



# **MANAGEMENT PLAN FOR CORONET FOREST ARROWTOWN**



**JANUARY 2017**

Prepared for: Queenstown Lakes District Council & Central Otago District Council

Prepared By: Briana Pringle, BForSc, Parks and Reserves Officer (Forestry), Queenstown Lakes District Council.

DRAFT

## CONTENTS

---

<b>SUMMARY</b>	5
DISCLAIMER	6
BACKGROUND	7
LEGAL DESCRIPTION/JOINT VENTURE	7
LAND RENTAL	8
SITE CHARACTERISTICS	8
VEGETATION	9
CURRENT USE OF THE FOREST	9
DISTRICT PLAN & DESIGNATION	9
EMISSIONS TRADING SCHEME (ETS)	10
<b>MANAGEMENT</b>	
MANAGEMENT OBJECTIVES	11
FOREST AREA	11
PRE HARVEST INVENTORY – YIELD ANALYSIS/EXPECTED YIELD	12
FOREST VALUE	14
WILDING CONTROL	15
PROPOSED SIGNIFICANT NATURAL AREAS	20
FIRE	21
FENCING, TRACKING AND ROADING	22
<b>HARVEST PLAN</b>	
BEST PRACTICES, HEALTH AND SAFETY	23
HARVEST PLAN	23
HARVESTING AND MARKETING OF THE FOREST	24
DOUGLAS FIR ESSENTIAL OIL AND BIO FUELS	24

## **REVEGETATION**

REVEGETATION OBJECTIVES	26
NATIVE/GREY SHRUB LAND RESTORATION	27
REVEGETATION OBLIGATIONS UNDER THE EMISSIONS TRADING SCHEME	30
LAND PREPARATION	30
MAINTENANCE WILDING AND WOOD WEED CONTROL	31
REVEGETATION COST	32
APPENDIX	34
MAPS	34

DRAFT

## SUMMARY

This management plan has been prepared by QLDC and describes the management proposals and revegetation recommended for a 2017 harvest. This plan uses estimates based on recent industry averages, conventional harvest engineering methodology and current knowledge.

The QLDC and CODC have an opportunity to harvest the Coronet Forest before full maturity, in order to mitigate the wilding threat and re-establish the site with more suitable vegetation. A full harvest now is a solution for dealing with the wider wilding spread that retention of the Forest will inevitably continue to contribute. Just harvesting the oldest stands will not solve the problem as the younger stands at the top of the Forest will continue to spread seed in high winds.

The Forest remains a significant seed source and contributor to the wilding pine issue. Future regulation arising from initiatives such as the Regional Pest Management Strategy (RPMS) may require the QLDC and CODC to reduce or eliminate the spread of Douglas fir from the Forest. This includes potentially being liable for lands outside the Forest now affected by infestations.

Some private landowners who own sizable wilding plantations are reluctant to participate in programs to remove the trees on the grounds that the Council is a massive wilding seed contributor. If a harvest now is implemented, these landowners may be willing to remove their trees.

In 2016 a more detailed survey of the wilding spread from the Coronet Forest was completed, this report increased the control area from 4km behind the Forest to 10km (and now included Crown Peak and the faces along the Crown Range). The cost to control the spread from the Forest if it was harvested at maturity (youngest stands in 2039) has increased to an estimated \$8.5 million to control around 5,500 ha of infested land.

The harvest plan provides a breakdown of staging within the Forest and gives an overview of the proposed road and landing locations as well as the harvest method throughout the Forest (ground based or cable) and direction of extraction. It has been projected that the harvest will produce 67,940 m<sup>3</sup> of recoverable log product from the Forest. The duration of the harvest has been estimated to be around a two-year duration, given the current market and the economics of harvesting most of the crop may be destined for an export market.

There is an opportunity for the community to realise additional valuable products from the Forest such as firewood, bio fuels and essential oil. The expected volume and log grade output calculated from the pre harvest inventory did not assess these products as the current local market is unknown. This management plan primarily investigates the log resource which the forest was grown for and there will be opportunities to investigate these markets further.

The agreement between QLDC and CODC is a joint venture for the one rotation of the forest, there is no obligation for CODC to remain in partnership with QLDC post-harvest or to re-establish or revegetate the land. Revegetation of the site is subject to conditions under the Emissions trading scheme and also the Operative and Proposed District Plans.

As the Coronet Forest is very prominent within the Wakatipu Basin, one of the key objective of the revegetation program is to promote vegetation the site as soon as possible after harvest to reduce the visual disturbance of the site. Another is to prevent the establishment of competing woody weeds, especially Douglas fir seedlings.

The plan is to establish 30% the site with planted beech forest, a further 10% of the site will be planted in grey shrub-land species and at higher altitudes tussock alpine species. The remaining 60% of the site will be revegetated with introduced grasses initially to suppress woody weeds, but to promote the establishment of a vegetation cover across the site.

Control of Douglas fir on the site is key in establishing a second rotation crop, not only does Douglas fir have to be controlled within the harvested area, but all seeding sources surrounding the forest will need to be removed to create a successful indigenous vegetation cover.

The planting will occur over three to four years and the plan is to carry out weed control over a ten year period from harvest.

#### **DISCLAIMER**

---

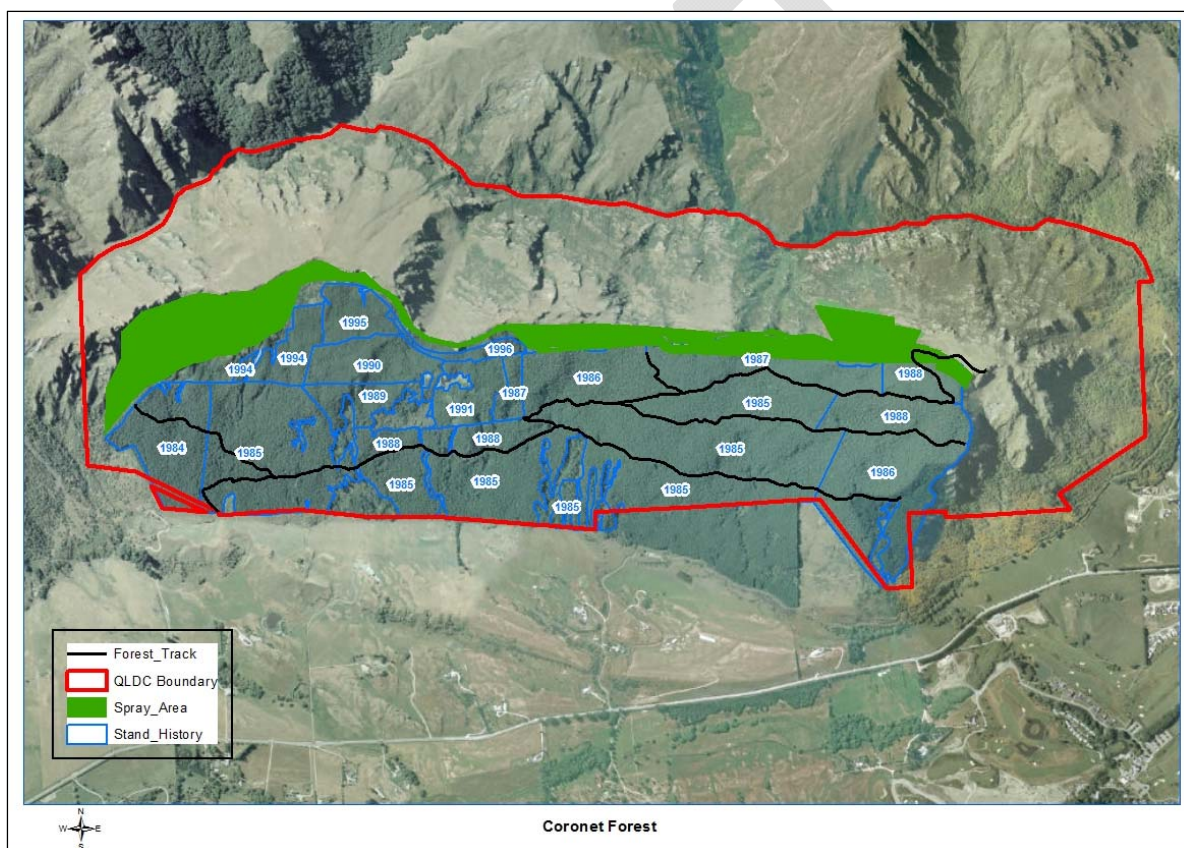
QLDC has compiled this plan and its associated financial analysis. Much of the information used to calculate costs and revenues is best estimate of what will be incurred or earned in future years. These estimates are based on recent industry averages, conventional harvest engineering methodology and current knowledge. Actual returns from this investment may be different from the returns calculated in this plan due to uncontrollable events.

## BACKGROUND

### LOCATION

Coronet Forest is located on the lower slopes of Coronet Peak close to Arrowtown. The site is steep with a southerly aspect and rises to about 650 meters above sea level. The Forest is accessed by Alan Reid Road which is a metalled public road off Malaghans Road. The land adjoins pastoral lease land to the north, run by Coronet Peak Station, and rural residential land to the south. Arrowtown Township is 1 km to the east. The Forest is highly visible throughout the Wakatipu Basin (Figure 1).

**Figure 1: Aerial of Coronet forest**



### LEGAL DESCRIPTION/JOINT VENTURE

The trees occupy an effective Net Stocked Area of approximately 172 ha on four separate Titles with a combined total area of 422.08 ha.

The legal description of the land the Forest occupies is:

Lot 1 DP 24277 and Lots 1 and 2 DP 21922 and Section 24 Block XVII and Section 23 Block XVIII Shotover Survey District, comprised within Certificate of Title 16B/451 of the Otago Registry.

The land is encumbered by lease 617100 to the Central Otago District Council (CODC) and Queenstown Lakes District Council (QLDC) for a term of 60 years from the 1st April 1983. The registered owner of the property is QLDC<sup>1</sup>.

The agreement between the QLDC and CODC is a joint venture and the asset is shared 75% with the QLDC, and 25% with CODC. The lease shall continue until the joint venture property is sold or otherwise disposed of, current management costs are split 75/25 between the QLDC and CODC.

## LAND RENTAL

---

The land is owned by the Queenstown Lakes District Council, and is under rental to the joint venture.

The most recent valuation at 13th March 2008 valued the current market rental value of the land at \$20,000 per annum.

The area of land rented is 413ha (Figure 1), only the southern face contains forest, the remainder of the land is not currently administered. The land has an east to west ridgeline running through it; the unplanted land is north facing falling towards Bush Creek, and is now populated with scattered young wilding Douglas fir. The land directly to the east has wilding Larch, Douglas fir and Sycamore present.

## SITE CHARACTERISTICS

---

**Soils:** The south facing slope has Brown Dunstan soils, with moderate fertility, but are very good forest soils. The north facing slope consists of Pallic Arrow soils with low fertility. The soils are prone to wind and sheet erosion, severe frost heave, and some landslides.

**Climate:** The average rainfall is 901-1,250 mm and the average air temperature is 8.5 -9 degrees Celsius (Otago Grow 2016).

**Altitude:** The Forest lies between an altitude of 500 metres and 1100 metres above sea level.

**Topography:** The topography of this Forest is a relatively uniform lower mountain slope of moderate to steep contour, and with a number of shelves of easy contour. There is an historic slip near the middle of the Forest which is slowly being stabilised by the trees. Rock outcrops occur on some ridges and spurs, but the site is not excessively rocky.

**Geology:** Coronet Forest is close to a number of smaller fault lines such as the Shotover fault. The underlying rock formation on Coronet Forest is metamorphic rock of the Haast Schist Group –

---

<sup>1</sup> The lease was originally between the Arrowtown Borough Council (as Lessor), the Alexandra Borough Council, the Arrowtown Borough Council, and the Queenstown Borough Council (as lessees). A deed dated 1993 transferred the ownership to QLDC and lessee to QLDC & CODC.



Chlorite subzone 4, which is coarsely foliated schist including some biotite schist, from the Permian to Carboniferous periods.

## **VEGETATION**

---

The original vegetation (before planting) was a mixture of tussock and introduced grasses, some native shrub species including Matagouri and Tutu, with and extensive cover of the introduced weed Sweet Briar, and Broom in the lower altitudes. In addition to tussocks and some introduced grasses, snow berry, Dracophyllum spp, wild Spaniard and sub-alpine herbs at the higher altitudes. It is highly likely that native beech forest – especially mountain beech – clothed the lower slopes until destroyed by early European or pre- European fires (Guild 2001).

## **CURRENT USE OF THE FOREST**

---

The Forest has several recreational uses such as horse riding, hunting and walking, but the only formal agreement is with the Wakatipu Riding Club, this was recently renewed in 2015 for another term of five years till 31 October 2020.

Under the licence the Wakatipu Riding Club must be given two weeks' notice in writing to cease using the facility whilst forestry operations take place and the, licensee can resume operations when written confirmation is received that operations have ceased.

There are spectacular views from the top of ridge and the Forest has potential for greater recreational use, such as mountain biking and walking tracks, authorised horse trekking activities, or a loop track to Bushy Creek connecting to Arrowtown.

## **DISTRICT PLAN & DESIGNATION**

---

The zoning of the land under the QLDC Operative District Plan is Rural General, and the Forest has been designated for the purpose of forestry operations, which means the use of the land primarily for the purpose of planting, tending, managing and harvesting of trees for timber or wood production.

Designation 375 allows QLDC to carry out forestry operations in the area known as Coronet Forest.

In summary QLDC is required to undertake these operations under the following conditions:

*Operations must be undertaken in accordance with best management practices as specified under the NZ Environmental Code of Practice for Plantation Forestry Operations. For reference the current version of this is dated May 2008 and is readily available on the NZ Forest Owners website*

<http://www.nzfoa.org.nz/resources/file-libraries-resources/codes-of-practice/44-environmental-code-of-practice/file>

The designation specifies that all management plan updates shall address re-establishment of forest following harvesting operations. This includes the detail of plant schedules, density of planting, and maintenance programs. The designation also states that management of wilding regeneration should be addressed following a harvest operation.

## **EMISSIONS TRADING SCHEME (ETS)**

---

The Emissions Trading Scheme (ETS) is New Zealand's main tool for reducing emissions. Forestry was brought into the ETS on the 1st January 2008.

Forestry is New Zealand's largest potential carbon 'sink'. As trees grow, they absorb carbon. When trees are harvested, carbon that is stored is released back into the atmosphere as the wood decays. At present, all harvested wood taken off site is assumed to be immediately released back into the atmosphere.

The emissions trading scheme has two classes of forests Non-Kyoto Forests (pre-1990 forests) and Kyoto Forests' (post-1989 forests).

**Non-Kyoto Forest Land** - Owners of pre-1990 Forest Land are automatically entered into ETS, and incur obligations under the scheme if they deforest, they also receive a one-off allocation of NZUs to help offset the decrease in land value due to decreased land-use flexibility. In 2013 due to the loss in land value, QLDC as the landowner was allocated NZ units/carbon credits for 84% of the Coronet Forest.

QLDC's liability under the ETS is that once the forest has been harvested it must be revegetated with a crop which meets the definition of a Forest<sup>2</sup>, or submit an emissions return to Ministry for Primary Industries (MPI), and pay units for deforestation (at age 33, this equates to around 763 Carbon units per ha, MPI- carbon stock look-up tables). At a carbon price of \$17.50 in January 2017 ([www.comtrade.co.nz](http://www.comtrade.co.nz)), this liability equates to \$13,352 per ha.

**Kyoto Forest Land** - Owners of post-1989 Forest Land - can choose to enter the scheme and earn New Zealand Units (NZUs) as their forests grow. QLDC as landowner decided not to enter any of the Coronet Forest post-1989 land into the scheme as these trees are situated at a higher altitude where carbon sequestration is slower, and due to siting and prevailing wind direction these trees can displace seed for many kilometres onto susceptible land.

---

<sup>2</sup> The ETS defines a forest or forest land as; At least 1.0 hectare of trees which have (or will have) tree crown cover from forest species of more than 30% in each hectare, with an average width of at least 30 metres. which is capable of reaching five metres in height at maturity in the place they are growing.

## MANAGEMENT

### MANAGEMENT OBJECTIVES

The management objectives of the Forest, is to grow a crop of Douglas fir for maximum profitability within the constraints of:

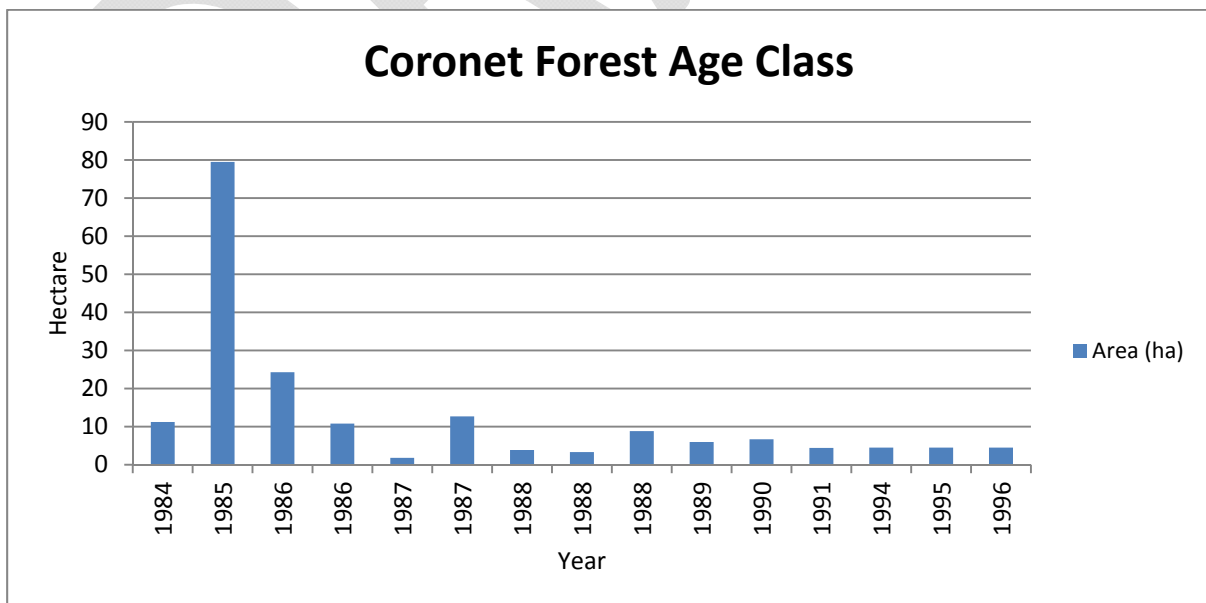
- Good forestry practice
- Sustainable land use, and
- Respecting the wider social objectives (of landscape and public use) of the Queenstown Lakes District Council as contained in the District Plan.

### FOREST AREA

QLDC GIS Team have access to aerial photography and the net stocked area of the forest is updated from this. The aerial photography has enabled the Forest stand boundaries to be mapped. All forest operations (planting, thinning etc) have been digitised and are stored in a database which provides a history of all events in the forest as well as stocking and area (Figure 1: Aerial of Coronet Forest).

The Coronet plantation is a monoculture of Douglas fir (*Pseudotsuga menziesii*), the oldest stand was planted in 1984 and the youngest stand was established in 1996 (Figure 2).

**Figure 2: Coronet Forest Age Class**



The stands were planted at stockings between 2,000 and 1,667 stems per hectare (SPH). A blanking occurred in 1999 and 300 seedlings were planted in gaps caused by mortality.

Within the Forest there were a high proportion of malformed trees due to genetic problems such as double leaders, ramicorn branches, stem wobble and coarse branching. Some trees in the Forest had been damaged by wind and snow causing broken tops and butt sweep. The proportion of malformed trees was what would typically be expected in a stand and scheduled thinning operations removed most of the malformations so that the best formed trees now remain as the final crop.

## **PRE-HARVEST INVENTORY - YIELD ANALYSIS/EXPECTED YIELD**

---

A review of the management of the forest was carried out by Forme Consulting in June 2014, this review recommend a full inventory to enable more robust modelling to understand the available yield in a “harvest now” situation for planning, log markets and decision making.

A full inventory is a vital tool in estimating the total stem volume and also the mix of log products that could be expected when the Forest is harvested. This is referred to as the yield from the Forest and is based on a sample of the trees, taken from plots established throughout the forest.

Establishing plots throughout the Forest provides a sample of the stand, enabling a visual assessment of the external tree characteristics such as their dimensions (DBH and HT), straightness, branching, malformation etc. This data can then be assessed using growth models and anticipated market log specifications for varying clearfell ages.

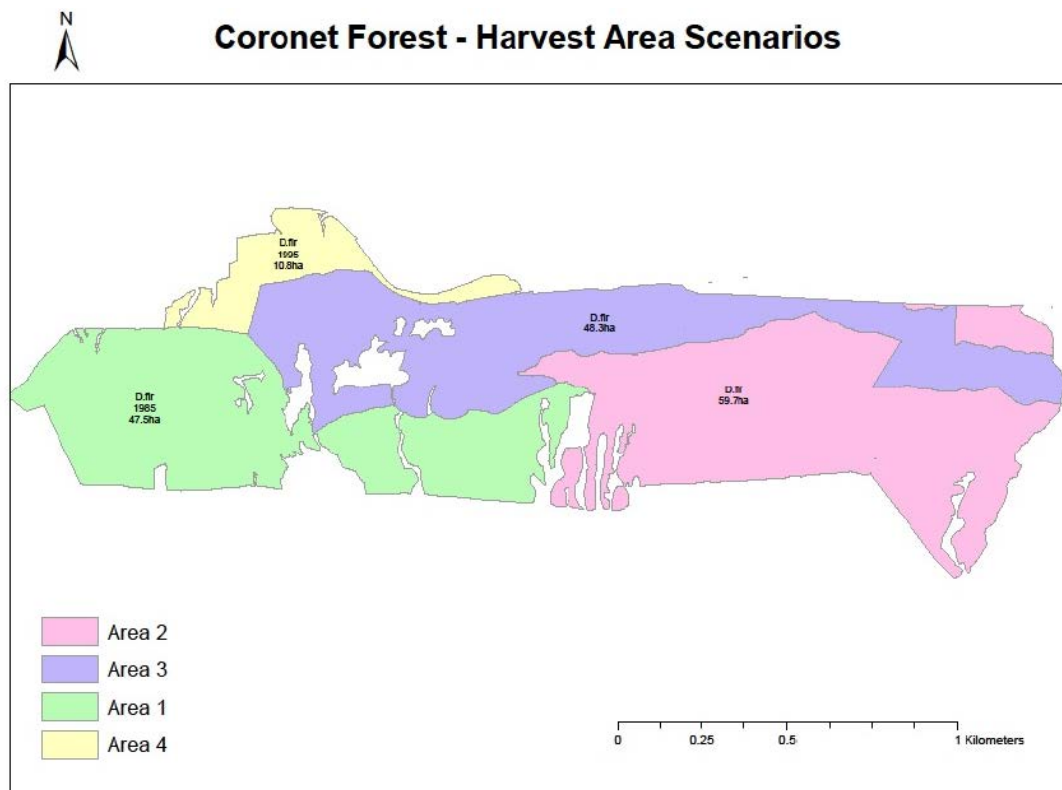
The first step in deriving estimates of future volume is to stratify the forest into crop types. Each crop type is then clearly defined, and mapped. Crop types may be distinguished from one another by species, age class, silvicultural treatment, or productivity. Coronet Forest is remarkably uniform, being just one species, and of similar growth throughout.

Interpine Forestry Innovation carried out an inventory of the Coronet Forest in January 2016, the forest was stratified into four sampling/crop types areas based upon planting age, tending history and stocking (Figure 5 – Coronet Forest Harvest Area Scenarios). The three larger areas were measured as pre-harvest inventory and the youngest stands at the top of the forest were measured as mid rotation inventory. Area 1 had received two thinning to waste operations and Areas 2, 3, 4 had only received a single thin to waste<sup>3</sup> operation.

---

<sup>3</sup> ‘Thin to waste’ is the silvicultural practice of removing selected trees to promote the rapid growth of the crop trees, to waste is where the trees are left on the forest floor, production is where the trees are removed for use

**Figure 5: Coronet Forest by Crop Type – Harvest Area Scenarios**



A total of 112 plots were [set up and](#) measured across all areas. The plots were sized to allow the measurement of 17-20 trees per plot which meant the average plot size was between 0.03 ha and 0.04 ha.

The data recorded in the inventory was entered into YGen (Yield Table Generator) software which generates the expected yield tables for a harvest using the South Island Douglas Fir 1 (SIDFIR\_1) Growth Model. It combines the process of growing and projecting tree volumes with log bucking algorithms to model tree merchandising through to log products.

In order to generate the expected volumes by log grade, a cutting strategy is devised. The cutting strategy utilised the current Douglas fir log prices obtained from exporters in the Southern South Island outlined below in Figure 6.

**Figure 6: Export Log Grade Specification Utilised in the Cutting Strategy**

	Min. SED	Max. SED	Max. LED	Lengths	Branch size	\$/m3 JAS
<b>CF+</b>	30	N/A	N/A	3.9, 5.9	<= 12 cm	135
<b>CF-</b>	20	N/A	N/A	3.9, 5.9	<= 12 cm	125
<b>CF16</b>	16	45	45	3.9	<= 22 cm	112

The yield analysis prepared by Interpine were reviewed and summarised (Forme 2016), Figure 7 below shows the total volume of recoverable wood product for the whole forest is 67,940 m<sup>3</sup>.

Please note that no allowance for firewood volume has been included at this stage. The analysis below only details log products produced in the cutting strategy detailed in Figure 6.

**Figure 7: The expected volume and grade output at 2017**

Population	Established	Current Age	Area (ha)	Recoverable Volume m3/ha	Total Recoverable Volume m/3
				2017	2017
<b>Area 1</b>	1984, 1985	30.9	47.5	509.3	24,192
<b>Area 2</b>	1986, 1987	30	59.7	446.6	26,662
<b>Area 3</b>	1986, 1987 1988, 1999 1990, 1991	27.4	48.3	325.3	15,712
<b>Area 4</b>	1994, 1995 1996	20.7	10.8	127.2	1,374
<b>Total</b>			<b>166.3</b>	<b>408.5</b>	<b>67,940</b>

The estimates produced from the inventory are only as good as the data being used, and the models themselves, nevertheless, the information provided by such programs is of immense value in providing a base on which to plan the harvest.

**Notes:**

1. Current age assumed as average at each age classes in population.
2. Recoverable volumes at 2017 as per Interpines yield analysis
3. The area stated in Figure 7 is less than the reported stocked area due to the trees that are not of size to be classified as merchantable and exclusion of trees affected by wilding spray.

## FOREST VALUE

---

The Forest is valued annually for the purposes of reporting the value of the asset in the respective owners' accounts. The value represented in the current accounts is the "current" value or value that the Forest is worth if it's sold in its immature state. The valuation is for the trees only, as the land is not for sale.

The valuation at the 30th of June 2016 was \$1,149,695, this was calculated by Laurie Forestry Ltd a Forestry Consultant Group registered by the NZ Institute of Forestry Inc.

## WILDING CONTROL

---

Douglas fir is considered a wilding species in the Wakatipu and aggressively establishes itself in areas of un-grazed tussock land. Wilding spread especially occurs in the direction of the prevailing wind.

In 2005 and 2006; 8.8ha of planted trees at the top of the Forest in the bush creek catchment area were cleared, this was undertaken to reduce the risk of wilding spread.

A containment line was boom sprayed across the top of the Forest in 2010, the idea behind this was to help prevent seedling take off along the ridge of the Forest by creating a wall of standing dead trees which would act as a barrier to the spreading seed. However due to the increase in seed below, and prevailing wind direction, seed is continually blown up the faces and deposited many kilometres over the land behind the Forest.

Wilding conifers can grow well above the natural beech tree line, which is between 900 and 1,100 meters in Otago. Wilding Douglas firs have been found above 1,400m on the range behind the Coronet Forest.

A visual inspection of the land behind the Forest indicates the significant population of young seedling reappearing in the open tussock land. As the Forest, has matured a significant number of wilding Douglas fir seedlings are now appearing on Coronet Peak Station, and up above the Crown terraces on the Crown Range as high as Crown Peak (Figure 8).

As altitude increases so does wind speed, the Douglas fir planted along the top ridges of Coronet Forest disperse seed vast distances due to the increased wind speed at these altitudes. Seed dispersal is mainly by wind. While much of the seed falls within about 60m of the parent on flat sites, dispersal distances of several km are common in the South Island (Hunter & Douglas 1984).

Distances of up to 40km are possible in very strong winds (Ledgard 2001, 2009). If left undisturbed these outlier trees can produce seed within ten years and masses of consequent wildings within 15 years.



**Figure 8: Crown Peak and Crown Range above Arrowtown, taken from the top of the Forest**



Figure 9 below shows the average annual maximum wind speed around the Forest, the darker colour represents the highest wind speed (115-120 km/hr) and is located along the top of ridges. Coning windings positioned at on ridge tops will disperse seed vast distances due to the increased wind speed at these altitudes.

**Figure 9: Average annual maximum wind speed on Coronet Forest (Otago Grow, 2016)**



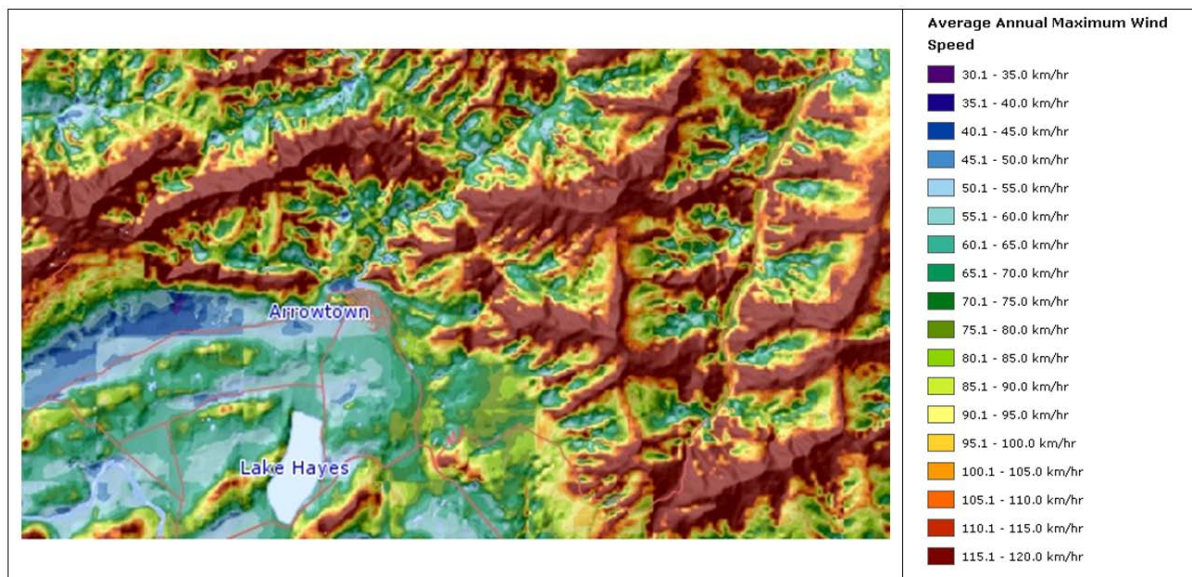


Figure 10: Wilding Spread below Brow Peak behind the Forest



Figure 11: Wilding Spread from Coronet Forest in Sawpit Gully



The Coronet Forest will produce constant seed rain onto neighbouring land until harvest, the amount of seed produced from the Forest will continue to increase as the tree crop matures, so there will be an exponential increase of seed produced as the forest ages.

If the Forest is left to maturity without a wilding control program the faces on Coronet Peak Station up behind Arrowtown, areas such as German Hill, Brow Peak and Big Hill, will become exotic forests in a very short time (Figure 10 and 11). A large investment in wilding control in terms of both professional contractor time and volunteer time has already been spent in these areas and in some cases volunteers are now returning to clear an area for a third and fourth time.

The eastern steep faces of the Forest that used to be covered in tussock are now visually a bright green slope, this is a new population of thousands of Douglas fir seedlings, which are growing as thick as grass.

The Wakatipu Wilding Conifer Control Group (WCG<sup>4</sup>) was created in 2009 and along with Coronet Peak Station and Volunteers has invested many hours of control on the faces behind the Forest.

In 2010 it was decided by the WCG executive to discontinue control work up behind the Forest until a commitment to clear the Forest was made. Any wilding free areas behind the Forest in the direction of the prevailing wind are clear (wilding free) as a result of control by local volunteers.

---

<sup>4</sup> WCG is a community, not-for-profit organisation created in April 2009. It is focused on protecting biodiversity and the remarkable landscape of the Wakatipu for the benefit of residents, users, tourists and particularly, future generations.



This season wilding conifers are now visible in large numbers up along all of the Crown Terrace faces below Crown Peak. While some of the spread may have come from a number of shelter belts below and single mature conifers, in a recent aerial survey of the area it was clear the majority of the wildings spread would have come from Coronet Forest.

The Douglas fir seed from the Coronet Forest is also affecting the faces directly above Arrowtown, which are recognised internationally for their autumn colours. Douglas fir is a dominant shade tolerant species and the golden colours are gradually changing to dark green (Figure 12).

**Figure 12: Arrowtown Autumn Colours**



The Wakatipu Wilding Conifer Strategy 2013-17 explains that the Wakatipu is now experiencing the consequences of forests that were planted close to areas of Outstanding Natural Landscape with ecological value. It is from these and other smaller scale plantations, shelter belts or pockets of established wildings that further wilding conifers will emanate if containment or removals are not undertaken.

The WCG's strategy work program is to target and remove seed sources or coning trees that are causing on-going wilding issues on vulnerable land, and implements the following 5x5 plan:

- **ALERT** – the community to the exponential spread and cost of wilding control
- **COMMUNICATE** – the WCG programme of control and the projected effects of no control.
- **ERADICATE** – all seeding trees where possible
- **CONTAIN** - non-removable wilding areas and planted forests
- **HAND BACK** - control maintenance to landowners, DOC and QLDC

The legislative framework required to support wilding conifer management is in place through the RMA 1991 and the Biosecurity Act 1993. QLDC has strict rules on new plantings of wilding species under the RMA, but there is nothing that can be done about spreading forestry blocks that were planted prior to the RMA (Coronet Forest is one of these blocks).

The only wilding species that is classified as a 'pest' in Otago under the Bio Security Act is Contorta Pine. The NZ Wilding Conifer Management Strategy 2015-30 released by the Ministry for Primary

Industries, suggests good neighbour rules in regards to wilding conifer plantings, but none of these rules are statutory.

The National Wilding Conifer Management Strategy led to \$16 million of new national operating funds being made available in the 2016 Budget to tackle wilding conifers. Approximately \$2.6 million of this funding has been allocated to the Wakatipu over the next four years.

QLDC contributes \$438,063 (increasing to \$500k in 2017/18 long term plan) to the WCG annually to fight the wilding battle. The wilding spread from the Coronet Forest compromises QLDC polices for the maintenance and values of the outstanding natural landscape.

The WCG will spend approximately \$1.4 million dollars on wilding control in the Wakatipu during the 2016/17 season; this includes contributions from QLDC, DOC, ORC, Landowner's, MPI, Business owners and from funding agencies such as Central Lakes Trust and the Lotteries Grants Board.

The cost to control identified land surrounding the Forest up to 4km in distance (aligning with natural boundaries such as Brow Peak and Big Hill) from now until maturity was conservatively estimated and reported to QLDC in 2015 as \$3 million over the life of the Forest. In 2016 a more detailed survey of the area was completed which increased the control area to include the Crown Range to Crown Peak (Figure 8), the cost of control a larger area up to 10 km from the Forest is now estimated at \$8.5 million to control 5,500 ha of land (Appendix 1, Coronet Forest Wilding Work Plan 2017-2039).

The assessment excluded the mature trees on the faces directly behind Arrowtown, the larch up on German Hill or any mature shelter belts, the control program is essentially dealing with the younger spread from the Forest.

The objectives of the management plan are:

- Remove all Douglas fir wildings from the area surrounding the Forest before they reach coning at around 14-16 years.
- Remove scattered wilding outliers from areas of open tussock grasslands and sub-alpine shrublands before they are able to produce cones and seeds and /or establish significant sites for further spread, thus protecting large areas of clear land from the probability of being infested.
- Containment of denser infestations using tools such as sprayed buffer zones
- Create buffers around native beech forest
- Remove conifers from within pockets of native beech forest
- To remove trees from take-off sites such as ridge tops. Take-off sites are a common source of distant spread, as high winds speeds on ridge tops escalate seed spread.
- The management plan recommends boom spraying large tracks of land behind the forest in the direction of the prevailing wind due to the density of seed on the ground. Boom spraying

is significantly cheaper than ground control, but covering large areas of land with herbicide will affect woody native species.

## PROPOSED SIGNIFICANT NATURAL AREAS

---

Behind the Coronet Forest in the Bush Creek catchment on Coronet Peak Station and QLDC administered land are two 'proposed significant natural areas' (Figure 13) which are documented in the QLDC Proposed District Plan. These areas are noted as "critically under protected" and "chronically threatened" and contain Mountain Beech forest remnants exhibiting a high degree of representativeness. These areas contain the only remaining examples of beech forest on Coronet Peak Station, and within the Shotover Ecological District which survived Polynesian and European fires.

Figure 13: Shows the location of proposed significant natural area G28A\_7 and G28A\_6



- G28A\_7 & G28A\_6 - Beech Forest Remnants– partially within QE2 area

The noted threatened species in the proposed areas are:

- *Falco novaezealandiae* “eastern” (eastern NZ Falcon), at risk but recovering.
- *Acanthistta chloris* (Rifleman)- At Risk - Declining

The proposed significant natural areas are under threat from wilding conifer seed from the Coronet Forest as low stature native vegetation /ecosystems are particularly vulnerable to wilding conifers. Douglas fir will establish in native beech forests with an open or thinning canopy and can lead to the local extinction of native plant communities (Froude 2011).

## **FIRE**

---

Fire Control rests with Otago Rural Fire Authority as the Forest is in a rural fire fighting area. Due to the value of the forest the trees are covered by a fire insurance policy.

## **FENCING, TRACKING AND ROADING**

---

There is a boundary fence around the older plantings (1984 to 1991), this area was fenced to protect the young trees from sheep browsing. There is no fence around the younger planting at the higher altitude.

The only tracks/roads on the property are the establishment tracks formed at the time of planting. These have been repaired from time to time but would not be suitable in their current form for any logging traffic. A major upgrade is required before harvest can be carried out. This upgrade will require widening, some realignment, re-culverting, application of base course and metalling.

## HARVEST PLAN

### BEST PRACTICES, HEALTH AND SAFETY

---

**Objective:** To ensure all forestry operations are carried out in accordance with industry best practice and in a way that ensures the health and safety of all involved.

All forestry operations will be carried out using Best Management Practices under the New Zealand Environment Code of Practice for Plantation Forestry. Second Edition May 2008

(<http://www.fitec.org.nz/Resources/NZ-Environmental-Code-of-practice-for-Plantation-Forestry/>).

The code should be referenced and industry expertise sought to plan and implement the correct mitigation methods available so that minimal environmental disturbance occurs on the site.

Regular monitoring or auditing of all operations should be written into Health and safety plans to ensure all consent conditions and best practice are implemented and followed.

All harvest operations in the forest will comply with the relevant sections of the Health and Safety at Work Act 2015 (including subsequent regulations and guidelines) for all persons involved in the work and at the work site.

The Health and Safety Act now places greater responsibility on all participants in an employment relationship which means QLDC, CODC, as well as contracted harvesting, cartage and stumpage sale

parties have a critical role to play. All health and safety operating systems should be audited and regular monitoring of these systems should be carried out to ensure a high-performance delivery is achieved.

All operations must comply with the requirements of the Resource Management Act 1991.

All high-risk jobs must be notified to the Worksafe New Zealand.

All contracted third party service providers for harvesting and re-vegetation of the site should have sound accredited health and safety records and industry expertise, as many operations such as aerial spraying, harvesting and log cartage areas are classified as high risk operations.

Strategies for mitigation of harvest risks will not vary significantly within the Forest but everyone will need to remain vigilant throughout the duration of the harvest operation.

## **HARVEST PLAN**

---

A harvest plan will be prepared by a suitably qualified expert prior to harvest of the Forest, this plan will detail the harvest extraction methodology (a mixture of ground based and cable) and include the proposed road and skid site location to process the logs.

The harvest plan will address the following objectives:

- To identify the optimal harvesting methodology for the Forest including and assessment of value recovery.
- To identify the extent of infrastructure required to enable the preferred harvesting methodology to take place.
- To identify key environmental risks associated with harvesting and recommend strategies for the management/mitigation of these.
- To identify key community risks associated with harvesting and recommend strategies for the management/mitigation of these.

## **HARVESTING AND MARKETING OF THE FOREST**

---

The Coronet Forest will be managed through a Graded Log Sale, this means the contracted forestry company will manage the entire harvesting and transportation roles and will sell the logs to customers as an agent for the Forest owner.

The harvest plan will be used to procure a forest company to carry out both the harvest operation and sale of the timber on behalf of QLDC and CODC.



Revenues will be dependent on the market conditions monthly. QLDC and CODC may implement a third party audit process over the top of the log sale agreement to provide additional transparency that the accounting and operational monitoring processes systems are robust.

The harvest will place large volumes of Douglas fir into the market and the economics of harvesting may mean that most of the crop is destined for an export market.

Many risks are involved in forestry as future log prices are uncertain, also the Coronet Forest is located some distance to ports and the domestic markets, and the future price of fuel is unknown.

---

## **DOUGLAS FIR ESSENTIAL OIL & BIO FUELS**

Wood fuels are a cost-effective and sustainable source of energy. Modern wood-fired burners are clean burning and highly efficient offering instant benefits over fuels such as coal and oil, wood energy and its production can also bring considerable economic benefits to the supply chain.

Forest harvest residues at landings and skid sites could be considered as potential sources of bio fuels. If a viable method for removing the wood is available.

There is an opportunity for the community to realise additional valuable products from the Forest such as essential oil and bio fuels. This management plan primarily investigates the log resource which the forest was grown for. After the forestry company is appointed there may be opportunities to extract bio fuels and essential oils from the residue of the Forest, if there is commercial interest in these products the operational detail can be included in the day to day planning and log recovery.

## REVEGETATION

### REVEGETATION OBJECTIVES

---

The agreement between QLDC and CODC is to establish, maintain and develop the Coronet Forest for eventual harvest and sale of the timber, after which the joint venture is dissolved. There is no obligation for CODC to remain in partnership with the Council (post-harvest) and re-establish/or revegetate the land.

Coronet Forest is subject to provisions of the ETS and the Operative and Proposed District Plans, and both require the revegetation of the site following the harvest of the plantation.

The key project objectives that the revegetation must achieve are:

- 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 – 30% coverage of the site by trees greater than five metres in height.
- 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 weedy species, e.g. especially Douglas fir seedlings and a range of woody weeds such as 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.

QLDC commissioned Davis Consulting Group Ltd (DCG) to prepare a proposal for the revegetation of the Coronet Forest post-harvest with natives (Appendix 2).

In addition, the following options were investigated in the preparation of this plan:

- Natives and grey shrub-land with a predator free fence
- Natives and grey shrub-land
- Mixture of Natives and Exotic Forestry Species
- Exotic Forestry Species

Native and grey shrub-land restoration is the preferred approach to achieve the revegetation objectives as detailed below. A detailed re-vegetation plan will be prepared as part of the outline plan process in accordance with the objectives and detail set out in this plan.

#### **NATIVE/GREY SHRUB LAND RESTORATION - GOAT FENCE**

---

A detailed proposal for this option is attached in Appendix 2. The proposal should be referred to in detail for the planning of the revegetation project.

The concept is to create 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.

The proposal includes the pricing of a goat fence to remove the predator threat and protect the plantings. The most practical fencing approach was to construct a perimeter deer fence around the site with gates at the top and bottom for future public access.

Restoration plantings are normally completed at one metre centres, which allows plants to provide shelter to one another and control weeds efficiently. To achieve 30% coverage of the site, approximately 521,100 mountain beech will be planted into the pasture grass and between windrows within the aerial spray buffer zone (Davis 2016).

As well as beech trees, 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.

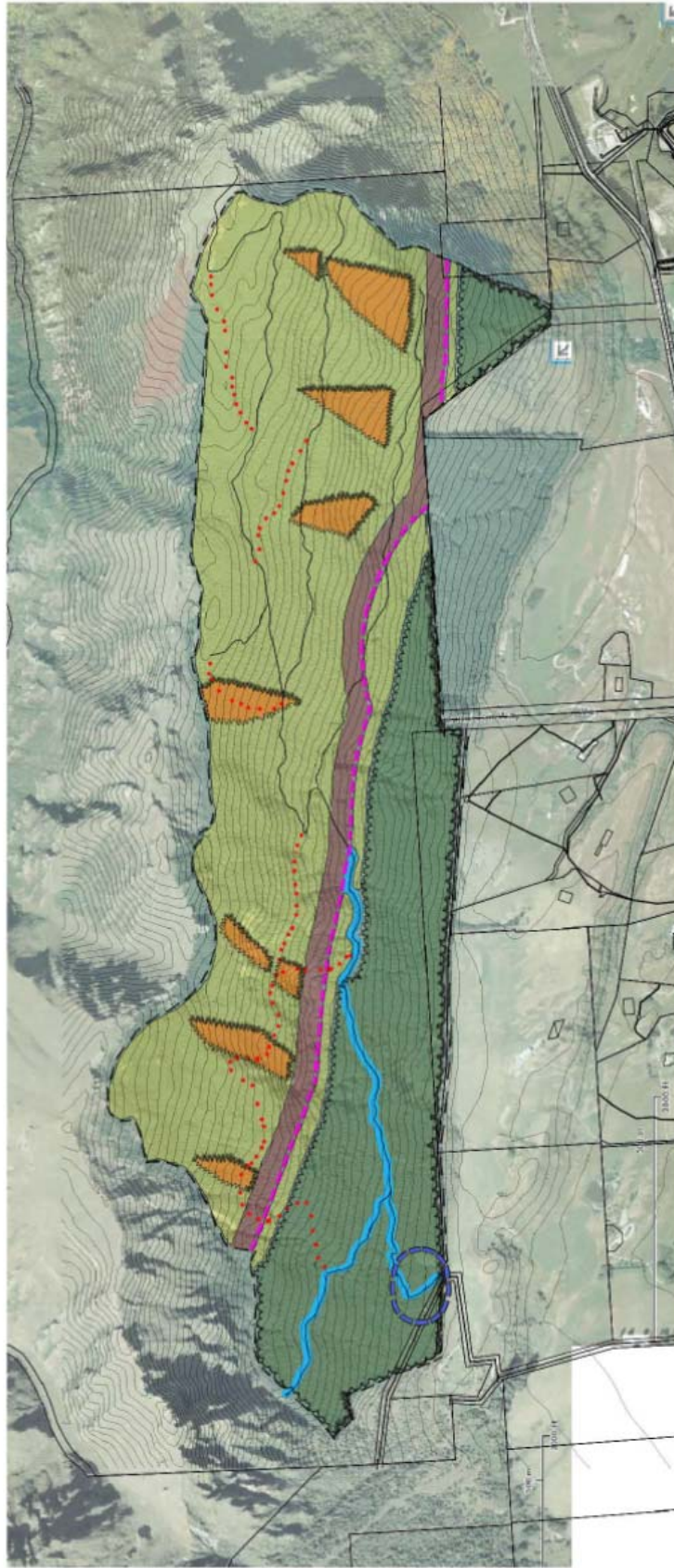
Grey shrubland is a key habitat for a number native passerine bird species (e.g. fantail and grey warbler), which in turn provides prey for the 'At Risk' New Zealand falcon. In order to achieve a shrubland cover of 10% a total of 173,700 plants will be required to be installed (David 2016).

Tussock grassland will be established above the 550m buffer to establish native vegetation in an area that will be aurally sprayed for weed control post-harvest.

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. Natural regeneration is the best mechanism to support landscape scale restoration of the site.

A revegetation landscape plan has been developed for the site Figure 15 and provides a graphical presentation of the proposed vegetation units, and details the self-sustaining native beech forest, grey shrubland and tussock grassland across the site.

**Figure 15: Coronet Forest, Revegetation Landscape Plan**



## LEGEND

- Hand planting - mountain beech @ 1.0m centres (Fuscospora cliffortioides)
- Hand planting - Grey shrubland species @ 1.0m centres
- Hand planting - Tussock species @ 1.0m centres
- Pasture grasses (via OSTD) with colonisation of bracken fern (via human assistance)
- 50m buffer strip of pasture grasses
- Future walking / biking / horseriding trail
- Indicative mountain bike tracks
- Potential for community planting and picnic areas
- Perimeter deer fence
- 500m buffer line

Project:	CORONET FOREST	Rev. Description	By	Date
		issued for comment	JD	20.10.16
		ORF revisions	JD	15.02.17
		NOT FOR CONSTRUCTION		
Title:	REVEGETATION PLAN	Scale:	Job No:	Date
		1:10,000 @ A3	2674	19.12.16
		Drawn / Checked:		
		JD / RL		
Location:	QUEENSTOWN	Drawing No:		
		This drawing is a plan view of the site and does not show the vertical profile. The drawing is not to be printed to any other party without the written consent of LANDLIS		
		L1A		



Figure 16: Coronet Forest Revegetation Section – Native/ Grey Shrub Land



Note: sections shown illustratively only, widths and species layout will vary

The ETS requires that the site is replanted such that 30% of the site will be covered in vegetation that can reach a height of at least 5 metres.

In order for QLDC to meet its obligations under the ETS, 30% or 52 hectares of the site will need to be planted in trees.

For the native option Mountain beech (*Fuscospora cliffortioides*) is the best species to meet this requirement in terms of height (approx. 10-15 m at maturity) and growing ability within the Wakatipu.

## LAND PREPARATION

---

Land preparation follows harvest and is usually carried out by the harvest crew. The proposed harvesting operation will be a mixture of ground based and cable/hauler logging. The cable/hauler harvesting system will result in a relatively clean post-harvest site as trees are felled on site and hauled to skid site for processing where accumulation of slash is significant. This means that the rehabilitation or land preparation operations such as wind rowing will be limited to ground based areas only.

Ground based logging will occur on less than half the forest area, therefore around 83 ha will be windrowed, based on the methodology proposed in the current Harvest plan. The windrowing is completed by raking wood debris and waste material into slash rows by an excavator based machine. The windrows will take a long time to degrade and provide a sheltered environment for the ongoing germination and establishment of woody weeds.

As the harvest areas are completed, they will be oversown and topdressed. Oversowing with pasture grasses (e.g. brown top) is the first step in restoring landscape values quickly and will help prevent woody weed establishment. Oversowing and topdressing will occur in the spring or autumn immediately after each of the four areas have been harvested (Figure 17).



**Figure 17: Windrows with surrounding exotic pasture grass near Moke lake (Davis 2016)**



---

#### **MAINTENANCE WILDING AND WOODY WEED CONTROL**

The wilding regeneration at this site will be prolific due to the seed in the ground and maximum control required with minimal management intervention.

Post-harvest, it is expected that the site will be subject to rapid woody weed establishment particularly from germinating Douglas fir seed, but also from a range of other weeds hawthorn, sycamore, rowan, briar, broom and gorse (among other weed species). It is noted that broom populated most of the site before it was established as a forest, so there is a seed source for that present.

Control of Douglas fir on the site is key in establishing a second rotation crop, and this will be one of the main goals of the revegetation plan. Not only does Douglas fir have to be controlled within the harvested area, but all seeding sources around the forest will need to be removed to create a successful vegetative cover.

The revegetation plan will detail the weed control for the area over a ten-year period from harvest.



The establishment of pasture grasses on site will help suppress the Douglas fir, but will not prevent it from re-establishing. Therefore, herbicide weed control will still be required, The method of weed control across the site will be determined by the proximity of neighbouring residents. Aerial application is the most efficient method; however, herbicides can only be applied at a distance of 550 metres or more from the nearest residence.

To ensure the efficient and effective control of Douglas fir and other woody weeds is achieved, all areas of the site that are over 550 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. This herbicide application will target the young Douglas fir growth and other woody weeds, but will not affect the grass and native tussock species which will create a suitable landscape cover. Three aerial applications will be required for this zone.

Weed control within 550m of the nearest dwellings will be carried out via hand-pulling and backpack or truck spray units.

To maximise the performance of the plantings, a landscape maintenance programme will commence immediately prior to the first round of planting. This will remove any weeds that might have established in the interim) and continue for three years after each planting season.

The plant maintenance work to be undertaken will include weed control, rabbit and hare control and a check of the fence line. 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.

## REVEGETATION COST

---

Figure 18 below provides a cost estimate to complete the revegetation projects described for the four options, the cost includes a 20% contingency.

**Figure 18: Provisional Revegetation cost estimate (excluding GST) for the four options.**

Revegetation Options	Cost (Inc. Contingency 20%)
Predator Fence with Native Species	\$17,524,748
Native Species	\$11,937,848
Mix Native and Forestry Species (50/50)	\$8,306,925
Forestry Species	\$4,676,001

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, the 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
- Douglas fir control on areas neighbouring the forest, where Douglas fir has established
- Bracken fern establishment above the 550m buffer zone
- Rabbit and hare control – e.g. Plantskydd
- Deer fence check, although this may be able to be included in the goat monitoring estimate
- Freight of plants and materials to site
- Costs of inflation.

## APPENDIX

Appendix 1: Coronet Forest Wilding Work Plan 2017-2039, QLDC, 2016

Appendix 2: Coronet Forest Revegetation Proposal, David Consulting Group, 2017

## REFERENCES

<https://www.comtrade.co.nz/> , Jan 2017 Carbon Price

Frodue VA, 2011. Wilding Conifers in New Zealand: Status Report Prepared for the Ministry of Agriculture and Forestry, Pacific Eco-Logic Ltd

Guild D, 2001. Management Plan for Coronet Forest, Arrowtown Management Plan, Wrightson Forestry Services, Prepared for QLDC and CODC.

<http://growotago.orc.govt.nz/> , 2016 Average Annual Maximum Wind Speed

Hunter G, Douglas M 1984. Spread of Exotic Conifers on South Island Rangelands. New Zealand Journal of Forestry 29.

Ledgard NJ 2001. The Spread of Lodgepole Pine (*Pinus contorta* Dougl.) in New Zealand. Forest Ecology and Management 141.

Ledgard NJ, 2009. Wilding conifers in the Hawke's Bay Region and in the upper catchment of the Rangitaiki River. Report prepared for Hawke's Bay Regional Council Envirolink Project 736 HBRC Wilding Control. Christchurch, Scion New Zealand Forest Research Institute Ltd.

Schrider J, 2014. Queenstown Lakes District Council, Coronet Forest Management Review June 2014, Forme Consulting Group Ltd.

Schrider J, 2016. Queenstown Lakes District Council, Coronet Forest Harvest Plan, Forme Consulting Group Ltd.

**Coronet Forest Wilding Work Plan (2017-2039)**

1. Front of Coronet Forest	Area (Ha)	Cost Per Ha	Man day cost	Heli cost	Total days	Total Cost		2017	2021	2027	2033	2039
<b>Ground crew</b> - clear wildings growing on ungrazed/unmanaged land in front of the forest			\$ 2,430		30	\$ 72,900		\$ 72,900	\$ 72,900	\$ 150,000	\$ 150,000	\$ 200,000
<b>2. West of Coronet Forest</b>												
<b>Ground crew</b> , heli drop off - clear scattered outliers			\$ 2,430	\$ 775	8	\$ 25,640		\$ 25,640	\$ 25,640	\$ 25,640	\$ 25,640	\$ 25,640
<b>Boom spray</b> spray thick Douglas fir (this area was previously sprayed in 2010)	40	\$ 650				\$ 650		\$ 26,000	\$ 26,000	\$ 26,000	\$ 26,000	\$ 26,000
<b>3. Above Butel Park</b>												
<b>Ground crew</b> - remove scattered outliers			\$ 2,430		10	\$ 24,300		\$ 65,000	\$ 65,000	\$ 24,300	\$ 36,450	\$ 48,600
<b>Boom spray</b> - thick wilding spread from the top of the ridge	15	\$ 650				\$ 650		\$ 9,750	\$ 9,750	\$ 19,500	\$ 19,500	\$ 19,500
<b>4 Back of Coronet Forest</b>												
<b>Ground Crew</b> , heli drop off & pick up- clear all scattered wildings			\$ 2,430	\$ 600	25	\$ 75,750		\$ 75,750	\$ 75,750	\$ 75,750	\$ 94,688	\$ 113,625
<b>Boom spray</b> to clear spread back from the ridge top	25	\$ 650				\$ 16,250		\$ 16,250	\$ 16,250	\$ 16,250	\$ 16,250	\$ 16,250
<b>5. Beginning of Bush Creek</b>												
<b>Ground crew</b> , heli drop off & pick up - cut back wildings from beech forest			\$ 2,430	\$ 1,550	15	\$ 59,700		\$ 59,700	\$ 74,625	\$ 89,550	\$ 156,713	\$ 119,400
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	10	\$ 39,800		\$ 39,800	\$ 49,750	\$ 59,700	\$ 104,475	\$ 79,600
<b>Boom spray</b> - thick areas of wilding conifers	54	\$ 650				\$ 35,100		\$ 35,100	\$ 35,100	\$ 35,100	\$ 35,100	\$ 35,100
<b>Spot spray/Lance</b> - spray outliers on ridge top not cleared by ground crew				\$ 18,000		\$ 18,000		\$ 18,000	\$ 22,500	\$ 27,000	\$ 31,500	\$ 36,000
<b>6. Brow Peak</b>												
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	15	\$ 59,700		\$ 59,700	\$ 59,700	\$ 74,625	\$ 111,938	\$ 119,400
<b>Spot spray/Lance</b> - spray outliers on ridge top not cleared by ground crew				\$ 18,000		\$ 18,000		\$ 18,000	\$ 22,500	\$ 27,000	\$ 31,500	\$ 36,000
<b>Boom spray</b> - thick areas of wilding conifers above Sawpit Gully	25	\$ 650				\$ 16,250		\$ 16,250	\$ 16,250	\$ 16,250	\$ 16,250	\$ 16,250

<b>Boom spray</b> - thick areas of wilding conifers	55	\$ 651				\$ 35,805		\$ 35,805	\$ 35,805	\$ 35,805	\$ 35,805	\$ 35,805
---	----	--------	--	--	--	-----------	--	-----------	-----------	-----------	-----------	-----------

<b>7. Arrow River</b>												
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	30	\$ 119,400		\$ 119,400	\$ 119,400	\$ 149,250	\$ 223,875	\$ 238,800
<b>Boom Spray</b> - thick patches												
<b>Spot spray/Lance</b> - spray outliers on ridge top not cleared by ground crew				\$ 18,000	3	\$ 54,000		\$ 54,000	\$ 67,500	\$ 81,000	\$ 94,500	\$ 108,000

<b>8. Big Hill</b>												
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	15	\$ 59,700		\$ 59,700	\$ 59,700	\$ 59,700	\$ 89,550	\$ 119,400
<b>Spot spray/Lance</b> - spray outliers on ridge top not cleared by ground crew				\$ 18,000	2	\$ 36,000		\$ 36,000	\$ 36,000	\$ 40,500	\$ 60,750	\$ 72,000

<b>9. Sawpit Gully</b>												
<b>Boom spray</b> - thick areas of wilding conifers above Sawpit Gully	75	\$ 650				\$ 48,750		\$ 48,750	\$ 48,750	\$ 48,750	\$ 48,750	\$ 48,750
<b>Boom spray</b> - thick areas of wilding conifers	40	\$ 650				\$ 26,000		\$ 26,000	\$ 26,000	\$ 26,000	\$ 26,000	\$ 26,000
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	15	\$ 59,700		\$ 59,700	\$ 74,625	\$ 89,550	\$ 156,713	\$ 119,400
<b>Ground crew</b> , heli drop off & pick up - cut back wildings from beech forest			\$ 2,430	\$ 1,550	5	\$ 19,900		\$ 19,900	\$ 19,900	\$ 19,900	\$ 39,800	\$ 79,600

<b>10. Crown Range, Crown Peak and Glencoe Station</b>												
<b>Boom spray</b> - thick areas of wilding conifers	50	\$ 650				\$ 32,500		\$ 32,500	\$ 32,500	\$ 65,000	\$ 65,000	\$ 97,500
<b>Ground crew</b> , heli drop off & pick up, clear scattered wildings			\$ 2,430	\$ 1,550	40	\$ 159,200		\$ 159,200	\$ 199,000	\$ 238,800	\$ 417,900	\$ 318,400
<b>Spot spray/Lance</b> - spray outliers on ridge top not cleared by ground crew				\$ 18,000	2	\$ 36,000		\$ 36,000	\$ 36,000	\$ 36,000	\$ 72,000	\$ 72,000

TOTAL

\$ 1,224,795   \$ 1,326,895   \$ 1,556,920   \$ 2,186,645   \$ 2,227,020

TOTAL COST AT HARVEST

\$ 8,522,275

# Coronet Forest Revegetation Proposal

*For*

Queenstown Lakes District Council



*February 2017*



*Davis Consulting Group Limited  
Arrow Lane  
Arrowtown 9302  
03 409 8664  
Document ID: 16047*



## **Coronet Forest Revegetation Proposal**

### **Document Status**

Version	Purpose of Document	Prepared By	Reviewer	Review Date
A	Draft for internal review	RT	GD	14 December 2016
B	Draft for client review	RT	GD	16 December 2016
C	Final	RT	GD	15 February 2017

## TABLE OF CONTENTS

<b>1.0</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Overview	1
1.2	Project Objectives	1
1.3	Proposal Outline	2
<b>2.0</b>	<b>PROJECT GOVERNING PRINCIPLES</b>	<b>3</b>
2.1	GP1 – Obligations Under the Emissions Trading Scheme	3
2.2	GP2 – Ecological Diversity	3
2.3	GP3 – Establishing the Conditions to Support Natural Regeneration Processes	3
2.4	GP4 – Landscape Restoration and Woody Weed Control	3
<b>3.0</b>	<b>PROPOSED APPROACH FOR REVEGETATION OF CORONET FOREST</b>	<b>4</b>
3.1	Site Preparation	4
3.2	Landscape Revegetation	7
3.3	Revegetation Maintenance	13
3.4	Equipment and Facilities	14
3.5	Limitations	14
<b>4.0</b>	<b>PROJECT SCHEDULE AND COST ESTIMATE</b>	<b>15</b>
4.1	Project Schedule	15
4.2	Cost Estimate	17
<b>5.0</b>	<b>PROJECT SUMMARY</b>	<b>18</b>

## **LIST OF FIGURES**

Figure 1: Landscape Plan (from LAND Landscape Architects). .....	8
Figure 2: Proposed Schedule for Coronet Forest Revegetation.....	16

## **LIST OF PLATES**

Plate 1: Windrows post-harvest. ....	5
Plate 2: Windrows with surrounding exotic pasture grass. ....	6
Plate 3: Mountain beech that have been hand planted into exotic pasture grass. ....	10
Plate 4: Native tree species in protective shelter. ....	10
Plate 5: Left: 'Lannen 35F' plant size; Right: 'V150' plant size. ....	11
Plate 6: Natural regeneration of native species through bracken fern in the Wakatipu Basin.....	13

## **LIST OF TABLES**

Table 1: Provisional cost estimate (excluding GST and the costs listed above). ....	17
---	----

## **1.0 INTRODUCTION**

### **1.1 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.

### **1.2 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 – 30% coverage of the site by trees greater than five metres in height;

- 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 weedy species, e.g. Douglas fir seedlings and a range of woody weeds such as 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.

### **1.3 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.

## **2.0 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.

### **2.1 GP1 – Obligations Under the Emissions Trading Scheme**

The ETS requires that the site is replanted such that 30% of the site will be covered in vegetation that can reach a height of at least 5 metres. The only 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. In order for QLDC to meet its obligations under the ETS, 30% or 52 hectares of the site will need to be planted in beech trees, which has therefore been adopted as a key governing principle for the revegetation proposal.

### **2.2 GP2 – Ecological Diversity**

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

### **2.3 GP3 – Establishing the Conditions to Support Natural Regeneration Processes**

The remaining 60% of the site will be revegetated with introduced grass species initially to suppress woody weeds from germinating and promote the fast establishment of a vegetation cover across the site. Within this area we also propose to introduce bracken fern with the objective of bracken colonising the grassed 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.

### **2.4 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. Furthermore, 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.



### **3.0 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 windrowed across half the site, with the remaining steeper areas of the site being relatively clear of logging slash, as this will be located around the skid sites. The windrows, and slash around 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 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 the effect of windrowing and surrounding pasture grasses on landscape values are provided in Plate 1 and Plate 2. Both photographs have been taken near Moke Lake. 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:** Windrows post-harvest.



**Plate 2:** Windrows with surrounding exotic pasture grass.

#### *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 within the area designated for aerial herbicide application, plantings will consist of pasture grass and native tussock species that are resistant to the woody weed selective herbicide. Three aerial applications are proposed for this zone, one soon after the harvest and subsequently four and seven 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. This area will contain all the beech forest and grey shrubland community plantings.

#### *Goat and Deer Browsing Control*

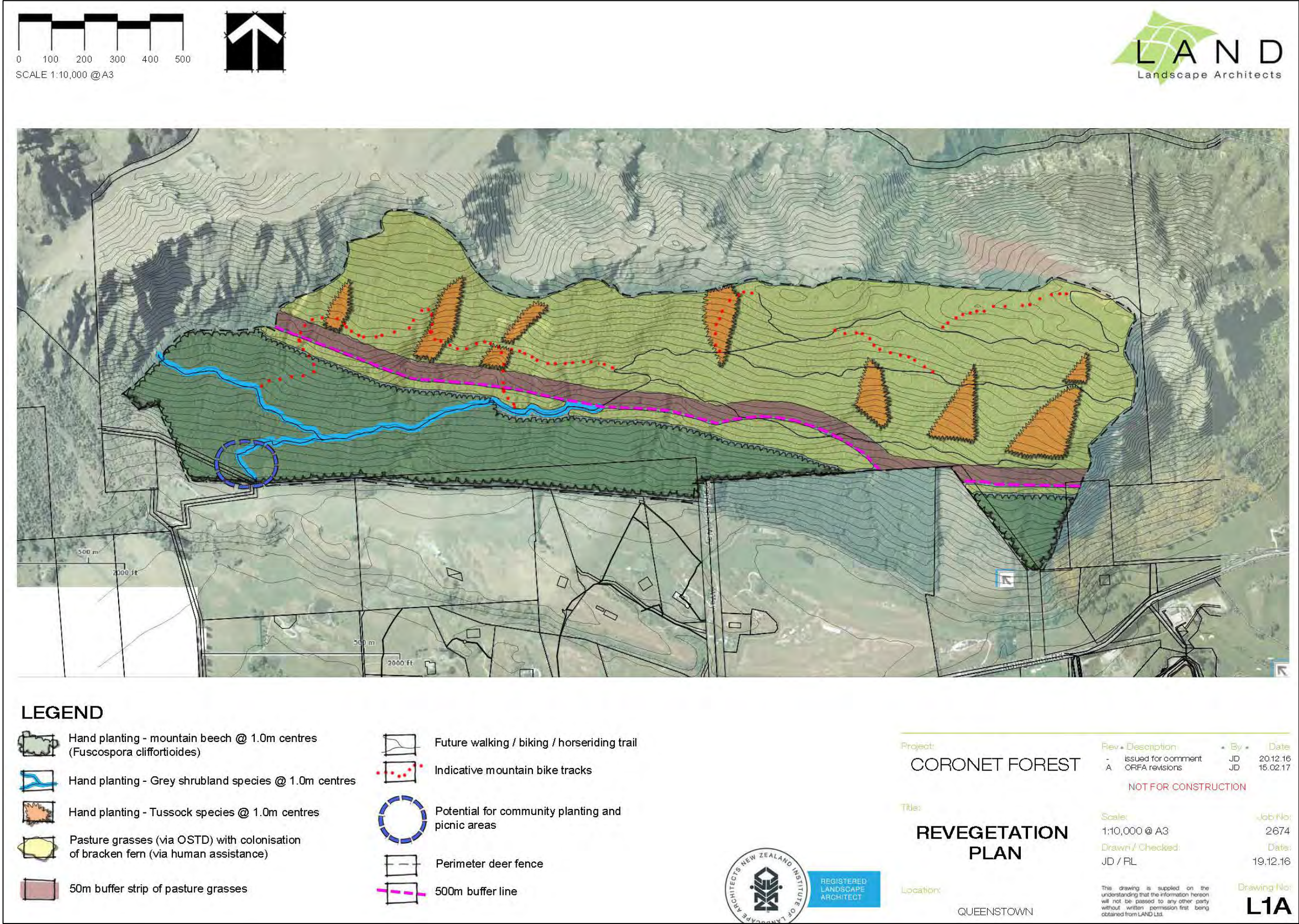
Due to the presence of goats and possibly deer, a deer fence is considered necessary to protect the plantings and maximise the performance of the revegetation work. The most practical fencing approach is to construct a perimeter deer fence around the site, with gates at the top and bottom for contractor 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 self-sustaining native beech forest, 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.







### *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 that will exceed a tree crown cover of more than 30% of the site. Mountain beech (*Fuscospora cliffortioides*) is the best species to meet this requirement in terms of height (approx. 10-15 m at maturity) and growing ability within the Wakatipu.

Restoration plantings are normally completed at one metre centres, which allows plants to provide shelter to one another and control weeds efficiently. To achieve 30% coverage of the site, approximately 521,100 mountain beech will be planted into the pasture grass and between windrows below the aerial spray 500 m buffer line (see Figure 1). Plate 3 provides an example of beech planted into pasture within the Wakatipu Basin. The beech will also 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.





**Plate 3:** Mountain beech that have been hand planted into exotic pasture grass.



**Plate 4:** Native tree species in protective shelter.





**Plate 5:** *Left: 'Lannen 35F' plant size; Right: 'V150' plant size.*

As well as beech trees, 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 falcon. To achieve a 10% cover over the site of shrubland and tussock grassland, approximately 173,700 plants will be required to be installed.

The grey shrubland mix will be planted at one metre centres in sections adjacent to the walking/biking tracks below the 500m buffer line (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.

Tussock grassland will be established above the 500m buffer line, to establish native vegetation in an area that will be aerially sprayed for weed control post-harvest (see Figure 1).

All the hand planting would occur over seven planting seasons, i.e. spring and autumn over three to four years (Figure 2). This timeframe allows for the plant supply from nursery's and the availability of experienced contractors to install the plants and plant shelters.

### *Natural Revegetation*

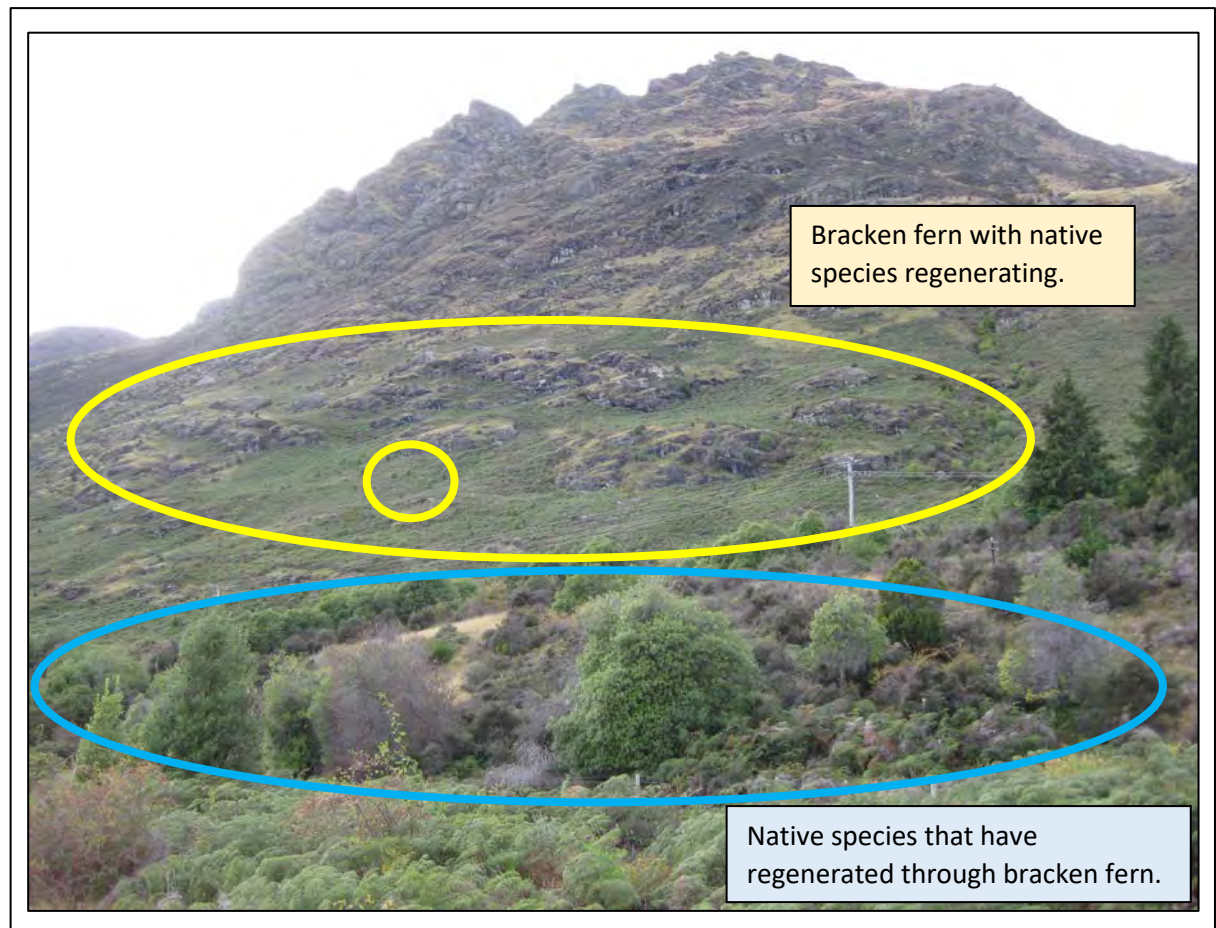
Due to the large-scale landscape level of restoration this project requires, it is not feasible to plant out the whole site. Therefore, providing support for natural regeneration processes is proposed. Natural regeneration is the best mechanism to support landscape scale restoration of the site. However, natural successional processes associated with the site is undermined by 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 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 mountain bike 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).

### **3.3 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.

### **3.4 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.

### **3.5 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.



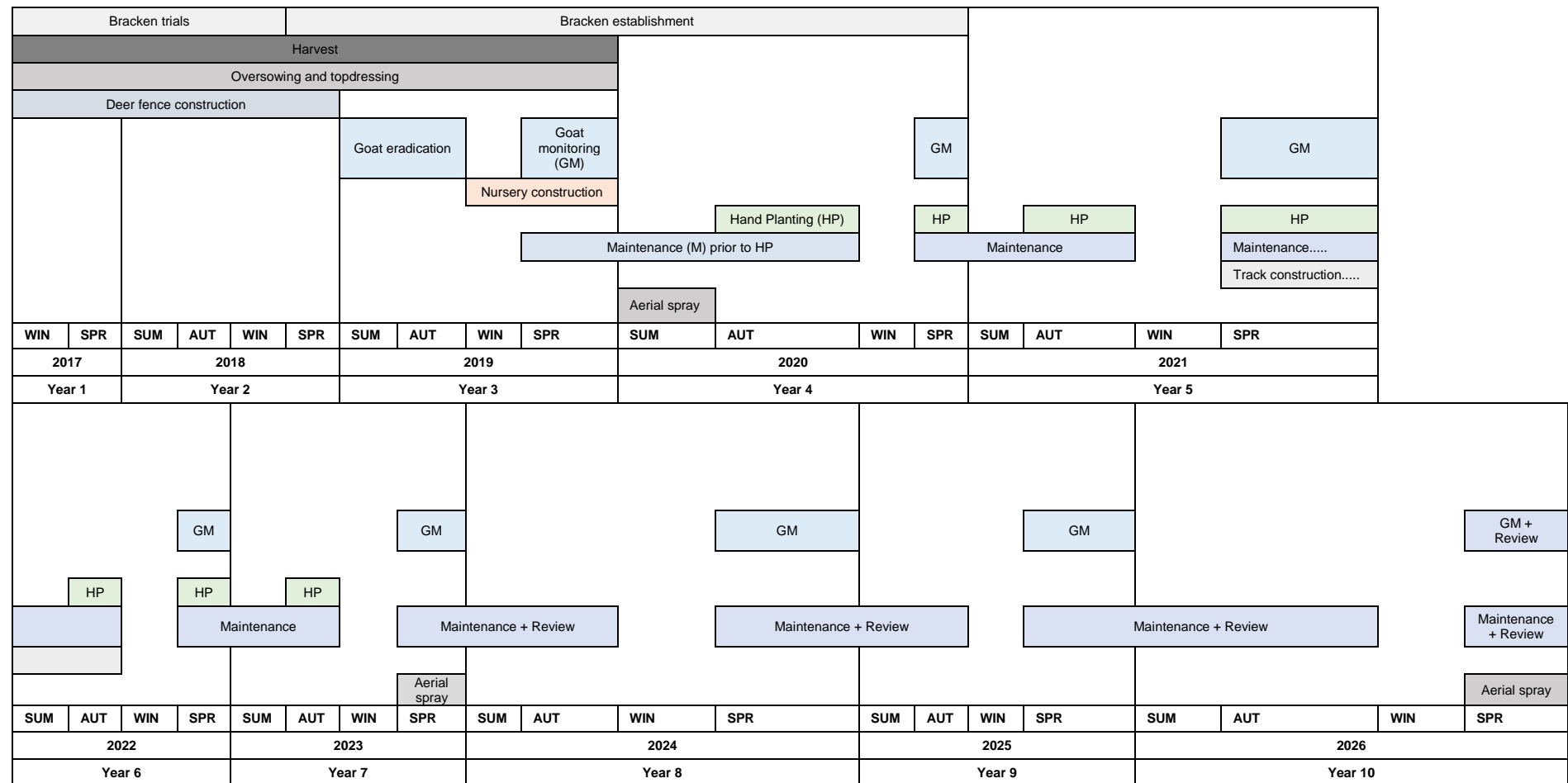
## **4.0 PROJECT SCHEDULE AND COST ESTIMATE**

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

### **4.1 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, 7 and 10.





**Figure 2: Proposed Schedule for Coronet Forest Revegetation.**

## 4.2 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 above the 500m buffer line;
- 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).

Work Item	Cost
Oversowing and topdressing (200 ha)	\$106,298.00
Perimeter deer fence	\$320,000.00
Goat eradication & monitoring (for 8 years)	\$17,000.00
Bracken fern trial	\$10,000.00
Beech seed collection (i.e. eco-sourcing)	\$30,400.00
Plants & shelters (521,100 beech & 173,700 grey shrubland/tussock spp.)	\$3,303,774.00
Planting & shelter installation (694,800 plants & shelters)	\$3,057,120.00
Maintenance prior to planting, & for 3 years after each planting event (e.g. weed control)	\$2,900,034.78
Aerial spray (once soon after harvest and then 4 and 7 years later)	\$203,580.00
<b>Subtotal</b>	<b>\$9,948,206.78</b>
Contingency (20%)	\$1,989,641.36
<b>TOTAL (excluding GST)</b>	<b>\$11,937,848.14</b>

## **5.0 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 mountain beech, 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.

