FORESTRY AND

SEQUESTRATION REPORT

WITHY PROPERTY

FEBRUARY 2023

PREPARED BY DON FRENGLEY

EXECUTIVE SUMMARY

The Withy property dairy unit of approximately 156 ha on the Oreti plain north of Winton. It is operated as a family unit. A small radiata stands close to harvest age exists on the farm. This report explores opportunities for establishing forestry activity on the farm, particularly with respect to carbon sequestration.

There is very little potential for forestry on the property without compromising the dairy unit. The land is flat and easily maintained in high productivity pasture, and any afforestation will occupy good quality agricultural land.

The Winton stream boundary is very convoluted and this could be straightened up for ease of management. However the 30m average width requirement for registering a forest as a CAA in the ETS would mean the straighter boundary fence would be pushed well into the paddock. The Winton Stream would require an additional 10m offset as a radiata (or other species) production forest, and this would push even further into the paddocks.

Forests provide possible additional benefits from shelter, water quality, diversification of income, and succession planning. Plantings of natives should be considered in specific locations due to restrictions on production forestry adjacent to waterways.

No areas can be recommended for forestry on this farm. However the existing radiata stand and Winton Stream boundary were modelled as CAAs producing NZUs as shown below:

	Pinus Radiata	Total Plantations	Native Forest	All Forests
Base Model - All Stands	1.0	1.0	5.0	6.0

There would be some investment into fencing and the native planting required in the early years.

The base model for the Withy property generates 1,593 NZUs over 32 years. Average net cashflow is $685 per ha per year.

Note that tax implications have been ignored throughout the modelling as everyone's tax situation is different. Tax is reviewed briefly in Appendix 6.

CONTENTS

INTRODUCTION

The purpose of this report is to review some possible forest sequestration opportunities on the farm. It addresses these through the existing regulatory and emissions trading scheme environment and does not review their impact on stock production or the 3 agricultural gases covered by the He Waka Eke Noa proposals.

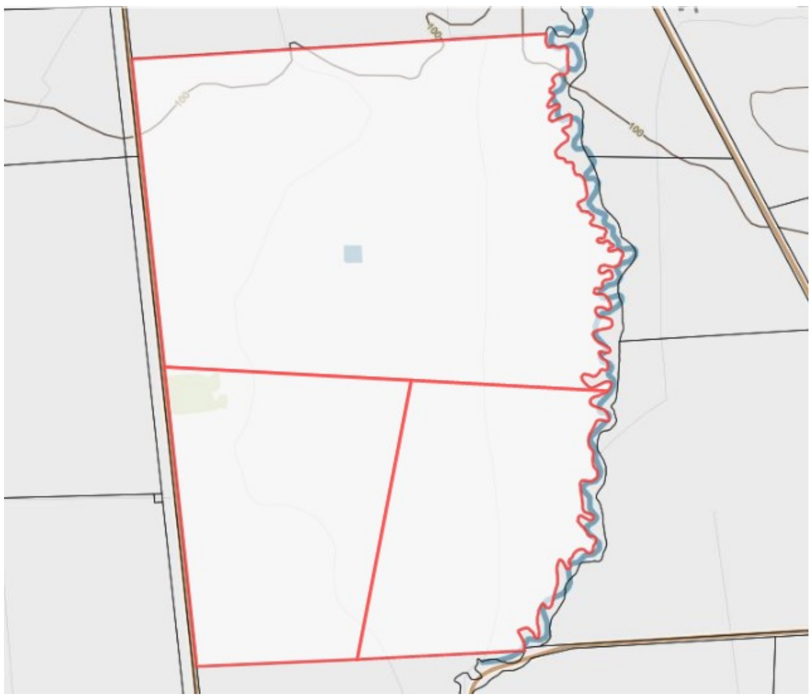
This report is a high level outline of possible species and regimes. It is not detailed forestry advice or a forestry plan for this farm. It is intended to provide some basic understanding of forestry and the Emissions Trading Scheme and a broad idea of how these might be integrated into this farming operation.

Costs, yields and prices are approximated and do not constitute advice, but should allow some comparative thinking. Before committing to a forestry plan, detailed advice should be sought from suitable qualified and experienced professionals. A good forestry plan will consider the forest and its purposes, impacts on the existing farming operation and impacts on the environment such as carbon sequestration and water quality and quantity.

THE FARM

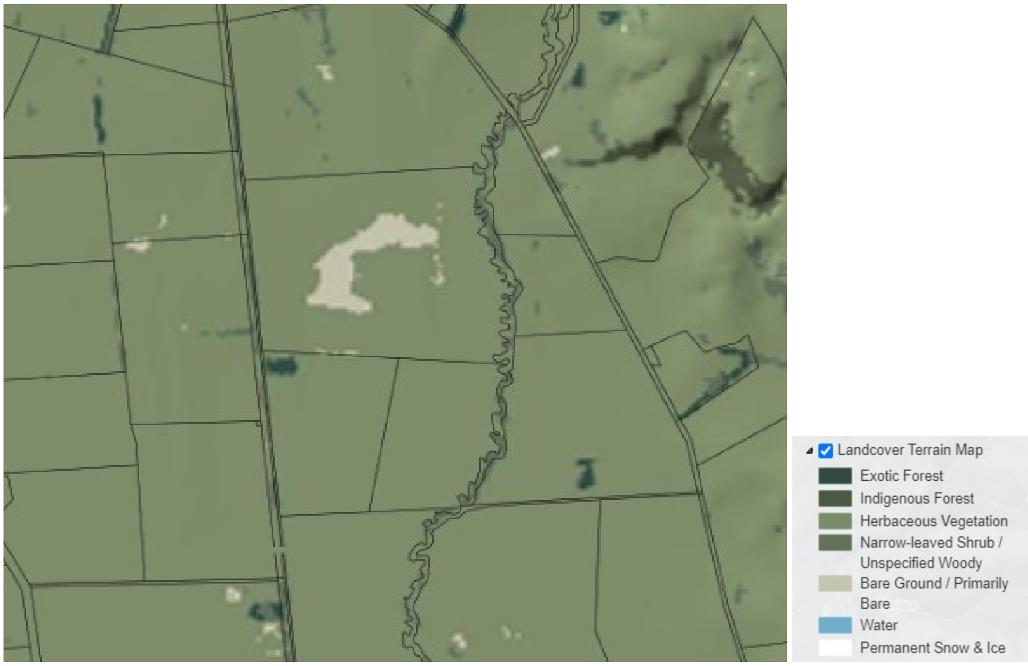
The Withy property is a family operated dairy unit of approximately 156ha on the Oreti river plain. The farm has a long boundary and very meandering boundary with the Winton Stream. Exact legal definition of this boundary will be important for CAA registration under the ETS and care will be needed if this is planned. Location is well suited to forestry with an expanding are of forest in the district. The Craigpine sawmill is a short cart down the main road and Niagara sawmill, Bluff Port and the Daiken MDF plant are all well within moderate cartage distance.

TOPOGRAPHY, COVER AND 300 INDEX



The property is flat land adjacent to the Winton Stream. A small rise exists where the dairy shed is sited and the Winton Stream meanders both legally and physically along the eastern boundary of the farm. Altitude is roughly 100masl, very much in excellent growing range for pretty much all species commercially grown in Southland.

LANDCARE RESEARCH COVER MAPPING (S-MAP ONLINE)



The farm is mapped with a small stand of Exotic Forest on the road boundary and some bare land in an odd area near the centre of the farm. Small amounts of herbaceous vegetation is mapped along the Winton Stream.

The small exotic forest area will need deforested for at least 5 years if it is to be enrolled as a CAA under the ETS.

300 INDEX[1]

The farm lies at a good altitude for pinus radiata. The 300 index for this farm ranges from 26 to 27.

For comparison, existing plantation forests in Southland are typically grown at a 300 index between 20 and 27.

The 300 index is a comparative measure of potential productivity, not a prediction of productivity. Many things will affect tree growth and site is only one.

[1] The 300 Index is a technical growth estimate used to compare the potential productivity of sites for radiata pine production. A high number indicates good productivity.

FORESTRY OPPORTUNITIES

EXISTING STANDS

There is one small radiata stand present on the farm. There are patches on native trees along the Winton Stream including a small “reserve”.

RADIATA 1

The radiata stand is a small area of mature trees close to the western boundary in the middle of the farm. It is sandwiched between the road and some farm buildings and is used as a standoff for stock during winter. The wintering value of this has been high in the past, but a herd home is being constructed on the farm which will decrease this alternative value.

This area could be felled and kept out of qualifying vegetation for 5 years if it is desired to register it into the ETS. It would have no useful tree cover for stock wintering for about 15 years if this were to be done. Area is just on 1ha.

NEW STANDS

NORTH WINTON STREAM

The Winton Stream boundary is a long and convoluted boundary. The existing fenceline closely follows the actual stream and I have roughly sketched the boundary shown above along the fenceline. The legal boundary is unlikely to lie on either the fenceline or the stream bed but it is the combination of legal boundary and planted boundary that would be taken into account in a CAA registration process – you can't claim the neighbour's trees.

It would be possible to straighten the Winton Stream boundary and plant a wide riparian zone along the stream. The difficulty is that the planting (and new fenceline) would need to be placed where it would meet the 30m average width requirement of an eligible plantation under the ETS. In addition, the Winton Stream would require a 10m setback for a production forest. Paddock land would be sacrificed to the planted area and in order to minimse the sacrifice the forest would need to become a permanent forest – probably native species.

I have sketched the type of boundary that might work above. Area of the plantation sketched is 2.4 ha and since this is just half the Winton Stream boundary, total area of paddock sacrificed would need to be close to 5ha.

The planting would have amenity and environmental values, but as a native planting would sequester carbon slowly. This area is would be more profitable as grazing on the dairy unit. For this reason I did not sketch the entire Winton Stream boundary with a plantation.

POSSIBLE AFFORESTATION MODELS

.There are no areas of the farm that are well suited to registration under the ETS. The pinus radiata plantation is too small to be worthwhile and the Winton Stream boundary would require considerable paddock land sacrificed to a low sequestration forest.

Despite this I have modelled the radiata stand as a CAA and a 5ha native forest along the Winton Stream to show the scale of NZU production available from this strategy.

Agroforestry was explored extensively in NZ by the Forest Service and the conclusion was that it compromises both stock and forest production. It is better to run them separately to optimise performance of each and the model assumes the stands are managed to optimise their forest potential.

Fencing has not been included in this model. The costs of fencing are significant relative to the forest size and should be considered in decision making. Boundaries drawn have not been done to optimise fence locations, but merely to indicate a possible afforestation area.

Planting areas and timing could be altered to suit the farm needs. The models presented use a simple set of guidelines and should not be considered advice.

Additional benefits from forestry have not been included in the modelling such as shelter impacts on stock or pasture, succession planning, or diversification impacts on farming risk.

ALL STANDS CASHFLOW

The table below assumes the radiata stand is harvested, fallowed and planted and registered as a CAA in 2029. The new Winton Stream planting is done in 2024 witner (note that fencing is not included in these cashflows).

Cashflows										
Year Ended 31 December	Yr	Estimated NZUs	Land & Other Costs	Forest Costs	Carbon Costs	Total Costs	Carbon Revenues	Fibre Revenues	Total Revenues	Net Cashflow
2023	1	-	-$ 140	-$ 5,000	$ -	-$ 5,140	$ -	$ 30,080	$ 30,080	$ 24,940
2024	2	-	-$ 140	-$ 26,500	$ -	-$ 26,640	$ -	$ -	$ -	-$ 26,640
2025	3	3	-$ 140	-$ 2,500	$ -	-$ 2,640	$ 240	$ -	$ 240	-$ 2,400
2026	4	3	-$ 140	-$ 2,500	$ -	-$ 2,640	$ 240	$ -	$ 240	-$ 2,400
2027	5	7	-$ 140	-$ 1,250	$ -	-$ 1,390	$ 520	$ -	$ 520	-$ 870
2028	6	11	-$ 140	-$ 1,500	$ -	-$ 1,640	$ 840	$ -	$ 840	-$ 800
2029	7	16	-$ 140	-$ 500	-$ 100	-$ 740	$ 1,304	$ -	$ 1,304	$ 564
2030	8	23	-$ 140	$ -	$ -	-$ 140	$ 1,856	$ -	$ 1,856	$ 1,716
2031	9	30	-$ 140	$ -	$ -	-$ 140	$ 2,400	$ -	$ 2,400	$ 2,260
2032	10	37	-$ 140	$ -	$ -	-$ 140	$ 2,920	$ -	$ 2,920	$ 2,780
2033	11	55	-$ 140	$ -	-$ 20	-$ 160	$ 4,400	$ -	$ 4,400	$ 4,240
2034	12	66	-$ 140	$ -	-$ 100	-$ 240	$ 5,280	$ -	$ 5,280	$ 5,040
2035	13	71	-$ 140	$ -	$ -	-$ 140	$ 5,680	$ -	$ 5,680	$ 5,540
2036	14	75	-$ 140	$ -	$ -	-$ 140	$ 5,960	$ -	$ 5,960	$ 5,820
2037	15	86	-$ 140	$ -	$ -	-$ 140	$ 6,880	$ -	$ 6,880	$ 6,740
2038	16	76	-$ 140	-$ 1,100	-$ 20	-$ 1,260	$ 6,080	$ -	$ 6,080	$ 4,820
2039	17	66	-$ 140	$ -	-$ 100	-$ 240	$ 5,280	$ -	$ 5,280	$ 5,040
2040	18	73	-$ 140	$ -	$ -	-$ 140	$ 5,840	$ -	$ 5,840	$ 5,700
2041	19	80	-$ 140	$ -	$ -	-$ 140	$ 6,360	$ -	$ 6,360	$ 6,220
2042	20	84	-$ 140	$ -	$ -	-$ 140	$ 6,720	$ -	$ 6,720	$ 6,580
2043	21	86	-$ 140	$ -	-$ 20	-$ 160	$ 6,840	$ -	$ 6,840	$ 6,680
2044	22	88	-$ 140	$ -	-$ 100	-$ 240	$ 7,040	$ -	$ 7,040	$ 6,800
2045	23	61	-$ 140	$ -	$ -	-$ 140	$ 4,880	$ -	$ 4,880	$ 4,740
2046	24	58	-$ 140	$ -	$ -	-$ 140	$ 4,680	$ -	$ 4,680	$ 4,540
2047	25	57	-$ 140	$ -	$ -	-$ 140	$ 4,520	$ -	$ 4,520	$ 4,380
2048	26	54	-$ 140	$ -	-$ 20	-$ 160	$ 4,320	$ -	$ 4,320	$ 4,160
2049	27	52	-$ 140	$ -	-$ 100	-$ 240	$ 4,120	$ -	$ 4,120	$ 3,880
2050	28	48	-$ 140	$ -	$ -	-$ 140	$ 3,840	$ -	$ 3,840	$ 3,700
2051	29	46	-$ 140	$ -	$ -	-$ 140	$ 3,640	$ -	$ 3,640	$ 3,500
2052	30	43	-$ 140	$ -	$ -	-$ 140	$ 3,400	$ -	$ 3,400	$ 3,260
2053	31	40	-$ 140	$ -	$ -	-$ 140	$ 3,160	$ -	$ 3,160	$ 3,020
2054	32	37	-$ 140	$ -	-$ 100	-$ 240	$ 2,960	$ -	$ 2,960	$ 2,720
2055	33	34	-$ 140	-$ 1,500	$ -	-$ 1,640	$ 2,720	$ -	$ 2,720	$ 1,080
2056	34	32	-$ 140	$ -	$ -	-$ 140	$ 2,520	$ 30,080	$ 32,600	$ 32,460
Total		1,593	-$ 4,760	-$ 42,350	-$ 680	-$ 47,790	$ 127,440	$ 60,160	$ 187,600	$ 139,810

The harvest of the 1ha of pines could be used to part cover planting of the Winton Stream stand or fencing.

This option generates 1,593 NZUs over 34 years. With all NZUs sold in the year received at $80 per NZU, the average net cashflow is $4112 per year, including 2 harvests of the radiata stand. Average net cashflow is $685 per ha per year.

APPENDIX 1: THE REGULATORY ENVIRONMENT

Production Forestry in NZ is mostly covered by a set of standard rules. These rules are legislated and enforceable through Councils and the courts. It is important to have a working understanding of the rules, but this report will only provide an introduction.

MPI, the NZFOA and the NZFFA all have excellent on-line references covering this in detail. The District and Regional Councils interpret and enforce the rules and should be consulted where there is any doubt.

THE NATIONAL ENVIRONMENTAL STANDARDS – PRODUCTION FORESTRY

Production forestry in NZ is subject to the National Environmental Standards – Production Forestry (NES-PF). The NES-PF came into force on 1 May 2018, and applies to any forest of at least one hectare that has been planted specifically for commercial purposes and is to be harvested. The NES-PF supersedes almost all district council plan provisions, and many of those of regional council plans, except in specific situations where the NES-PF allows councils to apply more stringent rules. The NES-PF rules outline when a forestry activity is permitted and when a consent is required.

There are separate sets of regulations for eight core forestry activities:

- Afforestation (planting new forest)
- Pruning and thinning to waste
- Earthworks
- River crossings
- Forestry quarrying (extraction of rock, sand, or gravel within a plantation forest or for operation of a forest on adjacent land)
- Harvesting
- Mechanical land preparation
- Replanting.

In addition to the activity specific rules, there are separate regulations for ancillary activities (NES-PF Regulations 83 to 95) and general provisions (NES-PF Regulations 96 to 105) that need to be complied with. These cover activities such as debris traps, indigenous vegetation clearance, riverbed disturbance, sediment discharges, dust, noise and bird nesting etc that can often be of relevance to earthworks or harvesting activities. For example, roading next to a river or through a patch of native bush.

Whenever a forestry activity is planned it is important to review the rules to ensure it is permitted, or to apply for a resource consent for the activity. If in doubt advice should be sought. The fines and remediation can be very costly.

NES-PF FLOW DIAGRAM – WILL I NEED A CONSENT?

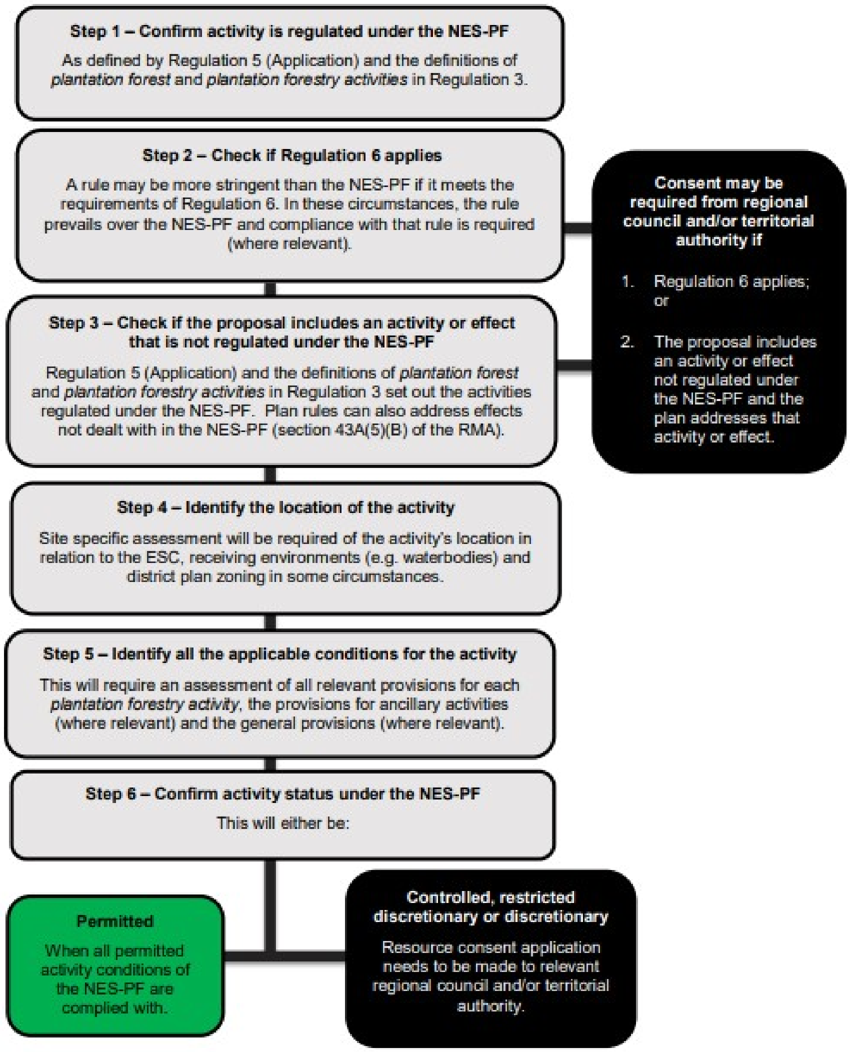


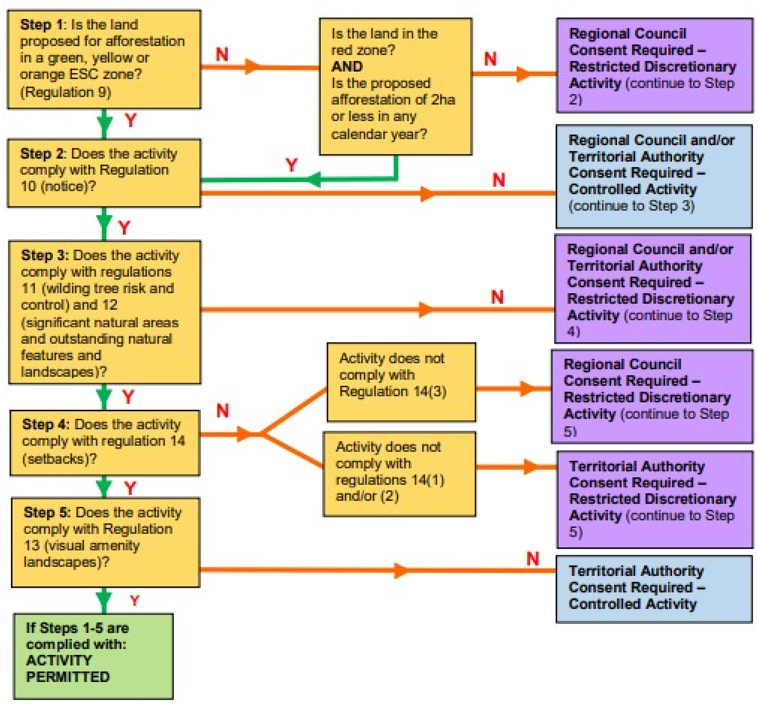
Figure 3: Steps to determine whether a plantation forestry activity complies with the NES-PF or requires a resource consent.

[2] Source: **NES-PF User Guide** located at https://www.mpi.govt.nz/dmsdocument/27930-Resource-Management-National-Environmental-Standards-for-Plantation-Forestry-Regulations-2017-March-2018

AFFORESTATION

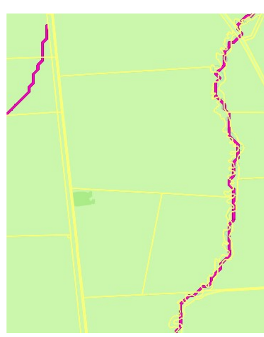
This report does not cover the rules in detail, but the site and species suitability must be assessed whenever a forest species is planted into unforested land, or a species change occurs in an existing forested area.

THE NES-PF provides a flow diagram to help understand what to do before planting:



For Glenroy Farm, the steps are as follows:

REGULATION 9 - ESC ZONES: Green, yellow, orange and red ESC zones describe erosion risk of the land. The vast majority of land under farming and production forest in Southland is either green or yellow. For the Withy property this appears on the ESC mapping tool as below:



Erosion potential is low and no consent is required under Regulation 9 for afforestation.

REGULATION 10 – NOTICE: Written notice must be given of proposed afforestation location, proposed setbacks, and planned start and end date of planting; and notice must be provided to council at least 20 and no more than 60 working days before the planned start date. Provided this notice takes place no consent is required.

REGULATION 11 – WILDING TREE RISK The Wilding Tree Risk Calculator sets out the factors to be considered when calculating the risk of wilding conifer spread as follows:

- The type of species being planted.
- How palatable the species is to grazing animals.
- Where the trees are in relation to the prevailing wind.
- Downwind land use.
- Proximity to existing forests.

Each non-contiguous planting area must be separately assessed. For example, the 10ha block in the northern corner of the farm might be assessed as follows (Note: this is only an example, not an actual assessment of wilding tree risk for this block)

	Radiata	Douglas fir
SPECIES – GROWTH	1	4
SPECIES – PALATABILITY	1	3
SITING OF NEW PLANTING	1	1
DOWNWIND LANDUSE – GRAZING	1	1
DOWNWIND VEGETATION COVER	1	1
	5	10

Consent is not required at 12 or below. In this case, neither Radiata nor Douglas fir would require a consent.

REGULATION 12 – SIGNIFICANT NATURAL AREAS AND OUTSTANDING NATURAL FEATURES AND LANDSCAPES: Significant Natural Areas (SNAs) are areas containing significant indigenous vegetation or significant habitat of indigenous fauna. Mapping of the SNAs in Southland is not yet available but first impression indicates it unlikely that there are any areas on Glenroy Farm that would qualify as SNAs. Outstanding Natural Features are identified in the District Plan. None exist on or near Glenroy Farm so consent is probably not required under Regulation 12. This could be confirmed with SDC prior to afforestation.

REGULATION 14 – SETBACKS: Setback rules under the NES-PF apply to rivers (5 to 10m), wetlands (5 to 10m), SNAs (10m), property boundaries (10m), dwellings (shading rule to 40m) and roads (shading rule). Provided these setbacks are applied and shown in the Notice to the SDC, a consent will not be required under Regulation 14.

REGULATION 13 – VISUAL AMENITY: Mapping of the Visual Amenity Landscapes in Southland is not yet complete. Currently the coastal environment and the Te Anau Basin area include VALs. Consent is probably not required under Regulation 13. This could be confirmed with SDC prior to afforestation.

APPENDIX 2: THE EMISSIONS TRADING SCHEME

This report is unconcerned with the science of climate change nor the argument around it. There is a regulatory framework in existence which is available for use, and this report briefly outlines how it works, and the potential gains that can be made by taking advantage of the opportunity it provides through forestry and the Emissions Trading Scheme (ETS).

BACKGROUND TO THE EMISSIONS TRADING SCHEME

Scientists, Governments and other organisations became concerned about climate change in the late 1900s. The first major international agreement on climate change was the UN Framework Convention on Climate Change of 1992 which NZ signed that year. The Kyoto Protocol was the first implementation of measures under the UNFCCC. It was adopted in 1997 and entered into force in 2005. NZs obligations under the Kyoto Protocol was the reason the ETS was created. The Kyoto protocol has been superseded by the Paris Agreement which entered into force in 2016.

Agreement	Target	End Date
Kyoto	Reduce greenhouse gas emissions to 1990 levels between 2008 and 2012	2012
Kyoto	Reduce gross greenhouse gas (GHG) emissions to 5 per cent below 1990 levels over the period 1 January 2013 to 31 December 2020	2020
Paris	50 per cent reduction of net emissions below our gross 2005 level	2030

The Paris Agreement Target is to be met by the following targets legislated under the Climate Change Reduction Act

Agreement	Target	End Date
CCRA (NZ Legislation)	10 per cent reduction below 2017 biogenic methane emissions	2030
CCRA (NZ Legislation)	24 to 47 per cent reduction below 2017 biogenic methane emissions	2050
CCRA (NZ Legislation)	Net zero emissions of all GHG other than biogenic methane	2050

The ETS was legislated into existence in 2007 and came into force in 2008. It has been the main method used to meet our obligations under the Kyoto Protocol.

The ETS is a system regulating companies that emit greenhouse gases. It also recognises sequestered carbon. It works by creating a market where supply of units comes from the government and forestry companies (offshore units are now strictly controlled), and demand comes from companies that emit carbon.

Biogenic methane and other agricultural gases are not currently included in the ETS at the request of the agriculture industry. The rules around these gases are being negotiated at the moment through He Waka Eke Noa. This report does not review or interpret He Waka Eke Noa.

FORESTRY IN THE EMISSIONS TRADING SCHEME

Carbon sequestration in both exotic and native forestry in plantations and permanent forests is covered by the Emissions Trading Scheme (ETS) in New Zealand. It is recognised under the ETS that forests sequester carbon as they grow to maturity (a steady state where as much carbon is being released by decaying forest material as is being sequestered by growing trees). A forest owner may claim the carbon sequestered by their forest while it grows to maturity. The record of the claimed carbon is kept in an account administered by the EPA and counted using NZ Units (NZUs). Each NZU represents one tonne of CO_2. Once the NZUs are in the account they may be sold. NZUs may also be bought and added to the account.

NZUs can be thought of in the same way as shares. They are a tradable certificate of ownership. This means that when a forest owner sells an NZU, the ownership of the sequestered carbon can move to someone completely unrelated to the forest in the same way that share ownership can move to people who have no physical relationship with the company. The carbon doesn't move anywhere, only the ownership of the carbon.

The rules of the ETS are administered by MPI. Growers must register their forest with MPI to claim NZUs. On registration each piece of forest will become a Carbon Accounting Area or CAA. The registration process will review that the forest:

- Was not forest as at 1 January 1990
- Is larger than 1 ha
- Is wider (on average) than 30m
- Has canopy cover >30% or will have at maturity
- The trees will be taller than 5m at maturity.

Note: once a CAA is established, there are specific rules around who holds the rights and obligations attached to the CAA and whether these can or must be transferred when land is sold or a lease or forestry right is established.

Once registration is achieved, the grower may claim NZUs for their forest. If the CAAs in an account exceed 100ha in area, the forest must be measured every 5 years. If less than 100ha "look up tables" must be used.

There are rules governing how NZUs may be claimed. Permanent forests may claim the NZUs for as long as they are sequestering carbon (or until the tables run out or they are moved out of the ETS). Older production forests may be under the Stock Change accounting system, but new production forests must use Averaging accounting which limits how many years you may claim NZUs. Production forest species have different growth rates and are harvested at different ages and this means they have different age limits for claiming carbon:

- Radiata pine: age 16
- Douglas-fir: age 26
- Exotic softwoods: age 22
- Exotic hardwoods: age 12
- Native (indigenous) forest: age 23

Once a CAA is registered it will remain in the ETS until de-registered. This means the carbon returns and obligations will remain in perpetuity, even if all the NZUs have been sold. One thing to keep in mind is whether the obligation may impact sales of land or forestry rights as the new owner will inherit any future costs or benefits associated with the ETS.

There are a great many more rules governing the ETS. For more details go to the MPI website.

EXISTING STANDS AND THE ETS

Specific considerations exist for existing eligible, unregistered stands. Any stand that meets the criteria for registration can be registered, however there are costs and benefits of registration to take into account.

On the cost side of the considerations, all stands registered have an administrative burden associated (this may be minor such as filling returns every year, or significant such as measuring every five years).

On the benefits side of the considerations, all stands registered after 1 January 2023 will receive NZUs under the Averaging scheme. Under this scheme Carbon can only be claimed for the first rotation, and up to the ages shown above (eg radiata age 16).

If an existing radiata stand already exceeds age 16 it has no available NZU claim and there is no advantage from being entered in the scheme. If the stand has not yet reached age 16 there may be carbon to claim, but it may not be much depending on the specific stand age and size.

It is possible to switch an existing stand back to a first rotation stand by removing the existing forest (eg by harvesting) and not replanting the area. The area must be "not a forest" for at least 5 years (it must be kept clear of wilding trees, native species, or any other species that qualifies under the ETS). Ideally the land would be cleared and returned to pasture, with woody weeds controlled. Evidence of the "not a forest" period and status of the land would need to be kept to support a future ETS application. This might include before and after photos, receipts for work done (eg land clearance, oversowing, weed control, cultivation) diary notes, farm or forestry consultant reports etc.

Once the land has reached the 5 years as "not a forest" it may be entered into the scheme as a first rotation forest. It is important to review the ETS rules before embarking on this path because the specific rules may exclude the stand under review, or the rules may change.

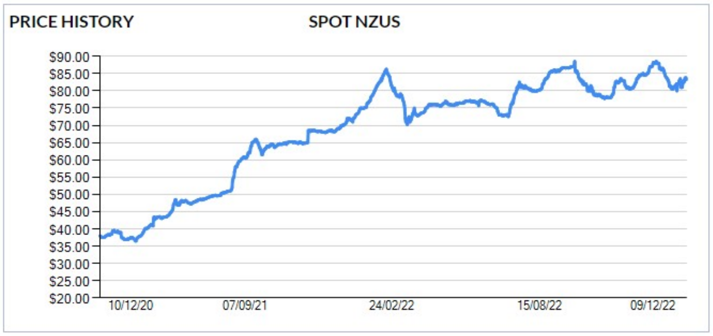
CARBON PRICE

It is a common misconception that the Government somehow "pays for the carbon" in the ETS. In fact, it is all economic actors in our economy (including you and I, businesses and the government) who pay for the carbon as the end users of products and services with a carbon price built in. For example we currently pay in the region of 20c per litre of petrol for emissions included in the ETS[3]. We don't see it itemised at the pump, but it is there all the same. The petrol importing company uses the money gathered when we buy petrol to buy enough units from the market to meet its surrender obligations under the ETS.

NZUs can be bought and sold. Transfers can be arranged directly between buyers and sellers, but this is usually for large parcels. Smaller parcels can be amalgamated by brokers and traded, or offers can be made for small parcels directly. A useful place to start is Commtrade.co.nz.

The graph of NZU spot price is below:

[3] The fuel companies buy carbon credits in the Emissions Trading Scheme to cover the emissions when their fuel is used. Every litre of petrol burned emits 2.45 kilograms of carbon. Carbon permits currently cost about $80/tonne, so the carbon charge is about 20c.



The government set up the Climate Change Commission to provide it advice around the current and future trajectory of NZ Carbon emissions. As part of its work it models NZs greenhouse gases using the Paris Agreement and the CCA targets and looks at where we are, how much is currently being emitted and existing rates of technology shift in each industry. It is required to look at the price of NZUs needed to achieve the NZ carbon targets under the Paris Agreement. It reports every 5 years and recently released its modelling summaries:

At the low end - with either low baseline emissions and mitigation costs, or a scenario of strong mitigation from other policies - we find a very similar minimum price path to achieve the targeted level of emissions in the NZ ETS. This is around $75 in 2030 (in 2022 dollars). This price path uses a fixed rate of increase or discount rate of 3%.

At the high end, under high baseline emissions and mitigation costs, we find a maximum price path reaching around $270 in 2030, also using a 3% discount rate. Under a scenario of weak mitigation from other policies, the modelling suggests even higher prices would be needed.

Effectively, if we as a nation aggressively reduce emissions and plant loads of trees, the CCC expect the NZU price will remain roughly where it currently is. However, if we increase emissions or don't plant enough trees, the NZU price will have to rise to around $270 or more in the next 8 years.

APPENDIX 3: SPECIES

There are a wide range of possible species to use for forestry and carbon sequestration. Only some of the species are suited to production forestry and this information is noted in the species descriptions below. The information here is very brief. Links to additional information are included.

Example regime cashflows are shown in Appendix 4.

NATIVE SPECIES

There are many species available within the native species category. For ETS purposes the mature tree must achieve 5m or greater in height. Unless the total CAA area exceeds 100ha, the growth rate of the species is unimportant for NZU calculations, which leaves species selection very broad. An approach being used is for the grower to plant species that will attract native birds such as kereru (wood pigeons). The birds are natural spreaders of native (and exotic) trees in the environment and they will help introduce canopy species which tend not to be available in large numbers from nurseries. Common nursery species include manuka, pittosporum, lemonwood, whiteywood, wineberry, with more limited availability of beech and podocarp species.

Management is somewhat complex (for example trees need to be planted in dug holes which slows planting down, and if a mixed species regime is planted there may be different releasing periods or chemicals for each species). A typical mixed species regime for 1 ha is outlined below based on planting 400 plants per ha (For most native species this is the minimum required to meet the 30% canopy cover threshold). Fencing is not included.

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 2,700
Release Spray Yr 0	0	- 500
Release Spray Yr 1	1	- 500
Release Spray Yr 2	2	- 300

PINUS RADIATA

Pinus radiata is the most commonly planted exotic tree species in NZ. It holds this position because it generates the greatest profitability of any of the exotic tree species across a wide range of planting areas. Profitability comes from a combination of scale, rapid growth, available markets, utility of products and workforce skill set. Pruning is becoming less common due to poor economics and winter pruning in Southland frequently leads to nectria damage of the stems (nectria is a fungus that can infect radiata through bark wounds caused by pruning, machinery or stock grazing). When severe this may result in a very poor return at harvest or even a total write off.

Carbon accumulation reaches 302 T/ha in Southland at age 16 (table basis).

Management is usually straightforward with a typical regime outlined below.

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 1,100
Release Spray	0	- 300
Thin	9	- 1,200
Build Roads	27	- 5,000
Harvest	28	24,000

Regimes should be adjusted to the needs of site, season, crop, cashflow and grower.

Brief mention should be made of pinus radiata x attenuata hybrid. This cross has largely replaced douglas fir planting in commercial forestry at higher altitudes in Southland. It appears to have good growth and form, tolerates snow and frost well, has a low wilding potential, and is showing good promise at elevations above 500m. Stock is in high demand and early ordering is required to secure supply. There are as yet no harvest age stands, so there is limited information on timber properties.

DOUGLAS FIR

Douglas fir is a common exotic plantation species in Southland. It was widely planted at higher altitudes during the 1990s and early 2000s but has recently fallen out of popularity in plantation forestry due to better alternatives. It is a common native and plantation species in the western US and Canada and is one of the most widely traded species across the Pacific. It has a ready market and fetches good prices, but is slower to grow than radiata pine. The slower growth makes it less profitable than radiata as a plantation species except where radiata is unable to perform due to altitude and snow.

Douglas fir has a light seed that is prolifically produced in cool conditions. Wind spread of the seed can reach kilometers from source trees. It has low palatability to stock and in downwind areas with light or infrequent grazing it will rapidly form a self-seeded forest. As a shade tolerant tree it has a tendency to crowd out every other plant species and at stockings exceeding 1000 stems per ha (spha) it can form a monoculture with no understorey growth. It can invade and eventually dominate native beech forests.

Carbon accumulation reaches 436 T/ha at age 26 (table basis).

A typical management regime is outlined below.

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 1,050
Release Spray Yr 0	0	- 300
Release Spray Yr 1	1	- 300
Thin	15	- 1,200
Build Roads	39	- 5,000
Harvest	40	45,000

CUPRESSUS MACROCARPA

Macrocarpa has been established in small plantation stands and has been widely used as a shelterbelt species on farms. As a timber tree it needs good sites and there is a market for pruned or small knot timber. It is intolerant of snow due to stiff branching which leads to stem damage. It can suffer canker and there is evidence that macrocarpa can cause abortion in cattle.

Macrocarpa is slower growing than radiata, but tends to have a shorter regime than Douglas fir because it is normally planted at lower altitude on better soils. Seedlings for large plantations will need to be pre-ordered from the nursery a couple of years ahead as they are not normally produced in quantity.

Carbon accumulation reaches 283 T/ha at age 22 (table basis).

A typical management regime is outlined below.

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 1,400
Release Spray Yr 0	0	- 300
Release Spray Yr 1	1	- 300
Prune to 2.5m	8	- 1,300
Prune to 4.5m	10	- 1,500
Thin	11	- 1,200
Build Roads	35	- 5,000
Harvest	36	35,000

EUCALYPTS

Eucalypts are widely grown in plantations in Southland. Plantation eucalypts (usually eucalyptus nitens in Southland) are a very fast growing tree, reaching large sizes by age 20 on most sites. They will outgrow most other tree species and sequester carbon very quickly (one third faster than radiata in Southland). Markets are limited with nitens not being well suited to sawing. They are most commonly used for pulp for high quality paper, but this is a declining market and returns at harvest tend to be low. There is often a market for export logs in small quantities.

E. nitens has an open canopy which allows understorey growth. It tends to self prune its lower branches which can produce good log form. Shed sticks and bark in eucalypt forests may build up a large fuel load for fires. Eucalypts can be attacked by insects (particularly paropsis) and this may need managed.

Carbon accumulation reaches 320 T/ha at age 12 (table basis).

A typical regime might look like this:

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 1,200
Release Spray Yr 0	0	- 300
Build Roads	17	- 5,000
Harvest	18	15,000

POPLARS

Poplars are commonly grown in Southland and are a reasonably common timber species throughout the world. They are often grown as amenity trees, but occasionally as a plantation species. In many areas of NZ they are used for erosion control. As a plantation there is a market for export logs, but this can be patchy. The timber has quite good properties, but tends to have low density. Planting is very straightforward as they will grow from poles cut from other trees. There is good information about the species on the NZFFA website.

Poplars are attracting considerable interest from farmers. NZU claims for poplars are made under the exotic hardwood carbon table (the same table as eucalypts). As an open canopy deciduous tree they will allow pasture to grow, but pasture volume is low and quality is poor relative to normal agricultural pastures. Autumn leaf fall can severely restrict winter grass growth around the trees. Poplars are a palatable species and will suffer damage while young if stock or pests are allowed access. It may be better to specialise areas than compromise (fence stock out of plantations and keep trees out of pasture areas).

Carbon accumulation reaches 320 T/ha at age 12 (table basis).

A typical regime might look like this:

	Year	Cost/ha
Land Prep	- 1	- 600
Preplant Spray	- 1	- 400
Plant	0	- 1,200
Build Roads	25	- 5,000
Harvest	26	15,000

OTHER SOFTWOODS

Other softwoods includes conifer species such as redwoods, larch, pines, spruces, cedars etc. Most of these have been grown as plantations and amenity species in Southland. They tend to perform poorly as plantation species due to problems such as slow growth, poor form, wilding spread, and limited markets.

They accumulate carbon under the Exotic Softwoods table. Carbon accumulation reaches 283 T/ha at age 22 (table basis).

Information on some of these species can be found on the NZFFA website.

OTHER HARDWOODS

Other hardwoods includes species such as oaks, European beech, birches, willows, sugar maple etc. These are mostly grown as amenity species in Southland but some (such as English oak) are well known as timber species in their native range. In New Zealand their use as plantation species suffers from limited availability, lack of industry knowledge, and limited markets.

They accumulate carbon under the Exotic Hardwoods table. Carbon accumulation reaches 320 T/ha at age 12 (table basis).

Information on some of the other hardwood species may be found on the NZFFA website.

APPENDIX 4: CASHFLOW MODELS FOR INDIVIDUAL SPECIES

WITH CARBON

The carbon price in these cashflows is $80 per NZU. Averaging and tables were used.

		New Stand	New Stand	New Stand	New Stand	New Stand
Previous Cover		Pasture	Pasture	Pasture	Pasture	Pasture
Forest Species		Pinus Radiata	Douglas Fir	Cupressus Macrocarpa	Eucalyptus spp	Other (native)
Year Ended 31 December	Year	1 ha	1 ha	1 ha	1 ha	1 ha
2023	-1	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2024	0	-$ 1,520	-$ 2,020	-$ 2,520	-$ 1,520	-$ 5,020
2025	1	-$ 496	-$ 512	-$ 504	-$ 504	-$ 472
2026	2	$ 116	-$ 270	-$ 456	$ 44	-$ 472
2027	3	$ 220	$ 4	$ 140	$ 140	-$ 166
2028	4	$ 300	$ 28	$ 700	$ 860	$ 148
2029	5	$ 1,320	$ 40	$ 1,080	$ 1,640	$ 216
2030	6	$ 1,820	$ 140	$ 1,500	$ 2,380	$ 324
2031	7	$ 1,820	$ 220	$ 1,420	$ 1,950	$ 412
2032	8	$ 1,740	$ 1,020	$ 300	$ 2,780	$ 500
2033	9	$ 2,380	$ 1,020	$ 780	$ 2,060	$ 588
2034	10	$ 220	$ 1,320	-$ 400	$ 1,080	$ 648
2035	11	$ 380	$ 1,500	$ 860	$ 540	$ 748
2036	12	$ 780	$ 1,660	-$ 260	$ 1,340	$ 820
2037	13	$ 1,260	$ 470	$ 350	-$ 20	$ 876
2038	14	$ 1,580	$ 1,980	$ 1,180	-$ 20	$ 924
2039	15	$ 1,720	$ 2,120	$ 1,240	-$ 40	$ 936
2040	16	$ 2,060	$ 2,220	$ 1,340	-$ 20	$ 988
2041	17	-$ 20	$ 2,300	$ 1,340	-$ 20	$ 996
2042	18	-$ 20	$ 2,460	$ 1,340	-$ 20	$ 1,004
2043	19	-$ 20	$ 1,180	$ 1,420	-$ 20	$ 996
2044	20	-$ 40	$ 1,400	$ 1,320	$ 7,225	$ 952
2045	21	-$ 20	$ 1,660	$ 1,340		$ 956
2046	22	-$ 20	$ 1,900	$ 1,340		$ 916
2047	23	-$ 20	$ 1,900	-$ 20		$ 884
2048	24	-$ 20	$ 2,140	-$ 20		$ 844
2049	25	-$ 40	$ 2,120	-$ 40		$ 784
2050	26	-$ 20	$ 2,140	-$ 20		$ 748
2051	27	-$ 1,520	-$ 20	-$ 20		$ 708
2052	28	$ 30,060	-$ 20	-$ 20		$ 660
2053	29		-$ 20	-$ 20		$ 612
2054	30		-$ 40	-$ 40		$ 552
2055	31		-$ 20	-$ 20		$ 524
2056	32		-$ 20	-$ 20		$ 484
2057	33		-$ 20	-$ 20		$ 436
2058	34		-$ 20	-$ 20		$ 404
2059	35		-$ 40	$ 27,140		$ 352
2060	36		-$ 20			$ 332
2061	37		-$ 20			$ 308
2062	38		-$ 20			$ 276
2063	39		-$ 20			$ 244
2064	40		$ 31,180			$ 208
2065	41					$ 196
2066	42					$ 188
2067	43					$ 156
2068	44					$ 148
2069	45					$ 104
2070	46					$ 116
2071	47					$ 100
2072	48					$ 92
2073	49					$ 76
2074	50					$ 48
TOTAL		$ 43,980	$ 61,000	$ 41,690	$ 19,835	$ 18,382

WITHOUT CARBON

		New Stand	New Stand	New Stand	New Stand	New Stand
Previous Cover		Pasture	Pasture	Pasture	Pasture	Pasture
Forest Species		Pinus Radiata	Douglas Fir	Cupressus Macrocarpa	Eucalyptus spp	Other (native)
Year Ended 31 December	Year	1 ha	1 ha	1 ha	1 ha	1 ha
2023	-1	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2024	0	-$ 1,520	-$ 2,020	-$ 2,520	-$ 1,520	-$ 5,020
2025	1	-$ 520	-$ 520	-$ 520	-$ 520	-$ 520
2026	2	-$ 20	-$ 270	-$ 520	-$ 20	-$ 520
2027	3	-$ 20	-$ 20	-$ 20	-$ 20	-$ 270
2028	4	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2029	5	-$ 40	-$ 40	-$ 40	-$ 40	-$ 40
2030	6	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2031	7	-$ 20	-$ 20	-$ 20	-$ 770	-$ 20
2032	8	-$ 20	-$ 20	-$ 820	-$ 20	-$ 20
2033	9	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2034	10	-$ 1,140	-$ 40	-$ 1,040	-$ 40	-$ 40
2035	11	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2036	12	-$ 20	-$ 20	-$ 1,220	-$ 20	-$ 20
2037	13	-$ 20	-$ 1,370	-$ 770	-$ 20	-$ 20
2038	14	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2039	15	-$ 40	-$ 40	-$ 40	-$ 40	-$ 40
2040	16	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2041	17	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2042	18	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2043	19	-$ 20	-$ 20	-$ 20	-$ 20	-$ 20
2044	20	-$ 40	-$ 40	-$ 40	$ 7,225	-$ 40
2045	21	-$ 20	-$ 20	-$ 20		-$ 20
2046	22	-$ 20	-$ 20	-$ 20		-$ 20
2047	23	-$ 20	-$ 20	-$ 20		-$ 20
2048	24	-$ 20	-$ 20	-$ 20		-$ 20
2049	25	-$ 40	-$ 40	-$ 40		-$ 40
2050	26	-$ 20	-$ 20	-$ 20		-$ 20
2051	27	-$ 1,520	-$ 20	-$ 20		-$ 20
2052	28	$ 30,060	-$ 20	-$ 20		-$ 20
2053	29		-$ 20	-$ 20		-$ 20
2054	30		-$ 40	-$ 40		-$ 40
2055	31		-$ 20	-$ 20		-$ 20
2056	32		-$ 20	-$ 20		-$ 20
2057	33		-$ 20	-$ 20		-$ 20
2058	34		-$ 20	-$ 20		-$ 20
2059	35		-$ 40	$ 27,140		-$ 40
2060	36		-$ 20			-$ 20
2061	37		-$ 20			-$ 20
2062	38		-$ 20			-$ 20
2063	39		-$ 20			-$ 20
2064	40		$ 31,180			-$ 40
2065	41					-$ 20
2066	42					-$ 20
2067	43					-$ 20
2068	44					-$ 20
2069	45					-$ 40
2070	46					-$ 20
2071	47					-$ 20
2072	48					-$ 20
2073	49					-$ 20
2074	50					-$ 40
TOTAL		$ 24,780	$ 26,120	$ 19,050	$ 3,995	-$ 7,490

INDIVIDUAL SPECIES NPV

NPV stands for Net Present Value, a technical and widely used method of comparing future cashflows. Comparing NPVs can help guide investment decisions, but it does not capture all things that can impact the decision. For example it does not capture (or only partially captures) personal preferences, externalities (such as pollution), catastrophes or changes in technology. It is one method of comparing options, but it is not the only one.

The NPVs in the table represent an approximation of the cashflow of a single ha of each species. The detailed cashflows are shown in Appendix 2. The NPVs presented here ignore land value, because each regime requires the same land area.

CARBON INCLUDED

Carbon is only available for the first rotation under the Averaging scheme of the ETS. Modelling of individual species, including sale of all NZUs in the year they are earned gives the following NPVs.

Discount Rate 10.0%

	Pinus Radiata	Douglas Fir	Cupressus Macrocarpa	Eucalyptus spp	Other (native)
NPV 28 Years	$36,384	$25,420	$12,640	$14,687	$9,890
NPV One Rotation	$36,384	$47,412	$32,663	$17,715	$14,287
Rotation Period (yrs)	28	40	35	20	50

Two lines are presented: the NPV at age 28 (the length of a single radiata rotation) and the NPV at one rotation of each species. The relative rankings do not alter significantly at discount rates ranging from 4% to 20% and all remain positive throughout the range (because the up-front investment of the land is ignored).

The NPV of one rotation shown above includes carbon at $80/NZU.

CARBON AT $200 PER NZU

At a carbon price of $200/NZU the NPVs for a single rotation alter significantly.

Discount Rate 10.0%

	Pinus Radiata	Douglas Fir	Cupressus Macrocarpa	Eucalyptus spp	Other (native)
NPV One Rotation	$62,650	$92,325	$62,813	$39,837	$46,469
Rotation Period (yrs)	28	40	35	20	50

Note the greatly increased performance of the native regime.

CARBON EXCLUDED

The following table shows the NPV of a single rotation without carbon.

Discount Rate 10.0%

	Pinus Radiata	Douglas Fir	Cupressus Macrocarpa	Eucalyptus spp	Other (native)
NPV One Rotation	$18,873	$17,470	$12,564	$2,966	-$7,167
Rotation Period (yrs)	28	40	35	20	50

Native species are assumed to have no harvest within the 50 year period modelled and thus yield a negative NPV. Native forests will not require replanting every 50 years so the NPV shown is a little pessimistic for that reason.

At very low discount rates (5% or less) Douglas fir and radiata have closely comparable NPVs. It should be noted that 5% is an unusually low discount rate.

ETS PERMANANCE AND NPV

Once an area of land is committed to the ETS, it is extremely expensive to remove it from the ETS. It can be considered permanent forest from that point forward. This means that in order to extract value from the forest over multiple forest rotations, the carbon exclusive NPV in the second table will apply once the first harvest is in.

Douglas fir will shows a higher NPV in the first rotation under the ETS (based on this assumption set) and will yield a comparable NPV to radiata under subsequent rotations. This may make it a preferable option on paper but there are a couple of other points to consider:

- You would need to plant a Douglas fir stand when you are aged 30 in order to harvest it at age 70. As a general rule, planting a Douglas fir stand is planting for the next generation to harvest.
- Three rotations of radiata will typically take about the same period as two rotations of Douglas fir. This means that the positive cashflows from harvest are better spread with radiata than Douglas fir.
- It can be expensive under the ETS to change from one species to another due to differences in carbon sequestration.
- Forestry carries externalities that could potentially lose their “social licence”. Eg Douglas fir has a severe propensity for wilding spread. The cost of this is currently socialised (DoC picks up the burden of wilding removal from Crown land). This may not remain so over time. Another example is that radiata currently has a significant slash problem in severe flood events. The “social licence” for radiata forestry is currently changing as a consequence.

APPENDIX 5: ENVIRONMENTAL CONSIDERATIONS

Environmental considerations in forestry run two ways: how the environment impacts the forest and how the forest impacts the environment.

ENVIRONMENT IMPACTS ON FORESTS

ALTITUDE

Forests grow more slowly at higher altitudes and all species have an upper altitude limit. Trees are shorter and timber volumes are lower as altitude increases. Some species are better adapted to cooler environments, but these species will also suffer the effects of altitude. Where the forest is not planted for production of sawlogs (eg amenity or ETS plantings) this is less important, however the effective altitude limit for native forest in Southland is 1000m. Slow growth at altitude may be an important consideration where ETS plantings exceed 100 ha and must be measured.

Typically, on sites that are not exposed (wind or snow) altitude limits for production forest species in Southland will be roughly:

Radiata 500-600 m

Radiata x Attenuata hybrid 700 m[4]

Douglas fir 600-700 m

Larch 400-500 m

Macrocarpa and Sequoia 300-400 m[5]

Poplar, oak and other hardwoods 300-400 m[6]

Eucalypt species 400-500 m

All these species can survive and grow at higher altitudes than this, but are unlikely to perform well as production forests. As the climate warms, the effective altitude limit for forests is rising, approximately 50 to 100m per degree of warming.

No species perform well on very wind exposed sites such as ridgelines.

FROST AND SNOW

Frost prone areas, particularly at high altitudes (above 700m), may cause establishment failures. Seedlings are particularly sensitive to frosting and complete failures across large areas can occur. Some years are worse than others and it is very difficult to predict. Species selection may help, but will not prevent failure. Planting a frost exposed area across several seasons may reduce failure risk but trees can remain vulnerable for several years. Budgeting for re-establishment or accepting crop failure in some areas may be the best strategy.

---

[4] This is a relatively new hybrid that produces good form trees at 600masl and will probably grow adequately at higher altitudes than this. However due to its relative newness its range is not well explored and may be higher or lower than 700 m.

[5] Insufficient plantings to be sure of the altitude range for these softwood species

[6] Insufficient plantings to be sure of the altitude range for these hardwood species

Some species tolerate heavy snow with little damage and other species are very easily damaged by snowfall. This is important for species grown for timber. Soft, fine branched species, and deciduous species tend to be more tolerant of heavy snowfall.

Radiata and macrocarpa are particularly sensitive to heavy snow loadings. Stiff branches under snow load can break often forming a socket at the stem. The resulting stem damage can cause an entry point for disease, stem deformation, multi-leadering and even tree death.

WIND

Exposure to consistent strong winds limits tree growth due to damage at the apical shoot. The higher the altitude, the more pronounced the effect.

In addition wind has a high cataclysmic risk: in the worst case situation entire stands can be lost to windthrow in extremely strong wind events. The older the forest, the more likely this is. Windthrown trees may be able to be recovered, but returns from the stand will be reduced due to stem breakage and related volume loss, increased harvest costs, and younger than optimal harvest age. Almost every species can be toppled, but softer, finer species are less prone to windthrow. Douglas fir tolerates very strong wind if it is infrequent, but is growth sensitive to frequent wind events. Macrocarpa is moderately tolerant to salt winds.

It may be possible to insure against windthrow.

FIRE

Some forest species are more fire resistant than others, but all large scale forests are vulnerable to fire. Southland normally has lower risk for forest fires than many areas of NZ, but as climate warms evaporation increases, dry spells become more intense and air temperatures increase. This will increase the frequency and severity of forest fires even in Southland.

Under existing legislation, forest fires will not normally be allowed to burn out unless planned and permitted. Control of forest fires can be very expensive and this can be charged back to the person who started the fire if known.

It may be possible to insure against fire risk.

FOREST IMPACTS ON THE ENVIRONMENT

Carbon sequestration and timber production are discussed in detail elsewhere in this report. Forestry has other significant impacts on the environment, beyond carbon sequestration and timber. The majority of forest species will have quite similar impacts and these are briefly discussed here.

WATER

Forests generally result in different water quality and quantity compared to agricultural land uses.

WATER QUALITY

Waterways in forests tend to flow with good water quality. Land-use comparisons generally show water quality improves from pasture to planted forest to indigenous forest. Afforestation of pasture land significantly improves a wide range of water quality attributes such as stream temperature, nutrient and sediment concentrations and microbial contamination within 4-6 years of planting. Water quality in midrotation to mature forests, a large proportion of the forestry cycle, is highly variable but characterised by cool water temperatures, low concentrations of sediment and nutrients, with aquatic invertebrate communities indicative of high water quality.

Particular mention must be made of the detrimental impacts at harvest time. During road construction and harvesting serious sediment discharges can occur. Good quality road construction will result in low erosion risk and good sediment management. Care is particularly required near waterways and on steep slopes and consents will often be required for these. There is a manual for forest road engineering and strict standards apply.

Harvesting is the time of greatest risk for adverse impacts on water quality. The most common issue is sediment discharge caused by the operation of heavy harvesting machinery such as skidders, forwarders and excavators during wet weather. Enormous amounts of mud slurry can be generated and these may enter waterways. Mitigations may be available such as moving to a drier location, tracking uphill in sensitive areas, and slash or soil bunding. Sometimes the best option is to temporarily cease harvest until conditions improve. There are strict rules governing waterway crossings and sediment discharges at harvest time.

It has become very clear in recent years that harvest slash can be extremely damaging in major flood events. No parts of NZ are immune to this and we are expecting significant changes to the production forestry rules to reduce the probability and severity of slash related events. Slash management has already changed significantly due to the Tolaga Bay event of 2018, but more is to come.

WATER QUANTITY

Forest canopy will intercept significant amounts of precipitation, especially important where rainfall is less frequent or lighter, or where mists and clouds form a large part of the precipitation. The intercepted precipitation can evaporate before it even reaches the soil. In experimental studies around New Zealand reductions in annual water yield of between 30% to 80% have been measured following afforestation of pasture

These effects are not normally problematic in most areas of Southland as there tends to be plenty of rainfall and air temperatures are relatively cool, but they could be important if the forest is planted across the majority of a low volume catchment that provides stock or house water.

During particularly dry periods trees tend to survive much longer than pasture plants. There are several reasons for this including ground shading, wind reduction and deeper rooting, but the major reason is that trees tend to have a greater ability to regulate transpiration losses than pasture species. This means that during very dry periods forests may result in increased surface water runoff compared to pasture.

The combination of intercepted precipitation and reduced drought impact means that forests tend to have more stable river flows than pastures. The peaks and troughs of river flows are reduced. However forests cannot protect against extreme events and as has been seen recently trees and forestry activities can compound the destructive effects of storms with long return periods.

Some species may be helpful in drying out wet areas. Most species do not like wet soils, so care should be taken where the soils remain soggy wet throughout most of the year. Note: under the NES-PF (see the Regulatory Environment section for more explanation) production forests cannot be planted within 5m of a small stream or wetland, or 10m of a large stream or wetland.

SOIL

Most forests receive little to no fertiliser, so forest soils tend to revert to their natural fertility and pH over time. Almost all forests will result in soils that are lower fertility and more acid than agricultural soils. And almost all tree species result in similar fertility and acidity levels.

Soil structure tends to be very good under forests as surface compaction from stock and machinery is removed and high organic deposition occurs. Organic mixing is slower than in agricultural soils.

SPECIES DIVERSITY

The effect of forests on species diversity will depend on the environment they are placed in and the species planted. Some forest species will provide food and habitat for birds, some will allow a vigorous understorey and others will be relatively monocultural. With a few exceptions (eg heavily stocked douglas fir), forests will improve species diversity compared to grassland agriculture.

Because forests remain relatively undisturbed for multi-year periods they frequently provide good refuge for animal and bird species. This includes pest animals including possums, goats, pigs and deer. Management of these may be required.

The exclusion of stock from forests will typically allow growth of understorey species. Where woody weeds are already present they will benefit from this reduced grazing and may require management around boundaries and at forest establishment.

FIRE

Forest fires in built up areas can be devastating to individuals, businesses and communities. Built infrastructure should be considered when forest locations are being planned. It is important to be aware that forest fires during strong winds can cause “spotting” more than a kilometre downwind due to ember flight.

WILDINGS

Many introduced tree species have mobile seed that is capable of establishing trees at some distance from the mature parents. In some areas (including northern Southland) this is a significant and very costly problem. DoC spend many millions of dollars every year managing wilding spread on the conservation estate.

Wilding spread must be assessed prior to afforestation under the rules of the NES-PF (see the Regulatory Environment section for more detail). Wilding forests have special rules under the ETS.

It should be noted that Pinus contorta, Pinus silvestris (scots pine) and Pseudotsuga menzesii (douglas fir) are particularly prone to wilding spread. Pinus radiata has a relatively low spread risk.

AGRICULTURAL SHELTER EFFECTS

Over the years research has been conducted on shelter effects on farm productivity and profitability. The effects of shelter can be seen on animals and pastures, but depend on the type and location of the shelterbelt and the climate it is in.

Generally, shelter improves performance of stock and pastures:

Wind increases evapotranspiration and mechanical agitation of pasture leaves which can result in inhibition of plant cell expansion. It causes greater evaporation and physical damage to the plants, which also reduce pasture yield. At any given temperature, wind raises the lower critical temperature for an animal, and this is potentially wasteful in terms of energy utilisation, and it increases the risk of hypothermia and mortality in particularly sensitive stock such as newborn lambs and recently shorn ewes. Ewes that are shorn pre-lambing seek protection from the wind and there is a greater likelihood of them lambing within shelter if it is available. The tendency to lamb in isolation away from shelter depends on breed and weather conditions. For most purposes, the best shelterbelt is one which has between 40 and 60% porosity that is distributed evenly throughout its length and height and protects the maximum area of pasture from the wind. Under cold conditions shelter has been shown to improve pasture yield, and growth rate, ovulation rate, and wool growth rate in cattle and sheep, and to reduce lamb mortality and abortions that are induced by hypothermia. Providing shelter from the sun during hot conditions has been shown to improve milk yield, milkfat yield, freedom from mastitis, and conception rates in dairy cattle, and growth rate in fattening cattle. The welfare benefits from shelterbelts and shadebelts are implicit in their greater use during cold-windy and hot-sunny conditions and they relate to the thermal comfort of animals. Trees-on-pasture systems provide protection from wind and raise the minimum grass temperature, but because of the competition introduced with the trees they are usually less productive in terms of livestock yield than pasture alone. There are a number of disadvantages in growing shelterbelts but many of them can be controlled with appropriate management procedures.[7]

AGROFORESTRY

Agroforestry was widely examined in New Zealand by the NZ Forest Service and Ministry of Agriculture from the 1950s to the 1980s. Many different systems were tried which mixed production forestry and livestock or crop farming in different ways and using a variety of species. The result of all the experimentation was that mixing forestry and agriculture resulted in suboptimal performance of both activities. Stock and forests don't mix well.

This is not to say that stock should not enter forests once they are well above browse damage – they have a place in storm shelter, during tight feed periods, and can even used as wintering pads in some circumstances. However pasture grown underneath trees tends to be low quality and quantity and stock will not perform well on it.

Equally, there are good reasons to plant individual trees or groups of trees in pasture areas such as trees planted for stock shade, or groups of trees planted in wet areas or to control erosion. Or for simple amenity reasons – a farmer might like to see trees on the farm.

When trees are planted as a stand the appropriate management can be applied to optimise their performance for timber without having to take account of the management effects on stock. For example, herbicide applications can be applied that may kill all the grasses or clovers in the forest crop. This is not desirable in an agroforestry situation but is frequently done in forest management.

As a general rule, it is best to keep the production forests out of pasture areas and keep stock out of the production forests.

[7] The role of shelterbelts in protecting livestock: a review N. G. GREGORY: New Zealand Journal of Agricultural Research, 1995, Vol. 38

APPENDIX 6: A NOTE ON TAXATION

The following information came from the NZFFA website dated May 2018. For specific tax advice for your situation see your accountant.

TAXABLE ACTIVITIES

Carbon credits: If you are growing either timber or trees and earn NZ Units from post-1989 forests under the Emissions Trading Scheme, they are not taxable on issue or surrender, but create taxable income on sale [CB 36].
If you were issued NZ Units for pre-1990 forests, they are effectively capital and not taxable on issue, surrender or sale, [CB 36 and CX 51B].
If you buy and hold stocks of NZ Units for trading then they are generally valued at cost with no annual revaluation and consequent gains and losses.

Fencing: this is fully deductible if you are a farmer [DO 1] but depreciable at 10% of the diminishing value (DV) if you are a forester [Schedule 20 and DP 3]. One would think the fence around a forest to keep animals out would get the same wear and tear as a fence around a paddock but IRD thinks not.

Harvesting and marketing: these are part of administration costs and fully deductible for foresters [DP 1] and farmers. You must declare any income you earn from harvesting and marketing as part of your normal taxable activity. Timber harvested and used in the forest or on the farm does not generate taxable income.

Income: Anyone who harvests timber and sells it, or sells standing timber or a cutting right, is liable for income tax on the proceeds. If the timber is sold for less than its market value the Commissioner of Inland Revenue is entitled to assign a market value for tax purposes.

Inventory (stock-taking): part of administration costs and fully deductible for foresters [DP 1].

Land clearing: this is fully deductible if you are a farmer [DP 1] but depreciable at 5% DV if you are a forester [Schedule 20]. Of course land cleared for farming might later be subject to a Forestry Right.

Land preparation: this is a capital cost for famers or foresters, depreciable at 5% DV [Schedule 20].

Management, fertiliser, weed and pest control: these costs are fully deductible if you are a farmer managing trees for erosion control, shelter or water quality [DO 2]; and deductible up to $7,500 a year if you are managing for timber [DO 3]. For a forester all management is fully deductible [DP 1].

Plant and machinery purchase: this is a capital cost depreciable according to the nature of the equipment.

Planting: planting and planting stock is fully deductible if you are a farmer planting for erosion control, shelter or water quality [DO 2]; and deductible up to $7,500 a year if you are a farmer planting for timber (roughly equivalent to planting around 8 ha a year) [DO 3]. For a forester all planting is fully deductible [DP 1]. Note several Regional Councils offer subsidies for erosion control planting, which do not affect deductibility.

Repairs and maintenance: this is fully deductible for farmers and foresters [DG 7 and DP 1].

Selling standing timber: Income from the sale of standing timber is taxable [CB 24]. In a sale of land with standing timber, the part of the sale income that's attributable to the timber is taxable [CB 25]. The buyer of the standing timber can't claim the purchase as an expense against other income, but must carry it forward until the timber is harvested or resold [DP 11 and EA 2]. This anomaly is because IRD has chosen to make standing timber a 'revenue account property' like land for subdivision. It's not a big deal if the harvest is imminent, but can be a problem if the harvest is decades away. The provision does not apply where an owner grants a forestry right to himself or herself under the Forestry Rights Registration Act 1983.

Selling standing trees: The Tax Administration Act 1994 outranks the Income Tax Act and presumes all trees are timber unless proven otherwise. Trees for shelter, erosion control or carbon are treated as timber, and taxable on their sale as standing trees [CB 25]. Farmers who sell land with such trees should have them valued for tax, or obtain a certificate [Tax Administration Act Section 44 C] proving they are incidental, horticultural or ornamental. "A certificate as to whether trees are planted mainly for the purposes of timber provides conclusive evidence if it is given by a properly authorised officer of the relevant regional council; or a properly authorised officer of the Ministry for Primary Industries; or any other person suitably qualified." This is enlarged on below.

Spreading of income: Both farmers and foresters can spread income from the sale of timber forward for up to 5 years, using an interest bearing income equalisation account held at IRD [EH 1 to EH 36]. Interest is paid at 3% pa with daily rests [EH 6]. You only pay tax on the amount of income withdrawn from the account in any year. A forester may also spread income backwards for three years [EI 1, with the rules set out in EW]. It looks as if a forester can use both methods at once, allowing a spread of up to 8 years.

Tracks, roads, culverts and bridges: For farmers these are capital costs depreciable at 5% DV [Schedule 20]. For foresters these are fully deductible costs if the assets are used for less than 12 months [DP 1]; but capital expenditure if they are designed for a longer life, depreciable at 20% DV if they are partially or not metalled, and 5% DV if they are sealed or metalled [Schedule 20].

These two additional comments by Jeff Morrison and Joanne Ziegler of Russell McVeagh appeared in the August 2000 issue of the New Zealand Tree Grower.

Compensation payments: A compensation payment, for example insurance proceeds for the damage or loss of timber, is deemed assessable income. However the taxpayer is entitled to a deduction for an amount equal to the cost of the timber that was lost (i.e. its value as standing timber before the damage occurred – H Moore comment).

Deductions for partnership investors: To be able to claim deductions for forestry operations a taxpayer must 'carry on a forestry business' in New Zealand. This raises the issue of whether passive investors in a forestry partnership can be said to be carrying on a forestry business. Following a couple of high level decisions in the courts, the following factors should be taken into account to meet the standards required of a partnership agreement:

- there should be a requirement that funds provided by the investor should be used for the forestry activities;
- the investor should have a right to direct employment of forest advisers;
- the investor should receive regular management reports;
- the investor should have a right to be physically involved in the forestry activities, by way of site visits, inspections and discussions;
- the investor should have entitlement to the tree crop and not just the proceeds.

The combination of some or all of these factors is necessary to ensure that the investor can be shown to be carrying on business operations, and not merely making an investment in the forestry activity.