



Land Information
New Zealand
Toitū te whenua

Crown Pastoral Land Tenure Review

Lease name : MINARET STATION

Lease number : PO 274

Conservation Resources Report – Part 1

As part of the process of Tenure Review, advice on significant inherent values within the pastoral lease is provided by Department of Conservation officials in the form of a Conservation Resources Report. This report is the result of outdoor survey and inspection. It is a key piece of information for the development of a preliminary consultation document.

The report attached is released under the Official Information Act 1982.

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**DOC CONSERVATION RESOURCES REPORT ON
TENURE REVIEW OF**

MINARET PASTORAL LEASE

PAL-274

**UNDER PART 2 OF THE CROWN PASTORAL LAND
ACT 1998**



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PART 1: INTRODUCTION

1.1 Background

The lessees of Minaret Pastoral Lease (referred to in this report as “the PL”) have applied to the Commissioner of Crown Lands for a review of the property’s pastoral lease tenure. The property is leased by Minaret Station Ltd. Over the past 15 years, the property has been developed into a large deer, cattle and sheep property running in excess of 30,000 SU.

The PL is located on the inaccessible western shores of Lake Wanaka, approximately 34 km north of Wanaka, Otago. Minaret Burn forms the southern boundary, while the Albert Burn forms the northern boundary. The PL occupies approximately 19752 ha in the “West Wanaka” area. The property extends about 14 km from Lake Wanaka westwards to the headwaters of Minaret, Estuary and Albert Burns.

No conservation lands or unoccupied Crown Land are present within the PL. However, extensive conservation lands adjoin the PL: Minaret Burn Mouth Conservation Area to the south by Lake Wanaka; Albert Burn Conservation Area to the north and north-west; and Mount Alta Conservation Area to the south-west. Mount Aspiring National Park is located to the west and north of Albert Burn Conservation Area. All but Minaret Burn Mouth Conservation Area are included in the Te Wahipounamu South West New Zealand World Heritage Area.

There is no road access to the property. Access is either by air, or by boat for materials and supplies, utilising the boat access point at Camp Creek on SH6 on the eastern side of Lake Wanaka.

Altitude ranges from 280 m along the shores of Lake Wanaka to 2193 m asl at Minaret Peaks.

The property is within the Lakes Ecological Region, and is part of the Wanaka Ecological District (McEwen 1987). No Protected Natural Area Programme (PNAP) survey has been conducted within the ED. The district has a distinctive natural character, both ecologically and visually. The PL comprises steep mountains and deep glacial valleys on the west side of Lake Wanaka, a landscape seen for many kilometres from the Hawea/Makarora highway. From Lake Wanaka, the PL backs onto the remote Albert Burn, which forms the boundary of Aspiring National Park and the high glaciated peaks beyond. The climate at the PL is significant because the property straddles the transition zone across which precipitation and temperature fall and rise respectively, as a function of prevailing westerly storms. The western boundary of the PL experiences high precipitation and cool temperatures, which change by steep gradients toward and across Lake Wanaka.

Vegetation communities include extensive snow tussocklands, fellfield, snowbank, cushionfield, beech forest, celery pine forest, broadleaved forest, kanuka-manuka forest, tussock-shrubland, alpine short tussock grasslands, scrub, wetlands (cushion bog, ephemeral wetlands, seepages, flushes, snowbanks and lake margins), and exotic pasture.

A legal road is located between Minaret Bay and a parcel of freehold land. Marginal strips are present along the shores of Lake Wanaka, and all the creeks where the bed is 3 m or more wide (i.e. Albert Burn, Estuary Burn, Minaret Burn, Rough Burn, Bay Burn and Bells Creek).

PART 2: INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

2.1 Landscape

Location and Landscape Context

Lake Wanaka is one of the classic ice gouged inland lake basins of Otago. The adjacent inland basin of Hawea lies to the east separated by the narrow stretch of land referred to as 'The Neck'. The appearance of the landscape of the entire Wanaka/Hawea area is dominated by the effects of glaciation. This is manifested in ice gouged valleys, steep mountain slopes, extensive lumpy ice worn topography, U-shaped valleys, arêtes, over-steepened slopes, cirque basins and other features. Subsequent fluvio-glacial processes have further shaped the landscape forming terraces, old lake benches, valley infill and alluvial surfaces and ripply, slump topography.

The majority of the PL comprises a steep land type, very rugged and rocky and founded on steeply dipping, high grade schist. Bluffs and rock outcrops are common on all parts of the colluvial slopes.

The property has been grazed for more than one hundred and fifty years. The lake faces are the most culturally modified areas of the PL with the lower slopes converted to pasture but retaining significant native shrubland/beechn forest along the lakeshore, within incised gullies and watercourses and on steeper bluff country. Bracken, short tussock and scrub also occur on lower slopes. Above around 1100 m snow tussock forms the main vegetation type. The backcountry tributaries are dominated by snow and alpine tussock grassland and herbfield; subalpine and alpine scrub; fellfield and scree vegetation. Narrow valley floors and lower colluvial side slopes support short tussock grassland with matagouri, manuka and broadleaved scrub, with some wetlands and beech forest.

The lake faces of the property are highly visible from the Makarora Lake Hawea Road (SH6).

Methods

The process of landscape assessment of the PL includes the following steps:

- Landscape units are defined. The landscape units reflect areas of similar landscape character. Landscape character is based on how the land looks, and attributes such as visible geology/formative processes, water bodies, vegetation type and pattern and any cultural use by humans.
- The landscape character of the individual landscape unit is described.

- The visual and scenic values of the property are described. Visual and scenic values can be considered in two ways: firstly by inherent visual values, and secondly by visibility from public places such as roads, lakes, waterways or public land.
- An assessment of landscape vulnerability is given.
- Landscape values are then assessed using the 5 criteria outlined below.

Naturalness - refers to the condition of the natural vegetation, patterns and processes and the degree of modification present.

Legibility - refers to its expressiveness; how obviously the landscape demonstrates the formative processes leading to it.

Aesthetic Factors - include criteria such as distinctiveness; the quality that makes a particular landscape visually striking. Frequently this occurs when contrasting natural elements combine to form a distinctive and memorable visual pattern. A further criteria assessed under aesthetic factors is coherence. This is based on characteristics including intactness, unity, continuity, and compatibility. Intrusions, alterations, disruptions tend to detract from coherence.

Historic Values - refers to historically valued attributes in the context of a high country landscape

Visibility - refers to the visibility from public places such as highways, waterways or local vantage points.

Property Landscape Analysis and Evaluation

Two landscape units (LUs) as shown on Map 4.2.2 are defined on the PL:

- Lake Faces (LU 1)
 - Minaret Burn to Estuary Burn
 - Estuary Burn to Albert Burn
- Backcountry Tributaries (LU 2)
 - Albert Burn faces
 - Bay Burn and Rough Burn
 - Estuary Burn
 - Bells Creek
 - Minaret Burn

The boundary between LU1 and LU2 is indicative and cuts across tributaries, rather than following around the head of the tributary catchment. This is because the head of the tributaries extend quite some distance to the west and are generally considered to be back country rather than lake faces. The location of the line between the two landscape units is therefore indicative and there is clearly overlap between the lake face unit and the backcountry unit.

Lake Faces (LU 1)

Character Description (refer Part 4.3.1: Photos 1-23)

This LU extends over 28 km of lake faces. It is a diverse and varied landscape unit. Characteristics and features however that are common to the entire lake face include:

- Lumpy ice shaped landform especially close to the lake
 - Ripply slump topography higher up
 - The lake faces are broken by steeply incised tributary waterways and streams. Smaller narrow watercourses and runnels are cut into the mountain slopes between the main watercourses.
 - Prominent fans, deltas and terraces, and old lake benches feature along the length of the lake faces
- Vegetation is a varied patchwork of introduced pasture, remnant and regenerating indigenous vegetation and exotic trees.

Minaret Burn to Estuary Burn

North of the Minaret Burn the lake face drops off steeply above the lake with vigorous shrubland regeneration on the lower slopes. An access track follows the lakeshore and then cuts up to a higher bench to presumably gain stock access to higher slopes and into the Minaret Burn faces. Upper slopes on the Minaret Burn corner are a mix of pasture, scrub, tussock and shrubland.

To the north, the lakeshore widens out forming low flats between the lake and a band of lumpy topography which then breaks to merge with a wide sloping fan at the base of the main mountain. Below the tall tussock zone is a patchwork of bracken and regenerating shrubland. The latter occur on damper sites and are dominated by cabbage trees. Between these patches of shrubland are intervening areas of converted pasture. Small areas of rocky rubble occur in places.

Bells Creek is deeply incised into the lake face and is highlighted by the dark green of native shrubland lining the gullies which contrasts with surrounding pasture and bracken. Between Bells Creek and the Estuary Burn there is a clear pattern of predominantly converted pasture on lower and mid slopes with shrubland confined to narrow gullies cut into the slope.

The mouth of the Estuary Burn is defined by a lakeshore delta with associated terraces. On the true right, kanuka vegetation is retained on the terrace risers but the terrace flats are sown pasture. However, the true left of the Delta forms a significant remnant of kanuka treeland. Kanuka forms a lakeshore fringe for some distance south of the Estuary Burn and has been fenced out from grazing.

Estuary Burn to Albert Burn

From the mouth of the Estuary Burn around to Minaret Bay a thin strip of lakeshore kanuka shrubland continues around and merges with other areas of more significant shrubland on steeper slopes and bluffs within the bay and onto the southern face of the large ice-worn promontory that flanks the outer landform of the Bay. The remnant kanuka is an important aspect of the landscape character of the Minaret Bay area and lakeshore of the western side of Lake Wanaka. An extensive roche moutonnée also rises above Minaret Bay now mostly converted pasture but also includes small remnant pockets of shrubland and a larger area of

shrubland in a gully on the backslope of an ice-worn landform which is out of view from the lake.

Willows and other exotic trees occur back from the beach in Minaret Bay and are mixed with significant areas of native vegetation notably kanuka which occurs on adjacent slopes. On the flats behind the Bay is more exotic tree planting of mainly eucalyptus and pine, including shelterbelts. Some of this planting is within the pocket of freehold land. Between the promontory and the base of the main slope, flax and other wetland species occur on a reasonably large area of swamp located here.

The slopes above Minaret Bay are fairly similar to south of Estuary Burn and consist of either lumpy terrain or smooth slopes of predominantly pasture with steep narrow runnels running downslope and patchy regenerating shrubland. Steeper areas of rock outcrops and bluff have not been converted to pasture and are mainly bracken and regenerating shrubland.

Below the Rough Burn, substantial pockets of kanuka shrubland link with other lakeshore areas of kanuka, and enclose developed areas of pasture and more intensively farmed land. This pattern of shrubland and cleared areas forms a coherent and diverse landscape. The new station homestead and the airstrip are also located in this sector.

The Rough Burn is a very rugged, narrow steeply incised gully where it emerges into the lake basin. At its mouth, the Rough Burn also forms an alluvial delta containing significant kanuka shrubland. A formation of low terraces is located south of the Rough Burn delta.

The area between the Rough Burn and Albert Burn becomes increasingly rugged and gnarly. Lower slopes are either pasture or bracken/pasture mix. Lumpy topography is again a dominant feature with pockets of shrubland tucked into gullies or associated with steep bluffs. An elevated glacial bench is a feature between the Rough Burn and south of the Bay Burn where it is at its widest. Towards the Albert Burn is a bracken/pasture mix but with substantial areas of mixed shrubland and kanuka.

The entrance to the Albert Burn is extremely steep with massive bluffs and steep drop offs. The Albert Burn mouth also forms a large delta with adjacent flats and low terraces extending south to Snag Bay. Lakeshore kanuka is a significant feature around the lake edge and other remnant stands adjacent to the mouth of the river and north of Snag Bay. Elsewhere the flats are mainly developed farmland. Large covered yards and shed are located back from Snag Bay.

Visual and scenic values

The lake faces as a whole have very high visual and scenic values forming part of the backdrop and setting to Lake Wanaka. The lake faces are both highly visible and visually sensitive from public places including from the lake and from SH 6 Lake Hawea Makarora Road.

Contributing to visual and scenic values are the many landform features including steep mountain slopes, bays, river deltas, terraces and lumpy ice worn landform. Adding to the landform features is the mosaic of remnant shrubland and other indigenous vegetation especially vegetation associated with watercourses and the lakeshore are significant and

important visual features. A summary of landscape assessment of Minaret Lake faces is provided in Table 1.

Table 1: Summary Evaluation of Minaret Lake Faces (LU 1)

Criteria	Value	Comment
Naturalness	Medium	Lakeshore, gully and other shrubland/woodland remnants across the lake faces in association with tall tussock above 1100 m contribute to natural values. Large areas have been converted to pasture
Legibility	High	Glacial and fluvio-glacial processes are clearly expressed
Aesthetic Factors	High	Overall is generally a visually coherent landscape. The pattern of lakeshore/gully and shrubland remnants on steep rocky bluffs and steeper slopes with developed land elsewhere has created a relatively integrated, coherent and sustainable landscape.
Historic Factors	Medium	Cultural factors associated with early settlement of the bay and plantings from that era have contributed to landscape values
Visibility	High	The whole of the lake face is directly visible from Makarora Lake Hawea Road (SH6)

Landscape Vulnerability

Lakeshore and other shrublands are vulnerable to burning and depletion. Current management appears to be aimed at retaining natural areas and integrating farm management. This is vulnerable to future changes in management with a less sensitive outcome for the landscape.

Much of this LU is visually sensitive. However alterations and structures can generally be absorbed with careful siting and design and appropriate mitigation without adverse visual effects.

Backcountry Tributaries (LU 2)

Character Description (refer Part 4.3.1: Photos 24-57)

Albert Burn faces

The PL boundary follows the river for approximately 3 km and then cuts across the northern face of the Albert Burn in a straight line boundary (that equates to the old provincial boundary) west towards the head of the catchment. The entire face within the PL consists of extremely rugged mountainlands in a fairly advanced stage of regeneration. Above the bushline is snow tussock and sub-alpine and alpine scrub. The western sector is mainly upper basins of the range and includes a hanging basin.

Bay Burn and Rough Burn

Both of these tributaries are narrow, v-shaped and comparatively short with little or no valley floor. The entrance from the lake face is also steep and narrow and deeply incised with remnant beech forest on either side. Other characteristics include very steep, broken slopes with colluvial slopes at the foot of the slope. Ridge lines are steep and narrow with serrated and very jagged peaks with extensive schist bedrock and scree. Natural erosion surfaces are a feature especially on the north face. The highest point at the head of the Rough Burn is 1972 m. The south face contains extensive sub-alpine and alpine scrub with beech forest at the neck. The colours associated with this vegetation type are predominantly olive green and dark green hues. The north faces are dominated by olive-green/ochre of snow tussock contrasting with extensive grey schist.

Estuary Burn

The Estuary Burn is the largest of the tributaries within the PL. It extends over 15 km to the west and divides into a left and right branch. The right branch divides further into upper headwater basins. The upper basins are dominated by snow tussock. Small tarns occur on the saddle area surrounded by dense tussock and herbfield. East from the saddle the mountain slopes are characterised by extremely jagged grey schistose peaks culminating in Minaret Peaks (2193 m) which tower above the valley floor and separate the Estuary Burn from the Minaret Burn. Other features include over-steepened ice shorn bluffs, extensive landslips, scree, slump topography and bare rock. Snow tussock clings precariously to steep, broken slopes at high altitude. At lower levels and particularly on fans and lower slopes on the true left is extensive sub-alpine scrub.

Below the confluence of the left and right branch the valley widens out to a grassy valley floor comprising browntop and sweet vernal and scattered short tussock. Valley sides are variable. The southern shady side supports modified tussock, with shrubby fans, while opposite slopes are very steep, supporting forest and scrub. The Minaret Lodge is a recent cultural addition and is located on the edge of the grassy flats. The valley floor and sunny faces show greater effects of grazing compared to most other parts of the Estuary Burn.

East of Minaret Lodge, beech forest occurs on steep, bluff south faces with grass covered colluvial slopes beneath. The valley constricts downstream with extensive subalpine scrub, exposed rock and scree but also more gentle slopes and small narrow grassy flats. Upstream of the entrance to the Estuary Burn there are signs of more intensive grazing and pasture development similar to the lake faces. As with everywhere within the backcountry tributaries, steep rocky bluffs are a ubiquitous feature. The true right faces are a mix of regenerating scrub, pasture and tussock on the more gentle side slopes alternating with steep, rocky bluffs and faces.

Bells Creek

Bells Creek is another of the smaller v-shaped tributaries. It has a similar impressive mix of rock, scree, herbfield, alpine and sub alpine scrub, shrublands and forest. Minaret Peaks at the head of valley are a dominant feature.

Minaret Burn

The PL includes the south face of the Minaret Burn. The vegetation in this area has similar characteristics and features as the Estuary Burn and the other tributaries. These include a diverse mix of high alpine basins, extremely rugged terrain, huge bluffs, rock and scree and associated vegetation. Snow tussock is the dominant vegetation cover and extends from the

ridge to the valley floor but is complemented by sub-alpine scrub, shrubland, and pockets of beech forest. Short side tributaries descend sharply from the ridge. The widest and most prominent side tributary leads directly down from Minaret Peaks.

As with the Estuary Burn, vegetation modification is apparent on the south face at the entrance to the valley with more intensive pasture development occurring in recent times.

Visual and scenic values

The entire backcountry tributaries landscape unit has very high visual and scenic values throughout. The whole area contains visually highly impressive and distinctive landform characteristics, which are complemented by the diverse and highly natural vegetation association and patterns. There are no visually discordant or jarring features.

The second aspect of visual and scenic values is visibility from public places. This unit is not visible from the Lake Wanaka or public roads but is visible from the extensive public Conservation Land that bound the PL.

A summary of landscape characteristics of the backcountry tributaries is provided in Table 2.

Landscape Vulnerability

The back country catchments are fragile mountain lands vulnerable to landscape degradation from inappropriate use or change. Alteration to vegetation patterns through grazing and burning or other human activities can impact on the natural character and pattern of this natural landscape. The steep mountain faces are especially vulnerable and visually sensitive. The valley floor has the greatest potential for any landscape change. Siting, design and scale are critical for any earthworks or proposed structures.

Table 2: Summary Evaluation of Landscape Values – Backcountry Tributaries

Criteria	Value	Comment
Naturalness	High	Overall high naturalness with all natural processes and patterns in tact despite significant areas of modification in parts i.e. parts of the valley floor of the Estuary Burn and sunny north faces of main valleys. Also secondary re-growth areas of the Albert Burn. However from a landscape perspective the whole area appears as a natural landscape.
Legibility	High	Formative processes highly legible
Aesthetic Factors	High	Distinctive and visually striking throughout. Highly coherent. Little or no discordant features
Historic Factors	Low	Association with early pastoralism and settlement of the station
Visibility	Low	Low visibility from public places such as waterways and highways however is visible from adjoining public Conservation Land

Significance of Landscape Values

Map 4.2.2 shows the areas with significant landscape values.

The entire backcountry tributaries including the Albert Burn, Rough Burn, Bay Burn, Estuary Burn, Bells Creek and Minaret Burn are the best remaining representative examples of landscapes that characterised original New Zealand. These tributaries represent the outstanding natural landscape of the West Wanaka area. All natural patterns and processes are intact. The whole area is extremely diverse in characteristics from alpine areas to valley floor and from one end of each valley to the other. Impressive landform features and associated vegetation patterns are synonymous with the area. The area represents some of the best mountain landscapes in Otago. It is contiguous, similar and complementary to adjoining public conservation land. Minor areas have been modified by pastoral use but these areas are small in scale compared to the wider area. From a landscape perspective these changes make little difference to the magnificence and grandeur of the landscape as a whole.

The lake faces contain significant landform and/or remnant vegetation that contribute to the landscape character of the lake faces. These include lakeshore shrubland and riparian vegetation adjacent to the major streams and watercourses, also on steeper slopes and bluff areas or other areas of significant indigenous regenerating vegetation.

The lake faces are an integral part of the wider inland lake basin of Wanaka. They contain significant and important landforms and remnant vegetation that contributes to the character and diversity of this section of the lake face and to the broader character of Lake Wanaka. Large areas have been converted to pasture. However, the matrix of lakeshore and riparian shrubland, as well as other significant areas of shrubland or regenerating shrubland, are an important aspect of the character of the lakes faces. These need to be retained and enhanced into the future. There is already an existing pattern of shrubland and forest remnants associated with natural systems and features (waterways, lake margins, delta and fans and rocky/steeper lands). This integrated approach represents sound landscape (and ecological) management and should be preserved and enhanced into the future.

2.2 Landforms, Geology & Soils

a) Landforms and Geology

The property is composed of five mountainous ridges and a series of six deeply entrenched river valleys that run parallel to each other in an easterly direction into Lake Wanaka. The valleys are the Minaret Burn, Bells Creek, Estuary Burn, Rough Burn, Bay Burn and the lower Albert Burn. Slopes are steep to precipitous with numerous rock outcrops and bluffs. The ridges comprise numerous tops including Minaret Peaks (2193 m), Pykes Hill (1767 m), The White (1785 m), The Rouster (1365 m), and numerous unnamed tops.

Moderate to steep slopes above Lake Wanaka have been ice-scoured, and exhibit numerous rock outcrops interspersed with pockets of loessial accumulation. There are limited areas of flats and fans around the edge of Lake Wanaka and the upper valley floors of the Albert Burn, Estuary Burn and Minaret Burn.

The property is underlain by coarsely foliated quartzo-feldspathic schist with bands of green schist of the Haast Schist group of metamorphic rocks (Turnbull 2000), with alluvial deposits of gravel, sand and silt on most valley floors (Wood 1962; Mutch and McKellar 1964).

The glacial history is significantly reflected in the landform geology, particularly the last glacial advance (Hawea) when ice rose to over 600 m on the Lake Wanaka faces. Ice worn surfaces with undifferentiated glacial till material in the hollows are present all along the Lake faces (Turnbull 2000). Valley areas were over-ridden by glaciers up to an altitude of 1800 m during the Otira Glaciation.

The glacial landscape has been severely modified by subsequent events such as the accumulation of alluvial fans and down cutting of rivers to form gorges.

b) Soils

The river flats, terraces and fans are characterised by Matukituki sandy loams, silt loams and stony loams of medium natural nutrient status. These are recent soils with weak structural development. In addition, there are small areas of Queenstown fine sandy loams on flat high terraces above Lake Wanaka. The most productive soils on the PL are Wakatipu sandy-silt loams, developed from loess overlying schist alluvium. These are located near the homestead. Other soils of river flats, terraces and fans include Bourke sandy loams to very shallow stone fine sandy loams on gently to moderately sloping fans below 500 m asl; Nevis sandy loams on gravel on fans of the montane basins in Bell's Creek, Upper Minaret and Estuary Burns.

Maude Hill soils of medium to low fertility are present on moderately steep slopes along the Lake faces.

The steeplands are characterised by Dunstan Steepland sandy silt loams on sunny faces; Moonlight Steepland sandy loams, Dilston Steepland skeletal soils, Haast Steepland sandy loams, Creighton Steepland silt loams on steep slopes; and Maude Steepland soils on steeper slopes of the roche moutonnée near the homestead.

The sparsely vegetated mountain tops are characterised by Alpine Steepland Soils, with much bare or broken rocky surfaces.

Significance of Landforms, Geology and Soils

The landforms present on PL are likely to be representative of the Wanaka Ecological District, in which the property is located.

2.3 Land Environments of New Zealand (LENZ)

Two databases have been used to assess biodiversity protection (Walker et al. 2005):

1. Environmental distinctiveness has been assessed through the Land Environments of New Zealand (LENZ). This is a classification of New Zealand landscapes using a comprehensive set of climate, landform and soil variables chosen for their roles in

driving geographic variation in biological patterns (Leathwick et al. 2002 & 2003). It is presented at four levels of detail containing 20, 100, 200 or 500 environments nationally. The most detailed is called LENZ Level IV.

2. The area of unprotected indigenous cover in threatened land environments has been identified in the national land cover database (LCDB).

From the above databases, spatial data depicting indigenous cover and legal protection were overlaid on LENZ Level IV environments to identify biodiversity that is most vulnerable. This provides a measure for:

- a. percentages legally protected and;
- b. percentages of remaining indigenous vegetation cover

Based on these two criteria, five categories of threatened environments have been allocated to identify environments containing indigenous biodiversity at most risk of loss. They are classified as follows:

1. **Acutely threatened:** <10% indigenous cover remaining
2. **Chronically threatened:** 10-20% indigenous cover remaining
3. **At risk:** 20-30% indigenous cover remaining
4. **Critically underprotected:** >30% indigenous cover remaining and <10% protected
5. **Underprotected:** >30% indigenous cover remaining and 10-20% protected
6. **No Threat:** >30% indigenous cover remaining and >20% protected

Four LENZ environments (E, K, N & Q) (Leathwick et al. 2003) are present on the PL (Table 3). Detailed information for each land environment is provided in Appendix 1.

Significance of LENZ

Attributing significance to LENZ units must be treated with caution. Work is currently underway to improve the accuracy of underlying spatial data. For example, soils data is being upgraded, as median patch size for polygons sourced from the Land Resource Inventory is currently between 10,000 and 100,000 hectares, while at Level IV resolution, LENZ units cover areas as small as 10 hectares. Also underway is continuous improvement of the underlying classification process which generates LENZ units.

Where indigenous cover remains within threatened LENZ units, the significance of inherent values is enhanced. The distribution of threatened land environments is shown on Map4.2.6.

National Priority 1 in "Protecting our Places" (Ministry for the Environment 2007) is to protect indigenous vegetation associated with land environments (defined by Land Environments of New Zealand at Level IV) that have 20% or less remaining in indigenous cover. Of the Level IV land environments on the PL, E3.2b and N2.1a have less than 20%

Table 3: Land Environments of New Zealand (LENZ) Units on Minaret Pastoral Lease

LENZ Threat Category	Level 4 LENZ Unit	% Indigenous vegetation cover remaining nationally	% of LENZ unit protected for conservation purposes nationally	Area of LENZ Unit on Lease (ha)	Area of LENZ unit as a % of the Lease	Area of Level 4 LENZ unit on Lease as a % of its area nationally
Acutely Threatened	E3.2b	4	1	12.33	0.06	0.03
	N2.1a	0	1	0.35	0.00	0.00
At Risk	M2.2b	22	13	285.25	1.44	2.80
Critically Underprotected	K4.1b	36	2	2.21	0.01	0.03
	Q2.1a	38	9	0.40	0.00	0.00
	Q2.2b	45	6	1752.47	8.82	6.99
Underprotected	Q1.1c	91	18	3455.83	17.40	1.32
	Q3.3c	90	17	25.61	0.13	0.02
No Threat Category	E1.4c	60	27	2.92	0.01	0.00
	M2.3a	62	70	89.42	0.45	2.00
	M3.2a	73	47	80.26	0.40	22.94
	O1.4a	67	54	2.22	0.01	0.00
	O2.3b	100	98	0.27	0.00	0.00
	P5.1b	93	77	23.90	0.12	0.04
	P5.1d	97	92	12.43	0.06	0.02
	P5.1e	86	34	3739.76	18.82	7.68
	P5.2a	73	54	143.80	0.72	0.13
	Q1.1a	98	25	4.68	0.02	0.00
	Q1.2a	99	37	1431.38	7.21	0.73
	R1.1a	99	76	4875.02	24.54	2.43
	R1.1b	100	60	3907.72	19.67	3.68
R1.1e	100	99	18.01	0.09	0.01	

indigenous vegetation remaining nationally. The main areas where these environments with indigenous vegetation remain are near the mouth of the Estuary Burn, and total about 13 ha.

2.4 Climate

Climate is typical of the west Otago/Lakes region with warm but variable summers and cold winters. Frosts can occur throughout the year. Winters bring intermittent snow to lower parts of the property, and may lie for over 4 months at higher altitudes. Annual rainfall increases up the Lake from 600mm in Minaret Bay, to well over 2540mm in the high altitude parts of the property to the west. Nor' west winds reach gale force velocities at times, and bring most of the precipitation down the Lake.

2.5 Vegetation

Ecological Context

The pre-human vegetation patterns are still broadly evident on the PL where contemporary vegetation clearance has been concentrated on land at lowest altitude and in closest proximity to Lake Wanaka. Past forest removal, presumably by fire, is evident on the valley sides further west, where subalpine shrubland has migrated downslope to fill previously forested sites or where non-beech broad-leaved forest has established. Forest (predominantly beech) would have prevailed in almost all sites below the natural tree line except where edaphic limitations existed. Vegetation communities above the tree line are likely to resemble those that occurred before human settlement, notwithstanding some modification to composition and structure through both feral animals and farm stock.

Few previous botanical surveys are known to have been carried out over the PL. Dr Peter Wardle included descriptions of particular sites and communities from the PL in his descriptions of the distribution of native forest and Holocene forest fires in the upper Clutha district (Wardle 2001a, Wardle 2001b).

Botanical survey to support the tenure review of the adjoining West Wanaka Pastoral Lease was carried out in the late 1990s and vegetation descriptions resulting from that include communities in common with Minaret PL. The vegetation of Mt Aspiring National Park further to the west has been well described (Mark 1977) and this too has some vegetation communities in common with the PL.

Minaret PL falls within the Wanaka Ecological District (ED), one of five ecological districts that constitute the wider Lakes Ecological Region. The Wanaka ED has not been surveyed as part of the Protected Natural Areas Programme (PNAP).

Survey Method

The botanical survey for tenure review was undertaken on 5 – 9 March 2012 by three botanists. Small parts of the property were accessible via internal 4WD tracks, but the majority of the PL, comprising areas remote from tracks, was surveyed on foot following helicopter placement. Descriptions were made of the composition of major plant communities. Threatened plants were searched for in potentially suitable habitats. Digital photographs were taken of particular species, communities and landscapes to aid in interpretation. Specimens were collected of noteworthy or uncertain taxa for herbarium accession and determination.

Vegetation Description

For the purposes of describing the vegetation the property has been divided into eight units based on catchments and topography:

- Minaret Burn
- Bells Creek

- Estuary Burn
- Rough Burn
- Bay Burn
- Albert Burn tributaries
- Lake shore margins
- Front Faces and terraces

Minaret Burn

The Minaret Burn forms the south-western boundary of the PL. Of its two uppermost headwater branches, just the true left of the eastern-most branch falls within the PL. The head of the catchment reaches over 1900 m asl. The valley runs southeast for c. 22 km before disgoring into Lake Wanaka at c. 280 m asl. Several side valleys with cirque basins drain south into the Minaret Burn. The largest of these is a catchment that drains the southern slopes of the Minaret Peaks (>2000 m asl). Vegetation patterns in these side valleys are a microcosm of those described for the main valley below.

An extensive and sparsely vegetated fellfield is present at high altitude in the catchment head. This is a species-rich community dominated by mountain rush (*Marsippospermum gracile*), *Luzula pumila* and *Colobanthus buchananii* with many associated herbs and grasses. These include *Leptinella pectinata* subsp. *willcoxii*, *Agrostis muelleriana*, *Anisotome imbricata*, *A. piliferus*, *Ranunculus sericophyllus*, *R. buchananii*, *Myosotis pulvinaris*, *Epilobium purpuratum*, *Parahebe planopetiolata*, *Phyllachne colensoi*, *P. rubra*, *Celmisia hectorii* and *Montia sessiliflora*.

More sheltered hollows and terraces have snow patch grass (*Chionochloa oreophila*) with *Celmisia haastii* var. *haastii*, false speargrass (*C. lyallii*), *Aciphylla hectorii*, *Coprosma niphophila*, *Hebe hectorii* and *Brachyglottis bellidioides*. Seeps have white caltha (*Caltha obtusa*), white snow marguerite (*Dolichoglottis scorzonerooides*) and bog rush (*Schoenus pauciflorus*). Infant stream sides have *Lobelia glaberrima*, *Plantago lanigera*, *Colobanthus strictus*, *Carex lachenalii* subsp. *parkeri* and *Ranunculus maculatus*. Nearby well drained interfluves support cushion-forming *Dracophyllum muscoides*, *Phyllachne colensoi*, *Hectorella caespitosa*, *Celmisia sessiliflora* and *Chionohebe thomsonii*.

Eroded gully flanks, comprising damp gravel and sand, support a sparse flora of *Raoulia subulata*, *Stellaria gracilentia*, *Gingidia decipiens*, *Schizeilema haastii* var. *cyanopetalum*, *Parahebe planopetiolata*, everlasting daisy (*Anaphalioides bellidioides*) and *Poa novae-zelandiae*.

Slim snow tussock (*Chionochloa macra*) begins to dominate at c. 1600 m with ground cover that include many of the species mentioned above along with *Astelia nivicola*, alpine shield fern (*Polystichum cystostegia*), *Forstera sedifolia*, *Ourisia sessilifolia*, *Acaena saccaticupula* and *Wahlenbergia albomarginata*.

Rock outcrops at c. 1500 m have a characteristic rupestral flora including *Geum cockaynei*, *Parahebe brevistylis* and *Epilobium* spp. At 1400 m similar outcrops have the shrubs *Coprosma fowerakeri* and *C. dumosa* and thousand leaved fern (*Hypolepis millefolium*) around their sheltered bases.

An upper valley floor is reached at c. 1400 m. Highly disturbed riparian stonefields support *Epilobium purpuratum*, *Cardamine* "scree", *Stellaria gracilentia* and *Raoulia tenuicaulis*. Gentler reaches of the stream have less frequently disturbed margins and support more abundant and additional plants including *Acaena saccaticupula*, *Festuca mathewsii*, *Epilobium alsinoides*, *E. melanocaulon*, *Luzula traversii*, *Gingidia decipiens*, *Euphrasia zelandica*, mosses and lichens.

Colluvial footslopes on the true left have a generally continuous snow tussock cover with a range of intertussock and groundcover species. Slim snow tussock transitions to narrow-leaved snow tussock (*Chionochloa rigida*) with declining altitude. Dominant intertussock species include *Hebe hectorii*, false speargrass and *C. angustifolia*. Common ground cover include *Aciphylla montana*, *Coprosma cheesemanii*, *C. atropurpurea*, *Lycopodium fastigiatum*, *Gaultheria depressa*, *Rytidosperma setifolium*, *Chaerophyllum ramosum*, *Viola cunninghamii*, alpine hard fern (*Blechnum pennamarina*), and leek orchid (*Prasophyllum colensoi*). Short steep slopes, where the footslopes drop to the river bed, have a profusion of giant buttercup (*Ranunculus lyallii*), *Hebe hectorii*, and occasional cut-leaved alpine buttercup (*R. buchananii*). The seed heads of almost all the palatable large buttercups have been removed by browsers. Other plants in this local community include NZ anemone (*Anemone tenuicaulis*) and *Aciphylla crenulata*.

This relatively narrow band of gentle footslopes continues down valley but ends abruptly upslope where it abuts a continuous line of broken steep rocky outcrops. These outcrops support *Myosotis macranthus*, *Cardamine* aff. *bilobata*, *Deyeuxia avenoides*, *Trisetum tenellum*, *Cystopteris tasmanica*, *Gaultheria crassa*, *Hebe subalpina*, and *Dracophyllum rosmarinifolium*. A large rock talus field beneath bluffs on a bend in the valley at c. 1380 m supports similar vegetation. Additional common species include *Celmisia angustifolia*, *C. lyallii*, *Aciphylla hectorii*, *Astelia petriei* and *Epilobium purpuratum*.

Shrubland becomes increasing prevalent in the valley floor and lower slopes as the valley narrows before dropping through a gorge. Dominant shrubs are *Dracophyllum rosmarinifolium* and inaka (*D. longifolium*) with *Brachyglottis cassinioides*, *Hebe subalpina*, cottonwood (*Ozothamnus vauvilliersii*) and *Aciphylla horrida* also common. Small seepages amongst the shrubland have *Celmisia glandulosa*, NZ anemone, *Carpha alpina* and *Lobelia angulata*.

A steep gorge drops to the valley flats and junction of the two major headwater streams, separating an extensive celery pine (*Phyllocladus alpinus*) dominated forest on the true right (public conservation land) from similar forest on the PL. The forest also comprises mountain totara (*Podocarpus cunninghamii*), weeping matipo (*Myrsine divaricata*), *Coprosma serrulata*, and *C. pseudocuneata*. *Coprosma rugosa* is present along streambanks where thousand leaved fern and prickly shield fern dominate the ground cover. Shrubby forest margins are dominated by inaka, snow totara (*Podocarpus nivalis*), *Coprosma dumosa*, musky tree daisy (*Olearia moschata*) and mountain lacebark (*Hoheria lyallii*).

Well-drained river terraces in the valley floor are a mix of native and exotic herbs and grasses. Common exotics include sweet vernal (*Anthoxanthum odoratum*), Chewing's fescue (*Festuca rubra*), tussock hawkweed (*Hieracium lepidulum*) and white clover (*Trifolium repens*). Common natives include *Acaena inermis*, *A. dumicola*, *Geranium brevicaulis*, *Scleranthus brockiei*, *Coprosma petriei*, *C. atropurpurea*, *Galium propinquum*,

Wahlenbergia albomarginata, *Raoulia australis* and *R. tenericaulis*. Wetter terraces have dense swards of exotic grasses with correspondingly fewer native plants.

Apart from relatively narrow bands of grassland and herbfield on toe-slope terraces and fans, the dominant vegetation along the lower true left valley slopes, up as far the lower limit of the extensive snow tussock grasslands, is native scrub and shrublands. These communities mostly occupy sites that previously supported beech forest. Relicts of silver beech (*Nothofagus menziesii*), in the form of individuals or small clusters of trees, still occur in generally steep rocky refuges which have protected them from fire. The scrub and shrublands vary widely in their composition and structure reflecting particular site characteristics and the length of time that has elapsed since they were last disturbed (e.g. landslip, fire).

Shrublands on the steepest rocky sites, on cold aspects and with poor soil development, are inevitably dominated by inaka and *Dracophyllum rosmarinifolium* with occasional mountain akeake (*Olearia avicenniifolia*) and *Gaultheria crassa*. Matagouri (*Discaria toumatou*) dominated shrublands of relatively recent origin occur on well drained sites, often in conjunction with *Olearia odorata* and *Coprosma propinqua*, although much larger statured matagouri on tributary stream fans suggest some antiquity. Occasional stands of *Olearia odorata* dominated shrublands also dot the valley floor.

In contrast, shrublands on easy terrain with greater soil and fertility have greater species richness, particularly where they have not been disturbed for many decades. A typical example exists across the river from Slip Creek Hut. Here the community is comprised of inaka, mountain lacebark, *Coprosma propinqua*, *C. tayloriae*, *C. rugosa*, *C. dumosa*, *Brachyglottis cassinioides*, mountain akeake, *O. odorata*, *O. bullata*, *O. nummulariifolia*, koromiko (*Hebe salicifolia*), mountain wineberry (*Aristotelia fruticosa*), *H. rakaiensis*, *Coriaria sarmentosa*, desert broom (*Carmichaelia petriei*) and celery pine.

Several hectares of shrubland on the PL (located approximately 2 km opposite and downstream from Slip Creek) appear dead from presumed herbicide spraying.

The uppermost patch of silver beech forest is located in the river gorge approximately 4 km from the river mouth. This forest, up to 15 m tall, has a sparse understorey comprising *Coprosma tayloriae*, silver beech, mountain lacebark, false beech (*Gaultheria antipoda*), broad-leaved bush tussock (*Chionochloa conspicua*), *Olearia arborescens* and occasional desert broom. There is a dense ground cover of tussock hawkweed with occasional prickly shield fern and alpine hard fern. Other small patches of silver beech forest are present on steep slopes further downstream, and beech forms a narrow corridor in the river gorge near the mouth.

Coprosma-dominated scrub and fernland on hillslopes behind the forest have abundant emergent broadleaf (*Griselinia littoralis*) and kohuhu (*Pittosporum tenuifolium*) that become even more prevalent further east towards Lake Wanaka. Some patches show evidence of having been sprayed with herbicides.

Kanuka (*Kunzea ericoides*) scrub occupies dry terrace sites above the main gorge in the final 1.5 km of valley. Slopes above are a mosaic of pasture and shrublands, some large areas of which appear dead from herbicide spraying. Scrub and silver beech forest extend up the major gullies.

Kanuka scrub also dominates the dry terrace at the mouth of the Minaret Burn mouth with an understorey that includes *Corokia cotoneaster*, *Coprosma linariifolia* and mapou (*Myrsine australis*). Lakeside slopes are covered in dense regenerating broadleaf trees and shrubs. Common species include *Coprosma lucida*, lancewood (*Pseudopanax crassifolius*), marbleleaf (*Carpodetus serratus*), kohuhu, three-finger (*Pseudopanax colensoi* var. *ternatus*), false beech, *Helichrysum lanceolatum* and manuka (*Leptospermum scoparium*). A rich variety of ferns and fern allies are present, including *Blechnum fluviatile*, *B. chambersii*, *B. procerum*, *B. vulvanicum*, necklace fern (*Asplenium flabellifolium*), bracken (*Pteridium esculentum*) and climbing club moss (*Lycopodium volubile*).

Bells Creek

Bells Creek is a substantially smaller catchment to the north of the Minaret Burn that flows east for about 9 km from its catchment head at 2193 m, to Lake Wanaka.

Very steep slopes in the uppermost headwater basin above c. 1600 m are comprised of rocky ribs with scree in the interfluvies. Valley sides at similar altitude are less steep, more stable, and with less rock outcropping. This high alpine zone supports a sparse fellfield type flora of which common elements include mountain rush, blue tussock (*Poa colensoi*), *Luzula pumila*, *Raoulia grandiflora*, *Anisotome imbricata*, *Phyllachne rubra*, *Colobanthus buchananii* and *Leptinella pectinata* subsp. *willcoxii*.

Below c. 1600 m stable landforms support dense intact snow tussocklands dominated by slim snow tussock and curly snow tussock (*Chionochloa crassiuscula* subsp. *torta*) with narrow-leaved snow tussock at lower elevations. Also present around snowbanks are snow patch grass and *Chionochloa vireta*. A single stock track into the basin indicates infrequent grazing by cattle.

Active gravel fans spill from the valley sides into the upper valley floor. These frequently flood-disturbed sites support a 25 % vegetation cover comprising *Raoulia* and *Acaena* spp. with occasional exotic brown top and sweet vernal.

Low alpine tussock-shrubland on the true left occupies the debris-littered avalanche slopes. *Dracophyllum rosmarinifolium* and narrow-leaved snow tussock dominate with *Aciphylla horrida*, cottonwood and *Hebe subalpina* also common. Other shrubs are occasionally present on the riparian terraces and appear to be increasing in abundance in the absence of fire. These include *Hebe anomala*, *Coprosma pseudociliata*, *C. cheesemanii*, *Brachyglottis cassinioides*, and *Olearia nummulariifolia*.

The tussock-shrubland community described above is widespread on down-valley slopes, but is interspersed with patches of dense low-alpine shrubland. This shrubland is dominated by *Dracophyllum rosmarinifolium* and *Hebe anomala* but other commonly associated species include *Aciphylla horrida*, cottonwood, inaka, *Gaultheria crassa*, *Brachyglottis cassinioides* and *Ranunculus lyallii*. On the lower margins of solifluction lobes and slumps near the creek, *Brachyglottis cassinioides* forms monospecific shrub patches. There are strong aspect differences in relation to the density of shrubs in the upper valley, with shrubs being much more prevalent on the south-facing slopes on the true left of the creek.

A large fan located on the true left of Bells Creek, above the hut, is dominated by mossfield with abundant *Dracophyllum rosmarinifolium*, *Rytidosperma setifolium* and blue tussock. *Muehlenbeckia axillaris* is common at the lower extend of the fan.

Small valley floor terrace seepages are dominated by sharp spike sedge (*Eleocharis acuta*) and moss. Common associated species include *Carex sinclairii*, bog rush, sweet vernal, jointed rush (*Juncus articulatus*) and *Gunnera monoica*.

Below the hut and down to the deer fence are extensive tall tussock grasslands on both sides of the valley, although the true left might better be described as a shrub-tussockland as up to 10 % of the cover is provided by *Dracophyllum rosmarinifolium*. Feral deer use this area but apart from browsing of the heads of Mt Cook buttercup, little browse sign is evident.

Bluff and talus slope shrubland just above the deer fence is dominated by mingimingi (*Coprosma propinqua*), *C. rugosa*, *Coriaria sarmentosa* and *Helichrysum intermedium*. Associated species include mountain akeake, bracken fern, false beech, thousand-leaved fern, *Gingidia montana* and ragwort (*Jacobaea vulgaris*).

An abrupt change in tussockland is apparent below the deer fence, with tussock stature and density 25 – 30% lower than that above the fence. Tussockland continues below the fence on both sides of the valley but is depleted on the true left, occurring in a matrix with kanuka, matagouri, broadleaf, mountain totara, *Coprosma tayloriae*, prickly shield fern and bracken. The paddock on the true right below the fence maintains a strong homogenous tall tussock cover down to the limit of kanuka and bracken fern. Below this, on the lateral moraine above the kanuka gully is a paddock dominated by pasture grasses with up to 15% cover of matagouri and bracken. Kanuka remains in sheltered gullies, and kanuka seedlings and saplings are emergent in pasture.

The lower-most gully in Bells Creek supports a broadleaf dominated forest remnant. Other associated species include silver beech, kohuhu, mountain totara, marbleleaf, *Raukaua simplex* and kanuka.

Estuary Burn

The Estuary burn is a large catchment between Bells Creek and the Rough Burn. It has three small headwater tributaries separated from the Albert Burn by a range crest that rise to over 1900 m asl. It flows south east for 18 km from the catchment head to Lake Wanaka immediately south of Minaret Bay.

The highest and most exposed ridges, such as the dividing ridge with the Albert Burn, have a fellfield community with abundant lichen and *Phyllachne rubra*, and a wide range of associated species including mountain rush, *Luzula pumila*, *Anisotome imbricata*, *Ourisia glandulosa* and *Hectorella caespitosa*.

Below this is an extensive alpine shrub-tussockland on upper valley solifluction and slump surfaces. Mid-ribbed snow tussock (*Chionochloa pallens*) is the dominant snow tussock and *Hebe hectorii* the dominant shrub. Other common species include false speargrass, *Celmisia doretzii*, *C. haastii* and *Gentianella montana*. No exotic plants are present and only light hare browse is evident. Interbedded in this community are areas of snowbank vegetation and alpine seepages. Snowbanks are dominated by snow patch grass, curly snow tussock, blue

tussock, *Phyllachne colensoi* and *Kelleria croizatii*. Areas of alpine seepage are dominated by *Caltha obtusa*, *Epilobium brunnescens* and bog rush with occasional *Uncinia fuscovaginata* and *Juncus antarcticus*.

Alpine tussockland is also extensive and is variously dominated by mid-ribbed snow tussock, slim snow tussock, narrow-leaved snow tussock, snow patch grass and *Chionochloa vireta*, depending on microsite factors. With decreasing altitude and better drainage this community has an increasing component of *Hebe hectorii*, merging to an alpine shrub tussockland. Dense narrow-leaved tussock dominates a large fan in the upper valley floor of the true left branch (c. 1200 m) while nearby river terraces support bristle tussock with native herbs including *Raoulia tenuicaulis* and *Acaena saccaticupula*.

A dense and intact subalpine shrubland extends down the steep sided true left branch towards the Minaret Station Lodge. At its upper extent this community is dominated by *Dracophyllum rosmarinifolium* with some *Aciphylla horrida*, *Hebe subalpina* and *H. hectorii*. At lower elevation this transitions to mixed *D. rosmarinifolium* and inaka with other shrubs such as *Brachyglottis cassinioides*, *Olearia bullata*, *Coprosma pseudociliata*, *C. rugosa*, *C. tayloriae*, *Olearia nummulariifolia* and mountain wineberry becoming more common. Stock impacts are limited to the track margins.

The valley floor around the tent camp is highly modified grassland dominated by the exotic browntop and sweet vernal. Other common species include blue tussock, Chewing's fescue, selfheal (*Prunella vulgaris*) and white clover (*Trifolium repens*). There are seepages across the flats but these are highly modified by exotic species. Seepages around the toe-slopes are more natural with many natives including *Carex gaudichaudiana*, *C. sinclairii*, *C. buchananii*, *Juncus edgariae* and *Hydrocotyle sulcata*.

Vegetation on the south-facing slopes of the true left of the Minaret Burn below the tent camp is initially silver beech forest remnants with associated celery pine. The lower margins have mountain lacebark and *Coprosma tayloriae*. This grades into late successional scrub – low forest without beech. Common species include celery pine, *Coprosma tayloriae*, inaka, koromiko, broadleaf, mountain totara, cottonwood and *Olearia nummulariifolia*. A complex mosaic of these and other shrub communities continue down the constricting valley.

Montane secondary scrub continues on the true right down past the lower hut to the deer fence. Common species are *Coprosma* spp., kohuhu, mountain lacebark and broadleaf, with prickly shield fern an abundant understorey species. Silver beech occurs as clumps in gullies. In contrast the true left is monospecific silver beech forest with gullies that support broadleaf, mountain totara, *Coprosma* spp., and a deer depleted understory of tussock hawkweed, bush tussock and prickly shield fern.

Small clearings and terraces in the valley floor have grassland of alpine fescue (*Festuca mathewsii*) with an array of intertussock species including exotic browntop, sweet vernal, white clover, and native *Muehlenbeckia axillaris* and *Acaena caesiiglauca* that are heavily browsed by feral deer. Scrub margins are dominated by *Coprosma* spp., broadleaf and mountain wineberry.

One such grassland-scrub enclave amongst silver beech forest at about 540 m asl. has three shrubs of *Olearia hectorii* amongst the bordering scrub and one other 25 m down valley. A second clearing 150 m down valley has two further trees, including one of very large

dimensions that occur on rockfall debris toeslope within a typical frost inversion valley floor environment adjacent to a grove of fuchsia (*Fuchsia excorticata*). Open terraces with alpine fescue and *Carex sinclairii* below this site are heavily modified by grazing. An extensive face of *Dracophyllum* dominated scrub on the true left, opposite the *Olearia hectorii* site, suggests that this face has been previously burnt.

Frost-flat scrub extends further down the narrow confines of valley. This is dominated by matagouri, mountain wineberry, *Olearia odorata*, mingimingi, and prickly shield fern with occasional *C. tayloriae*, *C. rugosa* and bush lawyer (*Rubus cissoides*).

The lowermost gorge has a narrow strip of silver beech forest that is flanked by kanuka forest in various combinations. Close to the silver beech it occurs with broadleaf and *Coprosma tayloriae* although most broadleaf is restricted to bluffs. On the true right, below the deer fence, kanuka is expanding into the grassland matrix along with mingimingi, *C. tayloriae* and bracken. In areas where deer have easy access (i.e. where succession has advanced to canopy closure and natural thinning has occurred), almost all the understorey has been removed. A couple of shrub species, *Coprosma linariifolia* and *Helichrysum lanceolatum*, seem to be browse-tolerant along with a small selection of ferns and sedges. Rata (*Metrosideros umbellata*) forms a semi-continuous fringe along sections of the gorge rim.

The Estuary Burn delta supports an open treeland of kanuka, manuka, kowhai and mountain totara that has developed on inland dunes formed from wind-blown river sand. The area does not appear to be grazed and supports an understorey of exotic grasses, bracken, matagouri, snowberry, false beech, *Gaultheria macrostigma*, *Leucopogon fraseri*, *Corokia cotoneaster*, mountain totara, kowhai and *Coprosma tayloriae*. Succession to mountain totara woodland is expected in the long term.

Rough Burn

The Rough Burn lies between the Estuary Burn and the Bay Burn and flows east for 10 km before reaching Lake Wanaka between Minaret Bay and Snag Bay. Mountains at the head of the catchment rise to just below 2000 m asl.

Bare rock or fellfield communities prevail at the highest altitude areas in the valley head and on the steepest slopes. Easier slopes are covered in dense but short statured slim snow tussock, which in places has yielded to false speargrass as a result of grazing. Evidence of cattle and hare use is common. Other abundant species include bristle tussock, moss, *Raoulia grandiflora*, *Astelia nivicola*, *Celmisia haastii*, *C. angustifolia*, *C. sessiliflora*, *Anisotome flexuosa* and lichen.

Areas of snowbank within this wider slim snow tussock community are dominated by snow patch grass and alpine rush. Other common species are *Celmisia haastii*, *C. laricifolia*, *Ourisia caespitosa*, *Kelleria dieffenbachii*, *K. croizatii*, *Epilobium brunnescens*, and *Anisotome flexuosa*. Areas of alpine seepage also support a diverse assemblage of species. Although dominated by bog rush they support false speargrass, *Acaena saccaticupula*, *Viola cunninghamii*, *Hydrocotyle novae-zelandiae*, *Craspedia uniflora*, *Chaerophyllum ramosum*, *C. colensoi*, *Epilobium alsinoides*, everlasting daisy, wind grass (*Lachnagrostis filiformis*) and snow marguerite. A few exotic species such as mouse-ear chickweed (*Cerastium fontanum*) and white clover are present at very low density.

With declining altitude, woody species become increasingly more important amongst the snow tussock. Common species include *Hebe hectorii*, *H. pauciramosa*, *Gaultheria novaezelandiae* and *Dracophyllum rosmarinifolium*. Below 1250 m asl., the valley sides support a mosaic of shrub-tussockland. *D. rosmarinifolium* is the dominating shrub on the true left but on the true right narrow-leaved tussock remains quite open and prevalent shrubs are cottonwood and *Coprosma cheesemanii* rather than *Dracophyllum* spp.

At 1100 m on the valley floor there are large damp glades dominated by exotic grasses but these do not extend far up the hill slopes. Tussock hawkweed is common on better drained sites. More substantial river flats at c. 1000 m still support up to 50% narrow-leaved snow tussock along with blue tussock, silver tussock, *Coprosma petriei* and *Luzula rufa*.

Lower mid slopes on both sides of the valley are dominated by inaka, though disturbed areas such as fans and bouldery colluvium have *Aciphylla scott-thomsonii*, *Olearia cymbifolia*, cottonwood, *Hebe subalpina*, mountain lacebark and *Brachyglottis cassinioides*, with an understorey of prickly shield fern.

Small beech forest outliers on the hillslopes are present as the valley narrows in before the edge of the continuous beech forest is reached at 925 m. These rocky and unstable areas support *Coprosma rugosa*, mingimingi, inaka, *Aciphylla horrida*, bush tussock, *Hebe subalpina*, broadleaf, mountain akeake and tutu (*Coriaria sarmentosa*), with silver beech regeneration on the margins.

Around the hut, mature silver beech forest is present, which has a thick prickly shield fern understorey and mountain lacebark and celery pine at the margins. Beech forest is continuous down the true left and, outside of fern areas, generally has a sparse understorey with scattered *Coprosma pseudocuneata*, *C. rigida*, *C. tayloriae*, *Uncinia filiformis*, *U. uncinata*, wall lettuce (*Mycelis muralis*), *Myosotis forsteri* and occasional mountain totara.

The lower section of the Rough Burn on the true left above the deer fence, has been previously burnt, and is now regenerating vigorously. Young silver beech is emergent through scrub dominated by *Dracophyllum rosmarinifolium*, inaka, *Coprosma rugosa*, *Olearia cymbifolia*, *Brachyglottis cassinioides*, three-finger and mountain totara. Many of these species are also present in scrub on the true right. The vegetation on these slopes has been more modified but indigenous scrub is regenerating in and around the margins of mixed tussock and exotic grassland. Small patches of silver beech forest remain in rocky fire refuges.

Below the deer fence, silver beech forest continues as a narrow band down the tight gorge towards the mouth. Beyond the beech forest remnants, the gorge sides are covered in dense bracken fern. Elsewhere in the catchment the deer fence signals an abrupt change to much modified and exotic dominated vegetation.

The lakeshore fan at the mouth of the Rough Burn is vegetated in kanuka scrub and low forest similar to that described for the Bay Burn below.

Bay Burn

The Bay Burn lies between the Rough Burn and the Albert Burn. It is a small valley that flows eastwards for 8 km before entering Lake Wanaka at Snag Bay. It has a relatively small headwater catchment that rises to 1860 m.

The upper valley basin at c. 1700 m has a diverse fellfield-cushionfield with occasional patches of slim snow tussock. Common species include alpine rush, blue tussock, *Dracophyllum muscoides*, snow patch grass, *Celmisia haastii*, *C. laricifolia*, *Phyllachne rubra*, *Kelleria croizatii*, *Luzula pumila*, *Aciphylla kirkii*, *Gaultheria nubicola* and *Myosotis elderi*. Wet seepages are dominated by white caltha and *Argyrotegium mackayi*.

By 1550 m mid-ribbed snow tussock is the dominant tussock species and is associated with false speargrass, *Carpha alpina*, *Hebe hectorii*, *Geum cockaynei*, *Astelia nivicola*, *Rytidosperma pumilum*, snow patch grass, *Aciphylla montana* and *Pentachondra pumila*. Mid-ribbed snow tussock gives way to narrow-leaved tussock at c. 1300 m and *Celmisia semicordata* and *Hebe subalpina* become more common amongst the tussockland. Alpine fescue occupies fans where tall tussock has been lost to fire and grazing and also areas below bluffs that are regularly disturbed from avalanches and grazing.

A gentle valley floor basin at c. 1170 m has a scattered (5 – 10%) cover of narrow-leaved tussock with the balance made up of grasses including exotic sweet vernal, browntop, and Chewing's fescue, and native *Poa cockayneana*. Associated herbs include *Anisotome flexuosa*, *Helichrysum filicaule*, *Wahlenbergia albomarginata*, *Muehlenbeckia axillaris*, *Scleranthus brockiei* and white clover.

Slopes above this on the shady true left are largely vegetated in shrubland of musky tree daisy, *Brachyglottis cassinioides* and *Coprosma cheesemanii* interspersed with blue tussock and bristle tussock. Adjacent boulderfields have similar species along with snow totara and *Aciphylla horrida*.

Descending the valley, slopes on the true right have a largely intact narrow-leaved tussock cover except for disturbed fans. On the true left *Dracophyllum* scrub dominates, although intervening bouldery slopes have more diverse shrublands comprising snow totara, musky tree daisy, *Coprosma cheesemanii*, *Hebe hectorii* and *Brachyglottis cassinioides*. Just above the hut is a large area of *Brachyglottis cassinioides* dominated shrubland with occasional emergent celery pine. Celery pine (up to 5 m tall) becomes a major component of the vegetation near the hut where it is emergent with 8 m tall mountain lacebark. The subcanopy here includes snow totara, mountain wineberry, *Coprosma tayloriae*, *Hebe subalpina*, prickly shield fern and wall lettuce. Around the hut is modified grassland comprising sweet vernal, cocksfoot (*Dactylis glomerata*), yarrow (*Achillea millefolium*), and silver tussock with scattered narrow-leaved tussock and sweet briar.

Celery pine forest continues on the true left below the hut for c. 200 m until the first silver beech forest is reached. The beech forest is fringed by *Coprosma rugosa*, mingimingi, *C. fowerakeri*, prickly shield fern and *Aciphylla horrida*. The interior of the forest is bare except for a carpet of tussock hawkweed. Beech forest on the true right is more modified than true left with more breaks and clearances, and consequently more of an exotic component. With steepening slopes leading to bluffs, the vegetation changes to typical scrub of inaka, musky tree daisy and *Brachyglottis cassinioides*.

Broadleaf forest and scrub dominate slopes on the true right further down valley. Common species include broadleaf, mountain akeake, weeping matipo, mountain flax, koromiko, mountain lacebark, inaka, *Coprosma rugosa*, pohuehue (*Muehlenbeckia australis*), bush lawyer, *Blechnum novae-zelandiae*, and *B. montanum*. Kohuhu is present at 730 m along with the first European broom, kanuka, and manuka, all of which become more common further down the valley. At 680 m this scrub has emergent silver beech trees, estimated to be c. 25 years old.

Vigorous manuka and bracken regeneration is present below the deer fence, along the 4WD track.

The mouth of the Bay Burn supports a largely intact kanuka dominated forest that is particularly notable for the large number of trees that support the hemi-parasitic dwarf mistletoe *Korthalsella salicornioides*. The forest has an understorey of rank exotic grasses, tutu, mingimingi, *C. rugosa*, *Corokia cotoneaster*, kowhai, tussock hawkweed and wall lettuce. Clearings and edges have matagouri along with bush lawyer and pohuehue.

Albert Burn tributaries

Approximately 5% of the PL, in two disjunct units, is located in the catchment of the Albert Burn, along the true right side of the valley.

The smaller and western unit is adjacent to the headwaters of the western branches of the Estuary Burn. This remote unit is located above treeline, and is comprised mainly of northwest facing slopes. Vegetation communities present show little sign of animal impacts. *Dracophyllum* dominated subalpine scrub and tall snow tussock communities dominate. The high exposed ridge crests and areas subject to frequent disturbance have fellfield and cushionfield communities.

The second and much larger unit is adjacent to a portion of the headwaters of the Rough Burn and has a common ridge line boundary with the north side of the Bay Burn catchment. It tapers to the floor of the Albert Burn near the northeast extent of the PL. This generally north-facing valley side is steep and gullied with several small subsidiary catchments. This unit has a wide altitudinal range and more varied topography. Silver beech forest would once have clothed the lower slopes below c. 900 m but is now restricted to tiny fire refuges. Previously forested slopes now support successional communities dominated by broadleaved forest, bracken, kanuka, manuka and *Dracophyllum*. Above the natural forest zone are extensive *Dracophyllum* dominated subalpine shrublands. With increasing altitude these are replaced by tall snow tussock communities dominated by various *Chionochloa* spp. As in common with the remainder of the PL, the high exposed ridge crests and areas subject to frequent disturbance have diverse fellfield and cushionfield communities.

On the true right mouth of the Albert Burn there is extensive and frequently flood-disturbed gravel flat. This is sparsely vegetated with native and exotic herbs. Common native herbs include *Raoulia hookeri*, *R. tenuicaulis*, *Epilobium microphyllum*, *E. melanocaulon*, and *Muehlenbeckia axillaris*. Exotic herbs include tussock hawkweed, mouse-ear chickweed, sheep's sorrel, catsear (*Hypochaeris radicata*) and moth mullein (*Verbascum virgatum*). Adjoining this, on a higher terrace, is a kanuka forest (c. 8 m tall) with a shrub understorey that includes manuka, mingimingi, *Corokia cotoneaster* and occasional blackberry (*Rubus*

fruticosus agg.). The groundcover here has a variety of small herbs including *Acaena juvenca*, *Leptinella squalida*, *Lagenifera cuneata* and *Helichrysum filicaule*.

Front faces and terraces

The front faces and terraces between the hill slopes and the lake shore are the most developed areas for pastoral farming. Despite widespread loss of indigenous vegetation, areas of significant native vegetation remain.

Snag Bay Lagoon is an ephemeral tarn, surrounded by sedgeland and kanuka forest that has been fenced from stock on the flats immediately north of Snag Bay. A shallow water-filled depression appears to receive periodic inflow from the west and consequently exhibits wide water level fluctuations. It is popular with waterfowl and their disturbance may contribute to the maintenance of an herbaceous turf comprising many species of diminutive native plants. Common species include *Myriophyllum pedunculatum* subsp. *novaezelandiae*, *Glossostigma elatinoides*, *Crassula sinclairii*, *Elatine gratioloides*, *Montia angustifolia* and *Callitriche* spp.

There is a large area of wetland comprising fen and swamp at the head of Minaret Bay, in front of the staff quarters. The swamp is dominated by harakeke (*Phormium tenax*) and purei (*Carex secta*); other common species include *Blechnum montanum*, mingimingi and bog rush. A drain around the lower margin of the swamp has the exotic jointed rush. An adjoining fen is dominated by *Carex sinclairii* and has been modified by drains, fires and stock impacts. Other common species include *Carex coriacea*, *C. geminata*, *Machaerina rubiginosa*, *Juncus edgariae*, *Potamogeton suboblongus*, *Centella uniflora*, *Leptinella squalida*, browntop and Yorkshire fog.

Cliff and talus scrub and shrubland on the east side of the wetlands described above are dominated by exotic broom but have a mix of associated native species that include species rare on the PL and in the district. Associated species are mountain akeake, *Melictyus alpinus*, mountain flax, weeping matipo, *Coprosma virescens*, cabbage tree, mahoe, *Coprosma wallii*, *Olearia lineata* and pohuehue.

Several highly modified depression wetlands occur on the roche moutonnée peninsula. Despite being heavily pugged by deer they retain a small suite of wetland plants that includes sharp-spike sedge, *Carex virgata*, *C. sinclairii*, purei, *Myriophyllum triphyllum*, jointed rush, *Machaerina rubiginosa*, and *Callitriche petriei*.

Elsewhere there are numerous early successional stands of hillside shrublands and scrub, mostly dominated by unpalatable manuka, kanuka and *Dracophyllum* spp. These appear to be expanding in to the surrounding tussockland or mixed pasture-tussockland. At least two small broadleaved forest remnants are located on rock and talus slopes at 500 – 600 m west of Snag Bay and Minaret Bay.

Lakeshore margins

Both indigenous shrub and herbfield communities are present in close proximity to the shore of Lake Wanaka. For completeness these are described despite the fact that all or parts of these communities will occur within the marginal strip that is present along the c. 28 km of the lake shore adjoining the PL.

Lakeshore turfs are present at a several localities but most notably between the Albert Burn and Snag Bay. At higher lake levels they would be mostly submerged. Dense herbaceous mats are comprised of a range of native diminutive wetland plants including *Myriophyllum pedunculatum* subsp. *novaezealandiae*, *Glossostigma elatinooides*, *Hydrocotyle sulcata*, *Plantago triandra*, *Leptinella* "seep", *Lobelia perpusilla*, *Lilaeopsis ruthiana*, and *Gunnera monoica*. Less common are *Leptinella maniototo*, *Limosella lineata* and *Triglochin striata*.

Higher up the shoreline, particularly on gravel and cobble beaches where seeps are common, are a range of taller sedges and rushes. These include both native and exotic species. Common species are sharp spike sedge, yellow sedge (*Carex flaviformis*), track rush (*Juncus tenuis*) and *Carex gaudichaudiana*. Occasionally present is square sedge (*Lepidosperma australe*) and the herb *Selliera radicans*.

The hard rock riparian zone is rich in shrubs and small trees. Common species include kowhai, broadleaf, *Corokia cotoneaster*, manuka, kanuka (often hosting the hemiparasitic *Korthalsella* spp. mistletoes), *Lophomyrtus obcordata*, mingimingi, weeping matipo, desert broom, cabbage tree, mahoe and mountain totara. Ferns are often a significant feature of the ground cover in these areas. Common species include leather-leaf fern (*Pyrrosia eleagnifolia*), *Polystichum neozelandicum*, *Asplenium appendiculatum*, *A. richardii*, hounds tongue fern (*Microsorium pustulatum*) and necklace fern.

In places, notably Minaret Bay, kowhai becomes a common lakeshore tree often in conjunction with mountain totara, with an understorey of manuka. At the south end of the PL, immediately north of the Minaret Burn, is a face of dense regenerating mixed broadleaved shrubland and low forest that extends to the lake edge. Elsewhere significant areas of kanuka and manuka fringe the lake shore, especially around the sandy and gravelly river mouths. These have been described above.

Significance of Vegetation

At least 363 native vascular plant species (see Appendix2) are present. Areas with significant botanical values are shown on Map 4.2.3.

Threatened and At Risk species

Of the native vascular plant species present, one is listed as 'Threatened', 14 as 'At Risk' and one as 'Data Deficient' in the most recent threat classification system listing (de Lange et al. 2009). A list of these species with their threat of extinction status and distribution within the PL is provided below in Table 4.

The New Zealand Threat Classification System provides a tool for assigning a threat status to candidate taxa. Species listed in the super category 'Threatened' are grouped into three categories: 'Nationally Critical', 'Nationally Endangered', and 'Nationally Vulnerable'. Taxa in these three categories are facing a very high risk of extinction in the wild.

The latest revision (Townsend et al. 2008) of the 2002 system includes the addition of the new categories 'Declining', 'Naturally Uncommon', 'Recovering' and 'Relict' within a super category 'At Risk'. Declining taxa do not qualify as 'Threatened' because they are buffered by a large total population size and/or slower decline rate. However, if the declining trends continue, these taxa may be listed as 'Threatened' in the future. The category 'Naturally

Uncommon' is adopted to distinguish between biologically scarce and threatened taxa. 'Recovering' allows for threatened taxa whose status is improving through management action and 'Relict' is used to encompass taxa that have experienced very large historic range reductions and now exist as remnant populations that are not considered unduly threatened. Where information is so lacking that an assessment is not possible, the taxon is assigned to the 'Data Deficient' category. Collection of sufficient demographic data to allow evaluation is a high priority as such data may confirm whether these taxa are 'Threatened' or 'At Risk'.

Table 4: Threatened plant species found on Minaret Pastoral Lease

Super Category	Threat Category	Species	Location on property
Threatened	Nationally Endangered	<i>Olearia hectorii</i>	Forest margin head of Estuary Burn
At Risk	Declining	<i>Coprosma wallii</i>	Western side of Minaret Bay peninsula
		<i>Lobelia ionantha</i>	Riverbed oxbow Minaret Burn
		<i>Olearia lineata</i>	Western side of Minaret Bay peninsula
	Naturally Uncommon	<i>Anemone tenuicaulis</i>	Alpine tussockland at head of Minaret Burn
		<i>Cardamine aff C. bilobata</i>	Dry alpine rock outcrops Minaret Burn
		<i>Carex lachenali</i> subsp. <i>parkeri</i>	Locally in alpine bogs and seeps
		<i>Chionochloa vireta</i>	Sporadically in alpine tussockland
		<i>Epilobium purpuratum</i>	Alpine screes throughout
		<i>Euchiton polylepis</i>	Wet gravels on floor of Minaret Valley
		<i>Juncus pusillus</i>	Ephemeral wetland Estuary Burn
		<i>Korthalsella salicornioides</i>	Hemi-parasitic on kanuka on lake terraces
		<i>Lagenifera barkeri</i>	Montane seeps Minaret Burn and Estuary Burn
		<i>Montia angustifolia</i>	Ephemeral wetland Shag Bay
		<i>Ranunculus maculatus</i>	Alpine seep Minaret Burn
Not evaluated	Data Deficient	<i>Leptinella maniototo</i>	Lake shore turfs

In addition, three species that are uncommon in Otago (Regionally Significant) were found. A list of these species is provided below in Table 5.

Table 5: Regionally significant plants found on Minaret Pastoral Lease

Status	Species	Location on property
Regionally significant	<i>Coprosma virescens</i>	Western side of Minaret Bay peninsula
	<i>Elatine gratioloides</i>	Snag Bay ephemeral tarn
	<i>Podocarpus nivalis</i>	Subalpine shrublands in upper Minaret Burn and Bay Burn

Rare Ecosystems

Terrestrial ecosystems that were rare before human colonisation of New Zealand often have highly specialised and diverse flora and fauna characterised by endemic and nationally rare species. Rare ecosystems are defined as those having a total extent less than 0.5% (i.e. < 134 000 ha) of New Zealand's total area (268 680 km²). A framework has been developed (Williams et al. 2007) based on descriptors of physical environments that distinguish rare ecosystems from each other and from more common ecosystems. Using this framework 72 rare ecosystems have been defined using pertinent environmental descriptors selected from soil age, parent material, soil chemistry and particle size, landform, drainage regime, disturbance, and climate

On the PL six rare ecosystems were identified, five in the wetland category (cushionbog, ephemeral wetlands, seepages and flushes, snowbanks and lake margins) along with inland sand dunes.

Although not technically defined as a rare ecosystem, the celery pine/mountain totara forest in the head of the Minaret Burn is recognised nationally as fine example of its type and is included as a priority site in the Department of Conservation's ecosystem prioritisation process.

Scientific Values

The entire PL, with particular emphasis on sites in the Minaret Burn and Estuary Burn, have been investigated as part of research describing the distribution of native forest and Holocene forest fires in the upper Clutha district (Wardle 2001a, Wardle 2001b).

2.5.1 Problem Plants

At least 47 exotic species of plants are present on the PL, but relatively few are of significant conservation concern. Many are plants of agricultural importance or are common pastoral weeds. Most are present only at the lower elevations. Tussock hawkweed is widespread particularly as ground cover under beech forest.

There are a suite of plants that are potential problems for the various montane wetlands and lake shore habitats. These include oval sedge (*Carex ovalis*), jointed rush (*Juncus articulatus*), soft rush (*Juncus effusus*), crack willow (*Salix fragilis*) and possibly gorse (*Ulex europeus*). They pose a threat to wetland values through their ability to compete with and suppress native wetland plants.

The weeds with the most disruptive potential outside of wetlands are broom (*Cytisus scoparius*) and wilding pine (*Pinus* spp.). The unchecked spread of particularly the broom presents a serious risk to indigenous biodiversity, natural character and recreational access. Williams (1981) in his study on the ecology of broom in Canterbury noted that the altitudinal limit of broom in New Zealand, as in Europe, appears to be limited by winter cold or winter drought affecting the previous season's growth. There would appear to be few natural impediments to a much wider extension of its range. Without intervention, many of the Significant Inherent Values (SIVs) identified on the lower altitude parts of the property, particularly river delta woodlands, are at risk of invasion by broom in the short to medium term.

2.6 Fauna

2.6.1 Invertebrate Fauna

Ecological Context

Otago is noted for its nationally high rate of invertebrate diversity and endemism (up to 60% of the New Zealand fauna; Patrick 1994). Several hypotheses are given for this level of diversity, including a complex geological history, a wide range of climatic conditions from semi-arid to very wet and high altitude mountainous lands that influence specific life history traits and speciation. The west Otago mountains are particularly renowned for their suite of interesting invertebrates including at least four species of *Lyperobius* weevil, chafer beetles (*Scythodes* and *Prodontria* spp.), alpine weta (*Deinacrida* spp.), geometrid moths and the velvet worm *Peripatus*.

There have been three entomological surveys carried out near the PL. These surveys were tenure review inspections of Mt Aspiring PL, Matukituki PL and the neighbouring West Wanaka PL. Several insect species of note were collected during these surveys and the habitats are similar if not continuous with the PL.

Survey methods and collecting areas

Invertebrates were collected using an aspirator, sweep netting and hand searching (beneath rocks and stones or within vegetation). Collecting effort was targeted toward endemic taxa of the following groups; Arachnids (spiders, harvestmen and pseudoscorpions), Coleoptera (beetles), Orthopteroids (grasshoppers, weta and cockroaches) and Myriapoda (millipedes and centipedes). These groups represent many flightless invertebrates that often display local endemism and are more familiar to the author. For this work, invertebrates were collected from spot sites, generally within the least (visually) modified habitats.

Given the size of the PL, the inspection was divided into three areas; the catchments to the north and south of Estuary Burn, the front country, and Lake Wanaka foreshore. Within these areas as many habitats as feasible were sampled. Habitats were targeted by degree of modification (the least modified being priority) and their diversity (including aspect and altitude). Invertebrate species of conservation interest were checked against the New Zealand Threat Classification System (Hitchmough and Bull 2007; McGuinness 2001).

Results and notable species

It was not possible to inspect all habitats and catchments on the PL. During helicopter flights however, it was noted that the backcountry supports continuous, widespread and undisturbed intact native vegetation and that invertebrate communities will be shared within similar habitats.

Sixty four invertebrate taxa of interest were collected during the survey (Appendix 3), and of these 60 species (over 90%) were endemic. The genus to species ratio was 0.96:1 (almost one to one), implying low competition and deep evolutionary lineages (high endemism). In general however, New Zealand insect taxa tend to show rapid radiation of many species within a genus, reflecting the sampling bias in favour of diversity.

Tussockland and subalpine habitats

High altitude habitats tend to have rates of invertebrate endemism in excess of 95% and are important for their 'ecological island' character. Several interesting spiders were collected from the tussocklands and alpine herbfields on the PL. These include *Mamoea montana* (?) an alpine agelenid spider (ground dweller) that was located on the ridge between Albert Burn and Estuary Burn at 1688 m. Another interesting species was *Cycloctenus westlandica*: Cycloctenidae ('scuttling' spiders, which are day hunters capable of moving at great speed). Several of these spiders were found amongst blocky scree on slopes above the true left of the Estuary Burn. Cycloctenid spiders are only found in New Zealand and Australia, and *C. westlandica* is endemic to the mountains of the lower South Island.

A diverse range of subalpine beetles were also collected throughout the high tussocklands and alpine herbfields. Four beetle families were represented which is significant because it suggests that a range of trophic guilds were present (detritivores, herbivores and predators), indicating an intact community structure and function. The beetle taxa include Moss beetles (*Liochoria* sp.: Byrrhidae), a ground beetle (*Mecodema* sp. (cf. *M.alternans*?), darkling beetles (*Artystona* sp.) and two speargrass weevils; *Lyperobius hudsoni* and a species of *Anagotus*. The latter are large, slow moving beetles, susceptible to rat predation.

The large scree weta *Deinacrida connectens* was found amongst rocky pavement and herb fellfields in a tributary of the Minaret Burn at 1560 m. These weta are among the heaviest insects in New Zealand and are confined to the alpine environment. Several specimens of the common *Hemideina maori* (mountain stone weta) were also found in similar habitats, but with a greater altitudinal range. *Hemideina maori* are omnivorous and are also susceptible to predation by rats and mice. The grasshopper *Alpinacis tumidicauda*, was common in all tussock grasslands visited.

Butterflies were represented by *Erebia butleri* (Butlers ringlet), which is uncommon, and the more common black mountain ringlet *Percnodiamon merula*. Both insects fly during sunny conditions on heat currents produced by dark surfaces, particularly rock and scree. At lower elevations, the related tussock ringlet *Argyrophenga antipodum* was active throughout all high country sites visited, except during cold conditions (<12°C).

Additional Lepidoptera of note include five species of geometrid moth: *Aponotoreas insignis*, *Asaphodes clarata*, *Paranotoreas ferox*, *Paranotoreas brephisota* and *Notoreas niphocrena*. These species are attractive, day flying moths with specific native host plants including; *Chionochloa* sp., *Ranunculus* sp., *Brachyglottis* sp., *Epilobium* sp. and *Kelleria* sp.

respectively. The diversity and relative abundance of these moths throughout the higher elevations on the PL is evidence that the indigenous ecological community is intact and functional.

Beech forests

Beech forest was present in varying quantities in all the valleys, typically confined to the mid and lower reaches of the valley floors, flanks and gorges. Ecological disturbance to the beech forests was limited to sheep and deer trails, historic fires and exotic plant encroachment (particularly in lower elevation forest toward Lake Wanaka).

Several native invertebrates typical of beech forest were collected. The large stag beetle *Mitophyllus parrianus* (Lucanidae), cave weta (*Isoplectron* sp.) and native cockroaches (*Celatoblatta quinquaemaculata*) were collected from beech tree bark. Several large ground dwelling spiders (*Uliodon frenatus* and Stiphidiids) were also found beneath logs on the forest floor. These spiders and the cockroaches are typical of this type of forest and indicate that rodent predation is not having a severe impact on the invertebrate ecology.

Introduced wasps (*Vespula* spp.) were not apparent in any of the beech forest inspected. While this is encouraging, it is probably a function of the cooler climate in Otago relative to the warmer northern forests from Canterbury to Marlborough where wasps are a serious ecological issue in the honey dew beech forests. Bumble bees were noted in the beech although they are not considered a problem in native forests.

Shrublands

Several native shrubland communities of interest were inspected. Of these the most extensive was a tall stand of kanuka (*Kunzea ericoides*) and some manuka (*Leptospermum scoparium*) located at the outlet of the Albert Burn and Lake Wanaka shore. A suite of native invertebrates typical of these comparatively drier habitats were present. Scarab beetles were common and included species from three genera: *Odontria* sp., *Pyronota festiva* and the common grass grub beetle *Costelytra zealandica*. All three taxa have larvae that feed on grass roots, while the adults are associated with kanuka and manuka foliage.

During sunny conditions the green cicada *Kikihia* and mountain cicada *Maoricicada* were active. *Kikihia* were common in shrublands and grassland below about 900 m, while *Maoricicada* were restricted to scree and rocky terrain at higher elevations on the PL. Both cicada are endemic and associated with native vegetation. Similarly, many native invertebrates were abundant on flowering plants including *Ozothamnus*, *Olearia*, *Hebe* and *Dracophyllum*. The majority of these flower-visiting invertebrates were pollinating insects specifically hoverflies *Melangyna* sp., flower beetles (*Dasytes* sp.), Muscid flies, Blow flies (Calliphoridae) and butterflies (tussock ringlets – *Argyrophenga antipodum*) and Copper butterflies (the Lycaenids).

Lake and stream margins

The PL includes approximately 28 kms of the Lake Wanaka foreshore, including two bays (Minaret Bay and Snag Bay). A substantial proportion of the lake front abuts land that has been converted to pasture. However, the shore is contiguous with native shrublands and wetlands at several locations, for example on the true right bank of the Albert Burn where kanuka and scattered shrublands extend from the river to Snag Bay.

During inspection of these shrublands and the stony shore, a wide range of native invertebrates were noted. Given the dynamic nature of the lake shore (level changes, inundation and wind-blown driftwood) the invertebrate community is remarkably diverse with three classes present (the arachnida, crustacea and insecta). The large water spider *Dolomedes aquaticus* was common under loose rocks near the water edge, a habitat shared with two crustaceans, slaters (Isopoda) and land hoppers (*Talorchestia*: Amphipoda). Representative insects include the large ground beetle *Megadromus sandageri*, the lowland grasshopper *Phaulacridium marginale* (abundant in grasslands and drift wood) and a small *Eudonia* grass moth.

Native moths were also found in the riparian vegetation of the lower Bay Burn; a mosaic of tall kanuka, low woody shrublands and beech forest that extends no further than the mouth of the Bay Burn gorge. Several Lycosid spiders were present on the narrow stony river bed of Bay Burn, indicating that even at the scale of several hundred meters, a community structure can be maintained.

Wetlands and braided rivers

Wetlands and braided river communities were confined to short stretches of Minaret Burn, Estuary Burn (specifically the outwash flats between the north and west branches) and the Lake Wanaka foreshore. Invertebrate collections were restricted to the Estuary Burn flats and lakeshore at which the nursery web spider (*Dolomedes minor*) was present. *Dolomedes minor* is a native species with a wide tolerance for habitat structure (they are often found in exotic wetland vegetation since they prey on small insects). Spiders are normally abundant amongst indigenous wetlands since many insect life cycles include aquatic stages that emerge as flying adults.

Estuary Burn braided river flats

The outwash flats of Estuary Burn cover approximately 100 ha and support a semi-wetland community comprising tall tussock and sedges. The upper Estuary Burn has been previously grazed. Sheep have recently been re-introduced and are establishing trails and stock camps with intense grazing at spot locations. At the head of the flats, there were populations of many native invertebrates interacting and associated with the grassland community, indicating that the ecological community was functional. Noteworthy invertebrates present were copper butterflies (*Boldenaria boldenarum* and *Lycaena salustius*, both of which feed on *Muehlenbeckia*); pollinating hover flies (*Melanagyna* sp.); damselflies (*Xanthocnemis zealandica*); robberflies (*Neoitamus* sp.); crambid moths (*Orocrambus* spp.); and a suite of grassland spiders, including orb weavers (Tetragnathids and Araneids) and active hunters such as wolf spiders (*Anoteropsis* sp.) and many nursery web spiders (*Dolomedes minor*: Pisuridae).

Significance of Invertebrate Fauna

No threatened invertebrate species were recorded on the PL. However, nine invertebrate species of conservation interest were found (Table 6). Rates of endemism were high (over 93%) and large bodied keystone insects were present, suggesting that rodent predation has been limited and this is probably a function of altitude and climate. The invertebrate communities were typical of the west Otago mountains, with many species shared between the neighbouring properties (Mt Aspiring and West Wanaka). This inspection found the indigenous ecology of Minaret PL to be in very good condition and in some locations pristine

(upper Estuary and Minaret Burns). Large areas of the PL supported intact ecological communities, most of which were continuous sequences across altitudinal ranges.

Table 6: Invertebrate species of conservation interest found on the PL

Common name	Scientific name	Notable feature	Location on PL
Scuttling spider	<i>Cycloctenus westlandica</i>	Endemic to the lower South Island mountains.	Head of Estuary Burn
Scree weta	<i>Deinacrida connectens</i>	Large endemic scree weta. Restricted to alpine habitat. Ten species of <i>Deinacrida</i> species are threatened.	Head of Minaret Burn
Mountain stone weta	<i>Hemideina maori</i>	Indicator species whose presence suggests low predation and intact indigenous habitat.	Minaret Burn tributary
Large ground beetle	<i>Megadromus sandageri</i>	Large endemic ground beetle that lives in wet beech forest and drier sub-alpine shrublands.	Mouth of Albert Burn
Large speargrass weevil	<i>Lyperobius hudsoni</i>	These are the largest native weevils found in the South Island. Presence indicates low predator density and suitable host plant density.	Head of Estuary Burn
Alpine grassland orange	<i>Aponotoreas insignis</i>	Attractive day flying alpine moth. Common in snow tussock, indicative of intact sub-alpine community.	Head of Estuary Burn
Butler's ringlet mountain butterfly	<i>Erebia butleri</i>	Uncommon alpine butterfly, endemic to South Island mountains.	Head of Estuary Burn
Black mountain ringlet	<i>Percnodiamon merula</i>	High altitude endemic butterfly. Highly restricted habitat requirements.	Head of Estuary Burn
Golden spotted looper	<i>Dasyuris transaurea</i>	Species indicate presence of native herbs (Caterpillars feed on native aniseed, <i>Anisotome aromatica</i>)	Head of Estuary Burn

Complete sequences of native vegetation occur on the PL, extending from the shore of Lake Wanaka to the mountain summits at head of the valleys. Intact kanuka and beech forest sequences are present in the lower catchments and these give way to indigenous shrublands and sub alpine tussockland / herbfields. Each of these vegetation sequences supports characteristic invertebrate communities.

Nothofagus forest and indigenous woody shrubland communities are widespread and support many different populations of native invertebrates.

Populations of large bodied endemic insects are supported on the PL, including the weta *Deinacrida connectens*, *Hemideina maori*, ground beetles *Megadromus sandageri*, *Mecodema* sp., and several large speargrass weevils (*Lyperobius hudsoni* and *Anagotus* sp.)

These insects are not necessarily at their range limit on the PL, however they are of regional significance and in some cases endemic to the lower South Island

2.6.2 Herpetofauna

Ecological Context

Previous lizard surveys in the general vicinity of Mount Aspiring National Park have yielded mixed results and, in general the lizard fauna is not considered diverse or abundant.

Lizards appear to be very scarce in mountainous regions of the Wanaka/Wakatipu area, particularly at higher altitudes (Herpetofauna Database). However, there are several lizard species known to be present in the Wanaka/Wakatipu area. There are two "alpine gecko" species recorded from this and nearby areas: the Roys Peak gecko *Mokopirirakau* "Roys Peak" and the Takitimu gecko *Mokopirirakau cryptozoicus* (Tocher & Marshall 2001; Jewell 2008). Both species are rarely found above 1500 m and have been assigned a threat ranking of "Nationally Vulnerable" (Hitchmough et al. 2010).

The Cryptic skink, *Oligosoma inconspicuum* is known from the Rees Valley, but its' distribution is apparently patchy (Whitaker et al. 2002, T. Jewell *pers. comm.* 2005). This species is currently ranked as "Not Threatened" (Hitchmough et al. 2010), along with *Woodworthia* "Otago/Southland", which is known from beech forest around Paradise.

The Jewelled gecko *Naultinus gemmeus*, which occurs on river flats in the Hunter Valley is ranked as "At Risk Declining" (Hitchmough et al. 2010). The Southern Alps Gecko *Woodworthia* "Southern Alps" and the Cromwell Gecko *Woodworthia* "Cromwell" are both ranked as "Not Threatened" (Hitchmough et al. 2010). The McCann's skink, *Oligosoma maccanni*, and Cryptic skink, *Oligosoma inconspicuum* are scarce in the Wanaka/Wakatipu area despite being relatively abundant elsewhere in north-west Otago. (Herpetofauna Database).

Survey Methods

Only the Minaret Burn, Estuary Burn and the front country were surveyed. Other team members also searched for lizards in the Rough Burn, Bay Burn and Bells Creek.

Areas of suitable lizard habitat were scanned for animals, both basking and active, using binoculars. Searches were also made for evidence of their presence including sloughs, skeletal remains and droppings. Visual and hand searching methods, including checking potential retreat sites such as rock piles and crevices, were used to locate lizards. Jewelled geckos or their sloughs were searched for in shrublands.

The lizard values were derived from a review of existing information including unpublished DOC Tenure review Conservation Resources Reports and DOC's Herpetofauna Database in combination with the field survey.

Results

No lizard species or their sign were found in the area surveyed. It is likely that lizards are present in some areas but at low abundances. However, some suitable habitat of threatened lizard species including the Jewelled gecko and the Roys Peak gecko were found.

Significance of Herpetofauna

The significance of lizard habitat on the PL is considered to be low.

2.6.3 Avifauna

Birds seen or heard during the tenure review inspection of the PL are listed in Table 7.

Table 7: Bird Species recorded on the PL

INDIGENOUS SPECIES		INTRODUCED SPECIES	
Common Name	Scientific name	Common Name	Scientific Name
Bellbird	<i>Anthornis melanura melanura</i>	Blackbird	<i>Turdus merula</i>
Bittern (J. Wallis pers comcomm.)	<i>Botaurus poiciloptilus</i>	California quail	<i>Callipepla californica</i>
Brown Creeper	<i>Finschia novaeseelandiae</i>	Canadian Geese	<i>Branta canadensis</i>
Grey warbler	<i>Gerygone igata</i>	Chaffinch	<i>Fringilla coelebs</i>
Kea	<i>Nestor notabilis</i>	Goldfinch	<i>Carduelis carduelis</i>
Morepork	<i>Ninox novaeseelandiae novaeseelandiae</i>	Greenfinch	<i>Carduelis chloris</i>
New Zealand Falcon	<i>Falco novaeseelandiae "eastern"</i>	Magpie	<i>Gymnorhina tibicen</i>
New Zealand Pipit	<i>Anthus novaeseelandiae</i>	Mallard	<i>Anas platyrhynchos</i>
Paradise Shelduck	<i>Tadorna variegata</i>	Redpoll	<i>Carduelis flammea</i>
Rock Wren	<i>Xenicus gilviventris</i>	Song Thrush	<i>Turdus philomelos</i>
Scaup	<i>Aythya noveaseelandiae</i>	Skylark	<i>Alauda arvensis</i>
Silvereye	<i>Zosterops lateralis lateralis</i>	Yellow hammer	<i>Emberiza citronella</i>
Southern Black Backed Gull	<i>Larus dominicanus dominicanus</i>		
South Island Fantail	<i>Rhipidura fuliginosa fuliginosa</i>		
South Island Rifleman	<i>Acanthisitta chloris chloris</i>		
South Island Tomtit	<i>Petroica macrocephala macrocephala</i>		
Spurwing Plover	<i>Vanellus miles novaehollandiae</i>		
Swamp Harrier	<i>Circus approximans</i>		
Welcome Swallow	<i>Hirundo tahitica neoxena</i>		
Wood Pigeon	<i>Hemiphaga novaeseelandiae</i>		

Significance of Avifauna

Threatened and At Risk species

Table 8 outlines the habitat and location of the six bird species present that are either 'threatened' or 'at risk' in the most recent threat classification system listing (Hitchmough 2008) (Table 8).

Table 8: Threatened and At Risk Bird Species Recorded on the PL

Common name	Scientific name	Threat Status	Habitat	Location
Bittern (J. Wallis pers. comm.)	<i>Botaurus poiciloptilus</i>	Nationally Endangered	Mainly wetland, especially with dense cover of raupo or reeds	Minaret Bay wetland
Rock Wren	<i>Xenicus gilviventris</i>	Nationally Vulnerable	Alpine zone, among rock falls, screes and subalpine scrubs	Minaret Burn, upper North Branch
New Zealand Falcon	<i>Falco novaeseelandiae</i> "eastern"	Nationally Vulnerable	Forest and bush patches, open tussockland and rock outcrops	Minaret Burn, Rough Burn, Minaret Bay, Bells Creek
New Zealand Pipit	<i>Anthus novaeseelandiae</i>	At Risk Declining	Open habitats from coast to alpine tops, on shingle riverbeds and scree slopes	Estuary Burn, upper South Branch. Minaret Burn, upper North Branch. Rough Burn scrublands. Minaret Burn tributary south of Minaret Peaks
South Island Rifleman	<i>Acanthisitta chloris chloris</i>	At Risk Declining	Native forest and scrub; favours beech forest. Some in exotic forest, gorse and willow	Minaret Burn, Bay Burn shrublands.
Kea	<i>Nestor notabilis</i>	At Risk Naturally Uncommon	Mainly alpine zone, but also in forest descends to lowland river flats	Estuary Burn, upper South Branch. Minaret Burn, upper North Branch. Minaret Peaks. Upper Rough Burn basins

Taxa listed as "Nationally Endangered" and "Nationally Vulnerable" are threatened, and face a very high risk of extinction in the wild. Species listed in the category "At Risk" do not meet the criteria for any of the 'Threatened' categories. However, they are declining, biologically scarce, recovering from a previously threatened status, or survive only in relictual populations.

2.6.4 Aquatic Fauna

Introduction

Water-courses on the PL drain Minaret Peaks in an easterly direction and discharge directly into Lake Wanaka. These water courses represent a variety of in-stream habitats influenced

by past Pleistocene glaciation (Turnbull 2000). Hanging valleys have been formed by the retreating ice; sequences of them in the larger catchments have created substantial cascades. In the larger catchments of the Minaret, Estuary and Albert Burns there is evidence of landslides. Large volumes of gravel from debris fans have helped create large sequences of rapids, characterised by sections of multi channelled braiding and depositions of boulders. The small un-named headwaters of the larger catchments and three smaller tributaries of Lake Wanaka, Bells Creek and Rough Burn are characterised as fast flowing, over loose boulder and gravel substrates, with many cascades and rapids.

Historical fish records from the New Zealand Freshwater fish database (NZFFD) within the PL are sparse (Appendix 4). Several NZFFD records occur in the unnamed headwater tributaries of the Minaret Burn and two records from the main stem. No species were observed from sites in the upper catchment. However, koaro (*Galaxias brevipinnis*) were abundant in the Minaret Burn above its confluence with Lake Wanaka.

Lake Wanaka has a variety of fish species including introduced brown trout (*Salmo trutta*), brook char (*Salmo fontinalis*), rainbow trout (*Oncorhynchus mykiss*), and Chinook salmon (*Oncorhynchus tshawytscha*), and native longfin eel (*Anguilla dieffenbachii*) and common bully (*Gobiomorphus cotidamus*).

Methods

Survey sites were accessed using a helicopter. Electric fishing was undertaken pursuant to the guidelines specified in “*Non-migratory galaxiid survey methods*” (Department of Conservation 2007). A total of 20 m² was fished at all sites to standardise fishing effort. A variety of in stream habitat types were included within the surveyed area e.g. rapid/riffle/run and pool sequences, to maximise the opportunity to capture any fish species present. Any fish species captured were identified in the field using morphological characters derived from “*The Reed Field Guide to New Zealand Freshwater Fishes*” (McDowall 2000) and measured to the nearest millimetre, then released.

Benthic invertebrate taxa were identified in the field to a genus and where distinguishable in the field, to a species level using “*A Photographic Guide to the Freshwater Invertebrates of New Zealand*” (Otago Regional Council 1997 and Winterbourn et al. 2006). Macroinvertebrate Community Index (MCI) values for individual taxa were used to assess water quality based on Stark (1998).

Results

The freshwater fauna survey was carried out on the 21 January 2012. A total of 10 sites were sampled in the Minaret Burn, Bells Burn Estuary Burn, Rough Burn and Bay Burn (see Appendix 4).

Minaret Burn

Three sites were surveyed; two in unnamed headwater tributaries (c. 1100 m asl), draining the southern slopes of Minaret Peaks, and one in the main channel. Riparian vegetation in the headwaters included snow tussock (*Chionochloa rigida*) and alpine shrublands. No fish species were observed in either of the headwater tributaries.

The main channel was braided, resulting from the high amount of bed material present, containing loosely packed gravels and sand. An area characterised by several groundwater resurgences and associated spring brooks has mainly exposed river bed and clumps of exotic pasture grasses in the riparian zone. A single koaro was captured in the main channel.

Bells Creek

A single site was surveyed in Bells Creek at 1000 – 1100 metres altitude to the west of Minaret Peaks. The riparian vegetation was comprised of snow tussock, exotic pasture grasses and sections of exposed bed. The in-stream characteristics were fast flowing run-and-riffle habitat. No fish species were observed here.

Estuary Burn

Four sites were surveyed along the length of the Estuary Burn to cover the variety of different habitats present. Table 9 outlines the characteristics of each site.

Rough Burn

One site at c. 1000 m asl was surveyed. The site had a high bed load of loose gravel, cobble and boulder particles and the riparian zone was dominated by large areas of exposed bed with snow tussock, exotic pasture grasses and patches of native shrublands on the higher slopes. In-stream habitat was fast water velocity riffles and rapids. No fish species were observed in this creek.

Bay Burn

One site was surveyed at c. 1000 m asl. This creek is topographically steep with rapids and cascades flowing over large boulders and cobbles. The riparian area supports exotic pasture grasses and native shrubland. No fish species were observed here.

Mouths of Waterways entering Lake Wanaka

While not surveyed during the tenure review inspection, based on observations made at sites in nearby West Wanaka Station Creek, it is highly likely that koaro occur with salmonids (rainbow and brown trout) at the lower end of all the tributaries exiting the PL. It is also highly likely that common bullies inhabit the lower sections of these creeks. The variety of stream macro-invertebrates observed during electric fishing was low (Table 10). The most numerous taxa were the mayfly *Deleatidium* spp., which was observed occupying all streams surveyed. The mayfly *Nesameletus* spp. was also widely distributed throughout the PL but less common than *Deleatidium*.

Less frequently encountered taxa were cased caddisfly *Pycnocentria* spp. in an unnamed tributary of the Minaret Burn, and stonefly *Zelandoperla* spp. which occurred in the two unnamed tributaries of the Minaret Burn. The small selection of taxa observed were all pollution intolerant (Table 1) and reflected a healthy water quality for stony streams (mean MCI value 8.5, MCI score > 160).

Table 9: Details for sites surveyed in Estuary Burn

Site Location	Channel Characteristics	Riparian Characteristics	Fish Species Recorded
Headwaters	High bed load of loosely sorted gravel and cobble particles	Exotic pasture grasses; mixture of tussock & shrublands on the higher slopes	None
Unnamed tributary on true right of main Estuary Burn, in broad valley section	Small gravelly streamlet	Exotic grasses	None
Main channel where valley broadens into large meadow	Shallow riffle habitat over fine gravel	Exotic grasses	None
Lower main channel where narrows	Fast flowing rapids and riffles with a variety of substrates from boulders to fine gravels. Note: Large mats of the invasive diatom <i>Didymosphenia geminata</i> were present throughout this section of Estuary Burn.	Native shrublands & forest	Koaro 6 recorded & more observed

Table 10: Benthic invertebrate fauna (order and genera) observed during the freshwater fauna survey of Minarets Pastoral Lease and the Macroinvertebrate Community Index scores based on Stark (1998). Interpretation of MCI scores for stony streams: Clean water > 120, doubtful quality 100 – 119, moderate pollution 80 – 99, severe pollution < 80.

Invertebrate taxa	Macroinvertebrate Community Index score
<u>Ephemeroptera</u> , mayflies	
<i>Deleatidium</i>	8
<i>Nesameletus</i>	9
<u>Trichoptera</u> , caddisflies	
<i>Pycnocentria</i>	7
<u>Plecoptera</u> , stoneflies	
<i>Zelandoperla</i>	10

Discussion

Koaro was the only species of native freshwater fish recorded on the PL, occupying two separate catchments. A single koaro was observed in the mid reaches of the Minaret Burn and six were captured, and more observed, in the Estuary Burn. The distribution of koaro in Lake Wanaka tributaries was mostly likely as a result of post-glacial dispersal (Main 1989). Koaro are part of a group of large bodied galaxias species (Department of Conservation 2005) that have a strong habitat association with forested streams (McDowall 1980, McDowall et al. 1996, McCullough 1998, Bonnett and Sykes 2002). There is almost a total absence of forested riparian vegetation in these water ways at higher altitudes. Although koaro are known to occupy fast flowing, tumbling streams (Main 1989, McDowall 2000) the highly unstable bed load of mobile gravels caused by natural erosion may create unfavourable conditions for occupancy.

Limited recruitment may explain the low number of koaro observed on the PL. The absence of koaro in the smaller tributaries may be associated with physical barriers to migration. Due to the existence of large cascades resulting from glacial processes (i.e. hanging valleys), migration conditions for juvenile koaro may be restricted to infrequent flow conditions or be totally non-existent.

The low taxonomic richness of the benthic macro invertebrate genera present in streams and creeks throughout the PL appeared to reflect the unstable bed load and frequency of high flow regimes of these catchments and a low level of sampling effort. However the limited number of taxa observed indicated excellent water quality (Stark 1998).

Of note was the series of spring / springbrook habitat observed in reaches of the Minaret Burn. Unmodified and unoccupied habitat of this sort is uncommon. Should the opportunity occur, investigation into suitability for the potential translocation of threatened lowland longjaw galaxias, *Galaxias cobitinis*, should be considered.

Significance of Aquatic Fauna

Koaro (*Galaxias brevipinnis*), recorded in the Minaret and Estuary Burn catchments, is listed as being At Risk and Declining in the most recent assessment of threat classification for fish (Allibone et al. 2010).

The decline in the national koaro population has been attributed to deforestation and the negative interaction with introduced salmonids (McDowall 2006 and references there in). Koaro readily develop lake locked populations, completing their life cycle entirely within freshwater environment (McDowall 1970).

With the formation of Lake Wanaka after the Pleistocene glaciation (Turnbull 2000), this has allowed koaro to colonise and then recruit directly from the lake. Koaro have the ability to scale substantial water obstacles (McDowall 1990) therefore allowing them to migrate substantial distances inland to colonise unoccupied habitat.

2.6.5 Problem Animals

Feral red deer, chamois, hares, possums, hedgehog, ferrets and stoats are present on the PL. Red deer trample alpine wetlands; browse tussock, herbfield, shrubland and forest; and rub their antlers on shrubs and saplings. Excessive deer numbers remove palatable species and change forest composition.

Hare browse tussock and herbfield.

Tahr have been present as they were released some decades ago. On-going control has reduced numbers to low levels but on-going control will be maintained.

The presence of the invasive diatom, *Didymosphenia geminata* in the lower Estuary Burn waterway, is evidence that even in remote localities unwanted organisms may occur for no apparent reason. Trout have had a serious impact on indigenous freshwater fauna (McDowall 2006).

2.7 Ecological Sustainability and Carbon Storage

Sustainability and Ecosystem Services

The Land Use Capability (LUC) system is a nationally consistent land classification system based on physical sustainability that has been used in New Zealand to help achieve sustainable land development and management since 1952. The LUC system has two key components. Firstly, Land Resource Inventory (LRI) is compiled as an assessment of physical factors considered to be critical for long-term land use and management. Secondly, the inventory is used for LUC classification, whereby land is categorised into eight classes according to its long-term capability to sustain one or more productive uses (Lynn et al. 2009).

Analysis of LUC for the PL reveals that four classes are present. Land at highest altitude (above c. 1400 m) and at lower altitude on very steep slopes is Class 8. Class 8 land has severe to extreme physical limitations or hazards which make it unsuitable for arable, pastoral, or commercial forestry use. Erosion control, water management and conservation of flora and fauna are the main uses of this land (Lynn et al. 2009). Land between approximately 1400 – 700 m is mostly Class 7. Class 7 land has severe physical limitations and consequently it is high risk land requiring active management to achieve sustainable production. Class 6 land generally occupies the lower front faces and extends well into the mountains along the valley floors. It indicates low suitability for pastoral grazing or production forestry but with less severe limitations than Class 7. Relatively small areas of Class 4 land are located on the flats around the Homestead and airstrip and on the terrace north of Snag Bay. While this class has severe limitations for arable cropping it has good suitability for pasture, tree crops and production forestry. The Class 6,7 & 8 lands have a subclass 'e' which indicates that erodibility is the main kind of physical limitation or hazard to use that has been identified.

Ecological Sustainability and Carbon Storage

The PL contributes to a number of "ecosystem services." Constanza et al. (1997) define ecosystem services as flows of materials, energy, and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare." They identify 17 "services". The Lease clearly contributes to several of these services. Those services of a recreation or cultural nature are described elsewhere.

Gas Regulation

Much of the existing tussockland and shrubland has potential for further carbon sequestration. The full potential of lower altitude tussocklands to increase in density and stature and ultimately to succeed to indigenous woody cover, is currently retarded by stock grazing, spraying and burning. The succession of montane shrublands to forest is also limited by stock grazing and shrubland clearance.

Carbon storage in regenerating shrublands, forest and tall tussocklands makes a modest contribution to ameliorating the current anthropogenic induced rise in atmospheric carbon dioxide levels.

Carbon storage varies depending on the vegetation cover present (Table 11).

Table 11: Carbon stock estimates for broad vegetation cover classes in the Vegetation Cover Map (VCM) found on the PL. (Source: Carswell et al. 2008)

Vegetation class	Carbon (t ha ⁻¹)
Unimproved pasture	2.1
Snow tussock grassland	27.2
Mixed indigenous scrub	99.4
Manuka/kanuka scrub or fern	50.5
Beech forest & scrub	179.8
Wetland communities	31.5

One hectare of mixed grassland/shrubland stores about 42 tonnes of carbon versus approximately 2t for unimproved grassland (Carswell et al. 2008).

Climate Regulation

Carbon storage in expanding shrublands, forest, tall tussock grasslands and consequential increased soil organic matter makes a modest contribution to ameliorating the current anthropogenic induced rise in atmospheric carbon dioxide levels.

Disturbance Regulation

Areas of forest, wetlands, upland bogs and extensive tussocklands on the PL make a modest contribution to disturbance regulation by reducing sediment yield into Lake Wanaka during flood events.

Water Regulation/Regulation of hydrological flows

The wetlands and upland bogs help maintain modest river flows during dry periods and have some dampening effect on flood peaks.

The Clutha River drains Lake Wanaka, and has numerous irrigation water takes, as well as making a major contribution to New Zealand's electricity needs. Protection of sensitive montane and alpine environments in the Clutha watershed, protects the interests of all downstream river users.

Water Supply Storage and Retention of Water

Snow tussock catchments have less variable flows than degraded tussock. In the absence of intact headwater vegetation cover, variability of flow would be even greater.

Erosion Control and Sediment Retention

Without extensive areas of snow tussock in the headwaters, sediment yields would be even greater than they are. Snow tussock catchments have been shown to have very low sediment yields by New Zealand standards (Fahey 2004).

Nutrient cycling

Studies have shown that tussock covered catchments yield very good water quality (ORC 1999) characterised by:

- Cool water temperatures
- High levels of dissolved oxygen
- Approximately neutral pH values
- Low conductivities
- Low total nitrogen levels
- Low NH₄ + NH₃ levels
- Low total phosphorous levels
- Low turbidity
- Low faecal coliform levels

MCI (Macro-invertebrate Community Index) values of waterways within catchments dominated by native vegetation (see Aquatic Fauna section) indicate water quality and good habitat condition in tussock catchments.

However, where native vegetation cover has been converted to exotic pasture, with significant inputs of fertiliser and stocking rates, there can be problems.

“Sediment erosion and nutrient loss from land are natural processes. In natural, unmodified ecosystems stream communities rely on regular inputs of nutrients to sustain life. In healthy native bush, catastrophic slip erosion occurs in response to climatic events, as do periodic floods and droughts. However, many agricultural practices accelerate natural processes leading to consistently higher levels of sediment, nutrients and surges of bacterial material being present in stream waters in agricultural catchments. Where land use and farm practices are changing and becoming more intensive, these effects are pronounced, both in waterways and shallow lakes, where sediments and nutrients tend to accumulate”. [Understanding the Issue, Ministry for the Environment 2001]

Scientists from the University of Otago have recorded an increase in the levels of algal growth in Lake Wanaka ([Http://vimeo.com/15243706](http://vimeo.com/15243706)). These algal blooms produce lots of polysaccharides, which cause the algae to stick together, forming a white fluffy growth termed Lake Snow. The highest levels of Lake Snow are thought to be associated with those parts of Lake Wanaka where nutrient enrichment from runoff has been the greatest i.e. where agricultural development is taking place.

Lake Snow is having a number of impacts:

- Blocking of Wanaka township's drinking water intake filters
- Fouling of fishing lines since 2003
- Clogging of the insides of water reticulation e.g. showers and washing machines in Wanaka

This issue highlights the importance of maintaining riparian buffer zones of native vegetation cover to minimise nutrient runoff into the lake.

Significance of Sustainability and Ecosystem Services

Given its location adjacent to Mount Aspiring National Park and other conservation lands, the PL makes a relatively modest contribution to ecosystem services such as water yield in the Clutha catchment and has an equally modest potential for carbon storage. However when the contributions from this property are combined with those gains associated with these other lands, benefits are significant.

Much of the existing tussockland and shrubland has potential for further carbon sequestration if management practises including stock grazing, spraying and burning were to cease. Likewise, the succession of montane shrublands to forest is also limited by stock grazing and shrubland clearance.

2.8 Historic

Historic records and Previous Archaeological Surveys

There have been no previous historic surveys undertaken on the PL, and there are no recorded archaeological sites listed with ArchSite (NZAA database).

2.8.1 Pre-contact Maori Sites

The lake shore contains many sheltered bays that would have provided safe landing places for Maori travelling around Lake Wanaka. The Ngai Tahu Deed of Settlement map dated 1879 – 80 (Beattie 1920) shows four named areas alongside the lake edge, including 'Te Kahika' at the mouth of Minaret Burn. Two smaller bays north of Minaret Burn (GPS 037) would have provided a safe haven as does Minaret Bay and Snag Bay. A Statutory Acknowledgement

area applies to Lake Wanaka, which is noted as a traditionally rich tuna (eel) fishery (Schedule 36, Kai Tahu ki Otago 2005: 184 - 185).

There is a high likelihood that cultural values around the lake shore pre-date Ngai Tahu influence in the Lakes District. Radiocarbon dates from an urupa at Hospital Flat supports the interpretation that some Maori lived permanently in the interior during late 1500's to early 1600's (Allingham 2007). Allingham also recorded a cultural charcoal layer exposed in the lake edge north of Minaret Burn at the southern extent of the high terrace where stock yards are located (GPS 054). This area is named 'Katikao' on the 1879 - 1880 Ngai Tahu Deed of Settlement map.

Hassing (1930) stated that a good many Maori resided on the shores of Lake Wanaka as they did at every lake in the early days before the arrival of Ngai Tahu.

2.8.2 European Heritage Values

Exploration

Nathaniel Chalmers was the first white man to view Lake Wanaka in 1853 accompanied by Reko, a Maori chief from Tukurau, and another elderly Maori, Kaikoura. H S Thomson and John Roy travelled through the Lindis Pass and up the Clutha River in 1859. They made a raft to cross the Clutha River and surveyed the land west of Lake Wanaka. The following year, G M Hassing and H S Thomson explored the head of Lake Wanaka where Thomson claimed the mountainous district known as West Wanaka. Twin Peaks, the Minarets and Rumbling Burn were named by James McKerrow during survey work around Lake Wanaka in 1862, accompanied by John Goldie and James Bryce. John Goldie borrowed a boat from Thomson to continue around inaccessible parts of the shoreline (Angus 1981; Beattie 1947, 1948; Hassing 1930; Ritchie 1980).

Vincent Pyke, Otago's Secretary to the Goldfields, accompanied by the Mining Surveyor Julian Coates, travelled through Minaret station in 1865 to find a practicable road line through to the West Coast (Otago Daily Times 1865). The party had to seek shelter in a small sheltered bay below Cameron's hut, a little to the south of Estuary Burn. Vincent Pyke named the bay Windbound Bay and Estuary Burn (also known as Pyke's Valley).

History of Pastoralism

William Filleul and his brother Richard took up the first licence for Minaret Station in about 1860. A C Thomson briefly operated a station at Minaret Peak, being granted an agricultural pre-emptive right to occupy Run 337, Section 2 south of the Albert Burn in March 1876. A track around the shoreline south from Thomson's pre-emptive right in Minaret Bay was in place by June 1875.

Thomson was instrumental in planting and raising trees from seed on a large scale including gum, *Wellingtonia*, cypress, insignia and firs (Otago Witness 1881). Some of these trees are still present. In the late 1870's, 12,000 sheep were recorded on Minaret Station (Angus 1981).

Minaret Station transferred to the Scotch Trust Co Ltd in 1872 and the PL was abandoned in the late 1880's (Angus 1981). At this time, the big sheep runs around the lake were beginning

to suffer from rabbit plagues, falling wool prices, and falling production due to declining grazing because of the destruction of the native grass cover.

The PL was taken up by William Dansey around 1893, while W and H Ewing took over Minaret Station in 1911 (Pinney 1981, Roxburgh 1977).

Charles and Frederick Freeman applied to cultivate 300 acres at Snag Bay in 1920. Runs 337 and 337A were transferred to Charles and Frederick Freeman in 1926. The run was transmitted to May Freeman and John Thompson in 1949 (Minaret pastoral lease file: Archives Wellington)

The PL was transferred to the Presland's in 1950, who retained a freehold section at Minaret Bay (Section 1 32 hectares) when they sold the PL to Sir Tim Wallis and family. This freehold section contains the original homestead and yards. The run boundaries have remained much the same throughout the history of the PL (Roxburgh 1990).

Sawmilling

In January 1860, the runholders of neighbouring West Wanaka Station, Messrs Stuart and Kinross, employed Hassing and Boddington to cut posts, rails, shingles and sawn timber for their run. They erected a hut in a small white - pine forest about three miles north of West Wanaka station at the mouth of Minaret Creek and established a pit saw mill, which they operated until the summer of 1861. (Angus 1981; Hassing 1930; Roxburgh 1977).

George Hassing was the first to start pit sawing at Makarora Bush in 1861 and introduced rafting of timbers down the lakes and the Upper Clutha River.

Survey Method

A survey of historic resources on the PL was conducted in two days. However, some areas were not surveyed. GPS coordinates taken to locate archaeological/historic features are depicted on Map 4.2.4. A list of waypoint coordinates will be held in the Otago Conservancy's historic database.

Historic Heritage Description

The archaeological/historic features include musterers' huts (stacked stone ruins and tin huts), shelter shed, a derelict wharf and shelter shed, 19 – 20th century fence lines, and 19th century Trig Stations (see Table 12 below). Photos of historic sites are provided (see Section 4.3.2).

Table 12: Key historic features recorded on Minaret PL

GPS ID	Description	New NZAA site record	GPS ID	Description	New NZAA site record
028	Trig AA	F39/13	050	tin hut Rough Burn	
029	stone ruin Bells Creek	F39/10	051	tin hut Bay Burn	
030	flat standard fence line		052	old wharf and shelter shed Minaret Bay	F39/12
032	tin hut mouth of Bells Creek	F39/16	053	tailing fence into lake	
033	wood post and flat standard fence line		055	stone shelter and 3 legged cooking pot, mouth of Minaret Burn	F39/8
036	flat standard fence line north of Minaret Burn		062	stone ruin upper Bells Creek	F39/11
046	tin hut Bells Creek			Trig CC Twin Peaks	F39/14
047	tin hut Estuary Burn				
048	stone ruin Estuary Burn	F39/9			

(i) Pre-contact Maori Sites

A fresh water mussel shell was noted beside a natural wetland at Snag Bay (GPS 039). The wetland is shown as a lagoon on SO 8324 (dated 1876). Brian Allingham recorded a blackened cultural layer containing fire cracked rock and fresh water mussel shell below a rock shelter at the foot of the Rambling Burn in Snag Bay directly west of the lagoon. Ngai Tahu will report on cultural values in a separate report.

(ii) Pastoral Farming***Huts***

A list of musterers' huts located on the PL, with their construction type and date, is held by the Dept. of Conservation. Dry stacked stone huts were constructed by W and H Ewing in around 1916. The later wood frame and iron huts were constructed by C & F Freeman in about 1935, and by E & F Presland in the 1950 – 1970's. It is not known whether the hut/tent sites indicate locations of earlier occupation sites, as it seems unlikely that no musterers' huts were on the PL prior to 1916. The site of Cameron's hut, noted in an Otago Daily Times (August 1865) article as being a little to the south of Estuary Burn, was not re - located.

Stacked stone hut/tent sites

A stacked stone hut/tent site (F39/10) lies at the mouth of Bells Creek (GPS 029). The chimney cavity is not visible, and the size of the hut/tent is not discernible due to spoil and fencing wire having been pushed into the hut. The remaining right angled walls are two

rocks' width thick (0.4 m), measuring 2.1 m x 1.1 m long and standing 1.28 m. The walls are mud packed.

A stacked stone hut (F39/11) is located in upper Bell Creek (estimated at GPS 062).

A stacked stone hut (F39/9) resides on the true right of Estuary Burn (GPS 048). The hut measures 4.2 x 2.6 m internally with 0.6 m thick walls standing 0.62 m high. The chimney is 2.2 m wide and 1.2 m deep standing 2.2 m high. There does not appear to be any mud packing between the stacked stone. The hut most likely functioned as a musterers' hut.

Tin hut mouth of Bell's Creek (F39/16)

A tin hut with kanuka pole framing and external flue chimney is located further inland from the mouth of Bells Creek (GPS 032). The hut measures 3.2 x 2.6 m externally and the doorway measures 1.99 m high. The corrugated iron cladding displays a red Lysaght Globe maker's mark, made in Bristol for the American and African markets but ended up being exported to Australia. John Lysaght registered the Globe Brand in Western Australia in 1887 (Lewis 2009, Warr 2000). Various artefacts are scattered around the hut including crown seal brown beer bottles, metal food tins, billy tin, clear glass bottles and jars.

Other structures

An open fronted shelter shed (F39/12) sits above the derelict wharf in Minaret Bay (GPS 052 Plate 12). The shed is clad with corrugated iron displaying a Redcliffe Crown maker's mark first manufactured in 1887 by Redcliffe Crown Galvanized Iron Company of St Philip's, Bristol (Lewis 2009).

Fencing

Modified and/or collapsed 19th - 20th century fence lines were recorded on the PL. A collapsed metal flat standard fence line lies at the mouth of Bells Creek (GPS 030). A collapsed triangular split wood post (possibly totara) and metal flat standard fence line (GPS 033) runs north – south below the tin hut in Estuary Burn. The fence contains four No. 8 wire strands, with galvanised wire added at a later date. As at September 1925, the Freeman Brothers were noted as being able to only fence off three blocks (Minaret pastoral lease file: Archives Wellington). A wooden post and wire fence line lies inland of Minaret Bay (GPS 041) along the boundary of the Freehold section. Many of the posts are blue gum, derived from the historic planting, of which some trees are still alive (~130 years old).

Snow line fence

A metal flat standard fence line, located north of Minaret Burn (GPS 036), is a snow line fence that runs north to the Albert Burn (Jonathan Wallis pers.comm.).

Wharves

Wharves have been an important component of life on Minaret Station as the property lacks access by land. Four wharves are historically located on the PL. One is located at Snag Bay, two at Minaret Bay (one derelict wharf at GPS 052), and one south of Bells Creek. The derelict wharf (F39/12) in Minaret Bay was constructed by Mr Freeman with assistance from the County Council. The wharf was built possibly using bluegum piles some years prior to being damaged by flooding in 1924. Mr Freeman requested financial help from the Marine Department to re-build the wharf, but the request was turned down as it was considered a private matter servicing only one settler (Minarets Wharf file: Archives Wellington).

Sawmilling

A stacked stone feature (F39/8) at the mouth of Minaret Burn lies 19 m above the beach berm (GPS 055). This feature may relate to George Hassing and William Boddington who built a hut at the mouth of Minaret Creek and operated a pit saw mill in 1860. Their saw mill may have been located on the true right of Minaret Burn outside the PL, although it is highly likely that they felled trees on the Minaret run side of Minaret Burn. Part of a three legged cooking pot lies on the ground surface within the stacked shelter.

Trig Stations

Three 19th century Trig stations exist on the PL although only two Trigs were visited during the survey: Trig 'AA' (code B2Q9) and Trig CC (B10W). These were both established May 1873 by Connell and Moodie.

Trig 'AA' (F39/13) consists of a 29 mm diameter galvanised pipe in a concrete plug set at ground level south of Bells Creek (GPS 028). The Twin Peaks Trig station, Trig CC (F39/14), consists of a metal flat standard.

Significance of Historic Values

The archaeological and historic evidence present on the PL reside within a wider historic landscape rather than existing as individual or isolated sites. Map 4.2.4 shows the distribution of historic values in the PL.

Significance is accorded to Maori use of the PL, historic sites and features related to 19th - 20th century pastoral history and transportation, and early sawmilling activity. George Hassing and William Boddington are known for founding the timber industry in the area (the first to start pit sawing at West Wanaka 1859 and Makarora Bush in 1861) and introducing the rafting of timbers down the Central Otago lakes and Upper Clutha River (Angus 1981, Hassing 1930, Roxburgh 1977).

The surveyors' markers (Trig stations) are of significance and should be noted as important 19th century reference points for pastoral land subdivision.

2.9 Public Recreation

2.9.1 Physical Characteristics

Historically, little public recreation has taken place on the PL because of the physical barrier that Lake Wanaka poses to the east, and the property's isolation from formed public roads. However there are ample high quality public recreation opportunities on the PL that arise from the following:

- It's location on the western shores of Lake Wanaka provides opportunities for lakeshore activities

- An existing stock access route, cut by the County Council in the 1950s, provides a physical (though not necessarily legal access) route along the western shores of Lake Wanaka, both on the PL, and to the south (West Wanaka Station/conservation lands) and north (Mt Albert Pastoral PL). A public access easement on West Wanaka Station provides access from Homestead Bay to the Minaret Burn
- The large size and natural characteristics of the property, and its proximity to existing conservation lands and Mt Aspiring National Park, provide an excellent setting for activities including multi-day tramping trips in a spectacular montane/alpine setting
- Aircraft access is already available to the PL, and provides an opportunity for more recreational use of the area.

In 1989, Federated Mountain Clubs compiled an outdoor recreation plan for Otago (Mason 1989) which included an area labeled "West Wanaka". The area that includes the lake front slopes, most of Bell's Creek, Rough Burn, Minaret Burn and Estuary Burn valleys is zoned "Open Space". Here, "sensitive landscape treatment is required to ensure maintenance of the scenic qualities for which the whole region is renowned". The document recommended that more informal camping areas be provided around Lake Wanaka.

The remainder of the PL is zoned "Natural Experience". Within this zone, the document recommends that practical public foot easements be provided across the PL to conservation lands.

Although somewhat out of date, in 1992, DOC compiled a Recreation Opportunity Spectrum (Harper 1992) for the entire Otago Conservancy whereby all areas regardless of land tenure were classified and mapped according to setting, activity and recreational experience characteristics.

The zoning on Minaret Station reflects the PL's altitudinal sequence and wide variety of topography.

The front faces down to the shores of Lake Wanaka are zoned "Backcountry 4WD Drive In" which "is characterised by a feeling of relative remoteness from populated areas". "The highly natural setting is a valued part of the experience and may be associated with motivations of "escape from town", education and nature appreciation".

The majority of the property, except the Lake Wanaka front faces, and the headwaters of the catchments, is zoned as "Backcountry Walk In", the definition of which is similar to "Backcountry 4WD Drive In" except that "although relative close to visitor developments, access to these areas is only possible on foot and is often associated with tramping tracks or routes."

The headwaters of the Minaret Burn, Estuary Burn, Albert Burn and Rough Creek are zoned as "Remote Experience". "This opportunity is characterised by a sense of complete isolation from human interaction and activity. The naturalness of the setting is an important part of the experience. Outdoor survival skills and experience will be essential to minimise risk. A high degree of self-reliance will be necessary." Recently, Minaret Station has been granted a recreation concession to operate a tented lodge accommodation in the upper Estuary Burn, serviced by helicopter. This activity somewhat changes the "Remote Experience" zone that was historically applied to this area.

When completed, the next Otago Conservancy Conservation Management Strategy, due for public notification completion in September 2012, will be the Department's guiding document.

2.9.2 Legal Access

Map 4.2.1 shows where marginal strips and legal roads exist on the PL.

a) Marginal Strips

A marginal strip along the shores of Lake Wanaka provides legal (though not necessarily practical) access along the entire eastern boundary of the property. Marginal strips extend along the Minaret Burn, the lower 3-4 km of Bells Creek, Estuary Burn, the lower 6-7 km of Rough Burn, the lower 2 km of Bay Burn and at the mouth of the Albert Burn. The marginal strips around the lake are fixed, under Section 58 of the Land Act 1948. These may be redefined on survey. Marginal strips on streams were created on lease renewal in 1994 under part IVA Conservation Act, and are moveable.

b) Legal Roads

A short section of partially formed legal road provides access from the shores of Lake Wanaka at Minaret Bay to a small block of freehold land encompassing the homestead and shearers quarters.

c) Adjacent Public Lands

Conservation lands adjoin most of the PL. These include Minaret Burn Mouth Conservation Area to the south, beside Lake Wanaka; Albert Burn Conservation Area to the north and north-west; Mount Alta Conservation Area to the south-west. Mount Aspiring National Park is located nearby, to the west and north of Albert Burn Conservation Area. There are two public access easements across West Wanaka Station that provide legal foot, bike and horse access across a block of freehold land in the lower Minaret Burn to land on the PL. One provides access to the mid Minaret Burn, while the other provides access to the mouth of the Minaret Burn.

d) Air Access

Alpine Helicopters, operated by the Wallis family, already provides air access to the PL for a range of commercial recreation activities. The ability to access the more remote parts of the PL would facilitate more recreational use of the area.

2.9.3 Activities

The PL has difficult access due to its location on the far side of Lake Wanaka. This has resulted in less public recreational use than would be expected for a property with such a spectacular mountain setting with pristine rivers, native bush, spectacular alpine basins and peaks that rival Mt Aspiring National Park.

Water-based and Shore-based Activities

Traditional recreational use of the PL has been water/lakeshore-based activities including boating, kayaking/canoeing, camping, short walks, fossicking, and landscape appreciation.

Recreational Fishing

While not strictly within the PL, most fishing takes place along the shores of Lake Wanaka. Snag Bay Lagoon holds a moderate population of brown trout and has been historically fished by anglers. It is fed by the Rambling Burn where fish spawn in the inlet and a short distance upstream. Fishing also takes place at the Albert Burn lagoon.

Mountain Biking

The Minaret farm road that traverses the PL beside Lake Wanaka, provides a 25 km long route within the PL suitable for mountain biking. Mountain bikers either get dropped off by boat at the Albert Burn mouth, or there is the potential to bike from Makarora via the roughly cut track down to the Albert Burn. Parties can continue southwards beyond the PL to Wanaka via easements on West Wanaka Station and Conservation Areas.

Walking

The Minaret farm road described above also provides an interesting walking route along the shores of Lake Wanaka.

Horse Trekking

The lakeshore route described above has been used in the past for an Otago Cavalcade horse trekking group. It is possible to ride from Makarora to Wanaka along the western side of the lake.

Tramping

The PL has better weather than Mount Aspiring National Park located further to the west, and provides both complementary and linked tramping opportunities.

A number of multi-day trips are possible on the PL. It is possible to travel up the Minaret Burn to the top forks, and up and over Minaret Saddle to the South Albert Burn flats (on adjacent conservation land). From here, trampers can travel up the river flats and slopes to the South Albert Burn Saddle, then descend to the Matukituki valley either via Dragonfly Peak (2165 m) or down to the East Matukituki valley on the true right of Hester Pinney Creek (Spearpoint 2005).

It is also possible to travel up the Estuary Burn, over PT 1546m saddle that provides access to the Minaret Burn (Spearpoint 2005), and then link into the tramping trip described above.

A number of loop routes that start and end at Lake Wanaka are feasible: between the Albert Burn and Estuary Burn or Minaret Burn (following the route described above), or between the Rough Burn and North Branch of Estuary Burn.

In addition, the valleys present on the PL provide opportunities for 'there and back' trips in a remote and attractive setting.

Mountaineering

Minaret Peaks (2193 m asl) are infrequently climbed.

Ski Touring

There are opportunities for interesting ski touring trips on the PL, given the terrain, snow pack and altitude. Some parties may choose to utilise a helicopter to provide access to the back of the PL.

Hunting

Recreational hunters occasionally visit this remote and mountainous terrain to hunt deer and chamois.

Commercial Recreation

Activities associated with Minaret Lodge Concession

Minaret Station has a concession to operate luxury tented lodge accommodation in the Estuary Burn with helicopter access provided by Alpine Helicopters. The Minaret Station website offers guests a range of activities on the PL including heli-skiing, heli-touring, hiking, mustering, wild game stalking, guided hunting, high country farm tours, alpine picnics, photography and artist tuition.

Heli-Skiing

Alpine Helicopters has a concession to heli-ski on the property; opportunities for heli-skiing are likely to increase. Other concessionaires provide opportunities to heli-ski on nearby Mt Alta and Albert Burn Conservation Areas.

Angling

Fishing guides take clients to Snag Bay Lagoon where there are a small number of good sized sport fish present.

Multi-day Adventure Racing

Competitors of the Iron Man adventure race that took place in about 1998, travelled up the Minaret Burn over to the Matukituki Valley.

Significance of Recreation

Routes of recreational significance are shown on Map 4.2.5.

While there has been some recreational use of the PL with landholder's consent, patterns of recreational use on the PL have been hampered by the isolation of the property, and lack of legal access to it. However, through tenure review, public access to the boundaries of the PL have, in recent years, improved, which, together with improved access to, and on the PL, a gradual increase in recreational activity might be expected.

The physical characteristics of the PL make it of regional importance in terms of potential recreation use. The PL provides a stunning setting for recreational activities including tramping, ski touring, walking, mountain biking and horse riding. The PL, surrounded by large tracts of existing Conservation Land, including Mount Aspiring National Park to the west, is strategically important. The PL, having better weather than the National Park to the west, provides opportunities for both complementary and linked-through tramping trips, some of which are described in Moir's Guide (Spearpoint 2005).

There are opportunities for commercial recreation, including heli-skiing.

There is potential for a long distance lake-side walkway/bike trail up the western side of Lake Wanaka from Homestead Bay (West Wanaka) to Makarora. Existing legal access easements across West Wanaka Station and adjoining conservation land already provide public access to the southern end of the PL, and a physical route continues north across Mt Albert Pastoral PL, access over which may be addressed through tenure review in the future. Access to the trail could be facilitated through the use of one-way boat access across the lake from SH6.

The PL has a high profile location, adjoining Lake Wanaka where the Makarora Lake Hawea Road (SH6) follows the opposite lake shore near to The Neck. This Highway is a major route for recreationists wishing to access Mount Aspiring National Park via Makarora. With boat and air access, the PL has the potential to greatly increase the breadth of recreational opportunities in this locality.

Boat usage on Lake Wanaka is likely to increase. The PL provides an excellent setting for water-based recreational activities.

PART 3: OTHER RELEVANT MATTERS & PLANS

3.1 Consultation

The following comments were made at the meetings with NGO's in Clyde on 22 September 2011:

- Important forest stands including mountain toatoa and matai.
- Want track along lake shore from West Wanaka, north.
- Lots of waterways have lost their cover from development. These need to be protected with buffers.
- Issue with nutrient input affecting water quality of streams and Lake Wanaka.
- Easements needed over any new freehold to get to rivers.

Federated Mountain Clubs (FMC) provided this summary of issues for the meeting:

- High country above ~1000m asl; LUC Class VIII & VIIe hence probably not eco-sustainable. Designate for Conservation.
- Potential for additional land to go to Mount Aspiring National Park.
- Beech forest and native forests on shady S faces likely to have high SIVs; designate for conservation.
- Limited narrow strips of LUC Class VI or better in upper valleys suitable for freehold.
- Significant areas on true right of valleys (sunny faces) might be suitable for eco-sustainable land use and hence freehold.
- Lower country could be eco-sustainable and hence freehold, but likely to contain islands of higher land (Non-sustainable, or areas of native shrubland which might be protected under Covenant).
- Public access easements over new freehold in Minaret Burn and Albert Burn valleys, fur access to Conservation land beyond the Western boundary.
- Public access for walk, bike and horses along lakeshore track but need to avoid homestead. Could go over Trig BB to avoid disturbing owner's privacy.

The full written submissions by Federated Mountain Clubs and Forest and Bird Protection Society (Dunedin and Central Otago-Lakes Branches) are included (Section 4.4).

3.2 Regional Policy Statements & Plans

Regional Policy Statement

The Regional Policy Statement for Otago provides a policy framework for all of Otago's significant regional resource management issues. It does not contain rules. District Plans shall not be inconsistent with the Regional Policy Statement. In respect of natural values the Regional Policy Statement includes the following policy and method statement:

- Policy:** To maintain and where practicable enhance the diversity of Otago's significant vegetation and significant habitats of indigenous fauna, trout and salmon.
- Method:** Identify and protect Otago's significant indigenous vegetation and significant indigenous habitat of indigenous fauna, trout and salmon, in consultation with relevant agencies and with Otago's communities.

In respect of landscape and natural features it includes the following policy and method statement.

- Policy:** To recognise and provide for the protection of Otago's outstanding natural features and landscapes.
- Method:** Prepare in conjunction with relevant agencies and in consultation with the community and affected landowners, an inventory of outstanding features and landscapes that are regionally significant.

Regional Plans

Within the Otago Regional Council Regional Plan: Water for Otago, the Minaret Bay Swamp is identified as being a Regionally Significant Wetland and also all tributaries of Lake Wanaka are noted as being sensitive to suction dredge mining and so consent is required to undertake such an activity.

Protection via the RMA is therefore limited to the controls set out above.

3.3 District Plan

The PL is identified in the operative Queenstown Lakes District Plan (the Plan) as being within the General Rural Zone.

The Plan requires that consent be gained for the clearance of areas of indigenous vegetation greater than 0.5 hectares; or where threatened plants (as listed in an appendix) are present; or in areas over 1070m asl.

Consent is also required for: earthworks over and above specified thresholds; subdivision and subsequent development; buildings; forestry and also ski area activities. Forestry is prohibited in areas above 1070m asl.

There are no registered historic sites or protected features as set out in the Plan appendices.

3.4 Conservation Management Strategy & Plans

The Otago Conservancy of DOC has prepared a Conservation Management Strategy (CMS) which was approved by the New Zealand Conservation Authority in August 1998.

The PL lies within the *Western Mountains* zone, which includes Mount Aspiring National Park to the west. The CMS notes that 'this zone has some of the highest remote experience and wilderness recreational values in the Otago Conservancy, because of its high degree of

naturalness, the large area of true wilderness and the variety of recreational resources'. Recreational issues to be addressed in this zone include retention of quality of wilderness and remote experience, and accommodating increased user numbers.

The CMS identifies 41 special places of conservation interest in Otago Conservancy. Most of the Lease is incorporated in the Matukituki Special Place.

Matukituki Special Place

The Matukituki Valley is important as the highly scenic corridor leading from Wanaka to Mount Aspiring, and the surrounding mountain lands have high nature conservation values in their own right.

Objectives for Matukituki

To protect the high landscape and ecological values of this major access corridor and buffer to Mount Aspiring National Park and provide for an appropriate range of recreational uses compatible with the character of the valley and surrounding mountains and with the maintenance of high quality visitor experiences.

Key implementation statements to meet this objective that are relevant to this tenure review include the following:

- Formal protection will be negotiated for areas of *Olearia hectorii*.
- Improve legal foot access from Raspberry Hut to the Aspiring Hut Conservation Area.
- Building controls and sensitive use of the valley will be advocated to protect the high landscape values.
- Freshwater fish surveys of the areas will be undertaken.
- Recreation and tourism concession activity will be permitted on the lands administered by the department if consistent with the objective. Helicopter concessions in the valley are considered inappropriate.
- Goats will be controlled to prevent their migration into the Mount Aspiring National Park using the Judas goat programme in accordance with the goat control plan.
- Opportunities that may arise through pastoral lease tenure reviews will be used to negotiate for the protection of areas of high landscape and biological importance, to secure recreational access to valued areas, and to lead to more efficient conservation management.
- Thar will be eradicated from the area in accordance with the national thar control strategy, and incidental control of chamois will be undertaken.
- Investigation of cross-country skiing opportunities off the ski field and elsewhere in the area will be undertaken, and negotiations with landholders initiated where appropriate.
- Promote Kai Tahu place names, and promote Kai Tahu traditions in interpretation.

Priorities for Matukituki

Improving the security of and opportunities for enhanced public enjoyment of this Special Place will be a priority.

Te Wāhipounamu - South West New Zealand World Heritage Area

The property is surrounded by the Te Wāhipounamu – South West New Zealand World Heritage Area, which is one of the world’s 400 or so special natural and cultural sites, as recognised by UNESCO. IUCN have recognised it as one of the world’s great areas of wilderness. Currently, The World Heritage area consists of 2.6 million hectares of conservation land in the West Coast, Canterbury, Otago and Southland Conservancies.

One of the key Implementation goals for the Te Wāhipounamu Te Wāhipounamu – South West New Zealand World Heritage Area is to “consider the addition of areas of high conservation value to Te Wāhipounamu – South West New Zealand World Heritage Area”. This could include those parts of the PL that exhibit similar characteristics as the adjoining areas of Heritage Area.

3.5 New Zealand Biodiversity Strategy

The New Zealand Government is a signatory to the Convention on Biological Diversity. In February 2000, Government released the New Zealand Biodiversity Strategy which is a blueprint for managing the country’s diversity of species and habits and sets a number of goals to achieve this aim. Of particular relevance to tenure review, is goal three which states:

Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments, and do what is necessary to:-

Maintain and restore viable populations of all indigenous species across their natural range and maintain their genetic diversity.

The strategy outlines action plans to achieve this goal covering terrestrial and freshwater habitat and ecosystem protection, sympathetic management, pest management, terrestrial and freshwater habitat restoration, threatened terrestrial and freshwater species management, etc.

3.6 Protecting Our Places

In April 2007 the Ministry for the Environment produced a new policy document titled ‘Protecting Our Places’ which was jointly launched by the Minister of Conservation and the Minister for the Environment. This publication introduces four national priorities for protecting rare and threatened native biodiversity on private land. The national priorities identify the types of ecosystems and habitats most in need of protection.

The policy statement supports the government’s pledge to maintain and preserve New Zealand’s natural heritage. This began in 1992 when New Zealand signed the United Nations

Convention on Biodiversity; followed in 2000 with the release of the New Zealand Biodiversity Strategy.

The four national priorities for biodiversity protection are listed below. They are based on the most up to date scientific research available.

National Priority 1:

To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

National Priority 2:

To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

National Priority 3:

To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

National Priority 4:

To protect habitats of acutely and chronically threatened indigenous species.

These national priorities have relevance beyond conservation initiatives on private land. For example they are used to help assess applications for grants under the government funded Community Conservation Fund which funds conservation projects on public land by community groups.

The national priorities also provide a useful measure for assessing tenure review recommendations and outcomes.

PART 4: ATTACHMENTS

4.1 Additional Information

4.1.1 References

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4.2 Maps

- 4.2.1 Minaret Topo/Cadastral Plan
- 4.2.2 Minaret Landscape Units and Values Plan
- 4.2.3 Minaret Botanical Values Plan
- 4.2.4 Minaret Historic Values Plan
- 4.2.5 Minaret Recreation Values Plan
- 4.2.6 Minaret LENZ Plan
- 4.2.7 Minaret Land Resource Inventory Plan

