for plants than expected. This proposal includes measures to mitigate this risk to the greatest extent possible via a perimeter deer fence, plant shelters, site specific plant species choice, planting spacing, eco-sourcing of plants, and allowing for maintenance.

Secondly, the supply of such large numbers of beech trees from nursery’s can be reliant on a mast year for seed collection. A mast year is a year of high beech seed production, which only happens every two to six years. The nursery’s will need a reasonable seed year, if not a mast
year, to collect enough seed. There will then be a two-year lead in for the growth from seed to an appropriate size for planting out (i.e. Lannen 35F). To help mitigate this risk, seed needs to be collected as soon as possible and additional seed collected in good seed years.
5.0 PROJECT SCHEDULE AND COST ESTIMATE

This section provides a provisional project schedule and cost estimate for the proposed Coronet Forest Revegetation as proposed above.

5.1 Project Schedule

Figure 2 below sets out a timeline of the key stages of the proposed Coronet Forest revegetation project. The timeline is indicative only and flexibility in the timing of activities will be necessary to respond to climatic variability and timing of weed establishment. For example, aerial spraying would be timed to kill as many Douglas fir seedlings as possible, which may not necessarily be in Year’s 4, 6 and 8.
Figure 2: Proposed Schedule for Coronet Forest Revegetation.
5.2 Cost Estimate

Table 1 below provides a breakdown of a cost estimate to complete the revegetation project described herein. The costs are based on preliminary cost estimates obtained from contractors and standard rates used by landscape contractors on smaller projects undertaken within the Wakatipu. Please note, this cost estimate excludes the following costs:

- Project management;
- Construction of onsite holding “nursery”;
- Track construction and signage;
- Monitoring to assess the performance of the project;
- Dust and erosion control if necessary;
- Douglas fir control on areas neighbouring the forest, where Douglas fir has established;
- Bracken fern establishment
- Rabbit and hare control – e.g. Plantskydd;
- Deer fence line check, although this may be able to be included in the goat monitoring estimate;
- Freight of plants and materials to site;
- Maintenance of plantings past the initial three years proposed; and,
- Costs of inflation.

Table 1: Provisional cost estimate (excluding GST and the costs listed above).

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<td>Plants &amp; shelters (521,100 forest spp. &amp; 173,700 grey shrubland/tussock</td>
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<td>Planting &amp; shelter installation (694,800 plants &amp; shelters)</td>
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6.0 PROJECT SUMMARY

In summary, the above proposed approach for the native revegetation of Coronet Forest is based on local ecological restoration knowledge and project management experience, and is consistent with the majority of views expressed in the public submissions. The proposed methods should effectively and efficiently as possible achieve a revegetated site that is utilised by the public. The methods include hand planting of native forest species, grey shrubland and tussock species, alongside the establishment of bracken fern as a natural weed suppressant and nursery to support natural successional processes across the site. Oversowing and topdressing as the harvest is completed should aid in weed suppression, and should provide relatively rapid grass cover of the site and mitigate the effect on landscape values until native revegetation fully establishes. These methods are consistent with the project objectives and governing principles.

We also note that, while outside the scope of this proposal's boundaries, the success of this proposal relies on the control of wilding pines outside the forest area. In particular, the area of Douglas fir immediately below the forest and also wilding trees to the west and east of the forest.

To the best of our knowledge, there is no comparative revegetation project within New Zealand, as most forestry sites would go back into a second rotation of forestry species. The proposed native revegetation of Coronet Forest is a unique opportunity to restore biodiversity values and would be a leading example of how landscape level ecological restoration can be successfully achieved within the Otago region and throughout New Zealand.