

Crown Pastoral Land Tenure Review

Lease name : CAMBRIAN HILLS

Lease number : PO 069

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.

Note: Plans which form part of the Conservation Resources Report are published separately.

These documents are all released under the Official information Act 1982.

May 07

**DOC CONSERVATION RESOURCES REPORT ON
TENURE REVIEW OF CAMBRIAN HILLS PASTORAL
LEASE (P 69) UNDER PART 2 OF THE CROWN
PASTORAL LAND ACT 1998**



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PART 1

INTRODUCTION

1.1 Background

The lessee of the Cambrian Hills Pastoral Lease (the lease) Cambrian Hills Limited (the lessee) has applied to the Commissioner of Crown Lands for a review of the property's pastoral lease tenure.

The 3144 ha property straddles the North Dunstan Mountains, with the majority of it lying within the catchment of the eastern draining Shepherds Creek. The homestead is located on a freehold block approximately 5 km south of the lease. The lease rises from approximately 540 m on its southern boundary to approximately 1660 m on the southwestern boundary and is divided into nine farm blocks, the names, approximate location and extent of which are shown on plan 4.2.4.

The tenure review inspection of the lease was conducted by multi-disciplinary teams of two and eight people between 12th – 15th December 2004 (the invertebrate survey) and 17th – 19th January 2005 (the remainder of the tenure review inspection) respectively.

1.2 Ecological Setting

The lease is within the Dunstan Ecological District (ED), one of the eight districts that make up the Central Otago Ecological Region. The ED of approximately 88,500 ha comprises the Dunstan Mountains and a small area of the terrace lands southeast of the upper Clutha and lower Lindis Rivers. The landscape typifies the Central Otago pattern of fault-block mountain ranges uplifted along faults on their south-eastern edges and tilted to the north-west, while the vegetation patterns are characterised by altitudinal sequences and aspect contrasts.

Due to their relatively central location the North Dunstan Mountains are the driest of the alpine Central Otago ranges. Annual rainfall at the homestead is approximately 500 mm per annum, while the alpine zone receives approximately 1200 mm per year of precipitation.

The ED was surveyed as part of the Protected Natural Areas Programme (PNAP) in the summer of 1984/85 and the report was produced in 1995. An area within the lease was identified as a Recommended Area for Protection (RAP), being RAP A1: North Dunstan. This RAP is approximately 2760 ha (of which approximately 860 ha is within the lease) and contains a wide range of alpine and subalpine-montane communities. The relevant extract from the Lindis/Pisa/Dunstan EDs PNAP Survey is attached as Appendix 1.

The western boundary of the lease adjoins the Lauder Basin Conservation Area (conservation unit number G40110), a 1516 ha area of *Chionochloa macra* tussock grassland and other alpine communities.

PART 2

INHERENT VALUES: DESCRIPTION OF CONSERVATION RESOURCES AND ASSESSMENT OF SIGNIFICANCE

2.1 Landscape

2.1.1 Introduction

The lease spans a wide altitudinal and topographical sequence and contains the typical cross profile of the North Dunstan Mountains, being a moderately steep scarp face in the southeast, an upland plateau studded with tors and rocky outcrops, followed by long back slopes that abruptly change into dissected hill country in the northwest.

The lease shares a common boundary with several other pastoral leases being Mt St Bathans to the east, Cluden to the north and both Lauder and The Cambrian to the west. To the southeast, much of the low freehold country that borders the lease has been “worked” for the alluvial gold washed down from the surrounding hard rock slopes. Nestled amongst the gold workings are the old cob cottages of Cambrian, a goldfields town established by Welsh miners in the early 1860s.

The main physical components of the lease comprise a segment of the Manuherikia Valley floor, front valleys and ridges, the catchment of Shepherds Creek, an alpine plateau and the upper catchment of the Cluden Stream that flows directly north towards the Lindis.

The main access to the front country is via Cambrian Road while the easiest access to the backcountry is by utilizing the neighbouring lease’s access tracks, especially the gravel track that crosses through both The Cambrian and Lauder pastoral leases. The closest main rural service town is Ranfurly, about 50km southeast of the lease.

The lease was inspected from various vantage points along Loop Road in the Manuherikia Valley, the lease’s access tracks and neighbouring tracks.

The fundamental components of the landscape assessment included dividing the lease into four landscape units (LU) principally based on catchment areas. The extent of these LUs is defined on plan 4.2.2 attached. The following assessment criteria were applied to each unit to help determine its distinctive character and landscape values with the overall appearance of each LU being assessed by common descriptive terms that included landform, land cover and land use. The criteria used to assess and evaluate each unit’s landscape value were based on the following attributes:

- Naturalness – which is an expression of the degree of indigenous content of the vegetative cover and the extent of human intervention.
- Legibility – which is an expression of the clarity of the formative processes and how striking these physical processes are.
- Aesthetic values – which include the concepts of memorability and naturalness. Aesthetic factors, which can make a particular landscape vivid, include simplicity in landform, muted colours and fine-textured ground cover.
- Visual values – which are a subset of landscape values and relate to the visibility of a particular landscape or natural feature seen from public vantage points such as along district highways.

2.1.2 Lower faces (LU1)

Description

This unit includes all of the front slopes on the lease, being the whole of Welshmans Gully, the mid and upper catchments of Sailors Creek, the low terraces that border the valley floor of Shepherds Creek as well as a segment of the Manuherikia Valley. A surveyed line defines both the lower boundary of the unit and lease.

The valleys formed by Welshmans Gully and Sailors Creek dominate the landform. Separating these valleys are rounded ridges that descend towards the valley floor in the southeast. The side slopes of these two valleys are typically lightly dissected with the main watercourses being indented within the colluvial mantle. There is random rock outcropping within the mid section of the side slopes, while the head basin of Sailors Creek features a cluster of impressive castellated tors. Separating Sailors Creek and the adjoining Shepherds Creek catchment to the east is a block of disjointed hill country. Stretching out from the front hill country is the even-graded valley floor that tilts gently towards Dunstan Creek in the south.

The vegetative cover is strongly dictated by aspect and altitude with the valley floor being subdivided into a series of large paddocks clad in pasture. The grazing blocks that occupy the front valley and ridges are extensively covered in modified short grasslands that comprise fescue tussock, introduced grasses and clover. A notable feature is the discontinuous band of manuka shrublands that occupy the front slopes at about 750 m. The upper catchment areas of both of the main valleys are clad in narrow-leaved snow tussock with an abundance of golden spaniard. Crack willow intermittently lines the margins of the main water channels. Surrounding an old cob cottage (hereby termed the mud-brick house) is a mixture of cultural plantings that include pines, larch, willow, bay laurel and old fruit trees.

Landscape Values

A large proportion of this unit possesses moderate inherent landscape values attributable to the extent that much of the original ground cover has been converted into dry pastoral farmland. The upper section of Sailors Creek contains significant inherent landscape values due to the combination of the near-intact tall tussock grasslands punctuated by tors and substantial rock outcrops.

In landscape terms, the unit forms the transition between the productive farmland on the valley floor and the extensive grazing blocks in the high country. This gradual change in land use is a distinctive feature of the lease.

Visual Values

The unit has significant visual resource value owing to the fact that the front rangelands on the lease are an integral component of the broader Maniototo landscape. These front rangelands are visually accessible from the surrounding network of rural roads and from along SH84, especially in the Becks district. The visual accessibility to these front rangelands is due to the lack of high or intermediate landforms across the Maniototo Basin.

Potential Vulnerability to Change

LU 1 has the potential to be adversely affected by the changes in land use and activities including:

- Introduction of a geometric monocultural land use such as plantation forestry.
- Spread of wilding pines.
- Further subdivision of grazing blocks that would fragment the existing open grasslands.

- Inappropriate siting, design and colour of structures, e.g. communication installations on prominent high points and natural features.
- Unsympathetic tracking or other earth disturbances across prominent slopes and steep ridgelines.

2.1.3 Lower Shepherds Creek (LU2)

Description

This unit incorporates the mid section of the Shepherds Creek catchment. The upper boundary of the unit follows the upper limits of the craggy rock buttresses that protrude out from the colluvial mid slopes. The side boundaries extend to the parallel ridgelines while the portal formed by Shepherds Creek's wider alluvial valley floor defines the lower boundary.

The unit's primary landform is an elongated V-shaped valley that forks into two separate sub-catchments, being the west and north branches of Shepherds Creek. Moderately steep side slopes that are frequently dissected by incised watercourses characterize the mid section of Shepherds Creek. The channel for Shepherds Creek is contained within a permanent bed that winds around a series of intersecting spurs. The creek is bounded by water-worn boulders and follows a sequence of white-water riffles and rocky pools.

At the point where the main stream of Shepherds Creek forks, the surrounding landform changes with the side slopes becoming over-steepened and feature extensive rock outcropping that jut out from the near-vertical slopes. The watercourses are constricted within deeply-incised channels. A natural feature is the narrow rock-cut gorge through which the west branch of Shepherds Creek tumbles over a string of short waterfalls.

The vegetative cover follows a sequence that is strongly dictated by altitude, aspect and grazing pressure. The lower section is moderately modified with a high component of introduced grasses and legumes. There is a discontinuous ribbon of matagouri - Coprosma shrublands lining the stream's margin along with the occasional crack willow. The adjoining side slopes are clad in a fragmented pattern of regenerating matagouri - Coprosma shrublands, patches of manuka and modified tall tussock grasslands. There is an overall impression that the vegetation is slowly reverting to woody shrublands.

In the mid section of the valley, where the valley floor begins to taper, the vegetation is a mosaic of native "grey" shrublands, groves of young and mature broadleaf, *Dracophyllum* shrublands and small areas of narrow-leaved snow tussock. A special feature of this unit is the substantial community of Hall's totara that tends to be confined to the west-facing talus slopes, possibly because these slopes have been a natural refuge from previous fires. The lessee has been active in the control of wilding pines across the whole of Shepherds Creek catchment.

Landscape Values

This unit conveys very significant inherent landscape values attributable to the fact that the mid section of Shepherds Creek is a well-defined entity which contains a diversity of plant associations and landforms. The area's significance was recognized during the PNAP survey, particularly the creek's altitudinal sequence that spans from intact tall tussock grasslands in the upper section of the west branch down to the mixed shrublands in the mid section.

In essence, the attributes that make this unit significant in a landscape context include:

- The memorable natural features in the form of near-vertical pinnacles of up-thrusted rock.

- The mosaic of different plant associations and the sense of the increase in the dominance of indigenous species.
- An overall impression of being wild and scenic due to the sense of enclosure, dramatic rock formations and the presence of white tumbling water.
- The overall impression of being in the backcountry due to the absence of “built” elements.

Visual Values

LU 2 has only a moderate visual resource value, being well contained by high ridgelines which consequently help to reinforce the unit’s backcountry qualities.

Potential Vulnerability to Change

This unit has the potential to be adversely affected by changes in land use and activities including:

- Grazing by heavy browsers as this would be a threat to palatable native species such as broadleaf.
- Burn-offs as these could endanger the groves of Hall’s totara.
- Further infestation of crack willow along Shepherds Creek.
- Spread of wilding pines.

2.1.4 Upper Shepherds Creek (LU3)

Description

This unit takes in the upper catchment areas of both the west and north branches of Shepherds Creek. The northern limit to the unit is the saddle that forms the watershed between Shepherds Creek and Cluden Stream. The western boundary is defined by the rounded ridgeline extending out from the high alpine plateau. Features of the high alpine plateau are clusters of both castellated and block tors. Further to the west of this ridgeline are the headwaters of Lauder Creek that form a part of the Lauder Basin Conservation Area. The eastern boundary to the unit is the prominent ridgeline that ascends towards Dunstan Peak on the neighbouring Mt St Bathans pastoral lease. The lower limits to the unit follow the margins of the prominent rocky formations (LU2).

The landform is dominated by the dish-like basins that form the headwaters of the west and north branches of Shepherds Creek. The side slopes of these basins are generally moderate with the periodic concave gully lightly indenting the ground surface. Both the permanent and ephemeral watercourses contained within the swale gullies have their origins in stepped alpine flushes just below the main ridgelines. A specific feature of the west branch is the extent of slumping created by colluvial earth flows.

The vegetation is dominated by tall tussock grasslands, the principle species being slim snow tussock that conveys an overall impression of being of a similar density, stature and condition over the entire unit. Inter-tussock species include false spaniard, little blue tussock and the ubiquitous golden spaniard. The alpine flushes and finger bogs are dominated by *Carex* spp. and cushion mosses. Surrounding the block tors, the native grasslands have been heavily modified due to localized stock grazing and camping, usually on the leeward side. Cladding the highest points are cushion herbfields that are dominated by dwarf *Dracophyllum*, little blue tussock and areas of bare ground.

Landscape Values

The unit has significant inherent landscape values due to its homogeneous qualities derived from the subtle variations in the tall tussock grasslands laid over rounded and smooth landforms. The visual coherence of the unit is accentuated by the absence of any subdivision fencing. The visual unity is also reflected in the near-

monochromatic tonal range of the ground cover that spans from the light oatmeal colour of the snow tussock to the occasional bright-green patch transmitted from the alpine flushes.

This unit is a large tract of high country that contains remote and semi-wilderness qualities due to the absence of human “built” elements.

Visual Values

There are significant visual resource values in LU 3 as it contains one of the North Dunstan Mountains highest points (being the tor located at GR G40 478 889). The tor and the upper and mid slopes of the west branch of Shepherds Creek, are highly conspicuous from many public vantage points across the wider Maniototo Basin.

Potential Vulnerability to Change

LU 3 has the potential to be adversely affected by changes in land use and activities:

- Fragmentation of the coherent tall tussock grasslands through subdivision and land use intensification.
- Spread of wilding pines.
- Unnecessary earth disturbances, especially track formations over thinner soils and fragile bogs.
- Scalping of snow tussocks to form wide firebreaks.
- Introduction of any “built” elements.

2.1.5 Upper Cluden Stream (LU 4)

Description

LU 4 incorporates the upper section of the Cluden Stream catchment at the lease’s northern end. The southern limit to the unit is the dipping saddle that forms the watershed between the Cluden Stream and Shepherds Creek (LU3). The northern boundary follows an arbitrary surveyed line across the upper Cluden Stream catchment. The unit is contained both in the east and west by parallel ridgelines. In the east the ridgeline descends towards Cluden Pass.

The landform is typified by extensive colluvial side slopes that form the headwaters of the Cluden Stream. These side slopes are lightly incised by small runnels that link into permanent or ephemeral watercourses. There is a central spur that projects northwards from the low saddle. The ridgeline and upper slopes of the spur feature substantial rock outcropping. Owing to a large proportion of the unit being orientated towards the north, isolated areas are affected by wind erosion.

The vegetation is influenced by aspect and earlier pastoral management practices with the upper slopes being covered in modified tall tussock grasslands supplemented by golden spaniard, possibly fire induced. Fescue tussock grades in over the lower sunnier slopes along with introduced grasses such as browntop. Over the sunnier faces there is a wide distribution of hawkweed. The shadier faces on the central spur are clad in narrow-leaved snow tussock in good condition; also present is native broom and fine-leaved *Olearia* that is generally confined to the margins of the Cluden Stream. The lessee has been actively controlling wilding pines.

Landscape Values

LU 4 possesses moderate inherent landscape values and are representative of the dry northern faces of the North Dunstan Mountains. It does not contain any memorable or striking natural features or landscape characteristics, but in aesthetic terms, the unit does possess coherent qualities due to the uniformity of the ground cover.

Visual Values

LU 4 has only moderate visual resource value, being confined by the high corresponding ridgelines, which results in much of the upper Cluden Stream catchment only being visually accessible within a very restricted area towards the north.

Potential Vulnerability to Change

This unit has the potential to be adversely affected by changes in land use and activities including:

- Spread of wilding pines.
- Unnecessary earth disturbances.
- Any subdivision fencing and intensive land use that would fragment the existing vegetation pattern.
- The scalping of snow tussocks to form firebreaks.

2.1.6 Significance of the Landscape

A large proportion of the lease makes a significant contribution to the North Dunstan Mountains high country as it overlooks the Manuherikia Valley and the wider Maniototo Basin, forming the visual backdrop where most people in the district live, work and travel.

Also significant is lease's contribution to the maintenance of the landscape integrity of a large segment of the North Dunstan Mountains, especially the good quality and diversity of plant associations that range over a wide spatial area and altitude. Additionally of note is the visual legibility of the dynamic processes that have created the Shepherds Creek rock-cut gorge, particularly the western branch that features a series of small cascading waterfalls.

The levels of the landscape, the level of diversity and the degree of visual amenity all combine to create a vivid and memorable landscape. The extension of the lease over a wide landscape continuum that spans from unvarying tall tussock grasslands, descending to mature mixed shrublands and woodlands is also significant.

2.2 Landforms & Geology

2.2.1 Background

The lease lies on the northeastern slopes of the North Dunstan Mountains, one of the series of fault-block ranges that typify Central Otago. The main expression of the range's topography is through the folding (due to movement on the alpine fault) and subsequent uplifting, warping and dislocation of the Haast schist basement. The range is on a northeast trend, with a bold eastern fault-scarp face and smooth crest gently dipping to the west. The smooth upland topography of the schist is commonly exposed as tors.

2.2.2 Geopreservation Sites

The lease contains part of Geopreservation Site No. 324 North Dunstan. The topography of the site is characterised by rolling to steep colluvial mountain slopes and broad tops, gorges, coarse talus soils, waterfalls, periglacial features (soil hummocks, solifluction lobes), scattered tors, asymmetric valleys and large-scale slumping. The parent material is schist/semi-schist and derived colluvium and the soils are upland yellow-brown earths (Dunstan), yellow-grey earths (Arrow Blackstone) (Arand *et al.*, 1991).

2.2.3 Significance of Landform and Geology

The portion of site 324 contained on the lease is of international importance as it contains:

- a) a high diversity of soil-vegetation associations, reflecting the wide range of altitudes, aspects and landforms; and
- b) soils under relatively unmodified tussock grasslands are rare internationally.

Appendix 2 contains a comprehensive description of North Dunstan (324) (Arand *et al.* 1991, p.94).

2.3 Climate

Due to being in the relatively centrally located North Dunstan Mountains the climate experienced by the lease is typical of Central Otago with hot summers, cold winters and overall dry. Rainfall varies from 450 mm on the lower country to 1200 mm on the tops. The open tops are very exposed and subject to frequent winds up to gale force. Snow can lie on the tops for much of the winter and snowdrifts can persist on the upper slopes well into the summer.

2.4 Land Environments of New Zealand (LENZ)

2.4.1 Introduction

There are two databases that have been used to assess biodiversity protection (Walker *et al* 2004).

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* 2003). It is presented at four levels of detail containing 20, 100, 200 or 500 environments nationally. LENZ Level IV, the most detailed, is analysed below.
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 (most likely to be lost). This provides a measure for:

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

Based on these two criteria, five categories of threatened environments have been used 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

Refer to plan 4.2.4 for the LENZ map.

Table 1: Level IV LENZ Environments on the Lease

| Level 4 | % Indigenous cover remaining nationally | % Protected nationally | Indigenous Cover Change 97-02 nationally | Threat Category nationally | Approx. Area (ha) on the lease | Approx. % of lease |
|----------------|--|-------------------------------|---|-----------------------------------|---------------------------------------|---------------------------|
| N3.1d | 13.5 | 0.53 | Decrease | Chronically Threatened | 26.8 | <1% |
| N3.2a | 7.3 | 0.7 | No change | Acutely Threatened | 137.3 | ~4% |
| N5.1b | 0.63 | 0.55 | No change | Acutely Threatened | 0.003 | <1% |
| Q1.1a | 98.37 | 24.81 | No Change | No Threat Category | 650.3 | ~21% |
| Q1.1b | 77.1 | 8.43 | Decrease | Critically Underprotected | 44.4 | ~1% |
| Q1.1c | 91.23 | 17.86 | No Change | Underprotected | 1356.7 | ~43% |
| Q1.2a | 98.99 | 37.2 | No Change | No Threat Category | 91.9 | ~3% |
| Q2.2a | 39.92 | 3.91 | Decrease | Critically Underprotected | 796.9 | ~25% |
| Q3.3a | 96.91 | 25.62 | No Change | No Threat Category | 42.2 | ~1% |
| Q3.3b | 80.51 | 0.94 | Decrease | Critically Underprotected | 1.2 | <1% |
| Q3.3c | 90.03 | 17.21 | Decrease | Underprotected | 12.6 | <1% |

2.4.2 Significance of LENZ

The lease has the following land environments that are significant because on a national level the indigenous vegetation has largely been removed, and/or little of the environment is represented in lands protected primarily for conservation purposes.

- 4% of the lease contains 2 Level IV LENZ units (N3.2a and N5.1b) that have less than 10% of their land area still in indigenous vegetation cover (whether protected or unprotected). These are ‘Acutely threatened’ environments.
- 27% of the lease contains 3 Level IV LENZ units (Q1.1b, Q2.2a and Q3.3b) that have 30% or more of their land area still in indigenous cover and <10% is protected. These are ‘Critically Underprotected’ environments.
- 44% of the lease contains 2 Level IV LENZ units (Q1.1c and Q3.3c) that have >30% of their land area still indigenous cover and 10-20% protected. These are ‘Underprotected’ environments.

2.5 Vegetation

2.5.1 Introduction

General site description

Overall the vegetation reflects a long history of grazing with areas of exotic grassland on the terraces and lower slopes grading into snow tussockland above. Valley floors and steeper, rockier, sites support varying density native shrubland often intermixed with exotic shrubs, sometimes predominantly so. Several fire refugia are evident.

Original vegetation

The pre-human vegetation of the lease is based on evidence provided in Walker *et al.* (2003).

Fellfield zone on Dunstan Peak and North Dome containing primarily open rock with scattered cushion and mat-forming herbs and woody species. Rock outcrops would shelter more sensitive high altitude herbs and shrubs.

The cushionfield zone would occur on the slightly less exposed flanks of Dunstan Peak and North Dome and sheltered sites in the fellfield zone. This zone would be dominated by cushion-forming herbs and *Dracophyllum muscoides*.

A subalpine shrub and tussockland zone containing low snow totara *Podocarpus nivalis*, celery pine *Phyllocladus alpinus*, bog pine *Halocarpus bidwillii*, *Myrsine nummularifolia*, *Melicytus alpinus*, *Gaultheria depressa*, *Ozothamnus leptophyllus*, *Dracophyllum* spp. and *Pimelea* spp. This would grade into higher altitude narrow-leaved snow tussockland (*Chionochloa rigida*) with patches of slim tussock *Chionochloa macra*, hard tussock *Festuca novae-zelandiae* and blue tussock *Poa colensoi* extending to the cushionfield and scattered into sheltered areas of the fellfield zones.

A montane to subalpine zone containing Hall's totara *Podocarpus hallii* and celery pine with stands of mountain beech *Nothofagus solandri* var. *cliffortioides* and occasional three finger *Pseudopanax colensoi* var. *ternata*. Shrub species such as *Aristotelia fruticosa*, *Myrsine divaricata*, *Dracophyllum longifolium*, *Coprosma* spp., with matagouri, *Coprosma propinqua*, *Melicytus alpinus*, coral broom, snow totara, *Brachyglottis cassinioides* and *Muehlenbeckia complexa* occurring on exposed sites.

A low montane valley floor zone with stands of *Hoheria* spp., *Olearia bullata*, *Coprosma intertexta* on valley floors grading into the montane zone as described above. Wet seepages would have a moss-based herbfield and some sedgelands.

A lowland zone containing stands of kowhai *Sophora microphylla*, kanuka *Kunzea ericoides* and black beech *Nothofagus solandri* var. *solandri* with intermingled *Coprosma* spp., *Corokia cotoneaster*, *Olearia odorata*, *O. lineata*, matagouri, *Melicytus alpinus* and *Muehlenbeckia australis* on valley sides. Valley floors and lower slopes were likely to contain broadleaf *Griselinia littoralis* forest with *Plagianthus regius*, *Coprosma lineariifolia*, *Olearia lineata*, *Olearia bullata*, and *Hebe salicifolia*. Steeper, rockier sites would have *Dracophyllum uniflorum*, *Dracophyllum longifolium*, *Melicytus alpinus*, *Helichrysum intermedium*, *Muehlenbeckia complexa*, blue tussock and hard tussock.

Dry terraces would have had extensive *Raoulia*, *Muehlenbeckia axillaris*, and bidibid (*Acaena* spp.) mats with sparse native grasses and tussocks, other herbs, native broom species and occasional taller shrubs of matagouri, *Coprosma* and *Olearia* species.

Overview of current vegetation patterns in area

Vegetation patterns for this area are described in Ward *et al.* (1995) and Peat and Patrick (1999).

Vegetation patterns of the Northern Dunstan Mountains are characterised by altitude-induced zonation, moisture availability and past land-use history. At higher elevations cushionfield and herbfields with wetland flushes predominate with extensive slim snow tussockland quickly intergrading into narrow-leaved tussockland over much of the lower elevations except for terraces, lower hills slopes, valley floors and bluffs. Lower hill slopes and terraces are primarily exotic grassland with common matagouri shrubland and increasing dominance by *Coprosma propinqua*, particularly nearer streams and around rock outcrops. Manuka and kanuka shrublands, much reduced in extent, are also present. Broadleaf forest remnants are scattered in gullies. Steep and rocky sites have allowed the survival of species and vegetation communities that are rare in the locality.

Vegetation descriptions

Much of the pre-human vegetation predicted for the lease has been lost or drastically altered, though near natural examples exist at higher elevations (above c. 1000m) with scattered remnants below this centred on gullies, rocky sites and fire refugia.

The lease has a very diverse native flora with 306 species recorded during the tenure review survey (species list is attached as Appendix 3). This represents 93% of the number of native species recorded during the PNA survey for the ED. Eighty four exotic species were recorded during the tenure review survey. This is 22% of the total number of species recorded during the inspection and it is estimated that this gave the primary character to 30% of the vegetated area of the site. The composition of the discrete communities examined in detail follows.

2.5.2 High elevation fellfield and cushionfield

This community is found on the ridge around Dunstan Peak and on North Dome, and is characterised by cushion herbs growing on rocky, frost-shattered lag field. Characteristic species are *Myosotis pulvinaris*, *Chionohebe thomsonii*, and *Abrotanella inconspicua*. Scattered short-stature grasses and creeping herbs such as *Acaena* species and *Leptinella pectinata* are present at the base of large solid rocks. It also includes populations of the threatened *Myosotis chessemanii*, *M. pygmaea* var. *glauca* and the uncommon *M. pygmaea* var. *drucei*.

2.5.3 Shepherds Creek headbasin snow tussockland and wetland flushes

This area covers the majority of the lease. It is covered by tussock grassland of *Chionochoa rigida* at lower elevations which is replaced by *C. macra* near ridge crests. Blue tussock, native grasses and herbs such as *Raoulia grandiflora*, *R. subsericea*, *Luzula rufa*, *Anisotome* and *Epilobium* species are common in inter-tussock spaces.

Seepages are common and overall are in good condition. They are principally dominated by *Oreobolus pectinatus*, moss, small sedges and other herbs. In the saddle between the two ridge systems is a cushionfield fen. This is the only site where the sedge *Uncinia rubra* was recorded and this fen has been damaged by stock trampling.

Tors and rocky sites hold a diverse collection of herbs and cushion plants such as *Neopaxia sessiliflora*, *Stellaria gracilentia*, *Cardamine corymbosa*, *Acaena* and *Epilobium* species and the prostrate shrub *Hebe buechananii*.

2.5.4 Faces mixed tussock, exotic grassland and shrubland

This community extends along the eastern scarp face from around 500 m to around 1000 m. It is dominated by exotic grassland and *Hieracium pilosella* intermixed with *Aciphylla aurea*, hard and blue tussock with scattered patches of narrow-leaved snow tussock and matagouri dominated shrublands containing occasional *Coprosma propinqua* and *Carmichaelia petriei* concentrated on small gullies. Open drier areas on spur crests are dominated by *Raoulia subsericea* and *Leucopogon fraseri*. Bracken forms patches around larger rock outcrops which harbour a variety of herbs and ferns.

2.5.5 Shepherds Creek shrubland

The shrubland occurs where Shepherds Creek falls steeply via a series of waterfalls to where it exits from the hill country. Terraces on the lower portion of this area are dominated by a mix of matagouri with occasional *Coprosma propinqua* and *Muehlenbeckia complexa* shrubland and exotic grassland while groves of *Olearia bullata* exist closer to the stream (willow and briar are more common on the lower reaches). These shrublands improve in quality and diversity going upstream until at the confluence of the two main tributaries where there is a high diversity of shrub and tree species including broadleaf, *Aristolelia fruticosa*, *Corokia cotoneaster*, *Rubus schmidelioides* var. *subpauperatus*, *Muehlenbeckia australis*, *M. complexa*, *Olearia odorata*, Hall's totara, *Coprosma linearifolia*, *C. "Taylorae"*, and three finger with groves of *Hebe rakaiensis* occurring on open boulder slopes. Bordering above these areas are extensive shrublands dominated by the turpentine shrub *Dracophyllum longifolium* intermixed with *Brachyglottis cassinioides*. Bluffs have mountain flax, *Helichrysum intermedium*, and broadleaf. The minor tributary on the northern side which enters below the aforementioned confluence has a simpler shrubland of matagouri with scattered broadleaf, *Olearia* species, and *Coprosma propinqua*.

2.5.6 Cluden Stream basin and shrublands

Cluden Stream basin is of a damper nature than the east facing basin of Shepherds Creek and has considerable dense hard tussock, golden spaniard and false spaniard on the higher slopes. Shrublands of *Carmichaelia petriei*, *Coprosma propinqua*, and matagouri with occasional *Olearia bullata* and rare *O. odorata* and *Aristolelia fruticosa* increase in density towards the stream, as does narrow-leaved snow tussock. A reasonable sized population of the threatened coral broom exists along the stream and lower hill slopes. On the small terrace near a musterer's hut at approximately GR G40 486 934 (hereby termed "musterer's hut") the following three threatened species were found; *Myosotis pygmaea* var. *glauca*, *Acaena buchananii* and *Leptinella serrulata*.

2.5.7 Mine tailings

Areas of mine tailings are present both adjacent to Sailors Creek and near Donald Stuart Creek. Both have large areas of bare ground that are actively eroding, with patches of exotic and native grasses and herbs. The Donald Stuart Creek site also has a few manuka, knotweed *Polygonum plebeium* and the threatened daisy *Kirkianella novae-zelandiae*.

The Sailors Creek site is much larger and includes outwash gravels on the adjacent flats that have been colonised by terrace vegetation, probably during formation when native vegetation still existed on the adjoining terrace. These outwash gravels are inhabited by a variety of native herbs and grasses including *Raoulia australis*, *Muehlenbeckia axillaris*, *Raoulia subsericea*, *Acaena inermis*, *Leucopogon fraseri*, *Wahlenbergia albomarginata*, *Geranium sessiliflorum*, *Epilobium microphyllum*, *Rytidosperma maculatum* and occasional *Melicytus alpinus* and matagouri. *Hieracium pilosella* and patches of stonecrop (*Sedum acre*) are common.

Adjacent to the outwash gravels are water-filled depressions that contain the buttercup *Ranunculus amphitrichus*, spike sedge *Eleocharis acuta*, and pondweed *Potamogeton cheesemanii*. The tailings themselves are deeply dissected and contains patches of a variety of native herbs and grasses including a purple-flowered (instead of the normal lilac coloured) population of harebell *Wahlenbergia albomarginata*, *Leptinella pectinata* subsp. *villosa*, *Elymus solandri* and the threatened daisy *Kirkianella novae-zelandiae* on the eroding walls. The more stable tops and fans have *Raoulia subsericea* and *Gaultheria antipoda* and on one larger “table” the threatened coral broom and *Pimelea pseudolyallii*. Briar and wilding pines are present in low numbers and one patch of broom (*Cytisus scoparium*) was noted.

2.5.8 Manuka Gully shrublands

The gully is a tributary of Shepherds Creek and contains a shrubland dominated by matagouri and *Coprosma propinqua* in the bed and extensive areas of regenerating manuka with occasional *Olearia bullata* and *Aristotelia fruticosa* on the slopes above, particularly on the eastern spur. A small gully to the south of this site has a small stand of kanuka with *Olearia bullata* and matagouri.

2.5.9 Dry Knob

This is an area of tors and dry rocky ground above the headwaters of Sailors Creek, centred on GR G41 498 867. It has appeared to act as both a fire and stock refuge as it contains snow totara, celery pine, *Gaultheria crassa*, *Coprosma cheesemanii*, *Dracophyllum prostratum* and one tree of bog pine. Also in the area were the threatened plant *Hymenochilus tanypodus* and the locally rare woodrush *Luzula ulophylla*. It was also the only site on the property where *Plantago raoulii* and the hooksedge *Uncinia aucklandica* were present.

The wetland area below Dry Knob is of high quality and is the only site where the sundew *Drosera arcturi* was recorded.

2.5.10 Terraces

These border Shepherds and Sailors Creeks and there is also a higher terrace containing an airstrip. These terraces are extensively dominated by exotic improved pasture and regularly cultivated. Very little of the original native vegetation survives in this area with the exception of scattered hard tussock, matagouri, *Carmichaelia petriei*, and *Melicytus alpinus* on the airstrip terrace. Wet terraces areas exist near the mud-brick house (GR H41 518 856) and are again dominated by exotic species.

2.5.11 Welshmans Gully and Sailors Creek Shrublands

Valley floors of these creeks are dominated by exotic grasses with patches of matagouri and *Coprosma propinqua* shrubland with occasional *Melicytus alpinus* and *Clematis marata*. Shrublands become more common on the valley slopes, particularly in Sailors Creek. Silver tussock and *Carex coriacea* form patches on damper sites and willow and briar are common. A small *Olearia bullata* intermixed with matagouri and *Muehlenbeckia australis* shrubland exists in the base of Welshmans Gully. This was the only site on the lease where tree nettle (*Urtica ferox*) was recorded. A small stand of the threatened *Coprosma intertexta* was present on a knoll in Welshmans Creek.

2.5.12 Problem Plants

Problem plants were primarily restricted to lower reaches of valleys where briar, gooseberry, willow and elder are common to locally abundant. Burdock is a rare component of this system. Wilding pines were noted at few localities primarily near existing plantations.

The only patch of broom *Cytisus scoparium* was recorded on the Sailors Creek tailings, however, it is abundant on gravel terraces adjoining the lease. Hawkweed *Hieracium pilosella* forms extensive patches in some dry areas where intensive grazing occurs.

2.5.13 Threats to Significant Inherent Values

Continued grazing of domestic stock, particularly from heavy grazers, is the biggest existing threat to most of the SIVs, especially those which occur in lower altitudes. This is evident by many species being restricted to rocky sites and by browsing on individuals of palatable species such as coral broom.

Woody weeds (especially briar) are displacing native shrubland from valley bottoms and if this continues will restrict the potential range of this community. Potential spread of broom from neighbouring areas is a big threat and should be monitored and if necessary controlled.

Pigs are present in low numbers and appear to have minimal impact currently. However, if numbers increase they will damage the tussock grassland and montane wetland communities.

Fire is an ever present risk. Some species, e.g. Hall's totara, snow totara, bog pine, broadleaf appear to only have survived in fire refugia with some small spread from these. Fire would once again restrict them to fire refugia only.

Vehicle traffic could easily damage fellfield and cushion vegetation and should be restricted to currently formed tracks.

2.5.14 Significance of Vegetation

The intactness, diversity and rarity of the floral communities recorded at high altitudes, in the headwaters of both Shepherds Creek and Cluden Stream, in the Shepherds Creek shrublands, on the mining tailings and on Dry Knob contribute to these areas significance. These communities contained 23 nationally or locally uncommon plant species and five rare communities. Diversity of native species on the lease is high with 304 species recorded during the survey. Exotic species were a moderate factor of the vegetation at 22% of the species recorded and are estimated to give primary character to 30% of the land area. Major threats identified were invasion of woody weeds, fire and grazing, especially cattle and/or deer, although these are not imminent threats.

Table 2: Threatened Plant Species, Regionally Uncommon/Locally Notable Plant Species and Rare Communities

| THREATENED SPECIES | | |
|--|------------------------------|---|
| Name | Threat classification | Location |
| <i>Myosotis cheesemanii</i> | “nationally critical” | Dunstan Peak area |
| <i>Myosotis pygmaea</i> var. <i>glauca</i> | “nationally vulnerable” | 3 populations recorded, largest two were near the Saddle and the musterer’s hut |
| <i>Acaena buchananii</i> | “gradual decline” | Sailors Creek tailings and near the musterer’s hut |
| <i>Carmichaelia crassicaule</i> | “gradual decline” | Cluden Creek headwaters and Sailors Creek tailings |
| <i>Leptinella serrulata</i> | “gradual decline” | Musterer’s hut and GR H41 504 849 |
| <i>Acaena tesca</i> | “range restricted” | Base of rock outcrops in the fellfield zone |
| <i>Carex berggrenii</i> | ‘sparse’ | Seep below Dunstan Peak |
| <i>Coprosma intertexta</i> | “sparse” | Lower Welshmans Creek |
| <i>Hymenochilus (Pterostylis) tanypodus</i> | ‘sparse’ | Grassland adjoining Dry Knob |
| <i>Kirkianella novae-zelandiae</i> | “sparse” | Steep, eroding faces at both Donald Stuarts and Sailors Creeks tailings |
| <i>Pimelea pseudolyallii</i> . | “sparse” | Near the mud-brick house and Sailors Creek tailings |
| <i>Ranunculus maculatus</i> | “sparse” | Seep below Dunstan Peak, highly likely to be present in similar habitat elsewhere |
| <i>Colobanthus brevisepalus</i> | “data deficient” | GR H40 503 915 |
| <i>Polygonum plebeium</i> | “data deficient” | Donald Stuarts Creek tailings |
| <i>Vittadinia australis</i> | “data deficient” | Cluden Creek area |
| REGIONALLY SIGNIFICANT OR LOCALLY NOTABLE SPECIES¹ | | |
| Name | Classification | Location |
| <i>Myosotis pygmaea</i> var. <i>drucei</i> . | Regionally Significant | Dunstan Peak and near the Saddle |
| <i>Carex hectorii</i> | Regionally Significant. | Dunstan Peak and near the Saddle |
| <i>Halocarpus bidwillii</i> . | Locally Notable | One tree recorded at Dry Knob |
| <i>Phyllocladus alpinus</i> . | Locally Notable | Several trees recorded at Dry Knob |
| <i>Podocarpus hallii</i> | Locally Notable | Extensive groves in Shepherds |

¹ Regionally Significant species are uncommon in Otago but not considered threatened nationally, Locally Notable species are uncommon in this area but reasonably common in the rest of Otago.

| | | |
|--|-----------------|---|
| | | Creek |
| <i>Podocarpus nivalis</i> | Locally Notable | Several trees recorded at Dry Knob |
| <i>Kanuka Kunzea ericoides.</i> | Locally Notable | Small regenerating grove south of Manuka Gully |
| <i>Mentha cunninghamii</i> | Locally Notable | In a water race between the mud-brick house and Donald Stuart Creek tailing |
| <i>Luzula ulophylla.</i> This small hairy woodrush was found at Dry Knob | Locally Notable | Dry Knob |

RARE COMMUNITIES

| Community | Location |
|---|---|
| Intact dryland shrublands are rare in Otago | Shepherds Creek |
| Low-rainfall fellfields are rare on the Dunstan Range, being restricted to only the highest elevations. | Dunstan Peak area |
| Cushionfield fen is unusual for the Dunstan Range where most wetlands are developed around seepages on hill slopes. | The Saddle |
| Shrublands containing three conifer species that are rare in the area and also a distinctive mix of dryland herbs. | Dry Knob |
| Mine tailing vegetation on schist workings are predominantly located in Otago and generally are highly degraded by invasion of exotic species. The Sailors Creek workings are a particularly good example of the native vegetation that colonises such sites. | Sailors and Donald Stuart Creeks workings |

2.6 Fauna

2.6.1 Invertebrate Fauna

Introduction

Invertebrates were sampled by hand searching, turning rocks, sweep netting, beating vegetation, aspirator (pooter), yellow pan and pitfall trapping. A fluorescent light trap was used for one evening. Given the survey was conducted between 12th-15th December and the lease's area a comprehensive survey was not feasible.

Therefore the adopted sampling philosophy was based on the Rapid Biodiversity Assessment (RBA) scheme of Ward and Larivière (2004). The difficulties with collecting excessive numbers and diversity of taxa are ameliorated under this regime according to the following four methods:

a) restricted sampling – not intensive;

- b) using higher taxonomic levels than species;
- c) using recognisable taxonomic units; and
- d) taxon focusing.

Specific target groups were Orthopteroids (cockroaches and grasshoppers), spiders, beetles (Tenebrionidae, Carabidae and Curculionidae), centipedes and millipedes. These groups include valuable biogeographical and ecological indicator species, and typically display high levels of endemism. Even so, due a variety of limitations, surveys of this nature can seldom reveal as much as 5% of the total invertebrate diversity of a property (Ian Millar, DOC invertebrate specialist, *pers. comm*).

Areas, habitats and invertebrate fauna

A total of 82 invertebrate species were collected, comprising 52 families, 11 Orders and 3 Classes. Appendix 4 contains the species list.. Of those species identified, 76 % were endemic. This conservative figure is characteristically high for relatively unmodified New Zealand sub-alpine habitats like that on the lease. Significant invertebrates collected on the lease are listed in Table 3.

The composition of the discrete areas examined are described below.

Head of Welshmans Creek

All 14 invertebrate species (10 insect and 4 spider) identified from the area were endemic and associated with a suite of native woody plants (i.e. broadleaf, *Coprosma propinqua*, *Gaultheria depressa*, manuka and matagouri). Insects of note were large *Megadromus* ground beetles, darkling beetles (*Mimopeus opaculus*) and high numbers of the cockroach *Celatoblatta anisoptera*, the latter being near its southern limit on the Dunstan range. These flightless insect species are characteristic of dry, stony sub-alpine habitats typical of south Canterbury and North Otago. The Boulder Copper butterfly (*Boldenaria boldenarum*, host plant *Muehlenbeckia* spp) was frequent at the site, as were numerous bright green manuka chafers (*Pyronota festiva*). Three groups of spider were collected, being Orb web, prowling and stealthy spiders (*Matua valida n.sp.* (Forster)), the latter being found beneath schist stones. This endemic species has very limited distribution with records suggesting the taxon is concentrated in Central Otago (Forster 1979).

Lower Shepherds Creek

Invertebrates found at this locality exploit a wide range of physical habitats comprising of extensive indigenous woody vegetation, a snowmelt creek, scree and rock outcrops. Twenty-two insect, 7 spider, 1 Opilione, 1 centipede and a single millipede species were collected. A night of pitfall trapping produced a medium sized *Hemidiena* tree weta species, six species of spider and a millipede (*Icosidesmus sp.*), each of which are endemic. Significantly, three species of endemic cockroach were also found at the site, being *Celatoblatta anisoptera* and the common Otago species *C. quinquemaculata* which occur with *Parellipsidion inaculeatum* amongst blocky talus slopes. The endemic darkling beetle *Artystona rugiceps*, a *Mecodema* (Carabidae) beetle and the seed bug *Rhypodes anceps* (Lygaeidae) were also recorded. An interesting find was the stinkbug *Oncacontias vittatus* (Acanthosomatidae). These bugs tend to be common at the margins of wetter native forests, suggesting they may well be confined to the shrublands of Shepherds Creek.

Foliage beating produced a suite of beetle taxa within a range of trophic guilds. An unidentified metallic-tinged *Clerid* spp. was collected from broadleaf shrubs. Generous numbers of the common ladybird *Coccinella undecipuntata* were noted and two species of Chrysomelid (Bruchinae) seed weevils were collected. Manuka beetles were also recorded as were tussock moths (Crambidae) and butterflies (Lycaenids). Fly taxa identified (but not collected) on site included the robber fly *Neoitamus melanopogon* (Asilidae), hover flies (Syrphidae eg. *Syrphus sp.*), dragonflies (*Uropetala sp.*), Tachinids and Mucids. Soldier flies (Stratiomyidae) were also

collected. The overall range of fly guilds (scavengers, pollinators and predators) at the locality is considerable and indicates the high quality of habitat.

Slopes above the northeastern branch of Shepherds Creek

Weather conditions during the survey of this area were cold and windy and no flying insects were seen, however, the tussock slopes of this area clearly supported typical South Island high country invertebrates. Eleven insect, 3 spider and 1 centipede species (all endemic) were collected throughout this area by hand and aspirator. Four species of ground beetle (Carabidae) were recorded: two *Megadromus* species, the smaller *Dimetrída sinuata* and *Holcaspis* sp. Cf. *H. bathana*. The common alpine grasshopper *Sigaús australis* occurred occasionally in tussock and a suite of cryptic insects were collected from beneath rocks. These included the endemic ant *Monomorium antarcticum*, a darkling beetle (*Artystona rugiceps*) and the two common cockroaches *C. anisoptera* and *C. quinque maculata*. Three species of ground dwelling hunting spider were found, each from separate families (being Tetragnathidae, Clubionidae and Miturgidae). Little is known of the conservation status for these spider groups. Similarly, the often recorded centipede *Zelanophilus provocator* is poorly studied.

Summit ridge running north/south from Cluden Pass

Hand searching and pootering resulted in 10 insect and 2 spider species (all endemic). The large mountain stone weta *Hemidiena maori* was found at two sites beneath schist rocks. The presence of this species demonstrates high ecological integrity of the habitat, likely to be a result of infrequent burning and few introduced predators coupled with altitude (~1600 m asl). Another species recorded was the weevil *Anagotus lewisi*, an Otago endemic which is associated with *Aciphylla* spp., often amongst damper tussock areas. Two species of spider are noteworthy; *Matua valida* was found occasionally in the habitat, the significance of which is described previously. The presence of a Lycosid spider, *Anoteropsis flavescens* is apparently the only the second record of the species on the Dunstan range. These wolf spiders are Otago endemics (Vink 2002).

Saddle dividing Cluden Stream and Shepherds Creek

Collections made by hand, aspirator, yellow pan trap and sweep net resulted in 21 insect and 2 spider species. Over 90% of the species collected from this location were endemic. The topography of the area forms a lee slope in which winter snow deposition is deep. Sloping gently away to the southeast, the basin supports a highly significant alpine wetland (fed by an extended snowmelt season) which drains into the main catchment of Shepherds Creek. The site supports a diverse community of invertebrates that exploit flowing water, small but deep pools and waterlogged cushion plants. This diversity is demonstrated by the collection of 11 species of fly including one species of Chironimid, a Dolichopodid (*Parentia* sp., a group of taxa which hunt small insects and/or feed on nectar), two species of Muscidae ('house' flies), two of hover flies (Syrphidae: *Platychieirus* sp. and *Syrphus* sp., both pollinators), a species of *Leptotarsus* Tipulid along with a Tachinid, a Soldier fly (Stratiomyidae) and Lonchopteridae flies, for which information is lacking.

The range of fly taxa illustrates the scope of ecological niche availability within a confined area of available water. Other flying insects collected included the abundant tussock moths, *Orocrambus aethenellus* and *Eudonia cataxesta*. A native bee, *Lasioglossum sordidum* was found in the yellow pan trap, this species visits *Celmisia* and yellow *Ranunculus* flowers. A seed weevil *Apion* sp. was collected from *Raoulia* cushions and the native diving beetle *Liodessus plicatus* (Dytiscidae) was abundant in pools. The presence of these diving beetles provides an indication of high water quality (Winterbourn *et al.* 2000).

Western boundary of lease (summit plateau of Dunstan range)

Seven insects and 3 spider species were collected by hand, aspirator and light trap. Of note was an Otago endemic jumping spider (Salticidae) identified as species 'A' (by Forster and Forster 1999). These characteristically hairy, black and white mottled spiders have been observed high on the Rock and Pillar, Pisa

and Remarkables ranges and while no formal identifications yet exist, the group are well recognised for their localised mountain-top endemism. It is entirely possible the two specimens collected from this site are themselves a unique Dunstan range variety. Despite considerable searching, the spiders were sparsely distributed. Aside from their obvious population isolation, little is known about the origin and biology of these jumping spiders. Other spider varieties found were two species of *Neoramia* (Agelenidae), a group of common South Island spiders.

Additional taxa collected from the rock tors included a moss beetle *Pedilophorus lewisi* (Byrrhidae). These small spherical beetles are members of a highly diverse group. Similarly, specimens of a ground beetle (*Mecodema* sp.) were found beneath schistose regolith sharing the habitat with the cockroach species *C. quinque maculata* and *C. anisoptera*. The grasshopper *Sigauss australis* was abundant in tussock country, from which an unidentified Brachonid wasp was also collected. Light trapping caught only one moth (*Tmetolophota acontistis*), presumably due to the cold and high wind at this altitude.

2.6.2 Significance of Invertebrates

The lease supports a number of significant invertebrate taxa occupying a diverse range of microhabitats. These are detailed on table 3 below. Endemic weta, spiders, cockroaches, beetles, and flies are well represented and, for the most part, confined to relatively undisturbed habitats. These habitats include Shepherds Creek (with an associated native shrub land and forest species), snow tussock slopes and basins, alpine wetlands, dry scree slopes and high altitude rocky tors.

Also of particular significance was the recording of the sympatric populations of three species of endemic cockroach (*Celatoblatta anisoptera*, Otago species *C. quinque maculata* and *Parellipsidion inaculeatum*).

Table 3. Significant Species.

| Taxon | Location (grid reference) | Significant feature |
|--|--|---|
| <i>Anagotus lewisi</i> (weevil) | H40 504 912 | Endemic Otago species, threatened by rat predation |
| <i>Anoteropsis flavescens</i> (spider) | G40 495 922 | Limited distribution |
| <i>Hemidiena maori</i> and <i>Hemidiena</i> sp. (Mountain stone weta) | H40 502 933 & H41 512 877 | At risk from rodent predators. |
| <i>Holcaspis</i> sp. cf. <i>H. bathana</i> (ground beetle) | H41 517 890 & H40 482 912 | Type locality is St. Bathans. |
| <i>Matua valida</i> n.sp. (spider) | H41 507 853 & H41 271 877 | Restricted to dry Canterbury / Otago sub alpine habitats. |

| | | |
|--|-------------|---|
| <i>Notiodrassus distinctus</i> (spider) | H41 512 877 | A southern South Island forest species. |
| <i>Oncacontias vittatus</i> (Stink bug) | H41 512 877 | Endemic genus, typically restricted to forest margins. |
| <i>Salticidae</i> : species 'A' Forster (jumping spider) | G41 479 897 | Highly distinctive group of Otago endemic alpine spiders (Forster 1999). Similar species occur on Rock and Pillar range. Probably restricted to Dunstan range |

2.6.3 Herpetofauna

“Site locations of rare and endangered herpetofauna are recorded in the original report. Herpetofauna of this nature is at risk of illegal activities including damage and removal through unlawful interference and disturbance. Accordingly, information regarding the locations of any such herpetofauna has been deleted from this version of the report. The Department of Conservation has put in place mechanisms to ensure that such information can be released for genuine scientific and research purposes. Please contact the Department of Conservation directly to determine whether the information can be released.”

Introduction

Between 1986 and 1989 a thorough herpetological survey was carried out through the Dunstan Mountains (Whitaker 1987, Whitaker & Loh 1990). Six lizard species are now well known from this ED (Whitaker et al. 2002). Furthermore the so-called “Roys Peak” gecko, *Hoplodactylus* aff. *granulatus* “Roys Peak”, which has a threat ranking of “nationally critical” has been found on the boundary between the Dunstan and Lindis ED’s, and recently in February 2005, near Cromwell Gorge.

Two species of lizards present in the Dunstan ED have a “gradual decline” threat ranking, namely *Oligosoma chloronoton* and *Hoplodactylus* aff. *maculatus* “Otago/Southland large”, and all other species have been ranked “not threatened” (Hitchmough pers. comm. 2005). *O. chloronoton* and *H. aff. maculatus* geckos are known from the Shepherds Creek catchment on the lease (Whitaker & Loh 1990) and their presence was confirmed by this survey.

Methods

An inspection of the herpetofauna values over the lease was conducted by two searchers. Over the survey period the weather was generally suitable for locating most of the lizard species likely to occur there, with the exception of *Hoplodactylus* aff. *granulatus* “Roys Peak” which is known from about 1200 m a.s.l. on a neighbouring pastoral lease (T. Jewell pers. comm. 2005); suitable habitat for this species was located, but due to time constraints no night searches were carried out. Searches were made for these alpine specialist geckos by day following rain and during cold windy weather. Under these weather conditions the geckos were likely to be far down in rock stacks and tumbles and almost certainly “unavailable” to searchers.

Searches were made for both basking lizards and active lizards. Potential habitat was scanned with binoculars and the habitat was entered watching and listening carefully for disturbed lizards. Searches were also made for sloughs, skeletal remains and for the distinctively large droppings (>2cm) produced by large-bodied skinks. In

both good and bad weather searches included retreat sites for inactive geckos and skinks; rocks were turned and crevices were searched.

Species

Five lizard species were found on the lease during this survey; the distribution and threat status for these lizards are summarised in the following table. Habitat for a sixth species (*Hoplodactylus* aff. *granulatus* “Roys Peak”) was located.

Table 4: Summary of herpetofauna recorded on the lease

| Species Name | Threat Status (Hitchmough pers. comm. 2005) | Distribution on the lease |
|--|---|--|
| <i>Hoplodactylus</i> aff. <i>maculatus</i> “Otago/Southland large” | Gradual Decline | Widespread up to 1200 m |
| <i>Oligosoma chloronoton</i> | Gradual Decline | Back country block only; from 1500 m down into Shepherds Creek through RAP A1 |
| <i>Hoplodactylus</i> aff. <i>maculatus</i> “Cromwell Gorge” | Not Threatened | Widespread up to 1200 m |
| <i>Oligosoma maccanni</i> | Not Threatened | Ubiquitous on the lease |
| <i>Oligosoma nigriplantare polychroma</i> | Not Threatened | Confined to lush vegetation around waterways at lower elevations. |

Back country block (2105ha)

Five lizard species and habitat for a sixth species were found in the Back Country block mostly within RAP A1. Two populations of the green skink *Oligosoma chloronoton* were located. *Hoplodactylus* aff. *maculatus* “Otago/Southland large” was also present and in places sympatric with the more common *H.aff. maculatus* “Cromwell Gorge”.

Habitat for *H. aff. maculatus* “Otago/Southland large” and *O. chloronoton* is well understood (Whitaker & Loh 1990, Gill & Whitaker 1996, Hitchmough 1997,) and includes rock tors and their associated talus slopes and vegetated boulder fields. Habitat suitable for both of these species was located outside the Dunstan RAP A1 in the Back country block and covers an area containing some of the more northern tributaries of Shepherds Creek and extends to approximately 1350m on the true left of the creek. Northwest ridges at the northern extremity of the lease also provided excellent habitat for these species, and also for the other lizards found on the lease. A search was made of the ridge leading down to the musterer’s hut; *O. maccanni* was extremely common and *H. aff. maculatus* “Otago/Southland large” was also present and in places sympatric with the more common *H. aff. maculatus* “Cromwell Gorge”.

The McCanns skink, *O. maccanni* was ubiquitous over all altitudes in the Back country block, but was most common at mid-altitudes (<1200 m). The common skink, *O. nigriplantare polychroma* was present only in and around streams, occupying the thick vegetation typical of riparian margins.

Hoplodactylus aff. *granulatus* “Roys Peak” was not found during the present survey. Habitat for this acutely threatened species is not well understood (Tocher & Marshall 2001, T. Jewell pers. comm. 2005), but given current understanding it is believed suitable habitat was present on the lease. Roys Peak gecko habitat includes tussock and rock fields with associated rock tors above 1200 m which provide deep, dry retreats (retreats not disturbed by snow melt and freeze/thaw action). Habitat deemed suitable was located near, and to the north and northwest of Dunstan Peak, but more likely habitat was found on the ridges running from the high point at the west of the lease down towards Shepherds Creek.

Shed block (662ha)

Four lizard species were found on the Shed block. The McCanns skink was ubiquitous over all altitudes and the common skink, *O. nigriplantare polychroma* was present only in and around streams, occupying the thick vegetation typical of riparian margins. *Hoplodactylus* aff. *maculatus* “Cromwell Gorge” were common on rock tors, even in the heavily grazed and developed areas. *Hoplodactylus* aff. *maculatus* “Otago/Southland large” was present in apparently low densities over the Shed Block. One specimen was captured but tors at higher elevations (within the RAP A1) were not thoroughly surveyed.

Manuka Gully (92ha)

This area was not well surveyed but was viewed from the Dark Face block and good views were obtained from the 4WD track leading up to Dunstan Peak. Approximately one third of this block (the northern part) is within Dunstan RAP A1 (which contains quality lizard habitat as described above). The Manuka Gully part of Dunstan RAP A1 is continuous with habitat that was surveyed for lizards in the Back Country and Dark Face block. By extrapolation from areas that were surveyed it is believed the area within the Dunstan RAP A1 contains the best lizard habitat for this block.

Dark Face (135ha)

Hoplodactylus aff. *maculatus* “Otago/Southland large” was common throughout rock tors and tumbles within this block. McCanns skinks were also common.

Dungies block (120ha)

This low altitude block contained good densities of McCanns skinks, especially in artificial rock piles, but very little search time was dedicated to this block. Some rock tors were visible from the vehicle track (approximately 700 m) which may have had resident geckos but these were not searched.

Threats

The most species-rich lizard fauna was found inside Dunstan RAP A1 which has retained high botanical values (Grove 1995). Although mechanisms are not clearly understood and are no doubt species-specific, loss of indigenous vegetation negatively impacts on lizard communities (Whitaker 1996). Fire, in particular is known to seriously deplete lizard populations (Patterson 1984).

As is common on mainland New Zealand, it is likely that lizard populations on the lease are subject to predation by the full suite of introduced mammalian predators including cats, ferrets, stoats, weasels, rats, and hedgehogs. In addition, habitat disturbance through rock heaving during pig rooting, sheep fouling and trampling and herbivory of rock tor vegetation are also threats to lizards.

2.6.4 Significance of Herpetofauna

Populations of both *Oligosoma chlonoton* and *Hoplodactylus* aff. *maculatus* “Otago/Southland large” have a “gradual decline” threat ranking (Hitchmough pers. comm. 2005). Within Otago Conservancy both of these lizards have been ranked in “moderate” need of conservation attention with a management objective “to ensure the continued survival of populations at sites that secure the full geographic range and which are representative of each recognised genotype” (Whitaker et al. 2002).

Only two other records of *O. chlonoton* are known from the Dunstan Mountains; a population was found close to Dunstan Creek in 1989 (Whitaker & Loh 1990) and a single skink was observed in the Lauder Basin Conservation Area in the early 1990’s (Jewell pers. comm. 2005). The discovery of a new population on the lease (at 1550 m) is therefore a significant event nationally, and particularly in the context of Otago Conservancy (Whitaker et al. 2002).

Research is currently underway at Landcare Research to determine the genetic distinctiveness of *O. chlonoton* populations in Otago, Southland and Canterbury. The work has involved genetic testing and morphological analyses. Interim results indicate the Dunstan Mountains (together with Eyre Mountain populations) form a distinct conservation management unit i.e. they are genetically distinct from other *O. chlonoton* populations including those from nearby Falls Dam (D. Gleeson pers. comm. 2005). However, presently the Dunstan *O. chlonoton* populations have retained a “gradual decline” threat ranking (Hitchmough pers. comm. 2005).

The occurrence of sympatric populations of *Hoplodactylus* aff. *maculatus* “Otago/Southland large” and *H. aff. maculatus* “Cromwell Gorge” has potential significance for research into barriers to interbreeding between these two species.

Although *Hoplodactylus* aff. *granulatus* “Roys Peak” was not recorded nor is its habitat well understood, given current understanding it is believed suitable habitat was present on the lease.

McCann’s skink, the common skink and the Cromwell gecko are common through the ecological district and beyond. All are ranked “not threatened” (R. Hitchmough pers. comm. 2005) and of “low” conservation status in Otago (Whitaker et al. 2002) but given they are found sympatric with *O. chlonoton* and *H. aff. maculatus* “Otago/Southland large” in RAP A1 they contribute to a species-rich lizard community at this site.

2.6.5 Avifauna

As the avifauna was not specifically surveyed during the tenure review inspection the following summary was generated through an analysis of several previous surveys. Please note however that Chukor (*Alectoris chukar*) was recorded at Dry Knob during the inspection.

Brown Creeper (*Finschia novaeseelandiae*) was recorded in the lower portion of Shepherds Creek during the PNA survey. Due to the availability of extensive intact habitat the following species are highly likely to occur on the lease (Ward, 1995).

- Australasian harrier hawk (*Circus approximans gouldi*)
- New Zealand falcon (*Falco novaeseelandiae*)
- Pipit (*Anthus novaeseelandiae*)
- Banded dotterel (*Charadrius bicinctus*)
- South Island pied oyster catcher (*Haematopus ostralegus finschi*)

- Black-backed gull (*Larus dominicanus*)
- Black-billed gull (*Larus bulleri*)
- Fantail (*Rhipidura fuliginosa*)
- Grey warbler (*Gerygone igata*)
- Bellbird (*Anthornis melanura*)
- Grey duck (*Anas superciliosa*)
- Paradise duck (*Tadorna variegata*)
- Black shag (*Phalacrocorax carbo*)

2.6.6 Significance of Avifauna

The record of Brown Creeper emphasises the importance of Shepherds Creek as a forest refuge, as this forest bird has not been previously recorded in Central Otago (nearest record in Bull *et al.* is near Lake Hawea).

Falcon (gradual decline) have been recorded in the adjoining Lauder Basin Conservation Area.

2.6.7 Aquatic Fauna

Introduction

The streams on this property are typically small, steep gradient streams draining the slopes of the Dunstan Range from 1600 m. The altitude range fished was from 580 to 1300 m.

Methods

The existing national NIWA Freshwater Fish Database was searched for records of freshwater fauna. No previous records existed for waterways on the lease.

Seven sites were fished, using a Kainga 300 backpack electric fishing machine, according to defined criteria (Allibone, unpublished draft). A NIWA FWF Data form was completed at each site. The sites selected contained both riffle/run and pool habitats. Stream width, depth, substrate and riparian composition were visually estimated and recorded on the data forms. In-stream invertebrates found during the survey were noted, but no comprehensive collection was made. All fish collected were readily identified on site and returned to the stream. Appendix 5 contains the location and specific results for each site.

Results

Of the seven sites fished four had fish present and three had no fish. Only one species of fish was found, being the introduced Brown trout (*Salmo trutta*).

Discussion

Freshwater fish found on the lease is limited to the introduced brown trout. New Zealand's most common and widely distributed exotic fish, the brown trout was abundant and widely distributed in waterways on the lease. As the fish occupy small waterways they do not reach a size to provide sport to anglers.

The streams on the lease are typical of many in Central Otago above 700 m; generally being shallow, low volume, experiencing large seasonal flow variation and having unconstrained flooding. The water quality in all the streams on the lease was high, with good riparian vegetation along most stream margins. Typical invertebrates present were mayfly (*Coloburiscus*, *Deleatidium*), caddis (*Olinga*, *Pycnocentroides*), stonefly (*Zealandobius*, *Zealandoperla*.); all species were common.

Streams of this quality are not uncommon locally but are declining as land development continues. The invertebrate communities that these waterways support would benefit from the maintenance and enhancement of the native riparian and catchment vegetation.

2.6.8 Significance of Aquatic Fauna

The freshwater fish on this lease are not significant and do not warrant any protection mechanism.

The general habitat quality of all streams on the property would benefit from the maintenance and/or enhancement of any existing native riparian and catchment vegetation.

2.6.9 Problem Animals

Pigs are present in low numbers and appear to have minimal impact currently. However, if numbers increase they will damage the tussockland and montane wetland communities.

2.7 Historic

Introduction

The lease was part of one of the earliest runs surveyed off in the 19th Century, which was known as Lauder and extended from the tops of the Dunstan Range to the Manuherikia River with the north and south boundaries being the Dunstan and Lauder Creeks. Bordering this property was the Hawkdun run (228) on the north and the Matakanui (223) run to the south (see Pinney 1981:100-105).

Lauder was originally held by William Davy and Edmund Bowler from 5 September 1858. However, on 1st March 1859 this run and run 224 (Manuherikia) were combined and sold to a Dr Thomas Black of Melbourne, this joint run being called Omakau station. In 1866 the run had to be sold to cover debts and was broken up, with Lauder being taken up by James and Charles Cogle and Des Voeux. The run was then sold for £17,000 with 13,500 sheep to the Glassford brothers and then to John Roberts and Hugh and John Stewart Handyside for £17,000 with 12,000 sheep and some cattle in 1869 (Pinney 1981:101). Both Hugh and John managed the run on site with John Roberts managing the finance and supply side from Dunedin. As part of Lauder lay in part of the Vinegar Flats gold-mining area (see below), 539 acres of the property was brought by the gold warden Robinson on 4 April 1874 for the purposes of establishing a water race and expansion of the gold-mining (Pinney 1981:102).

From 1874 to 1877 the run was very successful holding, in 1874, 25,000 sheep and 8000 lambs. By 1878, however, a slump in the farming industry had occurred. In 1882 the lease was due on Lauder and in this year it was divided into five new runs of which Cambrian Hills was created as run 226A. The *Runs Register* for Otago notes that both Handyside and Roberts held run 226a plus the freehold portion with the house and various buildings on, until its transfer to Ross and Robert Glendining in 1883 who stocked it with 24,470 sheep and 6,107 lambs (Pinney 1981:104). The run was next transferred in 1907 to William McConnochie and William Harold McConnochie and then in 1928 Thomas Alexander Shaw and Janet Helen Kerr became the lessees.

The area surrounding and including part of the lease is known for the extensive gold-mining claims at Cambrians, Welshman's Gully and Vinegar Flat and Hill. Gold was discovered in Welshman's Gully in 1862 by a group of miners outfitted by Johnny Jones from Waikouaiti. By 1869 the Cambrians township, founded mostly

by Welsh miners, was thriving and was established along Cambrians Road where some of the late 19th century sun-dried mud-brick houses can be seen today. In 1874 John Morgan and Thomas Hughes found extensive gold deposits on Vinegar Flat. Here they opened the “Never Fail Mine” and established the “Vinegar Hill Hydraulic Sluicing Company Limited” (the name “Vinegar Hill” was derived from the Battle of Vinegar in Wexford Ireland and alluded to the fights between the Welsh miners from Cambrians and the Irish miners from St. Bathans). Between 1874 and 1899, Morgan and Hughes extracted over £20,000 worth of gold making the mining operation very profitable (see Morgan 2001:16-21).

The scarred landscape following the west side of Loop Road from Cambrian to St Bathans was created through the hydraulic sluicing and elevating gold-mining method which literally carved out the hillside and flats. In 1884 the gold-mining magnate of Otago John Ewing began to heavily invest in hydraulic sluicing at Vinegar Hill and Cambrian with £10,700 alone being invested at Vinegar Hill in the same year. Between 60- 100 men were employed by Ewing at his Otago gold claims at any one time and included miners, race-men, stable-hands, blacksmiths and message-boys (Nicolson -Garrett 1977: 20). Also mining in this area were the Chinese miners who would work over the already mined areas of the Europeans using the more basic machinery of pumps, cradles, pans and shovels. Gold-mining continued in this area (mainly at St Bathans) through to the early 20th century.

From the brief history of Run 226a presented above, it is evident that the lease is located in an area of Central Otago with both an early recorded pastoralism history and where significant gold-mining operations of the late 19th century were undertaken.

Previous Archaeological Surveys

No previous archaeological surveys have been undertaken on the lease. Interestingly, even though extensive late 19th and early 20th century gold-mining remains are apparent along the western side of Loop Road from Cambrians to St. Bathans (a distance of *ca.* 5km), no systematic archaeological survey has been undertaken. The NZAA Site Recording Scheme records therefore show no archaeological sites (be that European, Chinese or Maori) being recorded on the lease.

Methods

The assessment methods to provide more archaeological/historic data first entailed identifying areas likely locations containing archaeological evidence of past gold-mining or pastoral activity based on historic records. Secondly, areas were chosen which could be surveyed within the timeframe allocated for the inspection. Finally, the southeastern section of the lease was surveyed. The main limitation of the assessment was the time available to survey the lease in detail.

2.7.1 Sites

Newly Recorded Archaeological Sites

Seven sites were identified, consisting of water races and a dam (site numbers **1, 2, 3, 4, 5, 6, 7 & 8**), a house and hut complex (site **9**) and the top end of the extensive Sailors Creek gully (part of the Vinegar Flat) gold-mining area (site **10**). These sites are summarised below.

Water races (sites **1, 2, 3, 4, 5, 6, & 7**) and Dam (site **8**)

Site **1**, a water race, originates on the true left in Shepherds Creek on the lease and can be seen on the NZMS 260 H41 Ranfurly topographical map following the 640m contour, but it is dry and unused. Water from this race would have been sourced for one or more of the various gold-mining claims on Vinegar Flat to possibly as far as Pleasant Creek on a neighbouring property where, on the topographic map, it appears to end.

On the opposite side of the Shepherds Creek gully are sites **2** and **3** (again water races) also indicated on the NZMS 260 H41 Ranfurly topographical map. The lower race site **2** appears to have originally started in a swampy area on the true right of Shepherds Creek, but a later more modern water source from lower down also on the true right of the creek now feeds this race as some water still runs in it (though not for the entire length). Site **3** travels from inside the lease skirting along a promontory above Vinegar Flat, and then leaves the lease still following the promontory and then returns into Cambrian Hills as a dry race moving along the top of the gold-workings up Sailors Creek gully. The race on the Sailors Creek gully side of the promontory is patchy and poorly preserved due to natural erosion, slips and farming activities, hence it is often difficult to make out in the landscape. This race would have been a water source for the gold-workings immediately below its path.

The top race site **3** also appears to start in a swampy area of land on the true right of Shepherds Creek, but possibly also originally received its water from a feeder stream into Shepherds Creek just to the north of this location. Along its path there is stone walling used to fill a slip on the race so it could continue its path along the same promontory as race site **2**. This race is dry along its path and much overgrown and patchy in places. It ends on the south side of Shepherds Creek gully on the promontory near the western boundary of the lease. It is possible the race originally continued to just the other side of the promontory above Sailors Creek gully, but the race has been cut by the construction of a road along the ridge top. As with site **2**, this race would have fed gold-workings above Vinegar Flat.

Water races (site **4**, **5**, **6** & **7** respectively) all begin on the true right of Sailors Creek. Site **4** was not followed to its source or termination point. The origins of site **5** and **6** are from the same location in Sailors Creek where the remains of an old rock diversion structure can be seen on the true right of the creek. These dry water races follow along the field to the south of the creek towards the mud-brick house (site **9**). Site **5** ends halfway across this field in a small dry water course that feeds down the field. Site **6** continues across the field where it stops in a small depression approximately 200m up from the farmhouse. The original purpose of these races is difficult to assess as they may have been built for either gold-mining or irrigation.

The exact start of site **7** (a water race) could not be determined but it would have originated in Welshmans Gully. The surviving portions of this race are patchy due to natural erosion, slips along its path and some stock damage. This race would have probably fed gold-workings in the gully and flats below to the south and east of the lease, although evidence of these past workings appear to have been largely destroyed by farming activities. Just above this race in the second gully south from Welshmans Gully are the remains of a stone dam which bridges the small gully (site **8**). This structure may have fed additional water to site **7** or perhaps been a water supply for pipes leading directly out of the dam to the mining in the gully below.

It must be noted that for the water races described above, all could have been used for irrigation or other farming purposes after their initial use for gold-mining had ceased, as it would appear for site **2**.

House and Hut (site **8**)

Site **8** consists of a house and the remains of a large schist hut. The hut may be that indicated on Arthur's 1870 map of Cambrians which shows a large structure at this location. A past resident of the house² has indicated that back in the 1930s the hut was largely intact and consisted of two rooms. Over the last 80 years stone has been removed from the structure for other building projects. The mud-brick house next to the stone hut ruins is in excellent condition and still retains its wooden floor, tongue and groove wooden ceilings, wooden window

² Information on the hut and house for site H41/103 was provided by a past resident of the house who did not want to be named in this report.

frames and Shacklock No. 2 oven. The end of a sluicing gun dating from 1906 was also found at the back of the house. The past resident believed it was built for the McConnochie family when they took over the lease in 1907. The builder was believed to be John Wilkensen who was a carpenter based in St. Bathans. *Stones Otago and Southland Directory* confirms that Wilkensen lived in St Bathans as a practising carpenter from at least 1892 until 1907. The good condition of the house may be due to the roof being well managed by the lessee over the years preventing major leaks into the structure. Old newspaper peeling off the walls shows that the interior was redecorated in 1928. This is a superb example of an early twentieth century pastoral house.

Gold-mining (site 10)

The southeastern corner of the lease contains the upper end of the Sailors Creek gully gold-workings which were part of the Vinegar Flat gold-mining area. The most noticeable feature of this section of gold-mining on the lease are the white cliffs which stand out from the sluiced hillside. Behind and up on top of the cliffs are what are probably small reservoirs and a series of headraces which lead down to the edges of the cliffs. Amongst the sluiced gullies and on small terraces in the workings can be seen tailings and at the bottom of the cliffs near the southeastern fence line riveted iron pipes typical of those used for gold-mining operations. Two prospector's pits were also found near the northwest edge of the gold-workings. Site 2 (a water race) was probably a water source for these workings and can be seen in various states of ruin running along the top of the ridge above. The gold-workings intrude *ca.* 340m into the lease from the southeast boundary fence with the maximum width of the workings being approximately 580m. Much of the features associated with the workings such as the water races, small reservoirs and tailings are masked by thick grass and matagouri growing on the site.

2.7.2 Significance of the Historic Sites

No Maori archaeological sites have been recorded previously on the lease nor were any found during the inspection. Maori sites which may have been located around the water-ways on the lower hills and flats of the lease would most likely have been destroyed by past gold-mining activities. The two main site types located on the lease were therefore gold-mining and pastoral sites.

The lease sits on the edge of a major 19th century gold-mining area in Central Otago. As described above, historic records regarding gold-mining on and surrounding the lease are detailed where the names of actual gold-miners who worked the various flats, creeks and streams are known. However, a perusal of the land bounding this pastoral lease on its south-eastern side during the inspection noted that much of the evidence of past gold-mining appears to have been destroyed through farming activities. Ploughing especially has destroyed areas of tailings and sluiced faces as well as tailraces. The section of gold-mining present on the lease, though, is well preserved and represents a good example of hydraulic sluicing in this area. The large water races that cross the lease were originally built for the purpose of gold-mining with some of these races, and the later races also observed crossing the hillsides, used for irrigation.

The foremost historic feature of the lease is the early pastoral house. This mud-brick house can be considered uncommon in Otago due to its unusually good preservation and that it is an excellent example of an early pastoral farming structure in Otago. Its potential for full restoration makes the house particularly significant.

2.8 Public Recreation

2.8.1 Physical Characteristics

The lease comprises the semi arid upper slopes of the Cluden catchment, most of Shepherds Creek and a small part of Lauder Creek forming part of the Dunstan Creek catchment including the alpine environment of the North Dunstan Mountains.

The contribution the lease provides for important opportunities for public recreation is based on the:

- a) Large and seemingly remote nature of the lease;
- b) Great views of the St Bathans Range, Pisa Range and to the Main Divide further west;
- c) Contributing to potential access to an extensive network of public access routes on nearby properties in the Lindis area which provide outstanding mountain biking and walking opportunities;
- d) Interesting mix of rocky outcrops, woody gorges, open tussockland and alpine cushionfield vegetation; and
- e) Access to the adjoining Lauder Basin Conservation Area which currently does not have legal access.

In 1989, Federated Mountain Clubs (FMC) compiled an outdoor recreation plan for Central Otago's Block Mountains (Mason, 1988). The document notes that the majority of the Dunstan Mountains (including part of the lease) is zoned *open space* and further it was stated that "this zoning recognises the highly modified landscapes resulting from extensive tussock depletion, pastoral development and vehicle tracking. Rights of public access through the zone need to be retained and extended".

A natural experience zone is also defined, centred on the Dunstan RAP A1. This natural experience zone covers much of the lease. This area of natural experience zone on the Northern Dunstan Mountains is characterised by being only lightly modified by farm tracking or other developments and comprises the largest natural area on this range. Recreational opportunities noted include cross country skiing on the Northern Dunstan Mountain tops, and walking/botanisising in the vicinity of Dunstan RAP A1.

In 1992 DOC compiled a Recreation Opportunity Spectrum (Harper, 1992) for the Otago Conservancy in which all areas were classified and mapped according to setting, activity and recreational experience characteristics. The property is 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. Four wheel drive vehicles are desirable to give access to high country tussock grasslands and block mountains and more rugged remote areas" (Harper, 1992). It is important to note that there is a limited network of tracks on the lease (described below) that require linkages with tracks on adjoining properties to provide this opportunity for this zone.

Several internal farm tracks provide good access to approximately 1000 m on the eastern faces, while sections of the higher altitude tracks on the eastern and western boundaries, in conjunction with tracks on adjoining properties, provide access to the Lauder Basin Conservation Area and Cluden Pass respectively. These tracks on the boundaries are linked by a roughly formed vehicle track located on the Saddle. A branch of this provides access to the musterer's hut. A system of internal farm tracks provides good access to the lower sections of the lease, including Shepherds Creek.

2.8.2 Legal Access

Two branches of Cambrian Road run to the lease boundary. The northern, formed branch runs to approximately GR H41 524 853, while the unformed southern branch runs to approximately GR H41 522 841. An area of Crown Land (Tail Race Reserve), being Block 1, St Bathans SD adjoins the boundary at GR H41 517 848.

2.8.3 Activities

Due to lack of both secure public access and internal tracking existing recreational use of the lease is low. With landholder permission, mountain bikers, walkers, horse riders, skiers and four wheel drivers can gain access to the North Dunstan Mountains (and adjacent Lauder Basin Conservation Area) and the Dunstan Creek catchment.

It is likely that recreational activity on the lease would increase if public access was formalised. In conjunction with other access proposals on adjoining leases undergoing tenure review, access through this lease would complete a network of public foot and mountain bike access routes (a recent outcome of tenure review on adjoining Lindis properties) along McPhies Ridge, and across and along the Chain Hills to the Manuherikia Valley.

2.8.4 Significance of Recreation

The location of the lease at the northern end of Dunstan Mountains is of great significance to recreational use. Current visitor numbers are low due to the recreational opportunities being relatively inaccessible and therefore little known and hence can reasonably be expected to increase as opportunities become better identified and available. For example, Central Otago is becoming recognised as a mecca for mountain-biking and horse trekking. In addition, the increase in tourism and visitor numbers to National Parks and the Great Walks has seen New Zealand trampers looking for new and less popular areas for their activities.

The recently formalised network of public access tracks for mountain biking and walking in the Chain Hills to the north will be complimented by access through the lease and other access proposals on adjoining leases undergoing tenure review. The rapid growth in mountain biking in the Alexandra and Wanaka areas is likely to result in increased demand for such opportunities.

The lease is also strategically placed to provide public access to the adjoining Lauder Basin Conservation Area, which currently has no legal public access route.

PART 3

OTHER RELEVANT MATTERS & PLANS

3.1 Consultation

The lease was discussed at an NGO early warning meeting on 23rd September 2004 and the following points were noted.

- Professor Alan Mark
The woody vegetation in the lower half of the lease is very significant and vulnerable to fire. Given the presence of these and other SIVs on the lease, maybe a Whole Property Purchase (WPP) should be considered.
- Public Access New Zealand (PANZ)

- The faces draining into the true right of Shepherds Creek hold decent snow cover for ski touring. Provision for foot access up to and over these slopes is therefore important. This access would also form part of the required access to the Lauder Basin Conservation Area.
 - There is a track which partially falls within the lease up the eastern boundary which links to the Cluden Pass, although access to this pass may be better through the Mt St Bathans PL.
 - Dunstan Peak is a good vantage point and access to this area should be an outcome of this tenure review.
 - There is potential to secure linkages to the Lindis group of ex pastoral leases for non-motorised vehicles, foot and horse.
- Upper Clutha F&B
Linkages with any outcomes from the Cambrian tenure review should be realised.
 - NZ Deerstalkers Association
Possibly a few pigs and chukor on the lease.
 - Central Otago 4WD Club
The track up to Dunstan Peak is very popular (but this is on the Mt St Bathans PL).

Additional comments were supplied by NGOs at a “report-back” meeting, held in Alexandra on 12th April 2005.

- Sue Maturin, Forest and Bird:
 - Has the securing of an altitudinal sequence in the proposed Dunstan Conservation Park been considered and if so the sequence on the lease should be protected.
 - The old water race up Shepherd’s Creek could be used for walking access to land recommended to be returned to full Crown ownership.
 - The department should determine the extent (if any) of any mining licences over the lease.
- Dr Alan Mark
 - Given the SIVs a Whole Property Purchase should be considered.
 - There is better access to the lease’s southwestern boundary off the lease itself through Lauder pastoral lease.

In addition to these comments, several NGOs submitted written reports.

Southern Lakes Branch NZDA has the following generic concern about all tenure reviews, being *the lack of recognition given to hunting as a recreational activity. Access with firearms and dogs is still often being put in the to hard basket* and would they would like *more recognition given to Hunting as a recreational activity and provision made where it is appropriate for access with firearms and or dogs.* A copy of their full report is attached in section 4.4.1.

Central Otago Deerstalkers Club also has generic concern about all tenure reviews and wish that the department note their request for:

- a) good public four wheel drive access be a result of tenure reviews;
- b) permission to carry guns be met by DOC permit only; and
- c) securing access for hunting dogs be a result of tenure reviews.

A copy of their full report is attached in section 4.4.2.

The Dunedin Branch of Forest and Bird recommendations are summarised below. A full copy of their report is attached in section 4.4.3.

- The lease offers scope for very rewarding tramping etc. up Shepherds Creek or one of its spurs onto the highest section of the lease with the potential to continue onwards to Cluden or Dunstan Pass down through Cluden pastoral lease to Lindis Pass.
- A farm track some way up a spur above Shepherds Creek would be an ideal starting point for a continuing track to the ridge top.
- Given the layout of the tracks, public vehicle access is neither desirable or possible as an outcome of this tenure review.
- Ideally, the area above 1100 m and the entire catchment of Shepherds Creek should be returned to full Crown ownership. The sequence from the tops into Shepherds Creek is of great ecological significance with major inherent values.

The Upper Clutha Branch of Forest and Bird recommendations are summarised below. A full copy of their report is attached in section 4.4.4.

- That the lower part of Shepherds Creek taking in all of Dunstan RAP 1 be returned to full Crown ownership and control.
- The top of the hill surrounding and to the north of Lauder Basin Conservation Area be returned to full Crown ownership and control.
- Access to the lower part of Shepherds Creek should be provided from the end of Cambrian Road into this area.
- Walking access should be secured from a car park at the end of Cambrian Road up to the end of a formed track on the true right of Welshmans then up the boundary fence between Cambrian Hills and the Cambrian to the boundary of land that shall be returned to full Crown ownership and control.

Federated Mountain Clubs (FMC) recommendations are summarised below. A full copy of their report is attached in section 4.4.5.

- This tenure review presents opportunities both to enhance the recreational potential and use of the Dunstan Mountains and the quality of recreational experience on those lands by recognising and protecting the SIVs.
- The future status of the portion of Dunstan RAP A1 within the lease will be an important issue in this tenure review.

- Recreationally the most significant issue will be the consideration of public access to the Lauder Basin Conservation Area, Dunstan peak and over the Cluden Pass between St Bathans (via Dunstan Creek) and the Lindis country.
- Although this review does not provide the opportunity to secure formed public access the Lauder Basin Conservation Area there is an opportunity to secure walking only access to the boundary of any proposed Conservation Area and thence to Lauder Basin Conservation Area.
- As land above about 800 m has been classed LUC Class VII it is questionable whether it can be grazed in a way that is ecologically sustainable, though this is dependent on the frequency of ASTOD. This should be assessed against the SIVs. Likewise, land below about 800 m is classed LUC Class VI and can probably be grazed in an ecologically sustainable way.
- Given the presence of SIVs the lower reaches of Shepherds Creek should be included in any proposed Conservation Area.
- Protective covenants are required over historic resources within Welshmans Gully and in the vicinity of Vinegar Hill, with a covenant condition being an obligation to control wilding pines. Public access to these areas should be secured via the creation of an easement.
- This tenure review clearly presents a good opportunity to progress the Otago CMS objective for the North Dunstan Special Place.

3.2 Regional Policy Statements & Plans

The entire lease is subject to the Otago Regional Plan: Water rule which requires resource consent for suction dredge mining.

3.3 District Plan

The lease is located within the Rural Resource Area of the Central Otago District Plan.

As at 22 February 2005, the proposed Central Otago District Plan (amended to incorporate Council decisions) requires resource consent (with certain exemptions) for the clearance of areas of indigenous vegetation greater than 0.5 ha or in the case of snow tussock grassland 10 ha, or above 1080 m, or areas containing any threatened plants listed in a schedule. This requirement does not apply to land that has been freeholded under the Crown Pastoral land Act 1998.

Resource consent is required for tree planting using certain tree species with wilding potential, subject to certain criteria. Resource consent is required for excavations or tree planting within specified distances of a water race or irrigation pipeline, and for development work within 10 m of any water body. There are no registered historic sites or areas of significant indigenous vegetation and habitats of significant indigenous fauna and wetlands as set out in the schedules of the plan.

The protected landscape provisions of the Plan require resource consent for development of land over 900 m, with an exclusion for land that has been freeholded under the Crown Pastoral land Act 1998.

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 CMS identifies 41 special places of conservation interest in Otago Conservancy. The lease lies within the North Dunstan Special Place.

The CMS objective for the North Dunstan Special Place relevant to the lease is:

To extend protection in the area to cover the remaining higher altitude areas of nature conservation importance, and to secure appropriate public access.

The key implementation methods relevant to the lease are:

- Pastoral lease tenure review on properties in the area may provide opportunities to negotiate to protect the areas of interest. Overall management of these new areas with the existing conservation areas will confer net conservation and management benefits.
- Opportunities to legalise public access points and develop appropriate public facilities will be explored. Once access is improved, public awareness of the area can be increased.
- Attempts will be made to negotiate as of right public foot and mountain bike access to high altitude protected areas.

Priorities for North Dunstan Mountains

The negotiation of protection arrangements for areas of biodiversity importance and recreational opportunities and access are the priority activities in this Special Place.

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.

PART 4

MAPS ETC.

4.1 Additional information

4.1.1 References

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4.1.2 Appendices

Appendix 1: Description of Dunstan RAP A1. Grove, P. (ed) (1994). Lindis, Pisa and Dunstan Ecological District: a survey report for the protected natural areas programme. New Zealand Protected Natural Areas Programme Series, 36. Department of Conservation, Dunedin.

Appendix 2: Geopreservation Site No. 324 North Dunstan. Excerpt from Arand, J.; Basher, L.; McIntosh, P.; Heads, M. 1991. Inventory of New Zealand Soil Sites of International, National and regional Importance. Part 1- South Island and Southern Offshore Islands (1st Edition). New Zealand Society of Soil Science Occasional Publication 1.

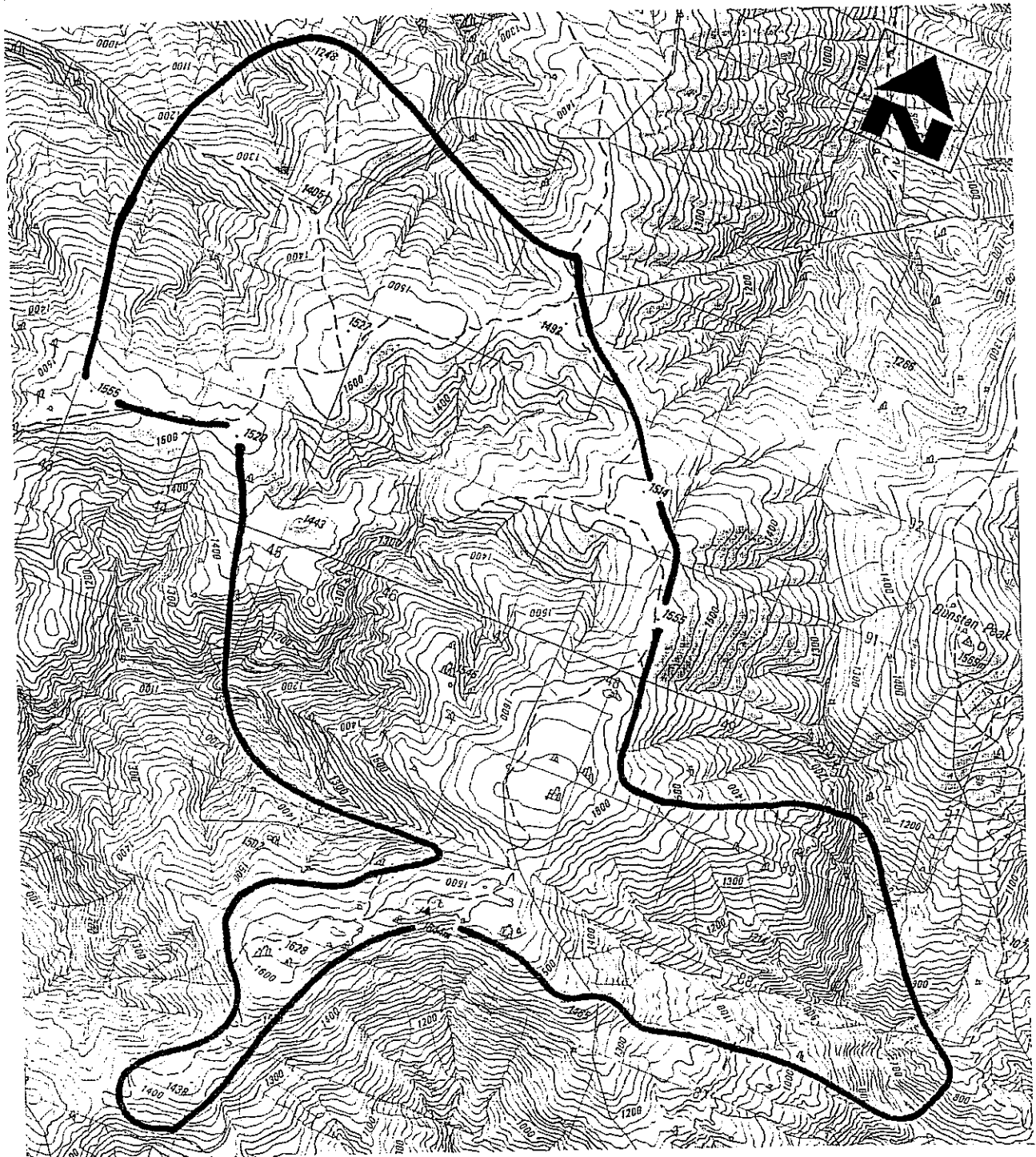
Appendix 3: Vascular plant list

Appendix 4: Invertebrate species list

Appendix 5: Fish Records

Appendix 1: Description of Dunstan RAP A1. Grove, P. (ed) (1994). Lindis, Pisa and Dunstan Ecological District: a survey report for the protected natural areas programme. New Zealand Protected Natural Areas Programme Series, 36. Department of Conservation, Dunedin.

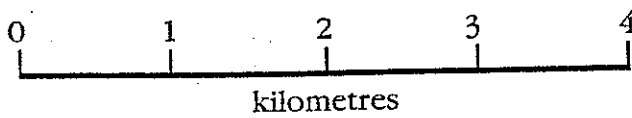
DUNSTAN - RAP A1 **NORTH DUNSTAN**



GRID REFERENCE - INFO MAP 260 G40 465 900

AREA - 2760 hectares

ALTITUDE - 640m - 1695m



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LINDIS RAP A1 - NORTH DUNSTAN

Bioclimatic Zones Montane to high alpine

| Ecological Units | Vegetation types | Landforms |
|-------------------------|---------------------------------|--------------------------------|
| | Pod halon | outcrop/rubblefield |
| | Gri lit-Cop pro | on derivative slope |
| | Gri lit-Cop pro | on riparian slope |
| | Sop mic-Cop pro-Dis tou | on derivative slope |
| | Dis tou-Cop pro | on colluvial slope |
| | Dis tou-Cop pro | on riparian slope |
| | Mixed shrubland | on outcrop/rubblefield |
| | Mixed shrubland | on riparian slope |
| | Fes nov | on colluvial slope |
| | Fes nov | on derivative slope |
| | Fes nov | on alluvial surface |
| | Chi rig-Fes nov | on colluvial slope |
| | Chi rig-Fes nov | on ripply colluvial slope |
| | Mixed outcrop vegetation | |
| | Dra lon | on colluvial slope |
| | Pod niv | on colluvial slope |
| | Chi rig-Fes mat-Poa col | on colluvial slope |
| | Chi rig-Fes mat-Poa col | on ripply colluvial slope |
| | Chi rig-Fes mat-Poa col | on derivative slope |
| | Fes mat-Poa col | on colluvial slope |
| | Chi mac-Fes mat-Poa col | on colluvial slope |
| | Chi mac-Fes mat-Poa col | on ripply colluvial slope |
| | Chi mac | on summit peneplain |
| | Chi mac | on colluvial slope |
| | Chi mac | on ripply colluvial slope |
| | Chi mac-Poa col | on summit peneplain |
| | Chi mac-Poa col | on ripply colluvial slope |
| | Poa col | on colluvial slope |
| | Poa col | on ripply colluvial slope |
| | Dra mus-Rao hec | on soil hummocks |
| | Dra mus-Rao hec | on solifluction lobes/terraces |
| | Dra mus-Rao hec | on ridge crest lag surfaces |
| | Dra mus-Poa col-Cel vis | on soil hummocks |
| | Sparse cushion vegetation | on ridge crest lag surface |
| | Leu fra-Chi den | on ridge crest lag surface |
| | Snowbank vegetation | |
| | Car gau-Ore pec-Moss | on flush |
| | Sch pau | on flush |

Landform A partial transect across the northern Dunstan Mountains, extending from low on the southeastern flank across the broad summit area to the upper northwestern flank.

In the east, Shepherds Creek flows in a gorge more deeply entrenched than other streams in the Cambrians land system. It exploits a line of faulting and dislocation in semischist on the edge of the transition zone from the Haast Schist characteristic of the Dunstan Mountains to the greywacke of the St Bathans Range. Coarse talus is present in some sections of the gorge. The western branch of Shepherds Creek, the main focus of the transect, is perched above the main stream and enters it via waterfalls. Its broad upper basin is dominated by slumped ripply colluvial slopes.

The summit plateau remnant around the head of Lauder Creek features very broad gently undulating ridges culminating in the unnamed highest point of the Dunstan Mountains (1690 m). The ridge crest southwest of this point is mainly a deflated stony pavement, but soil hummocks are characteristic elsewhere on the summit ridges. Other relict periglacial phenomena are localised solifluction lobes and scattered tors. The generally stable colluvial slopes steepen towards the streams and Lauder Creek becomes deeply gorged towards the end southwestern edge of the RAP.

The main ridges of the Cluden land system in the west generally slope 5 - 10 degrees NW, but tributaries of Cluden Stream are strongly incised. These valleys are asymmetric because of the moderate northerly dip of the Haast Schist here. Sunny aspects tend to be slumped while shady aspects are more commonly stable though steeper.

Soils of the priority area are predominantly hygroscopic yellow-brown earths-Carrick soils on the gentle summit slopes, Dunstan Steepland soils elsewhere, grading into yellow-grey (Arrow) earths in the lower reaches of Shepherds Creek.

Vegetation

Slim snow tussockland of moderate to high density dominates the broad summit ridges and upper slopes. Common associated species are false spaniard (in local concentrations), blue tussock, *Raoulia grandiflora*, *R. subsericea*, *Rytidosperma pumilum* and *Pimelea oreophila*. Alpine fescue becomes prominent below 1500 m.

Several minor communities are closely associated with slim snow tussockland. Alpine flushes are numerous and relatively extensive, commonly up to several hectares. They are dominated by *Carex gaudichaudiana*, *Oreobolus pectinatus* and mosses, with frequent *Epilobium komarovianum*, *Caltha obtusa*, *Centrolepis pallida*, *Agrostis pallescens*, *Abrotanella caespitosa* and *Gnaphalium mackayi*. Snowbank communities, with *Celmisia haastii*, *Raoulia subulata* and *Phyllachne rubra* are weakly developed and generally not characteristic of the area.

Cushionfields dominated by *Dracophyllum muscoides* with *Raoulia bectori*, blue tussock and *Luzula rufa* are commonly associated with tors on exposed sites, especially in the east. Other small areas of deflated stony soils are dominated by *Chionohebe densifolia* and blue tussock with other tussockland herbs and grasses. An extensive area of heavily deflated ridge crest southwest of the main summit features sparse cushionfield with *Chionohebe thomsonii*, *Colobanthus buechananii*, *Luzula pumila*, *Leptinella pectinata* and occasional edelweiss.

Slim snow tussockland extends downslope to a generally abrupt boundary with narrow-leaved snow tussockland at an altitude between 1350-1400 m on sunny faces and about 1200 m on shady faces in the west but as low as 1100 m in the east. Only a narrow zone of narrow-leaved snow tussockland is present in the west, it gives way downslope to fescue tussockland generally of low naturalness. Fire-induced blue tussockland has replaced snow tussockland on the slopes northeast of Trig G. A discontinuous line of flushes acted as a partial fire-break, and a sharp, irregular fire boundary against slim snow tussock remains clearly visible.

In Shepherds Creek narrow-leaved snow tussockland is more extensive, with abundant alpine fescue, blue tussock and the several sub-shrub species; *Pentachondra pumila*, *Gaultheria depressa*, *G. macrostigma*, *Leucopogon fraseri* and some *Leucopogon colensoi*. Fescue abundance increases downslope, generally to become dominant at low altitude especially on sunny faces.

The lower gorge slopes of Shepherds Creek feature a wide range of woody vegetation types. Hall's totara treeland occupies outcrops and rubblefield near the eastern extremity of the area, with *Corokia cotoneaster*, broadleaf and occasional celery pine. Streamside vegetation is predominantly mixed shrubland, with *Coprosma propinqua*, matagouri, koromiko and *Aristotelia fruticosa* dominant in the lower portion; broadleaf (trees) and *C. propinqua* in the mid section near the forks; and *Hebe subalpina*, matagouri and many associated species including scattered Hall's totara in the upper section. Snow totara as isolated plants and scattered clumps is present near the upper limits of shrubland and locally within snow tussockland.

Dense matagouri shrubland, of generally low diversity but locally with seedling broadleaf and three finger, is present in the lower section of Shepherds Creek, but has been reduced by fire. Manuka shrubland has been almost destroyed except for a clump a few metres across and scattered young plants within fescue tussockland. Dense *Dracophyllum longifolium* shrubland (patches of several hectares) on shady slopes at 800-900 m appear to be young communities invading tussockland.

Flora

A newly discovered tiny *Gentiana* species is common in many alpine flushes, and has since been described and named *Gentiana lilliputiana* (Webb, 1990). Small populations of rare *Myosotis oreophila* and *M. cheesemanii* occur locally on exposed sites on the ridge southwest of the high summit. These populations have been documented (Johnson & Robertson 1986) and further research is currently underway to learn more of their population dynamics. Edelweiss, found here, is uncommon in the District. Also found were *Microseris scapigera* and *Carpha alpina*, and a trifid leaved form of *Chionohebe densifolia* which is seemingly characteristic of the northern Dunstan Mountains.

Along Shepherds Creek are three finger, *Brachyglottis cassinioides*, *Olearia nummularifolia*, *Coprosma crassifolia*, *C. linariifolia*, mountain flax, *Hierochloa recurvata*, *Schizetelema trifoliatum*, *Blechnum fluviatile*, *Asplenium flaccidum*, *Lycopodium scariosum*, *L. australianum* and celery pine - all uncommon in the District.

Discussion

The northern Dunstan Mountains have been little studied by biologists, as emphasised by the discovery of a locally common new gentian species. The priority area is of outstanding significance for the extensive intact snow tussocklands on the summit area, and the altitudinal sequence in Shepherds Creek with continuity between snow tussockland and diverse woody vegetation types.

Slim snow tussockland on the broad upper slopes and plateau surface is the most extensive in the Lindis, Pisa and Dunstan Districts. It is in conspicuous contrast with the southern Dunstons, Pisa and Old Man Ranges where cushionfield dominates under conditions of generally similar altitude, terrain and annual precipitation. Most cushionfield in these areas is probably fire-induced. Fire modification to the alpine tussockland of this priority area is evident, especially in the northwest, but most has escaped destruction. The variety of cushionfield and flush communities, although covering much smaller areas, add considerably to the overall diversity of the alpine zone.

Clearcut altitudinal and aspect relations between slim snow tussockland and narrow-leaved snow tussockland, with sharp boundaries and minimal hybridism apparent, are distinctive and probably indicative of the relative lack of disturbance in these alpine ecosystems. The alpine zone of the North Dunstan priority area is of major importance for an understanding of the alpine ecological history of the Central Otago Region.

The dry northwest slope of the Dunstan Mountains (Cluden and Bendigo land systems) is generally strongly modified and almost devoid of snow tussockland. The area of narrow-leaved snow tussockland in the northwest of the North Dunstan priority area, although limited, is the largest surviving.

The altitudinal sequence from Shepherd Creek and its western tributary to the high point of the Dunstan Mountains is the best in the District. It ranges continuously from small areas of cushionfield, through slim and narrow-leaved snow tussockland with very few exotic species present, to the gorge of Shepherds Creek which shelters the greatest diversity of woody vegetation in the District. This includes the only substantial area of broadleaf treeland in the three districts, and one of the larger Hall's totara treelands, with numerous species generally characteristic of forest.

The significance of Shepherds Creek as a forest refuge is emphasised by the siting of a brown creeper, a forest bird not previously recorded in Central Otago (nearest record in Bull *et al.* 1985 is 45 km away near Lake Hawea). The combination of abundant rock outcrops and talus with the vegetation diversity probably indicated good habitat for lizards and diverse invertebrates.

CRITERIA SUMMARY : LINDIS RAP A1 - NORTH DUNSTAN

| | | |
|---------------------------|---|---|
| Representativeness | H | Excellent representation of original alpine communities, and altitudinal sequence to montane zone in east. |
| Diversity | H | Wide range of tussocklands and associated alpine communities, also of subalpine - montane woody communities. |
| Naturalness | H | Unusually high naturalness overall, especially in alpine zone, generally few exotics. |
| Special Features | H | Numerous rare or uncommon species. |
| Viability | H | Communities intact and functioning in natural interrelationships. |
| Buffering | H | Summit plateau surface well buffered by isolation. West slope only moderately buffered by depleted or oversown fescue tussockland. Shepherds Creek shrubland with some buffering but subject to fire. |
| Threat | M | Fire (shrubland and tussockland), stock impact in alpine flushes, potential oversowing in montane subalpine zones in east. |
| Landform | H | Good representation of northern Dunstan land systems with emphasis on the plateau surface and deeply incised Shepherds Creek. |

Appendix 2: Geopreservation Site No. 324 North Dunstan. Excerpt from Arand, J.; Basher, L.; McIntosh, P.; Heads, M. 1991. Inventory of New Zealand Soil Sites of International, National and regional Importance. Part 1- South Island and Southern Offshore Islands (1st Edition). New Zealand Society of Soil Science Occasional Publication 1.

solifluction debris and debris. **VEGETATION INFORMATION:** grassland; snow tussock grassland; broadleaved shrubland; cushionfield; thyme shrubland; matagouri-broadleaved shrubland; introduced grassland and sweet brier

SOILS: brown-grey earths (Alexandra), yellow-grey earths (Arrow), upland yellow-brown earths (Dunstan Carrick)

IMPORTANCE: 2 **SIGNIFICANCE:** (i) excellent altitudinal sequence of soils, in one of the driest parts of New Zealand.

VULNERABILITY: 2 **MODIFICATIONS/THREATS:** tracking; water-races; minor sluicing; much bare ground and introduced species; threatened by spread of exotic plants and oversowing

TENURE: pastoral lease, recommended area for protection **OWNER/MANAGER:** Waenga Station, Waikerikeri Station

CONTACT PERSON: Peter McIntosh **DATE OF INFORMATION:** June 1991

NOTES: Waikerikeri recommended area for protection is contiguous to the east.

REFERENCES: Ward et al. (1987)

(323) Neds Creek

REGIONAL/CITY COUNCIL(S): Otago **ECOLOGICAL DISTRICTS(S):** 67-03 Dunstan

LOCALITY and GRID REFERENCE: 14 km E of Omahau G41 281689

AREA(ha): 430 **ALTITUDE(m):** 670-1560 **RAINFALL(mm):** 400-600

TOPOGRAPHY: steep colluvial mountain slopes (scarp face) and tops; periglacial phenomena - soil hummocks and stripes **PARENT MATERIAL:** schist and derived colluvium **VEGETATION:** snow tussock grassland; short tussock grassland; podocarp treeland; podocarp-Dracophyllum shrubland and scrub; cushion-herbfield; manuka shrubland; matagouri shrubland

SOILS: upland yellow-brown earths (Carrick Dunstan), yellow-grey earths (Arrow)

IMPORTANCE: 2 **SIGNIFICANCE:** (i) good example of upland yellow-brown earths and yellow-grey soils under relatively unmodified vegetation.

VULNERABILITY: 2 **MODIFICATIONS/THREATS:** abundant exotics at lower altitudes; some threat from fire, oversowing and topdressing

TENURE: recommended area for protection

CONTACT PERSON: Peter McIntosh **DATE OF INFORMATION:** May 1987

NOTES: Separated by an arbitrary boundary from Bendigo Tops recommended area for protection.

REFERENCES: Ward et al. (1987)

(324) North Dunstan

REGIONAL/CITY COUNCIL(S): Otago **ECOLOGICAL DISTRICTS(S):** 67-03 Dunstan

LOCALITY and GRID REFERENCE: 34 km S of Lindis Pass G40 465904

AREA(ha): 1400 **ALTITUDE(m):** 640-1695 **RAINFALL(mm):** 600-800

TOPOGRAPHY: rolling to steep colluvial mountain slopes and broad tops; gorges; coarse talus slopes; waterfalls; periglacial features - soil hummocks, solifluction lobes and scattered tors; asymmetric valleys; large-scale slumping **PARENT MATERIAL:** schist/semi-schist and derived colluvium **VEGETATION:** snow tussock grassland; short tussock grassland; alpine flushes; podocarp treeland; broadleaved-matagouri shrubland; Dracophyllum shrubland; cushionfield

SOILS: upland yellow-brown earths (Dunstan), yellow-grey earths (Arrow Blackstone)

IMPORTANCE: 1 **SIGNIFICANCE:** (i) one of the largest and least modified areas in Central Otago. Also notable for the high diversity of soil-vegetation associations, reflecting the wide range of altitudes, aspects and landforms. (ii) soils under relatively unmodified tussock grasslands are rare internationally.

VULNERABILITY: 2 **MODIFICATIONS/THREATS:** parts have been burned and oversown; threatened by fire, grazing and oversowing

TENURE: stewardship land **OWNER/MANAGER:** Department of Conservation

CONTACT PERSON: Peter McIntosh **DATE OF INFORMATION:** May 1987

NOTES: Area of site is smaller than the recommended area for protection in Ward et al. (1987).

REFERENCES: Ward et al. (1987)

(325) Pisa Flats

REGIONAL/CITY COUNCIL(S): Otago **ECOLOGICAL DISTRICTS(S):** 67-03 Dunstan

LOCALITY and GRID REFERENCE: 13 km NNE of Cromwell G41 162791

AREA(ha): 3-4 **ALTITUDE(m):** 200 **RAINFALL(mm):** 500

TOPOGRAPHY: flat terrace, shallow former river channel **PARENT MATERIAL:** loess **VEGETATION:** introduced grassland; halophytic vegetation

SOILS: brown-grey earths (Manorburn Molyneux)

IMPORTANCE: 1 **SIGNIFICANCE:** (i) the only remaining Central Otago soil site retaining native flora and fauna including halophytes. Most other sites have been destroyed by border-dyke irrigation. Similar sites are uncommon

Appendix 3: Vascular plant list

Appendix 4: Invertebrate species list

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| Class: Insecta | Family | Species | Sites | Threat status* | Comment | Distribution notes |
|-------------------|---------------------------|--|--------------------------|--|---|---|
| Order | | | | | | |
| Blattodea | Blattidae | <i>Celatoblatta quinque maculata</i> Johns | 5,10,13,15,19,21 | Not known as threatened | Endemic cockroach species restricted to Canterbury & Otago (Johns 1966, Chinn & Gemmell 2004). | Common on block >1400m. |
| | | <i>Celatoblatta anisoptera</i> Johns | 1,2,5,8,9,10,12,13,19,21 | Not known as threatened | “ | Sympatric with <i>C. quinque maculata</i> , Less common . |
| | | <i>Parellipsidion inaculeatum</i> Johns | 4 | “ | “ | Occasional >1200m. |
| Coleoptera | | | | | | |
| | Byrrhidae:Byrrhinae | <i>Pedilophorus lewisi</i> Pascoe | 16 | Not known as threatened | Endemic moss beetle. The NZ fauna is very diverse | Noted occasionally on outcrops, beneath schist slabs > 1300m. |
| | Carabidae | <i>Demetrida sinuata</i> Broun | 7 | “ | Small flightless ground beetles. <i>D. sinuata</i> is widespread and endemic to the South Island (Johns 1986). | Occasionally throughout. |
| | | <i>Demetrida sp. ? moesta moesta</i> Sharp | 18 | “ | <i>Demetrida</i> (White) is an Australasian genus with eight species described for NZ. <i>D. moesta moesta</i> is restricted to Otago (Patrick 1994). | Found only at this site. Pitfall trap. |
| | Carabidae: Pterostichini | <i>Holcaspis</i> <i>cf. H. bathana</i> Butcher | 9,12 | Not known as threatened | Small endemic ground beetles. Type locality is St. Bathans. | Occasional throughout block. |
| | Carabidae: Broscini | <i>Mecodema sp. 1</i> | 5 | - | <i>Mecodema</i> (Blanchard) is an endemic genus of flightless ground beetles. So far, 58 have species have been described. Susceptible to mammal predation. | Found only at this site. |
| | Carabidae: Broscini | <i>Mecodema sp. 2</i> | 19 | - | “ | Found only at this site. |
| | Carabidae: Pterostichini | <i>Megadromus sp. 1</i> | 1,7,8 | At least one species of <i>Megadromus</i> is listed as a Category B Second Priority Threatened Species (Molloy et al. 1994) | Large fast running ground beetles. Valuable conservation and biogeographical indicator species. | Occasional throughout higher rocky, tussock country. |
| | Carabidae: Pterostichini | <i>Megadromus sp. 2</i> | 7 | “ | “ | Found only at this site. |
| | Chrysomelidae: Eumolpinae | <i>species 1</i> | 3 | - | Leaf beetles. NZ Chrysomelids are poorly known and in need of revision. Probably a native species of which there are 146 known (Klimaszewski & Watt 1997). | Found occasionally on <i>O. bullata</i> and <i>O. odorata</i> . Lower elevations. |
| | Chrysomelidae: Bruchinae | <i>species 1</i> | 18 | - | Seed weevils. | Collected from pitfall trap. Specimen in poor condition. |
| | Chrysomelidae: ?Bruchinae | <i>species 2</i> | 18 | - | “ | Ex. pitfall trap, specimen evidently attracted to yellow fowers. |
| | Cleridae | Awaiting full identification. | 4 | No NZ Clerids are known as threatened | Clerids prey on other insects. Collected from flowers and foliage. | Collected from this site only. |
| | Coccinelidae | <i>Adalia bipunctata</i> (L.) | 4 | Introduced species | Two spotted ladybird. Introduced from Europe. | Collected from this site only. |
| | Coccinelidae | <i>Coccinella undecimpunctata</i> (L.) | 4 | “ | Eleven spotted ladybird. Aphid predator. | “ |

| Coleoptera | | Diptera | | | |
|---------------------------------|--|--------------|---|---|--|
| Curculionidae: Apioninae | Apion sp. | 17 | - | Seed weevils. Attracted to yellow flowering plants (Legumes), the adults bore into plant tissue. | Collected from this site only, yellow pan trap. |
| Curculionidae: Brachycerinae | <i>Anagotus lewisii</i> Broun | 13 | - | A number of <i>Anagotus</i> species (giant weevils) are threatened and prone to rat predation. | Flightless weevils. Specialised habitat requirements. Considered endangered on the mainland (Klimaszewski and Watt 1997). Found above 1500m, feeds on tussock and snowberry (<i>Gaultheria sp.</i>). |
| Dytiscidae | <i>Liodessus plicatus</i> (Sharp) | 17 | - | Not known as threatened | Common native diving beetles. Occuring in alpine tarns and streams. A valuable Macroinvertebrate Community Index species (Winterbourn <i>et al.</i> 2000). Found only at this site. Sub alpine wet-flush. |
| Elatridae: Elatrininae | Awaiting full identification | 7 | - | - | Elatrids (click beetles) occur on foliage and are both herbivorous and insectivorous. The group is in need of revision and there is no comprehensive treatment available. Collected from this site only. |
| Scarabaeidae | <i>Pyronota festiva</i> (F.) | 1,3 | - | Not known as threatened | Common Manuka beetle, Ex. <i>Olearia bullata</i> (site 1). Frequent in lower elevations and amongst Shepherds creek native vegetation. |
| Tenebrionidae | <i>Artystona rugiceps</i> Bates | 5,6,10,12,15 | - | “ | Endemic species, feeds on dried rotten vegetable matter. Often found in clusters beneath stones. Common where found. |
| Tenebrionidae: Tenebrioninae | <i>Mimopeus opaculus</i> Watt | 1,12 | - | “ | Native species, feeds on dry rotting wood. Found only at these sites. |
| Agromyzidae; Phytomyzinae | <i>Cerodontha ?angustipennis</i> Harrison | 17 | - | “ | Minute flies, larvae are leaf miners, endemic. Widespread Collection records include Roxborough. Collected and observed from this site only. |
| Asilidae | <i>Neoitamus melanopogon</i> (Schiner 1868) | 1 | - | “ | Common predatory Robber fly. Native. Observed occasionally on lower slopes of mixed pasture/silver tussock (<i>Poa cita</i>). |
| Chironomidae | <i>Chironomus sp.</i> | 16 | - | - | Midges. Larvae associated with wetlands and streams. Ex. Yellow pan trap located at wet seep. |
| Dolichopodidae | <i>Parentia sp.</i> | 16 | - | - | Small, metallic hued flies. Predators of other insects. Over 150 species in NZ. Collected from this site only, yellow pan trap. |
| Lonchopteridae | ? <i>Lonchoptera sp.</i> | 17 | - | - | Small Aschizan fly. Larvae live in decaying vegetation. Possibly introduced from Europe via Australia. Information is lacking. Sweep net. This site only. |
| Muscidae | | 16 | - | - | One of 200 plus native Muscid flies. Collected from yellow pan trap |
| Muscidae | species 1 | 16 | - | - | “ “ |
| Muscidae | species 2 | 16 | - | - | “ “ |
| Sphaeroceridae | Leptocera thomasi Harrison | 18 | - | Not known as threatened | Aschiza flies, common throughout NZ. Frequent on lower elevations. |
| Stratiomyidae | species 1 | 4,17 | - | - | Soldier flies. Probably endemic. Numerous species are wasp mimics and feed on flowers. Collected from <i>Aciphylla</i> flowers. |
| Syrphidae | Syrphus sp. | 19 | - | - | Native hover fly. Sweep netting ex. tussock & wet flush. |
| Syrphidae | | 16 | - | - | Native hover fly Yellow pan trap |
| Tachinidae | Platycheirus sp. <i>Proccissio sp.</i> | 16 | - | - | Tachinidae is an immense and taxonomically difficult family. Larvae are Observed throughout block. |

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| Order | Family | Species | Count | Conservation Status | Description | Observation |
|-------------|------------------|--|-------------|---|--|---|
| Diptera | Tachinidae | species 2 | 13 | - | | “ |
| | Tachinidae | species 3 | 18 | - | | “ |
| | Tipulidae | <i>Leptotarsus sp.</i> | 16 | - | Crane fly. An immense family, found in damp habitats. | |
| | Tipulidae | ? <i>Paralimnophila sp.</i> | 1 | - | Specimen collected from wet-flush grasses. | Found only at this site. |
| | Trypetidae | <i>Trypanea sp.</i> | 17 | - | Endemic fruitflies, feed on native flowers (<i>Celmisia sp.</i>) | Found only at this site. |
| Hemiptera | Acanthosomatidae | <i>Oncacotias vittatus</i> Fabricius | 4 | Not known as threatened but see adjacent comment. | Stink bugs (Pentatomoid). Monotypic (at the generic level) and endemic. High NZ scientific value from an ecological perspective (Lariviere 1995; Lariviere & Laroche 2004) | Observed on a number of occasions at this site only. |
| | Aphidae | | 16 | - | Awaiting full identification. Probably a native sub-alpine species. | Collected in yellow pan trap. |
| | | species 1 | 16 | - | | “ |
| | | species 2 | 16 | - | | “ |
| | Lygaeidae | <i>Rhyphodes anceps</i> White | 4,6,18 | “ | Was <i>Hudsona anceps</i> . Hudsons bug, common on <i>Raoulia</i> mats (host plant). Endemic genus. | Observed occasionally on mat plants. Pitfall trap & sweep net. |
| | Lygaeidae | <i>Rhyphodes sp.</i> ? <i>R. triangulus</i> Eyles | 16 | “ | Collection records include Obelisk range, Wanaka and Mackenzie basin. Macropterous (can fly). | Yellow pan trap & sweep net. Common on <i>Raoulia</i> mats. |
| Hymenoptera | Formicidae | <i>Huberia striata</i> (Smith) | 18 | Not known as threatened | Native ants. | Common throughout block. |
| | | <i>Monomorium antarcticum</i> White | 1,2,8,12,13 | “ | | Common throughout block. |
| | Halictidae | <i>Lasioglossum sordidum</i> Smith | 16,17 | “ | Native solitary bees. | Small common Southern ant. Abundant in yellow pan trap. |
| | Ichneumonidae | <i>Ichneumon sp.</i> | 1 | - | Parasitic wasps. | Sweep net, found at this site only. |
| | Braconidae | Unidentified species | 17 | - | Insect parasitoids, particularly of Lepidoptera larvae. | Sweep netting tussock. Found at this site only. |
| Lepidoptera | Choreutidae | ? <i>Asterivora sp.</i> | 4 | - | Oligophagous grass moths. Larvae feed on foliage/shoots. <i>Asterivora</i> is associated with <i>Celmisia</i> . | Sweep net. Collected from this site only. |
| | Crambidae | <i>Orocrambus aethonellus</i> (Meyrick) | 16 | “ | Mire grass moth | Creek gullies/wet flushes. |
| | Crambidae | <i>Eudonia cataxesta</i> (Meyrick) | 17 | Not known as threatened | Tussock/grass moths | Common in herb fields and rock tors. Observed throughout. |
| | Crambidae | <i>Scoparia claranota</i> Howes | 2 | “ | | “ |
| | Lycaenidae | <i>Boldenaria boldenarum</i> White | 1,3,4,5,11 | “ | Boulder Copper butterfly | Common at low elevations. Tussock. Associated with <i>Muehlenbeckia</i> . |
| | Lycaenidae | <i>Zizina labrus oxleyi</i> Felder & Felder | 5 | Not known as threatened | Southern Blue butterfly. | Common throughout. Associated with <i>Carmichaelia</i> . |
| | Noctuidae | <i>Tmetolophota</i> | 20 | “ | Wainscot moth. | Light trap. Larvae on grasses. |

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| | | | | | | |
|-------------------|-----------------|---|------------------|--|--|--|
| <i>Orthoptera</i> | Acrididae | <i>Sigauss australis</i> (Hutton) | 6,12,13,15,16,19 | “ | Common large tussock grasshopper. Endemic species found throughout South Island high country (Bigelow 1967). | Frequent in tussock over entire block. |
| | Stenopelmatidae | <i>Hemidiena maori</i> Pictet & Sassure | 13 | Genus carries Range restricted species. Probably at risk from rodent predators. | Large, charismatic mountain stone weta. (A ground dwelling tree weta). Endemic. | Occasional amongst rock outcrops and blocky scree. |
| | Stenopelmatidae | <i>Hemidiena sp.</i> | 18 | “ | Ground weta. Diversity not well described. | Collected from pitfall trap. |

Non-insect invertebrates

Class Arachnida

| | | | | | | |
|-------------|--|---|------|--|--|---|
| Araneidae | | <i>Zealanranaea sp.</i> | 1 | - | Orbweb spiders. A small group, common in scrub & forest margins. Widespread in NZ. | Found at this site only, beaten e. <i>Griselinia</i> sp. |
| Archaeidae | | Unidentified species | 18 | - | A unique group with elevated carapaces and long chelicerae. | Collected from this site only. Ex pitfall trap. |
| Agelenidae | | <i>Neoramia sp. cf. M. mamoea</i> n.sp. | 19 | Not known as threatened | Common endemic genus | Occasional amongst rocky tors/outcrops |
| Agelenidae | | <i>Neoramia sp. 1</i> | 19 | “ | Common endemic genus | “ |
| Clubionidae | | <i>Clubiona species 1</i> | 7 | - | <i>Clubiona</i> is a worldwide genus of two-clawed vagrant spiders. | Found at this site only |
| Clubionidae | | <i>Clubiona species 2</i> | 1 | - | “ | “ |
| Gnaphosidae | | <i>Matua valida</i> n.sp. | 1,14 | Not known as threatened but see adjacent distribution comments. | Juvenile specimen <i>M. valida</i> is the type species, this endemic group is apparently restricted to Otago and Canterbury (Forster & Blest 1979) | Occasional beneath stones at higher elevations. |
| Gnaphosidae | | <i>Notiodrassus distinctus</i> Bryant | 4 | Not known as threatened | Type species. These hunting spiders are found in native forests of southern South Island. Endemic. | Found at this site only, amongst broad leaf litter. |
| Linyphiidae | | <i>Latesia sp.</i> | 18 | - | Money spiders. Possibly introduced. | Pitfall trap. |
| Lycosidae | | <i>Anoteropsis flavescens</i> L. Koch | 15 | “ | Wolf spider. Endemic, found only in the south east of the South Island. | Occasional throughout. Pitfall trap and hand collected |
| Lycosidae | | <i>Anoteropsis hilaris</i> Koch | 18 | “ | Common wolf spiders, all specimens juvenile. | Abundant in pitfall traps |
| Lycosidae | | <i>Anoteropsis sp.</i> (Juvenile) | 4,16 | “ | “ | Collected from this site only. |
| Miturgidae | | <i>Miturga sp.</i> | 9 | - | Prowling spiders. Genus shared with Australia. | Found at this site only. |
| Salticidae | | <i>species A</i> Forster | 19 | Conservation status unknown but see adjacent | A high altitude endemic jumping spider restricted to Otago mountains. No formal identifications exist. Collection records include Rock and Pillar, Remarkable and Pisa ranges. These spiders exhibit high endemism and speciation patterns (Forster & Forster 1999). | Found at this site only, beneath schist slabs. |
| Salticidae | | Unidentified species | 4 | - | Despite their widespread distribution, no formal keys exist for NZ Salticids. | Found only from this site. Ex. <i>Griselinia</i> beating. |

| | | | | | | | |
|-------------------------|--------------------|---|------|-----------------------------|---|---|---|
| Arachnida | Stiphidiidae | <i>Cambridgea antipodiana</i> Koch | 4 | Not known as threatened | Endemic sheet web spiders. A widespread group. | Occasional on lower elevations. | *Status based on McGuinness 2001; Hitchmough 2002; Pawson and Embersohn 2000. |
| | Tetragnathidae | <i>Tetragnatha sp.</i> | 6,16 | - | Big-jawed orb web spiders. Found near streams and marshes. Endemic. | Common in damp areas throughout block. | |
| | Thomisidae | <i>Diaea sp.</i> | 1 | - | Crab spider, a vagrant hunter. Ex. <i>Olearia odorata</i> . <i>Diaea</i> is a genus with widespread species distributions. Native. | Collected from a number of shrubs throughout block. | |
| | Triaenonychidae | <i>Nuncia sp.</i> | 5 | - | The Otago region supports a diverse and highly endemic Opilione fauna (Forster 1954). <i>Nuncia</i> also shows a high level of Pleistocene period isolation and speciation. Opiliones are an understudied group. Endemic. | Found only at this site, amongst Broadleaf litter. | |
| Opiliones | | | | | | | |
| Chilopoda | | | | | | | |
| | Geophilidae | <i>Zelanophilus sp.</i> cf. <i>Z. provocator</i> Pocock | 7,11 | Not known as threatened | Endemic genus of soil centipedes. | Widespread throughout. | |
| Class: Diplopoda | | | | | | | |
| | Sphaerotrachopidae | <i>Icosidesmus sp.</i> | 18 | Conservation status unknown | Endemic millipede genus. Nineteen species are recognised although more await description. <i>Icosidesmus</i> species display considerable local endemism (Johns 1964; 1969; 1970; 1979). | Collected from this site only. | |
| Polydesmida | | | | | | | |

Appendix 5- Fish Records

Table 1. Combined Freshwater Fish Records for Cambrian Hills PL.

| <i>Location</i> | <i>Site</i> | <i>NZMS 260 Map Sheet</i> | <i>Easting</i> | <i>Northing</i> | <i>Date</i> | <i>Fish Species</i> |
|-----------------------|-------------|-------------------------------|----------------|-----------------|-------------|---------------------|
| Sailors Creek | 1 | H41 | 2252212 | 5585922 | 17 Jan | Brown trout |
| Sailors Creek | 2 | H41 | 2252240 | 5585981 | 17 Jan | No fish |
| Shepherds Creek | 3 | H41 | 2251711 | 5587336 | 17 Jan | Brown trout |
| Shepherds Creek | 4 | H41 | 2251366 | 5587610 | 17 Jan | Brown trout |
| Welshmans Gully | 5 | H41 | 2251582 | 5585665 | 17 Jan | Brown trout |
| Upper Shepherds Creek | 6 | G40 | 2248924 | 5592269 | 18 Jan | No fish |
| Cluden Stream | 7 | G40 | 2248611 | 5593438 | 18 Jan | No fish |

4.2 Illustrative Maps

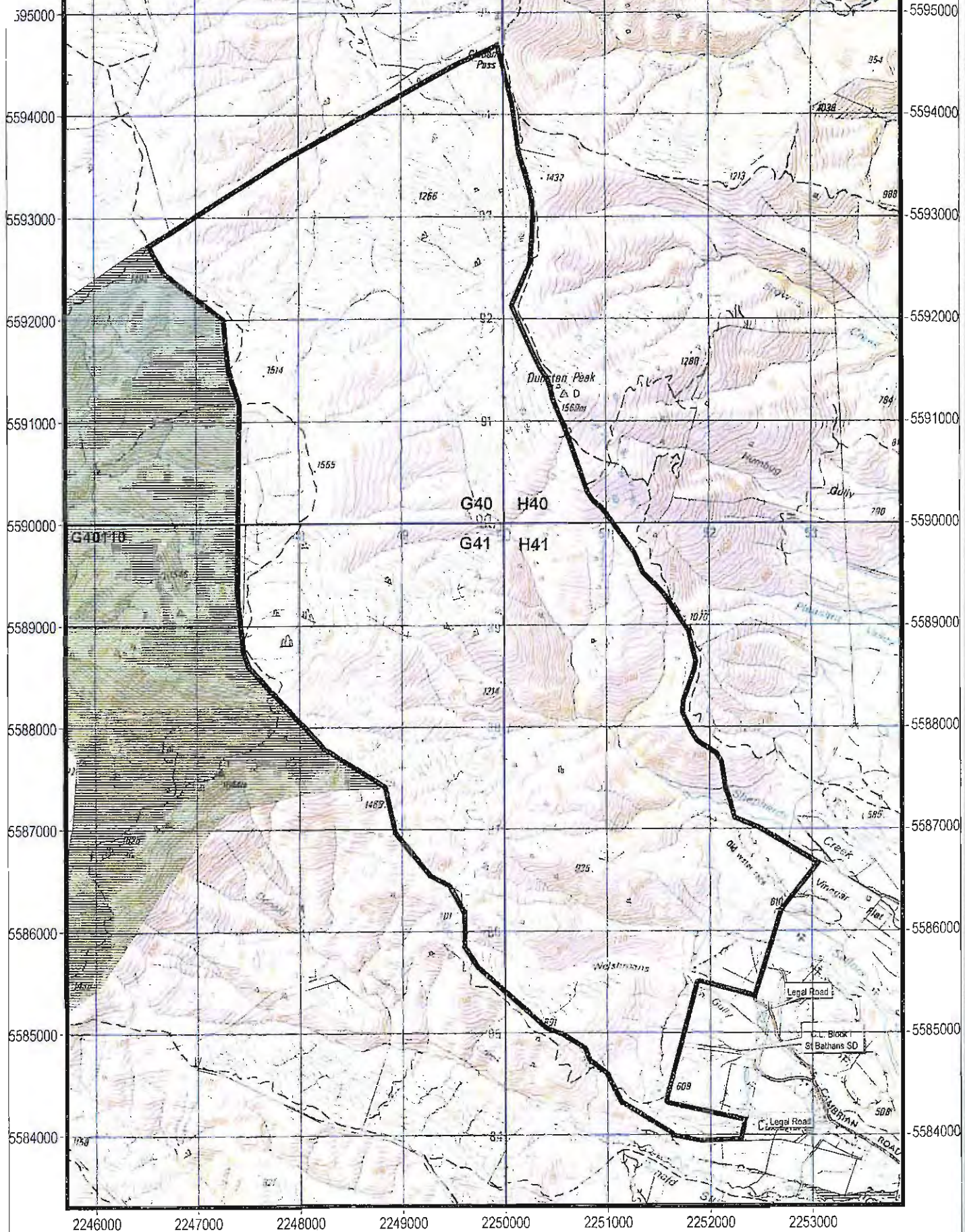
4.2.1 Topographic and cadastral boundaries

4.2.2 Landscape units and significant inherent landscape values


4.2.3 Ecological, historic and recreation resources

4.2.4 Level IV LENZ Environments

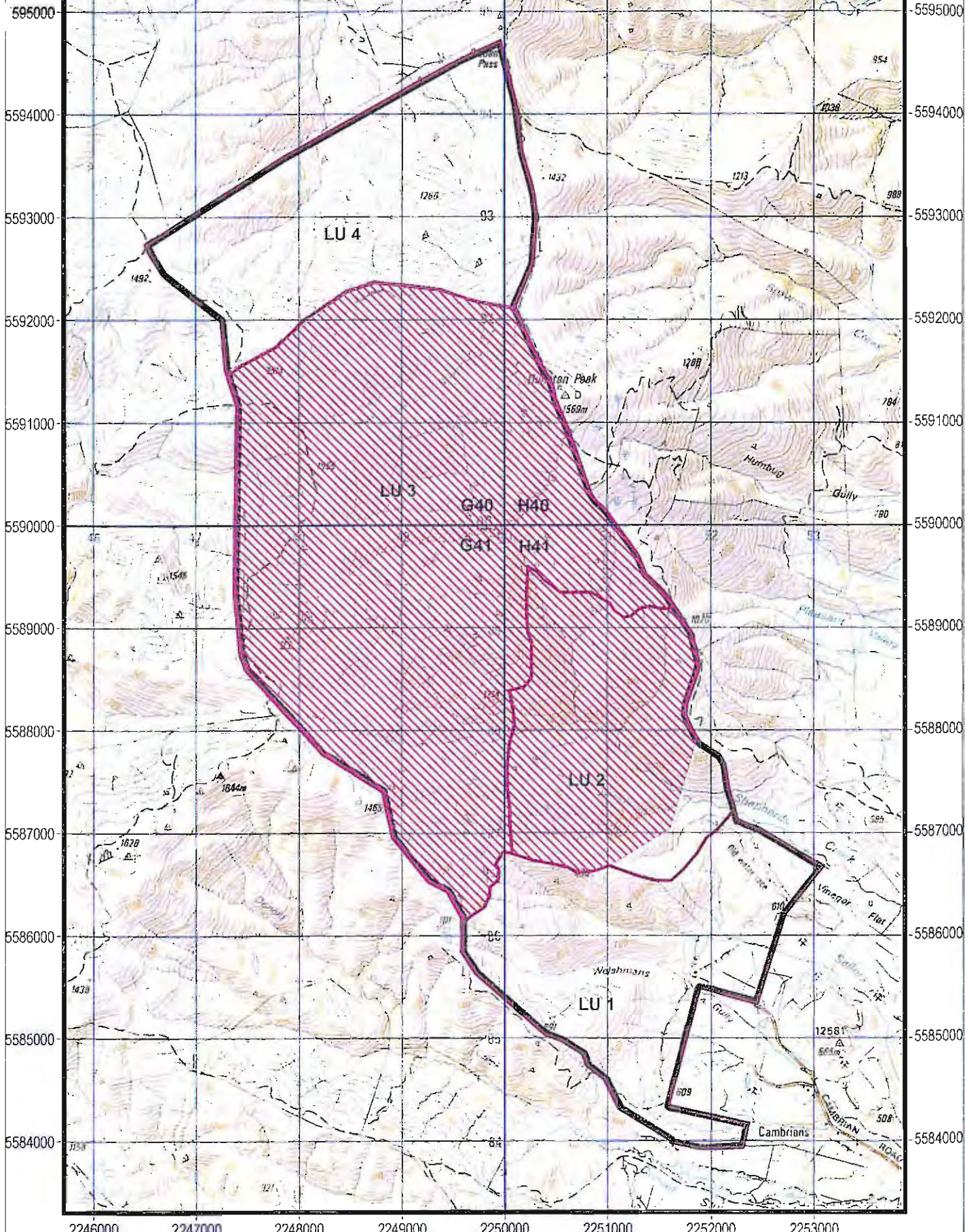
4.2.5 Partial farm block plan





4.2.1 Topographical / Cadastral Cambrian Hills

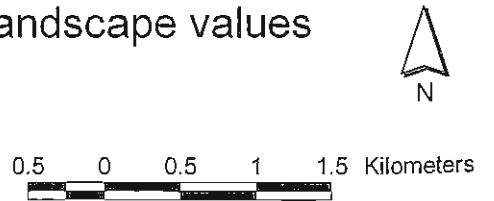
 Public Conservation Land

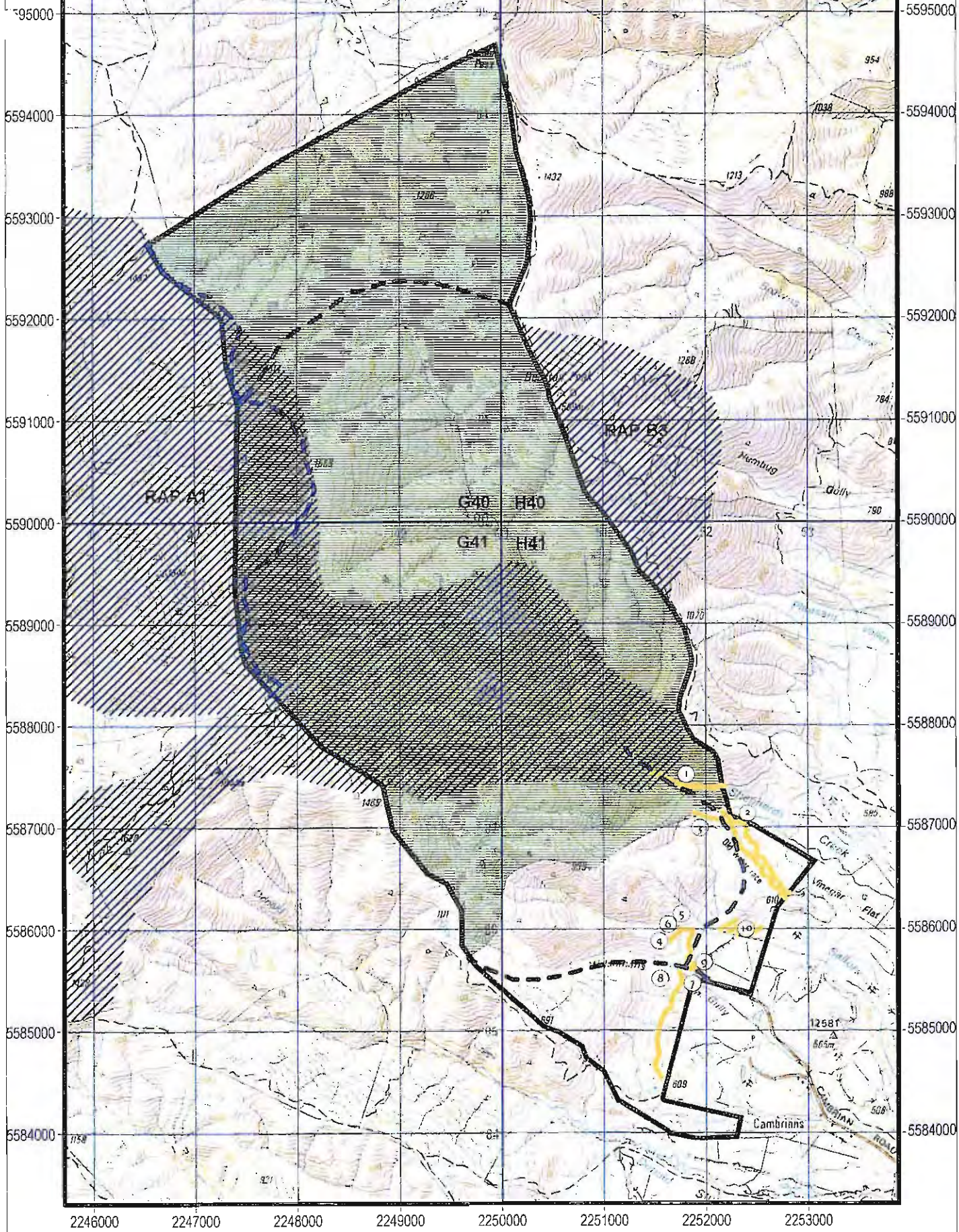
0.5 0 0.5 1 1.5 Kilometers







4.2.2 Landscape units and significant landscape values Cambrian Hills

-  Areas of significant landscape value
-  Landscape units

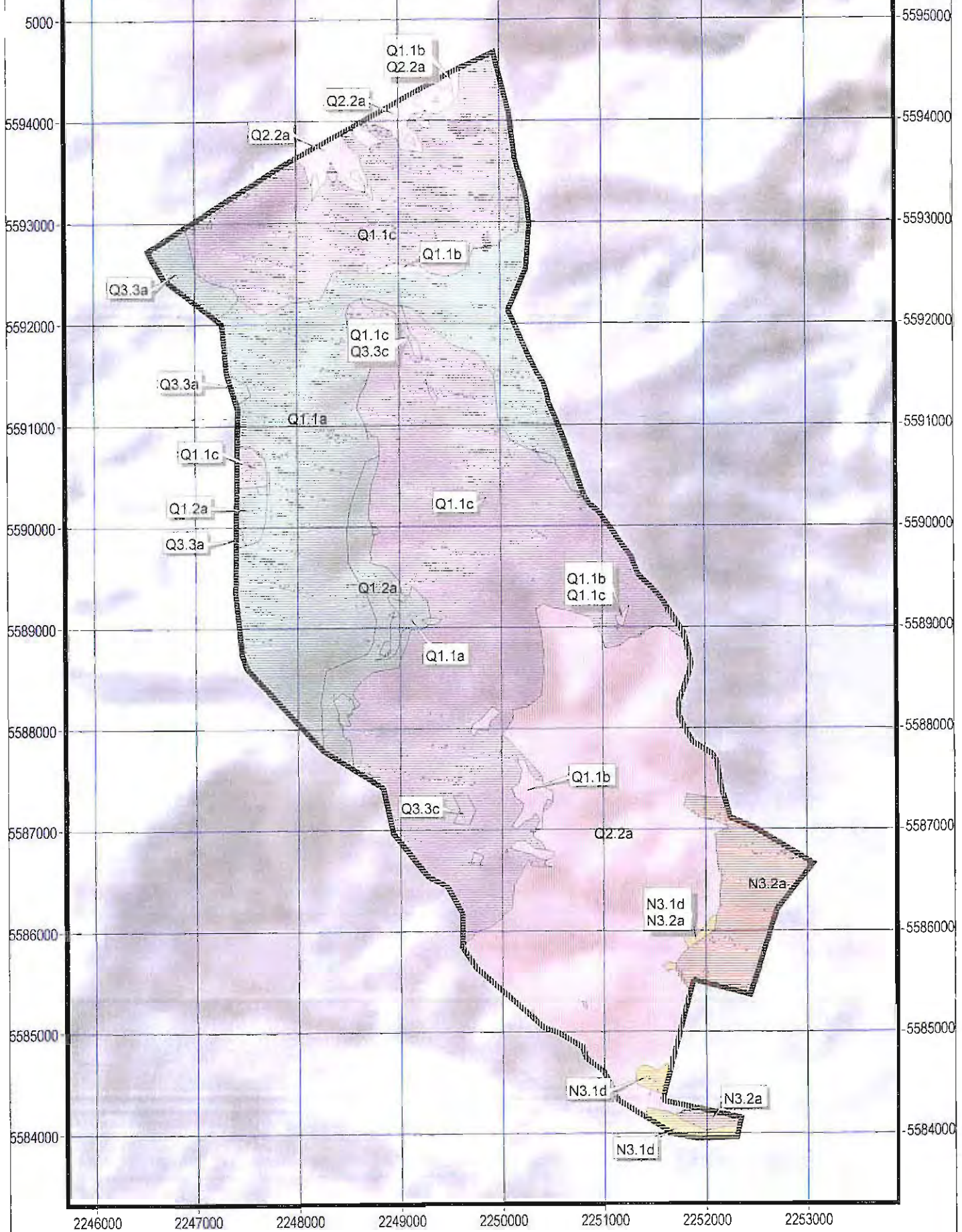




4.2.3 Values - Ecological / Recreation / Historic Cambrian Hills

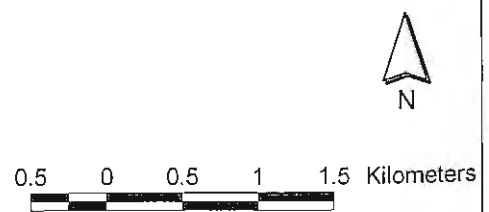
-  RAPs
-  Recreational routes
-  Historic SIVs
-  Ecological significant areas

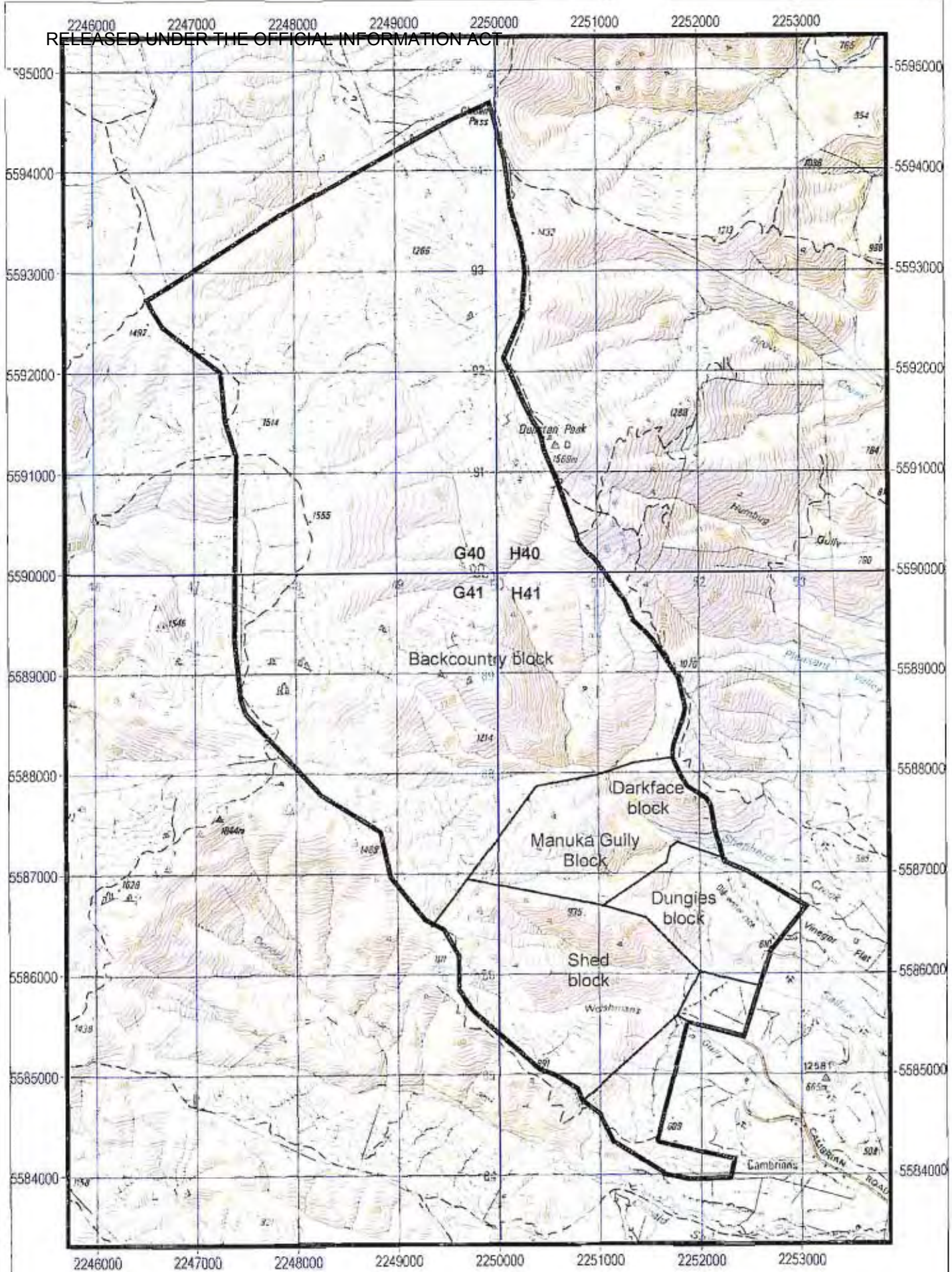




- CambrianV4.shp
- Acutely Threatened
 - Critically Underprotected
 - Chronically Threatened
 - At Risk
 - Underprotected
 - No Threat Category

4.2.4 LENZ level 4 Cambrian Hills





4.2.5 Farm blocks
Cambrian Hills

0.5 0 0.5 1 1.5 Kilometers