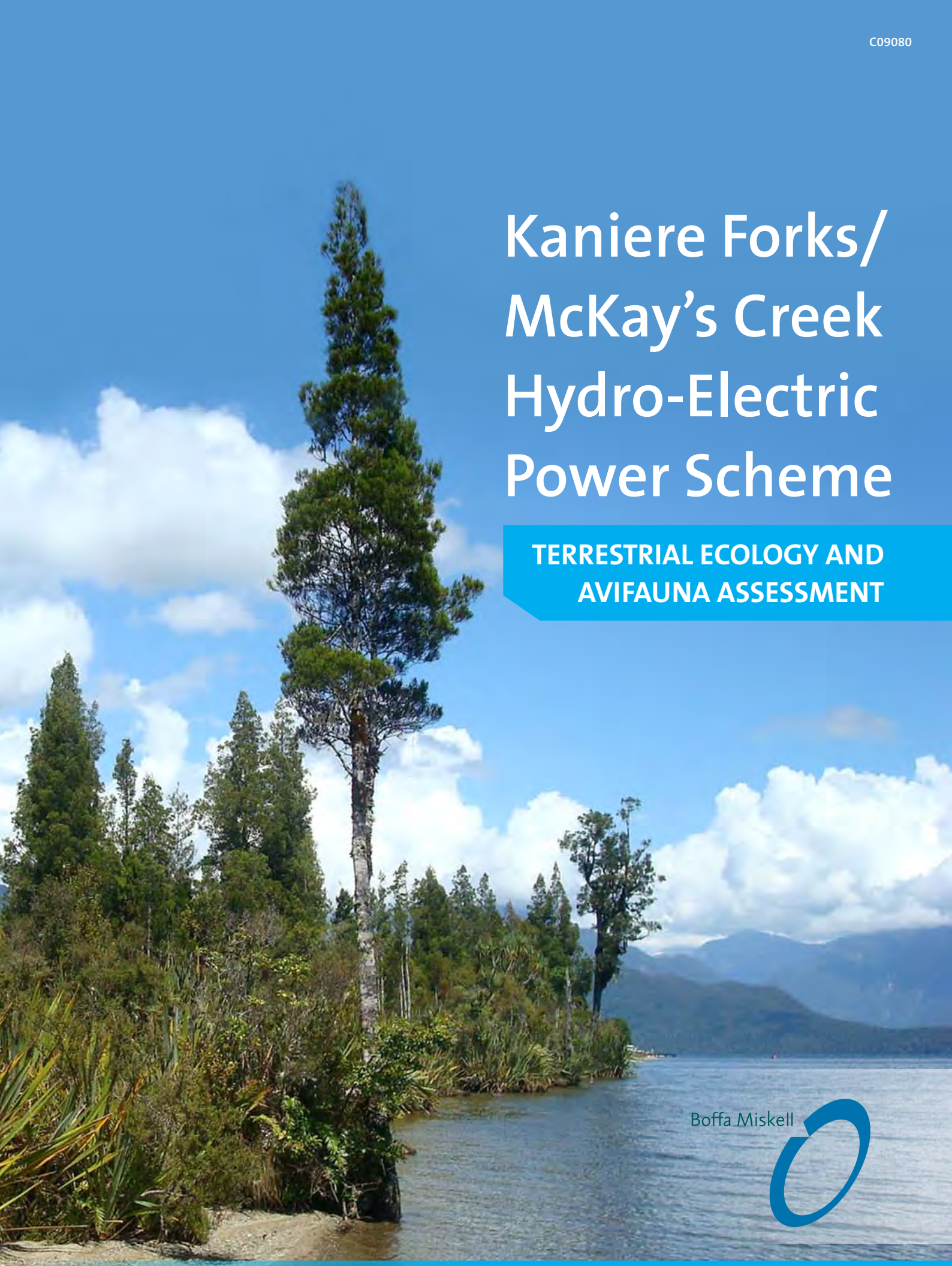
C09080

Kaniere Forks/ McKay's Creek Hydro-Electric Power Scheme

TERRESTRIAL ECOLOGY AND AVIFAUNA ASSESSMENT



Boffa Miskell

Prepared for Chancery Green on behalf of TrustPower Ltd by Boffa Miskell Limited • November 2010

Kaniere Forks/McKays Creek Hydro-Electric Power Scheme

TERRESTRIAL ECOLOGY AND AVIFAUNA ASSESSMENT

Prepared for

ChanceryGreen on behalf of TrustPower Limited

by

Boffa Miskell Limited

Boffa Miskell

November 2010

CONTENTS

1 Executive Summary 3
1.1 Introduction 3
1.2 Methods 4
1.3 Key Values 4
1.4 Summary of Effects and Mitigation 5
2 Introduction 7
2.1 Background 7
2.2 Scope of this Report 7
2.3 Summary of the Existing and Enhanced Scheme 8
3 Methods 10
3.1 Background Research 10
3.2 Scoping Investigations 10
3.3 Detailed Site Investigations (2010) 11
4 Consultation with Interested Parties 16
5 Existing Environment 17
5.1 Ecological Context 17
5.2 General Location and Context 18
5.3 Land Status 18
5.4 Lake Kaniere 19
5.5 Kaniere River 27
5.6 Kaniere Forks and McKays Creek HEPS Vegetation Communities 27
5.7 Kaniere Forks and McKays Creek Terrestrial Birds and Habitats 30
5.8 Kaniere Forks and McKays Creek Terrestrial Fauna 33
5.9 Ecological Significance Under Section 6(c) of the RMA 34
6 Project Shaping Process 42
7 Project Description 45
7.1 Existing Scheme 45
7.2 Proposed McKays Creek and Kaniere Forks HEPS Enhancements 49
8 Assessment of Effects 52
8.1 Lake Kaniere 52
8.2 Kaniere River Avifauna 59
8.3 Kaniere Forks and McKays Creek HEPS Terrestrial Vegetation Communities, Habitats and Fauna 61

8.4 Kaniere Forks and McKays Creek HEPS Terrestrial Avifauna 82

9 Mitigation and Monitoring..... 90

9.1 Lake Kaniere 90

9.2 Kaniere River.....90

9.3 Kaniere Forks and McKays Creek HEPS Terrestrial Vegetation Communities, Habitats and Fauna.....90

9.4 Kaniere Forks and McKays Creek HEPS Terrestrial Avifauna 95

9.5 Off-set Mitigation for the MKY and KNF HEPS Enhancements.....96

10 Conclusion..... 98

References 99

Appendix 1: Maps..... 103

Appendix 2: Scientific names of plant species recorded during site investigations or mentioned in the text 119

Appendix 3: Scientific names of bird species mentioned in the text..... 124

Appendix 4: Vegetation communities of the proposed Kaniere Forks HEPS enhancement..... 125

Appendix 5: Site photographs 149

Appendix 6: Description of the vegetation communities in the vicinity of the Wards Road Power Station 164

Appendix 7: Description of the vegetation communities along the proposed new MKY HEPS water race..... 172

Appendix 8: Significance criteria 176

West Coast Regional Council Significance Criteria.....176

Westland District Council Significance Criteria.....177

1 Executive Summary

1.1 Introduction

TrustPower's (TPL's) resource consents to operate the Kaniere Forks and McKays Creek Hydro Electric Power Scheme ('KNF/MKY HEPS', 'The HEPS' or 'The Scheme') expire in May 2011. By way of the present applications, TPL is seeking to:

- Re-consent the continued operation of the existing KNF/MKY HEPS with some operational enhancements; and
- Also obtain consent to construct two additional scheme enhancements, being to upgrade the existing McKays Creek HEPS (MKY HEPS) to increase abstraction into the McKays water race (at McKays Weir) from 5 to 8 m^3/s, and upgrade the Kaniere Forks HEPS (KNF HEPS) to increase abstraction into the Kaniere race from 1 to 8 m^3/s.

Together the optimised Scheme and enhancements are referred to as the 'enhanced Scheme'.

The enhancement to the MKY HEPS would involve:

- Minor repairs, maintenance and local improvement of the existing weir, Coal Creek Flume, McKays Tunnel and the existing water race;
- Potentially constructing an above ground water race to the south of the existing tunnel as an alternative to refurbishing and enlarging the McKays tunnel; and
- Constructing a new head pond, replacing the existing penstock and building a new power station immediately adjacent to the existing one.

The enhancement to the KNF HEPS would involve:

- Replacing the existing water race with a new 8 m^3/s canal;.
- Constructing a new penstock, power station and tailrace downstream of Wards Road; and
- Decommissioning the existing Kaniere Forks Power Station and de-watering the water races below the proposed Wards Road Power Station.

This report assesses the potential effects of the enhanced Scheme on the water birds of Lake Kaniere and the Kaniere River, and on terrestrial birds, vegetation, habitats and fauna.

1.2 Methods

To assess the potential effects of the enhanced Scheme, background research (including literature and internet searches and obtaining information from earlier scoping studies) and site investigations were undertaken. Site investigations included:

- Walkover surveys of the existing HEPS alignment, and general familiarisation with The Scheme;
- Surveys of the water and wetland birds of Lake Kaniere (undertaken previously by Boffa Miskell Limited (BML)) and the Kaniere River;
- A scoping survey of the Lake Kaniere riparian vegetation and wetlands (undertaken by boat), followed by more detailed wetland surveys and wetland mapping;
- Detailed vegetation surveys, including Recce plots and transects;
- Mapping of the vegetation communities within, and adjacent to the proposed KNF enhancement construction envelope; and
- Incidental observations of terrestrial birds, and surveys for fernbirds in wetland habitat.

1.3 Key Values

The key values that could potentially be affected by the operation of the enhanced Scheme include:

- The water and wetland bird communities and habitats of Lake Kaniere and the Kaniere River;
- Largely unmodified terrestrial riparian vegetation surrounding Lake Kaniere;
- Intact riparian wetlands on the eastern and southern sides of Lake Kaniere that support a diverse range of wetland flora and fauna;
- A wetland in the vicinity of Wards Road that is comprised of a number of indigenous vegetation communities;
- A range of indigenous terrestrial vegetation communities within and adjacent to the existing and proposed HEPS alignments. Many of these occur on public conservation land and include primary (rimu) – (miro) / kamahi – quintinia forest, secondary (rimu) / quintinia – mountain toatoa – southern

rata forest, secondary kamahi – quintinia forest and silver pine / manuka scrub; and

- Habitat for a range of fauna including several species of threatened birds. Bats have been recorded in the wider area and a range of lizard and invertebrate species are also likely to be present.

1.4 Summary of Effects and Mitigation

1.4.1 Effects of the proposed McKays Creek HEPS enhancement

The enhancements proposed for the MKY HEPS are not anticipated to have any significant adverse effects on bird habitats or the bird communities of Lake Kaniere. The section of the Kaniere River between McKays Weir and the MKY HEPS discharge provides habitat for a limited range of water bird species and the revised flow regime in the Kaniere River under the proposed enhancement is not anticipated to adversely affect the water bird populations that utilise the river. With the exception of a proposed new section of water race to bypass the existing McKays tunnel, the proposed enhancement is largely confined to the existing, narrow, historically modified envelope of the existing MKY HEPS infrastructure. Potential impacts relating to construction activities within the existing HEPS footprint are minor; however, the removal, disturbance and fragmentation of vegetation communities and faunal habitats along the proposed new section of water race will have adverse effects on terrestrial avifauna and terrestrial ecological values. Mitigation is proposed in this report to address these effects.

1.4.2 Effects of the proposed Kaniere Forks HEPS enhancement

As with the MKY HEPS enhancement, the proposed KNF HEPS enhancement is not anticipated to have any major adverse effects on bird habitats or the bird communities of Lake Kaniere, or the Kaniere River. However, the construction of the canal, new power station and other infrastructure associated with the enhanced Scheme will result in the removal, and further fragmentation of, significant vegetation and habitats including rimu/kamahi forest, secondary kamahi forest, (silver pine)/manuka scrub and a wetland in the vicinity of Wards Road. This will have short-term effects on terrestrial avifauna and other fauna during construction, as well as a number of long-term effects on terrestrial ecological values relating to habitat loss and fragmentation, edge effects, potential hydrological changes to vegetation communities, weed ingress and the loss of bird, lizard, invertebrate and possibly bat habitat.

1.4.3 Recommended mitigation and monitoring

Mitigation or monitoring will not be required for water birds on Lake Kaniere or the Kaniere River. Mitigation is proposed to minimise the adverse effects of the MKY HEPS where works are confined to the existing HEPS footprint. A comprehensive mitigation package is outlined to avoid, mitigate or remedy the adverse affects of the proposed new section of the MKY HEPS water race and the KNF HEPS enhancement on terrestrial avifauna, and terrestrial vegetation, habitats and fauna. Off-set mitigation is recommended to mitigate the permanent loss of significant 'core' vegetation communities and habitats that will result from the construction of a new section of McKays water race and the KNF HEPS enhancement.

1.4.4 Summary

The proposed MKY HEPS enhancement will have limited adverse effects on terrestrial ecological values where construction work is within the existing HEPS footprint. However, the proposed new section of water race will have adverse effects on ecological values, particularly within the Kaniere Farm Conservation Area (CA), that will require mitigation. The proposed KNF HEPS enhancement will have significant adverse effects on ecological values and a comprehensive mitigation package will be required. Details of a potential mitigation package for the proposed MKY and KNF enhancements have not been finalised. However, it is possible that there could be an overall environmental gain from the proposed enhancements, but this will require strong ecological input to ensure losses are appropriately mitigated.

2 Introduction

2.1 Background

The KNF/MKY HEPS are operated by TPL. They are located on the Kaniere River, approximately 8 to 16 km south-east of Hokitika (Map 1, see Appendix 1 for all of the maps referred to in this report) and are fed via water races that divert and then discharge water back into the Kaniere River. The Kaniere Forks Power Station was commissioned in 1909. Its twin-generators have a rated capacity of 430 kW and an average annual output of 3.75 GWh. The McKays Creek Scheme is supplied via a weir and race from the Kaniere River. Commissioned in 1931 to supply local gold mining operations, it has a head of 33 m, a rated capacity of 1.1 MW and an average annual output of 8 GWh. TPL holds resource consents from the West Coast Regional Council (WCRC) authorising the operation of both Schemes. These consents were granted in 1986 and expire in May 2011.

TPL is seeking to reconsent the operation of the KNF/MKY HEPS (with certain operational enhancements/optimisations). In addition to re-consenting the existing HEPS, TPL wishes to upgrade the existing Scheme to increase generation capacity. The proposed enhancements would require modifications to the existing KNF/MKY HEPS infrastructure and operating regimes. The existing Scheme and proposed enhancements are described in more detail in Section 7 and shown in Maps 2, 2a and 2b.

2.2 Scope of this Report

BML was initially engaged by TPL in June 2009 to prepare a report on the effects of the existing Scheme and minor enhancements to the KNF/MKY HEPS on avifauna and terrestrial ecology. Subsequently, TPL revised the Brief of Work and asked BML to also assess the effects of the existing Scheme, and more substantial enhancements to the MKY and KNF HEPS. The purpose of this report is to:

- Describe the existing ecological environment, with particular reference to the avifauna and the terrestrial ecological values associated with the enhanced Scheme;
- Assess the actual or potential effects on avifauna and terrestrial ecology of the enhanced Scheme; and

- Recommend measures to avoid, remedy or mitigate any potential adverse effects in relation to avifauna and terrestrial ecological values that are identified.

2.3 Summary of the Existing and Enhanced Scheme

2.3.1 Existing Scheme

The existing Scheme is comprised of two separate HEPS, the MKY HEPS and the KNF HEPS. The layout of the existing Scheme is provided in Maps 2, 2a and 2b and is described, in brief, below.

2.3.1.1 Kaniere Forks HEPS

Up to 1 m³/s of water is diverted through an intake at Kaniere Landing and into a relatively small timber and earth open cut race with a number of tunnels, boxed flumes and spillways that channels water for approximately 9 km (Map 2). It is then passed through a steel penstock and into the Kaniere Forks Power Station before being discharged via a short tailrace back into the Kaniere River.

2.3.1.2 MKY Creek HEPS

Up to 5 m³/s is diverted from the Kaniere River through two control gates at McKays Weir, which is approximately 7km downstream of Lake Kaniere (Maps 2 and 2b). The water is then passed through a water race which incorporates a flume and a tunnel on the true left side of the Kaniere River. The water passes down a penstock and into the McKays Power Station before being discharged into the Kaniere River approximately 9 km downstream of the Lake Kaniere outlet. An additional 1 m³/s is provided by an intake in Blue Bottle Creek.

2.3.2 Enhanced Scheme

TPL is seeking consent for enhancements to both the MKY and KNF HEPS. The proposed enhancements are described, in brief, below and shown in Maps 2a and 2b.

2.3.2.1 McKays Creek Enhancement

Under the proposed MKY enhancement, abstraction into the McKays water race (at McKays Weir) would be increased from 5 to 8 m³/s. In summary, the work required for the MKY HEPS enhancement would involve:

- Minor repairs, maintenance and local improvement of the existing weir, Coal Creek Flume, McKays Tunnel and the existing water race;
- Potentially constructing an above ground water race to the south of the existing tunnel as an alternative to refurbishing and enlarging the McKays tunnel; and
- Constructing a new head pond, replacing the existing penstock, and building a new power station immediately adjacent to the existing one.

2.3.2.2 Kaniere Forks Enhancement

Under the proposed KNF HEPS enhancement abstraction from Lake Kaniere into the Kaniere water race will be increased from 1 to 8 m³/s. In summary, this enhancement would involve:

- Replacing the existing intake structure and water race with a new 8 m^3/s canal (the new canal would follow a different alignment from the existing water race in places);
- Constructing a new penstock, power station and tailrace downstream of Wards Road; and
- Decommissioning the existing Kaniere Forks Power Station and de-watering the water races below the proposed Wards Road Power Station.

3 Methods

3.1 Background Research

Existing information on the birds and terrestrial ecology associated with the KNF/MKY HEPS was collated and reviewed.

Key sources of information on birds were scoping studies on the potential effects of the existing Scheme on birds, undertaken for TPL in 2005 by Sagar and Kelly (National Institute of Water and Atmospheric Research (NIWA)) with additional surveys undertaken by BML in 2007 and 2008 (BML 2009).

Sagar and Kelly (2005) undertook a boat-based survey of Lake Kaniere in October 2005 and obtained information from *Notornis* and *Southern Bird*[1] for the period 1984-2005, and from unpublished Ornithological Society of New Zealand (OSNZ) records, including biannual counts of wetland birds that have been conducted in summer (November-December) and winter (June-July) from 1983 to 1999. They also sought comments and information from staff at the Hokitika Area Office of the Department of Conservation (DOC) (Lisa Brook) and the Hokitika Office of the Westland Fish and Game Society (Chris Tonkin). Sagar and Kelly (2005) recommended that further surveys be undertaken to supplement their 2005 survey. These additional surveys were undertaken by BML and involved a boat-based survey in December 2007 and two shore-based surveys in December 2008. The results of BML's surveys are reported in BML (2009).

Background information on the terrestrial ecology associated with The Scheme was obtained from an earlier scoping study undertaken for TPL by BML (BML 2005). This study obtained information from a variety of sources including the Landcover Database Version 2 (LCDBII), Land Environments of New Zealand (LENZ), the *New Zealand Journal of Ecology*, DOC, previous TPL reports, a one day site visit and onsite discussions with TPL staff.

Further information searches were made for this assessment.

3.2 Scoping Investigations

Initial site visits were made by Scott Hooson (Ecologist, BML) on 12 August 2009 and 28 - 29 January 2010 prior to the preparation of a feasibility report for TPL.

[1] The quarterly journal and newsletter, respectively, of the OSNZ.

The purpose of the first site visit, which was undertaken by TPL staff and several of the technical experts, was to ensure that the technical experts were familiar with the existing Scheme layout (Map 2), to explain the enhanced Scheme, and to assess what further ecological work was required.

The purpose of the second visit was to conduct a walkover survey of the existing Scheme and the approximate construction envelopes of the proposed MKY and KNF enhancements. A water bird survey of the sections of the Kaniere River that could potentially be affected by the enhanced Scheme was also undertaken.

3.3 Detailed Site Investigations (2010)

Further, comprehensive field investigations were undertaken by Scott Hooson and Carol Jensen (Botanist) between 16 - 20, 23 – 25 and 30 - 31 August 2010 once the construction envelopes for both the MKY and KNF HEPS enhancements were available. These field investigations included detailed surveys of the vegetation communities within the KNF HEPS construction corridor, surveys of the proposed new MKY HEPS head pond area, penstock route and power station, a scoping survey of the Lake Kaniere shoreline, vegetation and wetlands (undertaken by boat), more detailed surveys of the wetlands around Lake Kaniere and the wetland at Wards Road and a survey for fernbirds within suitable habitat along the KNF HEPS construction corridor. A more detailed description of the methods used during site investigations is provided below.

3.3.1 Wetland surveys

During wetland surveys the vegetation communities within each wetland were mapped on laminated aerial photographs and the boundaries between different vegetation communities were marked using a GPS to further refine the wetland vegetation maps using GIS. Wetland record sheets (Clarkson *et al.* 2004) were completed for each wetland. Unbounded Recce descriptions (Hurst and Allen 2007) were used to describe each of the wetland vegetation communities. The location of each unbounded Recce was marked using a GPS and photographs were taken. Wetland plots (Clarkson *et al.* 2004) were not measured because this method would not sufficiently describe the vegetation for the purposes of this investigation. Notes were also made on:

1. The potential impact of, on average, lower lake levels (the minimum operating range will not change) on wetland vegetation communities;

2. The fauna observed, and potential habitat for fauna including threatened species (longfin eel, fernbird, crake etc);
3. The source of water (rainfall, lake, stream, run-off from surrounding areas etc.); and
4. Connectivity to the lake.

3.3.2 Lakeshore surveys

On 24 August 2010 a boat based scoping survey of Lake Kaniere's foreshore was undertaken. The purpose of this survey was to identify terrestrial ecological values along the shoreline that may be susceptible to the amended lake level regime resulting from the enhanced Scheme . Aquatic macrophytes were not surveyed as an assessment of the potential effects of changes in lake levels on aquatic plant communities has been undertaken by Ryder Consulting (2010). The entire shoreline was surveyed by boat with survey effort focussed on terrestrial riparian vegetation and riparian wetlands. Surveyors landed at numerous places around the lake to describe the dominant riparian plant species and vegetation communities, the substrate and the profile of the lake shore. GPS points and photographs were taken throughout the survey and locations of particular interest were noted so that they could be inspected more thoroughly during shore-based surveys.

3.3.3 Terrestrial vegetation communities

During initial site familiarisation visits the vegetation communities along the length of the existing MKY and KNF HEPS (Map 2) were recorded and described. Plant species within the different vegetation communities were identified and recorded and photographs and GPS waypoints were taken to assist with descriptions of vegetation types and habitats.

Information from the initial site visits was used to produce a map of the vegetation communities within and adjacent to the proposed KNF HEPS enhancement construction envelope. This map was refined during more detailed investigations of the vegetation communities in August 2010.

Vegetation maps have not been produced for the KNF HEPS below Wards Road because vegetation communities along this section of the KNF HEPS will not be affected by the enhanced Scheme. With the exception of the proposed new section of water race to bypass the McKays tunnel, the vegetation communities along the MKY HEPS have also not been mapped. This was not considered to be necessary because the proposed works are limited to the existing historically modified envelope

site and investigations did not identify any vegetation communities of high ecological value along the existing alignment.

Between 18 – 20 August and on 31 August 2010, temporary 20 x 20 m Recce plots (following Hurst and Allen 2007) were measured in representative areas of each of the vegetation communities along the proposed KNF HEPS enhancement construction envelope (vegetation structural classes follow Atkinson (1985)).

Corresponding control plots were also measured for each vegetation community. Control plots were located outside the proposed construction envelope, and where possible, 50 m from the plot inside the construction envelope in a direction perpendicular to the proposed canal alignment.

To obtain additional information on the structure of the forest communities, the diameter at breast height (dbh) of stems of woody species >100 mm diameter was measured 2 m either side of a 100 m transect (400 m^2). Transects were established along a compass bearing. This data was used to calculate mean and median dbh of woody trees for each forest community and the number of stems/m^2. Dbh measurements were not undertaken within scrub communities as the vegetation is more homogenous and vegetation structure can be more easily inferred from the Recce canopy height data.

The vegetation within a few specific areas along the construction envelope, such as proposed buffer storage sites (Map 2a), was described using unbounded Recce descriptions (Hurst and Allen 2007). Photographs and GPS waypoints were also taken.

'Habitat trees', i.e. large trees such as rimu, miro and rata, were identified where they were within or close to the construction envelope of the proposed KNF HEPS enhancement. These trees are likely to provide, or have the potential to provide, habitat for fauna (such as roost sites for long-tailed bats or roosting and nesting sites and seasonal food sources for birds). Their locations were marked using GPS and the shortest distance between these trees and true left edge of Kaniere water race track was measured with a tape measure.

A list of the plant species recorded during site investigations is provided in Appendix 2.

3.3.4 Vegetation survey and mapping limitations

Vegetation, wetland and lakeshore surveys were undertaken in August 2010. As a result, accurate identification of some *Carex*, *Uncinia, Juncus*, and grass species was not possible as they had either died off over winter or distinguishing features such as seed heads, or flowering or fruiting bodies were absent.

The aerial photographs used for mapping all of the terrestrial and wetland vegetation communities are sourced from BING images. The level of detail and the accuracy of the vegetation and wetland mapping is constrained by the resolution and quality of these images.

3.3.5 Avifauna

The habitat for terrestrial bird species was assessed on foot along the entire length of the enhanced Scheme on 28 - 29 January 2010. All species of birds sighted or heard were recorded and GPS points were marked where key native species were observed.

A water bird survey was undertaken on the Kaniere River from McKays Weir to McKays Power Station (approximately 2.5 km) following a standard walk through river bird survey methodology. The habitat for water birds along this stretch of the river was also assessed.

The section of the Kaniere River between the Lake Kaniere outlet and Wards Road (which would be more frequently reduced to the proposed minimum flow of 300 L/s under the proposed enhancements) was not surveyed because of access limitations along the heavily forested river bank and because observations along this section of the river suggest that it does not provide good quality habitat for water birds. Under the existing Scheme, the river channel is normally uniformly fast flowing (with a mean and median flow of 6.1 and 5.5 m^3/s, respectively) and full from bank to bank with no exposed boulders or beaches.

Surveys for fernbird were undertaken in the Wards Road wetland on 17 August 2010. The objective of the surveys was to determine the presence/absence of fernbird. A standard point count method was used with count stations established at approximately 100 m intervals. Count stations were marked by a GPS coordinate. The observer listened for 5 minutes at each count station, if no fernbird were recorded within that time playback calls were used as ‘lures’ to entice resident birds

to appear from cover or respond vocally. Calls were broadcast using a 30 Watt AS3190 Horn Speaker aimed into the centre of the most suitable habitat.

Lists of the bird species referred to in the text are provided in Appendix 3.

3.3.6 Other fauna

An assessment of the suitability of faunal habitats was made but specific surveys were not undertaken for bats, lizards or invertebrates. This level of assessment is considered to be sufficient given the absence of rare or distinctive habitat types, low levels of endemism in the West Coast's fauna, and the scale of the potential adverse effects of the proposed activities in the context of the wider area.

4 Consultation with Interested Parties

A meeting was held between Scott Hooson and DOC Staff from the West Coast Conservancy Office: Tim Shaw (Technical Support Officer: Terrestrial Fauna); Dr Jane Marshall (Technical Support Officer: Botanist); Vikki Addison (Planner); Kelly Stevens (Concessions and Statutory Land Manager) and the Hokitika Area Office: Ted Brennan (Programme Manager: Community Relations) on 16 August 2010.

The enhanced Scheme was outlined and explained and proposed field investigation methods were discussed. Following the meeting, Ted Brennan and Vikki Addison accompanied Scott Hooson onsite to discuss the proposed KNF enhancement.

5 Existing Environment

5.1 Ecological Context

The enhanced Scheme is situated within the Whataroa Ecological Region and the Hokitika Ecological District (ED). Awimbo *et al.* (1996) provide an excellent summary of the ecological context of the Hokitika ED, which should be referred to for more detailed information.

The ED is characterised by recent alluvial valleys separated by moraine hills and plateaux underlain by late Cenozoic muddy sandstone and mudstone in the north, a few scattered outcrops of early Paleozoic Greenland Group greywacke and argillites, Tuhua granite and Oligocene limestone.

The ED has a superhumid mesothermal climate with a high annual rainfall of 2500-4000 mm distributed relatively evenly over the year, but with a slight winter minimum (Hessel 1982, *In* Awimbo *et al.* 1996). Temperatures are mild but frosts occur in winter (McEwen 1987).

Well to poorly drained soils derived from greywacke granite and schist occur on the main river valleys and adjacent low terraces. Poorly drained gley soils, which are locally podsolised, have developed from loess, moraine and outwash gravels on the main terraces where small patches of poorly drained organic soils also occur. Better drained yellow-brown earths dominate the hill country and rolling moraines. Soils are generally infertile, due mainly to leaching by the high rainfall. The most fertile soils are present on the youngest surfaces (e.g. recent alluvial terraces and fans) (Awimbo *et al.* 1996).

Dense rimu and kahikatea forests were once extensive and dominated forest on the lowland plateaux and hills, but this has largely been cleared except around Lake Kaniere. Mixed podocarp-hardwood forest (mainly rimu with kamahi, southern rata, quintinia and toro) remains on higher hill country, although much of it has been logged. Extensive kahikatea and silver pine swamps occur in the valleys. The ED is the southern limit for lemonwood, northern rata and kanuka (McEwen 1987).

Modifications to the ED have included clearance of the recent alluvial flats and coastal marine terraces and sand dunes between the Taramakau River and Hokitika for farming (particularly dairy farming), plantation forestry, logging in lower altitude forests and the impacts of animal pests such as deer and possums (McEwen 1987). Other changes include the diversion and damming of rivers, road and railway

construction, alluvial gold mining and the expansion of urban areas (Awimbo *et al.* 1996).

The Threatened Environment Classification shows that all of the Level IV land environments in which the enhanced Scheme sits are 'Less Reduced and Better Protected' (i.e. there is >30% indigenous cover and >20% is protected on these land environments nationally) (Walker *et al.* 2007). However, for this particular area, this classification must be interpreted with caution and an understanding of its inaccuracies and limitations.[2]

5.2 General Location and Context

Lake Kaniere is situated south-east of Hokitika and is fed by a number of small tributaries that arise on Mt Graham to the west and Mt Tuhua and the Newton Range to the east. The Styx River, which flows west into the Kokatahi River, lies to the south and the Arahura River is to the north. The naturally formed lake is of glacial origin and is approximately 8 km long and 2 km wide for most of its length (Map 1).

The lake is drained by the Kaniere River, which flows approximately 15 km into the Hokitika River approximately 6 km upstream of where it enters the sea. Several tributaries join the Kaniere River downstream of Lake Kaniere. On the true left these are Kennedy, McKay, Striplands and Stony Creeks, while Butchers, Coal and Blue Bottle Creeks enter from the true right (Map 2).

5.3 Land Status

The KNF and MKY HEPS are largely within public conservation land administered by DOC (Map 3, Appendix 1). The start of the KNF HEPS water race is within the Lake Kaniere Scenic Reserve (SR), but also passes through a long, narrow, rectangular parcel of private land. From just beyond here, the KNF water race lies between the boundary of the Lake Kaniere SR and the Kaniere Forest CA before entering the Kaniere Forest CA much further down the water race. The Kaniere Forks Power Station is situated on a land parcel owned by TPL. The proposed KNF enhancement is largely within the Kaniere Forest CA. From where the construction envelope of the proposed new canal enters the Kaniere Forest CA, its alignment lies just to the north

[2] Despite extensive loss and modification, lowland forest on alluvial surfaces on the West Coast may be classified with Less Reduced and Better Protected environments. This is because the Threatened Environment Classification overlooks important distinctions within environments and indigenous cover classes that would show that lowland alluvial forest on the West Coast has been disproportionately cleared and modified compared to that on adjacent hill slopes. The classification should only be used in conjunction with field surveys (Walker *et al.* 2007).

of the Kaniere Forest CA's boundary with the Lake Kaniere SR. In places it crosses into the SR. The proposed Wards Road Power Station and penstocks are almost entirely within the Lake Kaniere SR, with the exception of part of Penstock Option 2 (not shown on Map 3), which is also partly within the Kaniere Forest CA.

The majority of the McKays water race is within the Kaniere Farm CA, although it crosses two DOC administered marginal strips at the intake and discharge points, and approximately 1 km of private land before the water race enters the tunnel. The MKY HEPS proposed head pond, penstocks and power station are all situated on private land owned by TPL.

5.4 Lake Kaniere

5.4.1 Lake Kaniere vegetation

5.4.1.1 Lake Kaniere riparian and shoreline vegetation

Most of Lake Kaniere's shoreline consists of either narrow beaches comprised of sand, gravels, and pebbles or on steeper higher energy beaches cobbles and/or boulders (Photo A5-1), steep bedrock faces (particularly where headlands extend out into the lake) (Photo A5-2). In most places, except the sheltered bays, the steep sides of the lake drop steeply into deep water (Photo A5-3).

The riparian vegetation is almost entirely podocarp/mixed hardwood-broadleaf forest down to the water line (Photo A5-4). The only exception to this is the mowed grassy recreational areas in the vicinity of Hans Bay, rough grassland south of Geologists Creek (Photo A5-5), various stream deltas (Photo A5-6) and a limited number of riparian wetlands in the sheltered bays on the eastern and southern shores of the lake. The wetland communities are described in more detail in Section 5.4.1.2.

The podocarp/mixed hardwood-broadleaf forest surrounding Lake Kaniere's shoreline is characterised by emergent (25 – 35 m) podocarps including rimu, miro and occasionally matai, with species such as hinau, kamahi, quintinia, mahoe, southern rata and *Metrosideros fulgens*, broadleaf, karamu, pate, red mapou, lemonwood, ponga, rough tree fern and kiekie growing immediately adjacent to the water's edge. In places, a thin 2 - 3 m band of lowland flax grows along the water's edge.

Between the southern end of Rocky Point/Tauotikirangi and the outlet of Geologists Creek is a thin band of kahikatea forest between the lakeshore and the farmland

immediately beyond (Photo A5-7). The kahikatea trees are large (35 - 40 m) and grow on a drier substrate above the sand and gravel beach on the water edge. The sub-canopy and understorey are comprised of species typical of a terrestrial forest environment.

On the more frequently disturbed stream deltas early successional and light tolerant species such as wineberry, tutu, mingimingi, koromiko, lowland flax and toetoe are more abundant (Photo A5-8).

In the few sheltered bays with shallower profiles occasional patches of oioi reedland grow around the lake margin.

The aquatic plant communities of Lake Kaniere are described in the Aquatic Ecology Report (Ryder Consulting 2010).

5.4.1.2 Lake Kaniere riparian wetland vegetation

Lake Kaniere's riparian wetlands are entirely restricted to the few sheltered bays on the eastern side of the lake in Canoe Cove, Hans Bay, Camp Bay and Big Bay and at the southern end of the lake in Slip Bay (Map 4). The 19 wetlands together comprise 15.1 ha, although many of these are small with only eight greater than 0.05 ha and two greater than 1 ha.

Table 5.1 lists the vegetation communities represented in Lake Kaniere's riparian wetlands and Maps 5 – 7 show the locations and extent of these wetland vegetation communities around the lake. Although not presented here, detailed information on the species composition and structure of each of these wetland vegetation communities has been collected.

Table 5.1: Riparian wetland communities around Lake Kaniere[3] with the area of each vegetation community in hectares (based on ground survey and GIS mapping).

Wetland I.D.	Wetland class	Vegetation community	Area (ha)
1	Swamp	(Kahikatea)/*Phormium* flaxland	0.01
2	Swamp	*Phormium* flaxland	0.00
3	Swamp	*Phormium* flaxland	0.02
4	Swamp	*Phormium* flaxland	0.03
5	Swamp	*Phormium* flaxland *Carex* sedgeland Kahikatea forest Open water	0.48 0.08 0.15 0.02
6	Swamp	*Phormium* flaxland	0.04
7	Marsh	*Oioi* reedland	0.03
8	Swamp, marsh	Kahikatea forest *Oioi* reedland	0.03 0.02
9	Swamp, marsh	Kahikatea forest *Oioi* reedland	0.13 0.10
10	Marsh	*Oioi* reedland	0.03
11	Marsh	*Oioi* reedland	0.05
12	Swamp	Kahikatea forest *Oioi* flaxland	0.08 0.06
13	Swamp	Kahikatea forest (Kahikatea)/*Phormium* flaxland Square sedge reedland	0.79 0.13 0.01
14	Swamp	*Phormium* flaxland	0.01

[3] Some of the kahikatea (*Dacrycarpus dacrydioides*) forest around the lake is either not associated with the lake itself (at Sunny Bight and immediately to the east and south of the Big Bay wetland), or are considered to be separate terrestrial systems (e.g. along the lake margin south of Rocky Point /Tauotikirangi and the outlet of Geologists Creek). These were not mapped and are not included in the this table.

Wetland I.D.	Wetland class	Vegetation community	Area (ha)
15	Swamp	*Phormium* flaxland	0.02
16	Swamp	Kahikatea forest	0.39
		Phormium flaxland	0.06
17	Swamp	*Phormium* flaxland	0.11
18	Bog, fen, swamp	Westland totara - mountain toatoa treeland	0.57
		Phormium flaxland	0.97
		(*Coprosma*/twiggy tree daisy)/*Phormium* flaxland	0.96
		Coprosma/ twiggy tree daisy scrub	0.49
19	Swamp, marsh	*Phormium* flaxland	0.67
		Raupo reedland	0.52
		Kutakuta reedland	0.18
		Phormium flaxland	0.28
		Coprosma shrubland	0.44
		Kahikatea forest	7.14
		Total riparian wetland area (ha)	**15.1**

The wetlands associated with Lake Kaniere's margins are primarily *Phormium* flaxland swamps (Photo A5-9), kahikatea swamp forest (Photo A5-10) or oioi reedland marshes (Photo A5-11). Often *Phormium* flaxland swamps have been formed by the impoundment of water behind sand and gravel beach berms, but in other situations flax occurs at the lake edge. Oioi reedlands occur in shallow waters where the lake profile is low or on sand or gravel beaches on, or near stream deltas. In places square sedge is present amongst the oioi. In a small area of Wetland 13 it grows as the dominant reed species. Kahikatea swamp forest occurs on flat, low lying land forms, often slightly back from the lake margin behind a thin band of oioi reedland or flax. Under the kahikatea forest there is usually a thick understorey of swamp astelia and understorey shrubs. The shade tolerant astelia is replaced by flax where the canopy is more open (notably Wetlands 1 and 13 (in part)) where kahikatea grow as scattered trees above the flaxland. The only areas of open water and *Carex* sedgeland are in the Hans Bay wetland (Wetland 5).

The 'Big Bay' wetland (Wetland 18) (Photo A5-12) is a large wetland that lies in a topographically confined flat area between low hills on its eastern and western sides. The northern half of this wetland (nearer the lake) is a *Phormium* flaxland swamp that is dominated by dense flax. Further from the lake the swamp grades into bog with areas of fen, particularly on the margins where there is some sub-surface water flow. The dominant vegetation communities in this wetland include: Westland totara and mountain toatoa treeland growing above *Carex* and *Sphagnum*, (*Coprosma tayloriae/*twiggy tree daisy)/*Phormium* flaxland also with a ground cover dominated by *Carex* and *Sphagnum* and on the southern margin of the wetland, denser *Coprosma/* twiggy tree daisy scrub (Map 6). Mature kahikatea forest grows on the outwash plain to the south of this wetland. This wetland is particularly intact, largely unmodified, has no introduced plant species and is highly representative.

The largest wetland is at the southern end of the lake (Map 7) at Slip Bay (Wetland 19) (Photo A5-13). It is comprised of several wetland vegetation communities that show a clear pattern of zonation driven by water depth and inundation frequency and duration. Kutakuta reedland occurs in deep water along the front of the wetland, as the water shallows this changes abruptly to raupo reedland, which occurs along the length of the bay. Behind the raupo is a *Phormium* flaxland swamp. A more elevated area with improved drainage above the lakeshore in the middle of the bay supports an area of mingimingi shrubland. Beyond this, surrounding the wetland and extending north around the lake edge is dense kahikatea forest.

No threatened plant species were recorded in any of the wetlands surveyed. Fernbird were recorded in the Big Bay wetland and are likely to be present in some of the other wetlands.

5.4.2 Lake Kaniere avifauna

Generally, Lake Kaniere provides limited habitat for water birds. The lake shore consists predominantly of steep sides that drop into deep water (Photo A5-3) or rocky shoreline (Photo A5-14), which provide limited foraging or roosting habitat. The smaller bays do provide sheltered waters and suitable roosting and breeding habitat for waterfowl.

The bird species recorded from Lake Kaniere during these surveys (Table 5.2) comprise an avifauna that is typical of this habitat type in Westland (Williams 2004). Species diversity is low, with a total of 16 wetland bird species recorded during the four surveys. Other species no doubt use the lake from time-to-time but they were not recorded during surveys.

Paradise shelduck, grey duck, mallard and New Zealand scaup comprised the majority of the birds counted but small numbers of other wetland bird species were present. The following birds were also observed on or flying over wet pastures within a few hundred metres of Slip Bay during BML's December 2008 survey: paradise shelduck, spur-winged plover, white-faced heron, welcome swallow and pied oystercatcher.

In all surveys, most of the waterfowl were seen in the sheltered bays at the eastern side of the lake, particularly Slip Bay and Hans Bay, reflecting the availability of shallow foraging waters and suitable, gentle-gradient roosting habitat along the shore. Small numbers of NZ scaup were also seen at Sunny Bight at the north-eastern end of the lake.

Although suitable habitat exists for crake and bittern, neither marsh or spotless crake were recorded during wetland survey work or boat based surveys that included specific surveys for these species using taped calls at Hans Bay, Big Bay and Slip Bay (BML 2009). Bittern were not recorded during wetland surveys, but may be present.

Australasian crested grebe, classified as 'Nationally Vulnerable' by Miskelly *et al.* (2008), historically occurred on the lake (West Coast Regional Council – Proposed Water Management Plan, June 2007) but their numbers and distribution have declined in recent decades (Jensen and Snoyink 2005). They were not recorded during a national survey of this species (Jensen and Snoyink 2005), nor during the surveys by Sagar and Kelly (2005), or BML (2009). New Zealand Dabchick (classified as 'Nationally Vulnerable') were recorded on the lake in the 1940s (OSNZ 1977) but are now considered extinct in the South Island (Heather and Robertson 1996).[4]

Whilst Lake Kaniere does not support a diverse bird population, it does form part of a wider habitat network that supports populations of water birds that range over large distances. Species with recognised New Zealand threat classifications (Miskelly *et al.* 2008) recorded on Lake Kaniere include grey guck (Nationally Critical), black shag (Naturally Uncommon) and South Island fernbird (Declining). Because of the occurrence of grey duck (Nationally Critical)[5] and the historical occurrence of

[4] New Zealand Dabchick have recently been recorded from Marlborough, but as far as we are aware, they have not been confirmed to be breeding.

[5] Grey duck are nationally endangered mainly because of hybridisation with the introduced mallard - a process unrelated to hydroelectric development.

Australasian crested grebes (Nationally Vulnerable), Lake Kaniere is recognised by the WCRC (2007) as having significant value for birds.

Table 5.2: Species and numbers of birds recorded at Lake Kaniere by NIWA in 2005 (Sagar and Kelly 2005) and BML in December 2007 and December 2008 (Source: BML 2009).

Date:	26/10/2005	7/12/2007	9/12/2008	10/12/2008
Surveyor:	NIWA	BML	BML	BML
Method:	Boat	Boat	From shore	From shore
Black swan	6	0	0	0
Paradise shelduck	28	25 + 24c	2	34 + 9c
Grey duck	24	18 + 1c	3	1
Mallard duck	22	10	1	11
Mallard/grey duck*	0	2	1	6
New Zealand scaup	29	60 + 6c	42 + 8c	48 + 2c
Spur-winged plover	0	5	0	2
Black shag	2	5	0	2
Black-backed gull	3	1	0	1
Variable oystercatcher	2	0	0	0
Pied oystercatcher	2	7	0	0
Variable or pied oystercatcher	-	-	2	0
New Zealand kingfisher	0	1	0	0
White-faced heron	0	1	0	1
Pukeko	4	9	0	1
Little shag	1	0	2	1
Welcome swallow	0	1	0	0
South Island fernbird	0	Heard	0	0

c = chicks

* = Either hybrid or not positively identified

5.5 Kaniere River

5.5.1 Kaniere River avifauna

There are no published reports of bird observations in the Kaniere River.

Between Lake Kaniere and the McKays Weir the riparian margins of the Kaniere River are heavily forested. The river channel is uniformly fast flowing, confined to a single channel and full from bank-to-bank. The lack of exposed boulders or beaches and open riparian margins means feeding, roosting and breeding habitat is extremely limited. Shags may feed in this section of the river from time-to-time, but our assessment of the bird habitat in this section of the river is that it does not provide good quality habitat for water birds.

An adult pair of paradise duck (Not Threatened) with three juveniles were the only water birds recorded during our January 2010 river bird survey between McKays Weir and the McKays HEPS. A separate incidental observation of a black shag (Naturally Uncommon) was made as it flew overhead above McKays Weir. Sagar and Kelly (2005) observed two black shags and two paradise shelducks upstream of the McKays HEPS and two grey ducks (Nationally Critical) in the Kaniere River immediately upstream of McKays Weir.

Below the discharge of the two HEPS the river is mostly confined to a single, confined channel that provides habitat for shags, ducks and shelducks (Sagar and Kelly 2005).

5.6 Kaniere Forks and McKays Creek HEPS Vegetation Communities

5.6.1 Kaniere Forks HEPS vegetation communities

The vegetation communities adjacent to the existing KNF water race above Wards Road, and the proposed KNF enhancements (with the exception of those in the vicinity of the proposed Wards Road Power Station and tailrace, see below) are:

1. Primary (rimu) - (miro) / kamahi -quintinia forest;
2. Manuka scrub;
3. Cleared, regenerating manuka / tangle fern shrubland (under the transmission line);
4. Secondary (rimu) / mountain toatoa – quintinia – southern rata forest;
5. (Silver pine) / manuka scrub; and

6. Weeping matipo scrub.

The location and extent of these vegetation communities in relation to the proposed construction envelope for the KNF HEPS enhancement are shown in Map 8. The vegetation communities are described in detail in Appendix 4. Photographs of the vegetation types along the existing KNF water race are shown in Appendix 5, Photos A5-15 to A5-19.

The vegetation communities in the vicinity of the proposed Wards Road Power Station and tailrace are:

1. *Carex* sedgeland (W);[6]
2. Mingimingi shrubland;
3. Mingimingi /*Carex* shrubland (W);
4. Manuka shrubland (W);
5. *Phormium* flaxland (W);
6. *Phormium* flaxland / *Sphagnum* (W); and
7. Silver pine forest.

The location and extent of these vegetation communities in relation to the proposed construction envelope are shown in Map 9 and described in more detail in Appendix 6.

From Wards Road to the forebay above the existing KNF Power Station (approximately 5 km, Map 2), the KNF water race passes through intact primary (rimu) - (miro) / kamahi - quintinia forest similar in composition and structure to that described in Appendix 4 (Photo A5-21). The penstock passes down a steep slope with a 10 m wide corridor cleared through regenerating secondary hardwood forest to the KNF Power Station below (Photo A5-22).

5.6.2 McKays Creek HEPS vegetation communities

Detailed quantitative studies (plots/transects) and vegetation mapping have not been undertaken for the MKY HEPS as, with the exception of the proposed new section of water race and fill sites, these will not be directly affected by the proposed Scheme as it is almost entirely within the footprint of the existing Scheme. However, a qualitative description of the vegetation adjacent to the Scheme's infrastructure is provided below.

[6] Those vegetation communities with a (W) are wetland communities.

The intake structure at McKays Weir is in modified cleared land and the canal margins are dominated by rough exotic pasture grasses with colonising gorse and manuka.

Between Lake Kaniere Road and the siphon over Blue Bottle Creek (Map 2b) the canal is cut through a low ridge of young regenerating secondary kamahi forest comprised of a diverse range of species such as kamahi, hard tree-fern, koromiko, mahoe, wineberry, fuchsia, *Coprosma* spp. and bracken (Photo A5-23). The exotic weeds gorse and Himalayan honeysuckle are also present. Kiokio is abundant on the steep sides of the canal. A vehicle track dominated by exotic pasture grasses runs along the northern side of the canal for some of this section.

The vegetation cover on the private land between the siphon and the boundary of the Kaniere Farm CA where the canal enters the tunnel is a mosaic of grazed pasture grassland, gorse scrub and early successional hardwood species that are regenerating through the gorse (Photo A5-24). Some secondary kamahi forest is present on the southern (true left) side of the canal before the tunnel. This section of the water race has been modified by farming practices and is fragmented and generally of low ecological value.

The canal enters a long earth tunnel near the boundary of the Kaniere Farm CA (Map 2b. The vegetation on the ridge through which the tunnel runs is intact primary rimu/kamahi forest of high ecological value (Photo A5-25). The tunnel exits onto a moderately steep slope with regenerating secondary rimu/kamahi forest above and kamahi forest below. There are a number of other prominent canopy species including quintinia, kahikatea, broadleaf, rough tree fern, mahoe, lancewood and hinau. A grassed vehicle track runs along the true left of the canal between the tunnel exit and the head pond (Photo A5-26). Riparian species along the length of the water race include kiokio, lowland flax, toetoe, gorse and exotic grasses including Yorkshire fog and creeping bent. There is a large intact kahikatea/lowland flax swamp on the valley floor at the toe of the slope to the west of the canal.

The proposed new head pond site (Map 2b) was formerly regenerating tree-fernland and secondary kamahi forest that has recently been cleared of vegetation. The former vegetation has been pushed up into windrows where a few individuals of species such as kamahi, hinau, karamu, rough tree fern and ponga remain. A large portion of the site has also been sprayed with herbicide (Photo A5-27). The areas of the proposed head pond site that have a sloping gradient are drier and dominated by young gorse seedlings although occasional bracken, toetoe, exotic grasses (e.g. browntop and Yorkshire fog), swamp kiokio, and wiwi are present. In the wetter areas sharp-fruited rush is very prominent.

The penstock route runs a short distance down a steep terrace face covered by secondary kamahi forest (Photo A5-28). Other common tree and shrub species include hinau, young rimu, rough tree-fern, karamu, marble-leaf, pate, wineberry, and koromiko. The vegetation on this terrace face was originally cleared for the installation of the existing penstock, and is fragmented by a 4WD access track leading up to the forebay and water race and a path that provides foot access to the 4WD track.

The proposed new McKays Power Station location (Map 2b) is a flat area of exotic grass and gravel immediately beside the existing McKays Creek Power Station (Photo A5-29).

The vegetation communities that would be affected by the proposed new water race and proposed fill sites are:

1. Gorse scrub;
2. Secondary kamahi - quintinia forest; and
3. Soft tree fern / rough tree fern tree-fernland.

These vegetation communities are described in more detail in Appendix 7.

5.7 **Kaniere Forks and McKays Creek Terrestrial Birds and Habitats**

Table 5.3 lists the terrestrial bird species that were recorded by BML during site investigations (on the 12/08/2009, 28 – 29/01/2010 and 18 – 31/08/2010) and Sagar and Kelly (2005), and those species that were not recorded but are likely to occur along the KNF and MKY HEPS. The existing and proposed new KNF alignments pass through forested habitats, including both primary podocarp/kamahi forest, secondary kamahi/quintinia forest and manuka scrub. The MKY HEPS passes through regenerating secondary kamahi/quintinia forest. The composition of the avifauna in the forested habitats along the KNF and MKY HEPS is fairly typical of similar indigenous forest habitats on the West Coast (e.g. Spurr *et al.* 1992). Common native species include bellbird, brown creeper, grey warbler, New Zealand pigeon, tui, South Island fantail, yellow-breasted tit and yellow-crowned parakeet. Morepork were heard in the forests surrounding Lake Kaniere, and this species will also occur in the forests along the HEPS. Shining cuckoo are present in forests in the area between September and April (Heather and Robertson 1996). South Island robin were not recorded but McEwen (1987) notes that within the ED robin are only found near Lake Kaniere and in the hill country in the south.

In addition to the common native species, five forest bird species classified either as ‘At Risk’ or ‘Threatened’ (Miskelly *et al.* 2008) were either observed, or have been

recorded from the Lake Kaniere area. Kea (Naturally uncommon) were heard and observed occasionally. A long-tailed cuckoo (Naturally Uncommon) was recorded in the secondary kamahi/quintinia forest near the McKays tunnel exit. This migratory species is sparsely distributed throughout the forests of the West Coast between October and March (Heather and Robertson 1996). New Zealand falcon (Nationally Vulnerable) were observed at Lake Kaniere in August 2010 and other sources (i.e. Robertson *et al.* 2007 and Bell 2009) also record this species as being present in the area. McEwen (1987) reported that South Island kaka (Nationally Endangered) were widespread in forest in the ED, but none were observed during field investigations. Small numbers of kaka probably occur in the primary forest surrounding Lake Kaniere. Western weka (Declining) are abundant throughout. They utilise a wide range of habitats along the HEPS from regenerating scrub and open pasture to forest.

The open pasture and regenerating gorse and scrub through which the McKays water race passes provides habitat for a number of widespread and common introduced species such as blackbird, chaffinch, redpoll and song thrush. Common native species in this habitat include Australasian harrier, brown creeper, grey warbler, pukeko, silver-eye and South Island fantail. Although not observed, a number of other common species such as spur-winged plover, and small passerines such as goldfinch, greenfinch and hedge sparrow are also likely to utilise these habitats.

South Island fernbird (Declining) have previously been recorded along the KNF water race and proposed new water race alignment (i.e. DOC unpubl.) and surveys and incidental observations during site investigations confirmed their presence within the construction envelope. Within the manuka scrub, fernbird appeared to favour the low vegetation cleared along the transmission line route. Four individual birds were recorded in the wetland in the vicinity of Wards Road during specific surveys for fernbird from count stations. McEwen (1987) reported that marsh crake (Relict) and spotless crake (Relict) were also present in suitable habitats. While crake may be present within the riparian margins surrounding Lake Kaniere, there is not suitable habitat for either species along the existing or proposed HEPS alignment.

Table 5.3: Terrestrial bird species recorded by BML (12/08/2009, 28 – 29/01/2010 and 18 – 31/08/2010) and Sagar and Kelly (2005), and those species that are likely to occur along the existing KNF and MKY HEPS alignment but were not recorded. KNF = species seen or heard along the existing KNF HEPS alignment and the proposed KNF enhancement construction corridor. MKY = species seen or heard along the existing MKY HEPS alignment. Blank spaces = birds not recorded during site investigations.

Species	**Threat classification (Miskelly *et al.* 2008)**	**BML**	**Sagar and Kelly (2005)**
Australasian harrier	Not Threatened	MKY	
Bellbird	Not Threatened	KNF, MKY	KNF, MKY
Blackbird	Introduced and Naturalised	KNF, MKY	
Brown creeper	Not Threatened	KNF, MKY	KNF
Chaffinch	Introduced and Naturalised	KNF, MKY	KNF, MKY
Dunnock	Introduced and Naturalised		
Goldfinch	Introduced and Naturalised		
Greenfinch	Introduced and Naturalised	KNF	
Grey warbler	Not Threatened	KNF, MKY	KNF, MKY
Kea	Naturally Uncommon	KNF, MKY	
Long-tailed cuckoo	Naturally Uncommon	MKY	
Spur-winged plover	Not Threatened		
New Zealand falcon	Nationally Vulnerable		
New Zealand pigeon	Not Threatened	KNF, MKY	MKY
Pukeko	Not Threatened	MKY	
Redpoll	Introduced and Naturalised	KNF	KNF
Silvereye	Not Threatened	KNF, MKY	KNF, MKY
Shining cuckoo	Not Threatened		
Song thrush	Introduced and Naturalised	MKY	
South Island fantail	Not Threatened	KNF, MKY	KNF, MKY
South Island fernbird	Declining	KNF	
South Island kaka	Nationally Endangered		
South Island robin	Not Threatened		
Tui	Not Threatened	KNF, MKY	
Western weka	Declining	KNF, MKY	
Yellow-breasted tit	Not Threatened	KNF, MKY	KNF, MKY
Yellow-crowned parakeet	Not Threatened	KNF	
Welcome swallow	Not Threatened	KNF	

5.7.1 Avifauna of the Kaniere Forks and McKays Creek water races

No water birds were seen associated with the race and flume associated with either the KNF or MKY HEPS during Sagar and Kelly's (2005) survey. A single mallard/grey duck was observed in the MKY water race during preliminary site investigations. In general, the water races provide limited habitat for water birds.

5.8 Kaniere Forks and McKays Creek Terrestrial Fauna

5.8.1 Bats

The primary rimu/kamahi forests adjacent to the existing HEPS infrastructure provide good habitat for bats. Long-tailed bats (*Chalinolobus tuberculatus*) are Nationally Endangered (Hitchmough *et al.* 2007). DOC have undertaken comprehensive surveys for bats in the Lake Kaniere area (DOC unpublished data) (Map 10) which have confirmed the presence of long-tailed bats in the Lake Kaniere area in the vicinity of Geologists Creek. Survey results indicate that there is a roost here with a large number of individuals. A single long-tailed bat was also recorded on the Milltown Road between Kaniere Landing and Pyramid Hill in 1998. Long-tailed bats have very large home ranges[7] and it is highly likely that they forage throughout the wider area, including the forests adjacent to the HEPS. While they have not been recorded along or adjacent to either the KNF or MKY HEPS, it is possible that long-tailed bats could roost in mature trees adjacent to the enhanced Scheme.

5.8.2 Lizards

Four species of lizard (two gecko and two skink species) have been recorded from the Hokitika ED (Whitaker and Lyall 2004).

McEwen (1987) reports that green gecko have been reported from the Kaniere State Forest. This reference is probably to the West Coast green gecko (*Naultinus tuberculatus*), which are classified as Declining (Hitchmough *et al.* 2010). Lizard distribution maps (derived largely from the Herpetofauna database) in Whitaker and Lyall (2004) also record an unknown *Naultinus* species from the Lake Kaniere Area. West Coast green gecko are virtually endemic to the West Coast. They inhabit lowland and montane shrublands and forests and are also found in seral vegetation such as kanuka and manuka shrubland, and in umbrella fern fernlands on pakihi terraces (Whitaker and Lyall 2004). The other gecko species known to be present in

[7] O'Donnell (2001) found that home ranges for adult males were 1,589 ha (max 5,629 ha) and 657 ha for non-reproductive females.

the Hokitika ED is the forest gecko (*Hoplodactylus granulatus*), which inhabits forest and shrubland habitats (Whitaker and Lyall 2004). It is widespread and relatively common in the forests of northern Westland and classified as 'Not Threatened' (Hitchmough *et al.* 2010).

The two skink species known to occur in the Hokitika ED are the speckled skink (*Oligosoma infrapunctatum*), classified as 'Declining', and the common skink (*Oligosoma nigriplantare polychroma*), which is 'Not Threatened' (Hitchmough *et al.* 2010). Both species are widespread. The speckled skink has most often been recorded on or immediately adjacent to the coast, but it is known to occur in some inland locations. Common skinks occur in a wide range of habitat types. In Westland they also occur in fernland or sphagnum swamps on pakihi terraces (Whitaker and Lyall, 2004).

The habitat types adjacent to The HEPS provide suitable habitat for West Coast green gecko, forest gecko and common skink. Speckled skink may also be present, but this is less likely.

5.8.3 Invertebrates

No published information on invertebrate fauna in the vicinity of the Kaniere Forks/McKays HEPS was found for this assessment. It is unlikely that rare or threatened invertebrate species occur in the habitats adjacent to The HEPS given that there are no rare or threatened habitats associated with the HEPS, invertebrates are generally widespread and well represented, and because of low levels of endemism in the West Coast fauna (T. Shaw *pers. comm.* 2010).

5.8.4 Introduced mammals

Red deer and hare sign was observed during field investigations. Other ubiquitous introduced mammals including rabbits, possums, rats, mice, mustelids (weasels, stoats and ferrets), hedgehogs and feral cats are almost certainly present in the various habitats adjacent to The HEPS.

5.9 Ecological Significance Under Section 6(c) of the RMA

For the purposes of this assessment of significance, the Westland District Council (WDC) significance criteria, set out in Part 4 of the Westland District Council Plan (2002) (District Plan), and the WCRC 'matters to be considered as a guide for decision making' (hereafter referred to as 'criteria'), set out in Policy 9.2 of the

WCRC's Regional Policy Statement (2000) (RPS) have been used as the primary criteria for determining the significance of the vegetation and habitats potentially affected by the enhanced Scheme.

The WDC and the WCRC criteria (Appendix 8) both include criteria relating to protection under New Zealand Statute (Policy 9.2. a) and b) of the RPS, and Part 4, Policy D (iv) of the WDC Plan). Protection is generally the desired outcome of the significance process and criteria relating to protection are not included in other widely accepted criteria for assessing significance under section 6(c) of the RMA (i.e. Whaley *et al.* 1995 and Norton and Roper-Lindsay 2004). For the purposes of this assessment, the WDC and WCRC criteria that relate to protection status have therefore not been considered in this assessment. Similarly, criteria i, j and k of the RPS are not ecologically based. These have accordingly also not been included in this assessment.

The remaining criteria are scientifically robust and are considered to be an appropriate basis to determine significance for section 6(c) purposes. For example, it is considered that a comparative assessment using the Norton and Roper-Lindsay criteria (Norton and Roper-Lindsay 2004) would likely result in the same outcome. The assessment detailed below is based on the following criteria which are considered to be scientifically robust and ecologically based.

WCRC criteria

c) The degree to which the area is representative of an association of species or an ecosystem that is typical of the region;

d) The likelihood of the area retaining its viability, quality and integrity of processes over a long time period;

e) The presence or absence of an indigenous species or community of indigenous species that is rare or threatened regionally or nationally;

f) The degree to which the area is distinctive in terms of indigenous species that are unusual, endemic, or that reach a distribution limit in the region;

g) The extent to which the area has been modified from a natural state or affected by weeds or pest species;

h) Its connection with other areas of significant indigenous vegetation or significant habitats of indigenous fauna;

l) The contribution of the area or habitat to maintenance and enhancement of ecological and reproductive processes water quality, water flow and soil conservation;

m) The relationship of the area or habitat to any water body included in a water conservation order;

n) Whether they occur near wetlands and estuaries;

o) The importance to migratory species, including whitebait; and

p) The relevance of ecological districts in relation to matters (c), (e) and (f).

WDC criteria

(i) Intactness

The area is unmodified by human activity, comprises a predominantly intact indigenous system and is not affected in a major way by weed or pest species; and

Size

The area of indigenous vegetation has a predominant cover of 5 hectares of more.

(ii) Representativeness

The area is one of the best examples of an association of species which is typical of its ecological district;

(iii) Distinctiveness

The area has indigenous species or an association of indigenous species which is unusual or rare in the ecological district, or endemic or reaches a distribution limit in the ecological district. The area may be distinctive because of the influences of factors such as altitude, water table, soil type or geothermal activity.

(v) Connectivity

The area is connected to one or more other significant areas in a way (including through ecological processes) which makes a major contribution to the overall value or natural functioning of those areas.

(vi) Threat

The area supports an indigenous species or community of species which is threatened within the ecological district or threatened nationally.

(vii) Migratory Species

An inter-tidal area or area of forest, wetland, lake, estuary or other natural habitat that is important for migratory species or for breeding, feeding or other vulnerable stages of indigenous species.

(viii) Scientific or other Cultural Value

The area is a type, locality or other scientific reference area, is listed as a geopreservation site, or has a distinctive amenity value (e.g. it contributes to a distinctive and outstanding landscape of the district, has other significant cultural value or is of international importance).

Under both the District Plan and the RPS, significant indigenous vegetation and habitats must meet one or more criteria.

Many of the vegetation communities adjacent to the enhanced Scheme provide habitat for the threatened western weka (Declining) and therefore could be considered to meet the criterion relating to 'rarity' or 'threat' under both the WDC and WCRC criteria. However, the presence of this species alone does not warrant classification of these areas as 'significant' as this species is widespread and common throughout a broad range of habitat types on the West Coast. Although weka are threatened nationally, it could be argued that because of their widespread distribution, ongoing expansion in range and local abundance, the sub-species is not currently declining on the West Coast (Shaw, 2007).

5.9.1 Lake Kaniere riparian vegetation and wetlands

All of the intact unmodified riparian vegetation and wetlands surrounding Lake Kaniere are of high ecological value. They are intact, have very few or no introduced weeds, are part of a large area of intact indigenous vegetation, are highly representative and provide one of the best examples of an association of species and habitats that are typical of the Hokitika ED and region. They also meet the 'threat' criterion because they provide habitat for a number of nationally threatened bird species. They are also very likely to retain the viability, quality, and integrity of ecological processes. These communities also play an important role in the maintenance of water quality in Lake Kaniere and the Kaniere River.

5.9.2 Kaniere Forks HEPS Vegetation and Habitats

The significance of each of the vegetation communities adjacent to the KNF HEPS is discussed below. The locations of these communities are shown on Maps 8 and 9.

The primary (rimu) - (miro) / kamahi -quintinia forest meets many of the WDC and WCDC criteria. It is representative, and one of the best examples of an association of species that is typical of the ED and region (when considered as part of the large, connected contiguous area of similar forest in the Lake Kaniere SR). This vegetation association (lowland outwash terrace and moraine podocarp forest) is also under-represented - approximately 10.5% of its 1860 area remained in 1990 (Awimbo *et al.* 1996). It is largely intact and has not otherwise been significantly modified from its natural state. It meets the WDC size criteria, and its viability is good. It meets the 'Threat' criterion because as part of a larger area of contiguous forest, it provides important habitat for a number of nationally threatened forest bird species including South Island kaka (Nationally endangered), New Zealand falcon (Nationally vulnerable), kea, long-tailed cuckoo (Naturally uncommon), western weka (Declining) and potentially long-tailed bat (Nationally endangered). There is little evidence of animal browse within the forest itself and there are no, or very few, introduced plant species or weeds. It is connected with other unmodified rimu-miro/kamahi-quintinia forest in the Lake Kaniere SR and has an important role as a corridor for the movement and dispersal of indigenous flora and fauna.

The manuka scrub is significant because it meets criteria relating to 'threat', intactness and connectivity. It provides habitat for two nationally threatened species including western weka (Declining) and South Island fernbird (Declining). Although it is likely to be an induced vegetation community that has been modified from its natural state, it is still largely dominated by indigenous species. There is little evidence of animal pests and only a small number of weeds occur on the margins of the water race and walking track. It is connected to the unmodified rimu-miro/kamahi-quintinia forest in the Lake Kaniere SR and in the context of the wider area, probably plays an important role as a corridor for the movement and dispersal of indigenous fauna. Because it occurs on public conservation land, its viability is good.

The secondary (rimu) / mountain toatoa - quintinia - southern rata forest has been logged, and in places directly adjacent to the existing KNF water race, appears to have been cleared. It does not meet criteria relating to representativeness or intactness. Despite this it is significant, as it is connected to the significant rimu-miro/kamahi-quintinia forest in the Lake Kaniere SR (although it is fragmented by the transmission line and Wards Road). It also provides habitat for nationally threatened forest bird species including kea, long-tailed cuckoo (Naturally uncommon) and western weka (Declining) and potentially, long-tailed bat (Nationally endangered).

The weeping matipo scrub probably represents a regenerating vegetation community following clearance of the original forest cover. However, it is considered

to be significant because it lies within a large area of contiguous forest within the Lake Kaniere SR and plays an important role in connecting two ecologically valuable areas of primary (rimu) - (miro) / kamahi - quintinia forest to the north-west and south-east.

The (silver pine) / manuka scrub in the vicinity of Wards Road is significant because, like the manuka scrub, it meets criteria relating to 'threat', intactness and connectivity. It provides habitat for two nationally threatened species including western weka (Declining) and South Island fernbird (Declining). Although it has been logged and fragmented by Wards Road, it is still largely dominated by indigenous species. It is surrounded by the unmodified rimu-miro/kamahi-quintinia forest in the Lake Kaniere SR, and is immediately adjacent to the wetland communities near Wards Road. Because it occurs on public conservation land, its viability is good.

The vegetation communities within the vicinity of Wards Road (*Carex* sedgeland, mingimingi shrubland, mingimingi /*Carex* shrubland, manuka shrubland, *Phormium* flaxland, *Phormium* flaxland / *Sphagnum*, and silver pine forest) (Map 9) have been modified by human activity and some, particularly the Carex sedgeland and mingimingi shrubland, have a high proportion of exotic species relative to other vegetation types in the wider area. Deer are also abundant here. These vegetation communities have historically been cleared of their original indigenous cover and are not considered representative or intact. However, they do meet the 'threat' criterion because they provide habitat for a small population of South Island fernbird (Declining) and western weka (Declining) are also present. By themselves these vegetation communities would probably not be considered significant. However, because they are surrounded by a contiguous area of significant indigenous vegetation within the Lake Kaniere SR, they are also significant.

The cleared, regenerating manuka / tangle fern shrubland (under the transmission line) is highly modified. Although it provides habitat for western weka (Declining) and South Island fernbird (Declining), it does not meet any other criteria and is not considered significant for this criterion alone.

5.9.3 McKays Creek HEPS Vegetation and Habitats

Many of the vegetation communities and habitats adjacent to the MKY HEPS do not meet the WDC or WCRC significance criteria. The only vegetation communities that are considered to be significant are the secondary kamahi/quintinia forest within the Kaniere Farm CA and the primary (rimu) - (miro) / kamahi - quintinia forest within the Kaniere Farm CA and the Kaniere Forks SR.

The primary (rimu) - (miro) / kamahi - quintinia forest within the Kaniere Farm CA and the Kaniere Forks SR will not be affected by the proposed MKY enhancements and was not surveyed. However, it appears to meet a number of the WDC and WCRC criteria including intactness (and size), representativeness, 'threat' and viability.

Although the kamahi/quintinia forest within the Kaniere Farm CA has been logged and is secondary vegetation, it is significant. It plays an important role in connecting the Kaniere Forks SR with the large area of protected forest to the south and east comprising the Kaniere Farm CA and Lake Kaniere SR. It probably also provides feeding and breeding habitat for both long-tailed and shining cuckoo (migratory species) from time to time, but the site is unlikely to be of any particular importance to either species.

5.9.4 Summary

In summary, the following vegetation communities and habitats are considered to be significant under section 6(c) of the RMA:

Adjacent to the KNF HEPS:

- Primary (rimu) - (miro) / kamahi - quintinia forest;
- Manuka scrub;
- Secondary (rimu) / mountain toatoa – quintinia – southern rata forest;
- (Silver pine) / manuka scrub;
- Weeping matipo scrub; and
- The vegetation communities within the vicinity of Wards Road (*Carex* sedgeland, mingimingi shrubland, mingimingi /*Carex* shrubland, manuka shrubland, *Phormium* flaxland, *Phormium* flaxland / *Sphagnum*, and silver pine forest).

Adjacent to the MKY HEPS:

- Secondary kamahi/quintinia forest within the Kaniere Farm CA; and
- The primary (rimu) - (miro) / kamahi - quintinia forest within the Kaniere Farm CA and the Kaniere Forks SR.

The primary (rimu) - (miro) / kamahi -quintinia forest adjacent to the MKY HEPS will not be affected by the proposed enhancement. The extent to which the remaining

areas are affected is discussed in Sections 8.3.1.1 and 8.3.2.2 for the MKY and KNF HEPS, respectively.

6 Project Shaping Process

Following preliminary site investigations, BML produced a *Draft Feasibility and Scoping Report* for TPL. In this report, BML made several recommendations to avoid high value ecological areas. Subsequent to this, but prior to the completion of the draft construction plans, and following further more detailed field investigations and mapping, and discussions with TPL engineers, the initial construction drawings were revised to avoid or minimise adverse impacts on avifauna and terrestrial ecological values. A further site visit was made on 6 October 2010 with the express purpose of discussing the proposed new KNF alignment with TPL's Civil Engineer (Rob Shelton) to discuss the proposed alignment and where it could be further revised to avoid or minimise adverse impacts on avifauna and terrestrial ecological values.

With regard to the proposed MKY HEPS enhancement, BML made the following recommendations:

- Confine construction works to the historically modified envelope of the MKY HEPS infrastructure wherever possible; and
- Where this is not possible (i.e. construction of a new section of water race as an alternative to enlarging the existing tunnel), confine proposed construction works to the most modified vegetation and habitats, and if possible the existing 4WD track through the Kaniere Farm CA).

The following recommendations were made with regard to the KNF HEPS enhancement:

- Where possible, avoid higher quality vegetation and habitats;
- Avoid large, mature 'habitat trees' wherever possible;
- Reduce the width of the construction corridor as much as practical where it passes through higher quality vegetation and habitats, such as the rimu-miro/kamahi forest at Kaniere Landing;
- Utilise the existing cleared transmission line corridor as much as possible to minimise vegetation clearance and habitat fragmentation;
- Penstock (option 2) should follow the existing cleared vegetation down the terrace face that resulted from a previous blow-out, and works should be confined to 10 m corridor;
- Shift the temporary works and lay down area to the north, closer to the terrace into less intact vegetation communities and away from wetter more intact part of wetland;

- Re-align the tailrace further to the north so it enters on the same alignment as the Kaniere River;
- Shift the proposed Wards Road Power Station to the north into the more modified vegetation communities and so it aligns with the re-aligned tailrace; and
- Several more specific recommendations were made regarding the placement of features such as buffer storage areas along the canal route to ensure effects on specific trees, vegetation communities and streams were avoided.

Where possible, TPL have modified their initial Scheme designs to accommodate these recommendations. The extent to which this has been achieved is discussed below.

With regard to the MKY HEPS enhancement:

- With the exception of the proposed new section of water race (and associated fill sites), construction works have been largely confined to the historically modified envelope; and
- Within the Kaniere Forest CA, from an engineering perspective, it is not considered to be feasible to align the proposed new section of water race with the existing 4WD track.

With regard to the KNF HEPS enhancement:

- Higher quality vegetation and habitats have been avoided wherever possible, but the proposed construction envelope does still bisect some high value areas, for example the mature rimu-miro/kamahi - quintinia forest at Kaniere Landing;
- Large, mature 'habitat trees' while be avoided wherever possible during the detailed design stage;
- The proposed canal and access road alignments in the original draft construction drawings have been substantially revised several times. They now utilise the cleared transmission line corridor wherever this is feasible from an engineering perspective. This has considerably reduced the amount of indigenous vegetation clearance required and the potential effects of fragmentation;
- The proposed alignment of penstock (option 2) now follows the existing cleared vegetation down the terrace face that resulted from a previous blow-out, and the construction corridor has been reduced to 10 m;

- The temporary works and lay down area has been revised to avoid the more intact vegetation communities within the wetland at Wards Road;
- The proposed Wards Road Power Station and tailrace have been re-aligned further to the north to avoid the more intact vegetation communities within the wetland at Wards Road; and
- More specific recommendations relating to buffer storage areas have also been taken on board by TPL.

The assessment of effects in Section 8 of this report considers the potential ecological effects that could not be avoided through the shaping process.

7 Project Description

TPL is seeking to reconsent the existing Scheme as well as the proposed enhancements to the KNF and MKY HEPS. These are described below.

7.1 Existing Scheme

7.1.1 Scheme operation

TPL's existing resource consents allow abstraction of 1 m^3/s from Lake Kaniere into the Kaniere Race and discharge of 1 m^3/s from the power station tailrace into the Kaniere River. No water can be diverted from Lake Kaniere for power generation when lake levels recede to a staff gauge level of -0.2 m (which equates to 100 mm above the minimum operating level for the local water supply) and the diversion of water from Lake Kaniere must be controlled to ensure a minimum flow of 200 L/s passes through the control structure and down the Kaniere River at all times.

The existing consents also allow abstraction of 5 m^3/s from the Kaniere River at McKays Weir and 1 m^3/s from its tributaries (Blue Bottle and Green Creeks) and for the discharge of 6 m^3/s from the McKays Creek Power Station tailrace into the Kaniere River. The diversion of water from the Kaniere River at McKays Weir must be also controlled to ensure a minimum flow of 200 L/s flows past the control structure and down the channel of the Kaniere River at all times.

Under the existing Scheme a low weir (Map 2a) controls the level of Lake Kaniere. Below this weir water is diverted through an intake at Kaniere Landing and into the Kaniere water race. This water race is a relatively small (1 m^3/s) timber and earth open cut race with a number of tunnels, boxed flumes and spillways that channels water for approximately 9 km (Map 2). In places the race has been designed to spill water to contribute to existing tributaries. The water passes down a steep slope inside a steel penstock and into the Kaniere Forks Power Station before discharging via a short tailrace back into the Kaniere River.

The McKays Weir (Map 2b) is a low concrete weir on the Kaniere River that diverts up to 5 m^3/s of water into the McKays water race via two control gates. The water is passed through a flume over Coal Creek, under Lake Kaniere Road and around the face of a ridge (via a cut) into a large steel siphon. From here it flows back into an open earth water race before entering a long earth tunnel under a forested ridge. The tunnel emerges on a steep slope and flows through an open earth water race to the head pond. From here it passes down the penstock and into the McKays Power

Station before discharging via a tailrace into the Kaniere River approximately 9 km downstream of the Lake Kaniere outlet. The MKY HEPS water race has several overflow features that limit flows to the consented maximum by discharging water into existing tributaries.

7.1.2 Lake Kaniere

Under the existing Scheme, over the 8 year period of records between 2002 and 2008, the level of Lake Kaniere has fluctuated between -0.13 m RL and 1.71 m RL with a median level over this period of 0.94 m (TPL 2010a). Figure 7.1 shows the actual (recorded) lake level distribution between 2002 and 2009. The lake is normally low over the winter months due to lower inflows during this period and the higher managed flow release for generation (TPL 2010a).

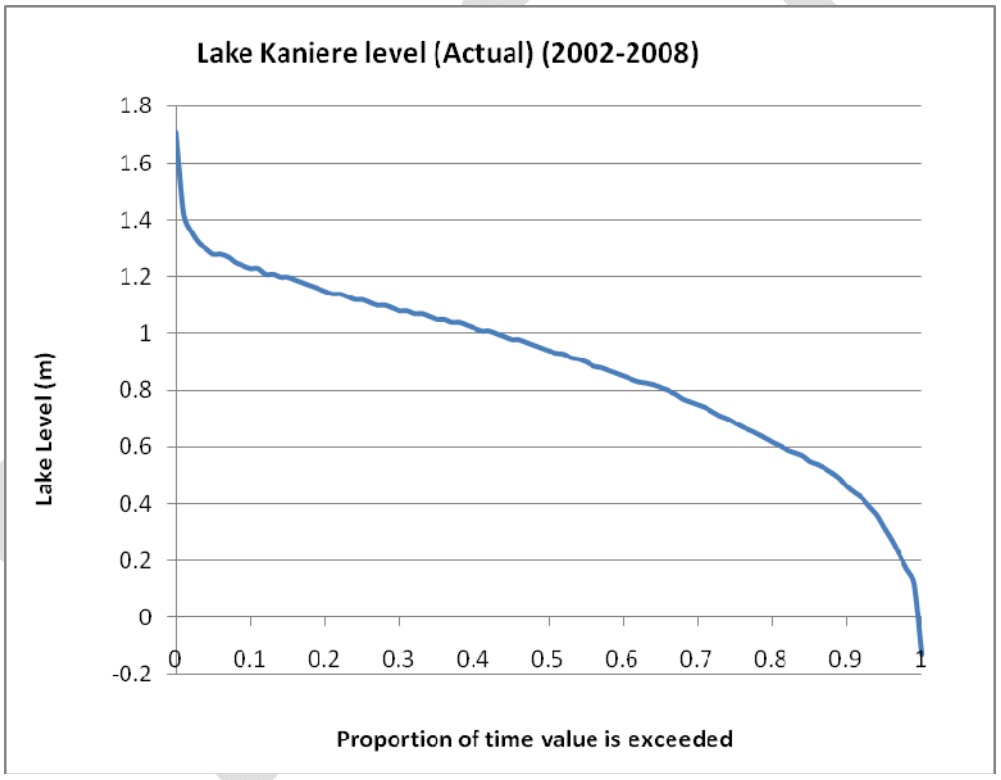


Figure 7.1: Actual Lake Kaniere level distribution between 2002 and 2008 (graphed from TPL unpublished data).

The Hydrology Report (TPL 2010a) provides more detailed information on the levels under the existing Scheme, and the Aquatic Ecology Assessment (Ryder Consulting 2010) describes the aquatic plant communities in Lake Kaniere.

7.1.3 Kaniere River

The mean and median flows in the Kaniere River under the existing Scheme, measured between 2002 and 2008 at various locations are provided in Table 7.1.

Table 7.1: Mean and median flows in the Kaniere River at six key locations. Measured between 2002 and 2008 (Source: TPL 2010a).

Location	Mean (m^3/s)	Median (m^3/s)
Lake Kaniere	6.1	5.5
Wards Road	6.4	5.8
Upstream of McKays Weir	6.8	5.6
Downstream of McKays Weir	2.9	1.4
Downstream of Kaniere Forks Station discharge	5.1	2.8
Downstream of McKays Creek station discharge	10.8	7.5

Figure 7.2 shows the actual flow distributions between July 2005 and June 2008 at these locations under the existing Scheme.

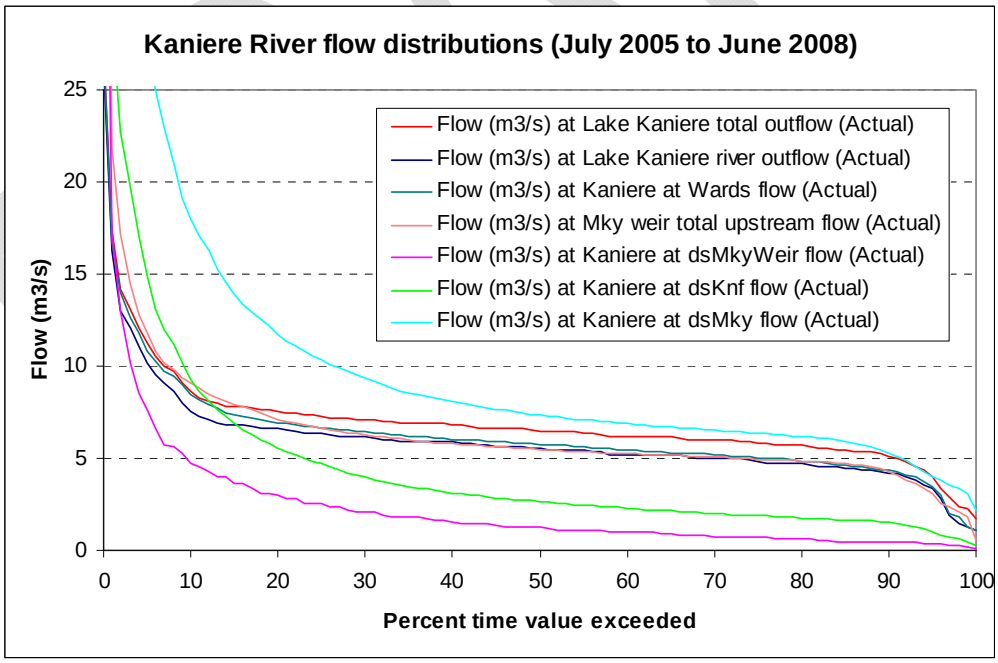


Figure 7.2: Actual flow distributions at key locations on the Kaniere River between July 2005 and June 2008.

The Hydrology Report (TPL 2010a) provides more detailed information on the flows in the Kaniere River under the existing Scheme.

The Aquatic Ecology Assessment (Ryder Consulting 2010) describes the water quality, periphyton and benthic macroinvertebrate and fish fauna of the Kaniere River.

7.1.4 Scheme maintenance

TPL staff maintain the infrastructure associated with the KNF/MKY HEPS. These activities are carried out within areas that have either been previously modified, or are maintained in a modified state, by the installation, maintenance and operation of The Scheme. The current maintenance activities are listed in Table 7.2.

Table 7.2: Activities required for general maintenance of the existing KNF/MKY HEPS (Source BML 2005).

Maintenance activity	**KNF HEPS**	**MKY HEPS**
Track and race vegetation control	✓	✓
Clearing wind throw	✓	✓
Repairing slips on the track or water race	✓	✓
Weed control (spraying)	✓	✓
Flushing sections of the race	✓	✓
Clearing sediment from tunnels	x	✓
Mowing race edges and station grounds	x	✓
Maintaining vehicle tracks	✓	✓
Penstock repairs and maintenance	✓	x

TPL staff periodically clear wind thrown trees and overhanging vegetation on the sides of the Kaniere Forks and McKays Creek water races using either manual methods or herbicide. Vegetation typically cleared includes *Blechnum* ferns, bracken, manuka saplings, gorse, young tree ferns, flax, grasses and early successional shrub and broadleaf species.

When slips occur and block or undermine the integrity of a section of the water race or track TPL staff clear away the debris and if necessary, repair the damaged water race or section of track. This can involve clearing a small canopy gap to allow materials to be dropped into the site by helicopter. The level of maintenance effort varies along the race. Many sections are disturbed less frequently or not at all.

Track clearance along the Kaniere Water Race Walkway is not an operational requirement and is undertaken for public amenity, although it also clearly has benefits for accessing and maintaining the race.

In addition to mechanical methods of vegetation clearance, TPL staff also use herbicide following standard operating procedures. Some areas, for example around the power stations, are also mowed. Vehicle tracks are maintained to ensure access to key parts of The Schemes infrastructure is possible.

Maintenance of the penstocks involves periodically replacing the air relief valves and attending to any leakages. Penstock maintenance occurs on average 1-2 times a year.

Lastly, sediment is cleared from the water race tunnels if there have been roof or wall collapses. Periodically the sediment in the tunnel on the McKays Creek water race is cleared. The material (<3 m^3/yr) is then deposited at the end of the historic tramway on an existing pile of spoil.

7.2 Proposed McKays Creek and Kaniere Forks HEPS Enhancements

The proposed enhancements to the MKY and KNF HEPS are described in Sections 7.2.1 and 7.2.2. For changes to the lake levels in Lake Kaniere and river flows in the Kaniere River that would occur under the enhancements refer to the Hydrology Report (TPL 2010a).

7.2.1 Proposed McKays Creek HEPS enhancement

Under the proposed enhancement of the MKY HEPS, TPL is proposing to increase abstraction into the McKays water race (at McKays Weir, Map 2b) from 5 to 8 m³/s. The capacity of the existing McKays Creek Power Station would be increased from 6 to 9 m³/s (the 9 m³/s includes the existing 1 m³/s being diverted from Blue Bottle Creek via Greens Creek).

The work required for the MKY HEPS enhancement is described in detail in the Civil Engineering Report (TPL 2010b) (refer to Map 2b for the layout of the existing and enhanced MKY Scheme). In summary it involves:

- Modifications to the existing weir;
- Minor repairs, maintenance and local improvement of the existing canal;
- Increasing the height of low spots on the access way side of the canal bank by up to 0.5 m;
- Replacing the existing Coal Creek Flume with a new two or three pipe bridge;
- Repairs to, and refurbishment and enlargement of the McKays tunnel;
- Construction of an above ground water race to the south of the existing tunnel as an alternative to refurbishing and enlarging the McKays tunnel;
- Constructing a head pond above the existing penstock;
- Replacing the existing underground penstock with an above ground penstock; and
- Building a new power station immediately adjacent to the existing one.

With the exception of the proposed alternative water race route, fill sites and the new head pond, penstock and power station, all of the proposed enhancements lie within the footprint of the existing Scheme.

7.2.2 Proposed Kaniere Forks HEPS enhancement

Under the proposed KNF HEPS enhancement, abstraction from Lake Kaniere into the Kaniere water race will be increased from 1 to 8 m³/s. The work required to upgrade the KNF HEPS is described in detail in the Civil Engineering Report (TPL 2010c) (refer to Map 2a for the layout of the existing and enhanced KNF Scheme). In summary it involves:

- Modifying the existing intake;
- Installing and overfilling a new box culvert, sized for 8 m^3/s, from the intake under Kaniere road to the start of the Kaniere Race;
- Replacing the existing 1 m^3/s water race with a new 8 m^3/s canal (which includes several buffer storage areas). The alignment of the proposed new canal follows the existing water race in places, but it is proposed that the majority of the canal would follow a new alignment that utilises the existing transmission line route (refer to the drawings attached to the Wards Road Enhancement Civil Engineering Report (TPL 2010c); and

- Building a new penstock, power station and tailrace immediately downstream of Wards Road.

7.2.3 Lake Kaniere

The Hydrology Report (TPL 2010a) describes the expected changes to lake levels in detail based on flow simulations of the proposed KNF and MKY HEPS enhancements and is relied upon for the purposes of this assessment.

7.2.4 Kaniere River

The Hydrology Report (TPL 2010a) describes in detail the expected changes to Kaniere River flows based on flow simulations of the proposed KNF and MKY HEPS enhancements and is again relied upon for the purposes of this assessment.

8 Assessment of Effects

This section presents an assessment of the effects of the enhanced Scheme as described in Section 7. Mitigation is introduced here, but discussed in more detail in Section 9.

8.1 Lake Kaniere

Under the enhanced Scheme, simulated data (with KNF HEPS and MKY HEPS both operating at 8 m^3/s) (TPL 2010a) indicate that the mean and median lake levels would be 0.43 and 0.54 m lower, respectively, than under the existing Scheme. Simulations of the revised regime for the proposed MKY HEPS enhancement alone (TPL 2010a) indicate that the mean and median lake levels will be lower still (0.54 m and 0.69 m lower than under the existing Scheme, respectively). Because the simulated lake level changes are greater under the proposed MKY HEPS enhancement than the proposed KNF HEPS and MKY HEPS enhancements, the potential effects of the MKY HEPS enhancement have been assessed below because this represents the widest range of possible effects.

Daily lake level fluctuations (< 0.05 m) under the proposed Scheme enhancements will be small (TPL 2010a) and minimum lake levels will still be governed by the supply of water to the Hokitika township and periods of low flows into the lake.

8.1.1 Avifauna

In general, changes in lake operating regimes can affect foraging and breeding of water birds, adversely or beneficially, depending on circumstances (Sanders 1999, Kushlan 1986, Williams 2004). The changes in the water levels of Lake Kaniere under the enhanced Scheme will on average expose areas of the lakeshore for longer periods, which may provide additional riparian roosting and loafing habitat for waterfowl, and may increase the availability of feeding habitat for species such as shallow and deep water waders. The avifauna of Lake Kaniere is primarily comprised of common generalist foragers. It is considered unlikely that a change in lake levels as a result of the enhanced Scheme will adversely affect the avifauna of the lake. This is supported by the Aquatic Ecology Assessment (Ryder Consulting 2010), which concluded that in relation to the aquatic plant communities in the littoral zone, under the enhanced Schemes '*any effects are anticipated to be minor as most species are present at a range of depths, the changes are within the existing operating range and variations in lake level will take place over a period of weeks rather than daily fluctuations'*.

8.1.2 Terrestrial riparian vegetation

In general, changes in lake levels have the potential to alter riparian vegetation communities (e.g. Johnson 1972, Mark *et al.* 1977, James *et al.* 2002). Lakeshores are an ecotone, which are naturally subjected to variations in lake levels. They are stressful environments for many species that exist at, or close to their tolerance limits. This is often reflected in lakeshore zonation patterns of both plant and animal communities (James *et al.* 2002).

Under the enhanced Scheme, there will be no change to the operating range of Lake Kaniere (including the consented minimum of -0.2 m). However, the amount of time that the lake is at levels within the current range will change. Simulations predict a maximum mean and median fall in lake levels of 0.43 and 0.54 m respectively (TPL 2010a). Daily fluctuations in lake levels are predicted to be minor with daily fluctuations greater than 2 cm occurring less than 50% of the time (larger changes in lake levels will be caused by natural increases associated with rainfall events) (TPL 2010a).

Changes to lake levels under the proposed enhanced Scheme are unlikely to adversely affect terrestrial riparian vegetation communities. There will be no change to the upper lake levels as a result of the proposed enhancement, and therefore no additional periods of inundation beyond those that already occur are expected.

In contrast, because lake levels would on average be lower, this could potentially be beneficial to terrestrial vegetation communities by exposing more available habitat along the lakeshore. Early successional terrestrial herbaceous species may colonise the low profile sheltered lakeshore during periods of extended low lake levels, but high lake levels will continue to occur in summer when the managed flow release for generation is lower and inflows are higher (due to higher rainfall). Inundation of early colonist terrestrial species during these periods of high lake levels will continue to be the most important factor defining the lower limit of terrestrial riparian species. Some species with a higher tolerance to inundation (e.g. oioi, *Juncus* sp. and flax) may extend their distribution down the lake shore, the extent of which will be governed by the local shoreline gradient.

The potential impacts of changes in lake levels on aquatic species in the littoral zone of the lake are discussed by Ryder Consulting (2010).

8.1.3 Riparian wetlands

Lake level changes that could affect the riparian wetlands around Lake Kaniere are the same as those discussed in Section 8.1.2. for terrestrial riparian vegetation. These changes may potentially adversely impact the riparian wetlands including changes to vegetation composition, structure and distribution as a result of less frequent inundation and de-watering. In general, other indirect effects include greater susceptibility to invasion by exotic species, increased access to browsing animals and introduced mammalian predators, and greater risk of fire (James *et al.* 2002).

Predicted changes to the wetlands around Lake Kaniere depend on a number of variables including their hydrology, size, form, distance from the lake, species and vegetation community composition. The predicted effects on each specific wetland are outlined in Table 8.1.

Table 8.1: Predicted potential effects on ecological values for each of the riparian wetlands associated with Lake Kaniere.

Wetland	Wetland area (ha)	Vegetation communities	Predicted potential effect
1	0.01	(Kahikatea)/*Phormium* flaxland	Wetland levels driven largely by lake levels, but also rainfall. Unlikely to be a shift in vegetation communities as their distribution appears to be largely defined by wave action (on the lake side). No important habitat values or open water.
2	< 0.01	*Phormium* flaxland	Very small wetland. Potential for small lakeshore shift of vegetation communities. No important habitat values or open water.
3	0.02	*Phormium* flaxland	Wetland formed by water impounding behind sand and gravel beach berm. Hydrology driven by run-off from surrounding land and inundation during high lake levels. Potential effects dependent on permeability of beach berm, but no adverse effects to wetland ecology predicted.
4	0.03	*Phormium* flaxland	Wetland formed by water impounding behind sand and gravel beach berm. Hydrology driven by run-off from surrounding land and inundation during high lake levels. Potential effects dependent on permeability of beach berm, but no adverse effects to wetland ecology predicted.
5	0.73	*Phormium* flaxland, *Carex* sedgeland, kahikatea forest, Open water	Wetland formed by water impounding behind sand and gravel beach berm. Hydrology driven by inundation during high lake levels and run-off from catchment behind? (but no connection observed under road). Potential effects dependent on permeability of beach berm. Reduction in open water and *Carex* sedgeland with shift towards flax? Lowering of surface water in wetland likely with loss of some internal connection during low water, but generally good water depth. No surface connection to lake exists, hence there is no loss of connectivity.
6	0.04	*Phormium* flaxland	Wetland formed by water impounding behind sand and gravel beach berm. Hydrology

Wetland	Wetland area (ha)	Vegetation communities	Predicted potential effect
			driven by run-off from surrounding land and inundation during high lake levels. Potential effects dependent on permeability of beach berm, but no adverse effects to wetland ecology predicted. Some native dryland forest species already present.
7	0.03	Oioi reedland	Low profile, shallow shoreline. Reedland community may shift towards the lake. No important habitat values.
8	0.05	Kahikatea forest, oioi reedland	Shallow shoreline, reedland community may shift towards the lake. In the long-term kahikatea may also shift toward lake. No important habitat values.
9	0.23	Kahikatea forest, oioi reedland	Shallow shoreline, reedland community may shift towards the lake. In the long-term kahikatea may also shift toward lake. No important habitat values.
10	0.03	Oioi reedland	Low profile, shallow shoreline. Reedland community may shift towards the lake. No important habitat values.
11	0.05	Oioi reedland	Low profile, shallow shoreline. Reedland community may shift towards the lake. No important habitat values.
12	0.14	Kahikatea forest, *Phormium* flaxland	Flaxland formed by water impounding behind sand and gravel beach berm. Hydrology driven by run-off from surrounding land and inundation during high lake levels. Potential effects dependent on permeability of beach berm, but no adverse effects to wetland ecology predicted. In the long-term kahikatea may shift toward lake.
13	0.94	Kahikatea forest, (kahikatea*)/Phormium* flaxland, square sedge reedland	Hydrology driven largely by run-off and inundation during high lake levels (particularly nearer the lake edge). No effect on existing kahikatea forest. Potential for long-term shift of existing communities, incl. kahikatea towards the lake.
14	0.01	*Phormium* flaxland	Flaxland to water's edge, no predicted effect except possible small shift of flax towards lakeshore

Wetland	Wetland area (ha)	Vegetation communities	Predicted potential effect
15	0.02	*Phormium* flaxland	Flaxland to water's edge, no predicted effect except possible small shift of flax towards lakeshore
16	0.45	Kahikatea forest, *Phormium* flaxland	Hydrology driven largely by run-off and inundation during high lake levels (particularly nearer the lake edge). No effect on existing kahikatea forest. Potential for long-term shift of existing communities, incl. flax and kahikatea towards the lake. Possible increase in the extent of oioi along the lakeshore?
17	0.11	*Phormium* flaxland	Hydrology driven largely by stream inflow and high lake levels. Flaxland to water's edge, no predicted effect except possible small shift of flax towards lakeshore.
18	2.99	Westland totara – mountain toatoa treeland, *Phormium* flaxland, (*Coprosma/*twiggy tree daisy)/*Phormium* flaxland, *Coprosma/* twiggy tree daisy scrub	Hydrology driven largely by inflows from stream, run-off from surrounding elevated land and direct rainfall into this flat, topographically constrained wetland. Inundation during high lake levels may play a role on the immediate margin of the lake. Overall impact of lake levels likely to be negligible given primary hydrological drivers. High rainfall will retain high moisture levels in central bog area, inundation will still occur, and at a similar frequency to the existing situation during the summer months. Flaxland on margin of lake may continue to expand outwards. Invasion by introduced weeds unlikely, as none are present.
19	9.24	*Phormium* flaxland, raupo reedland, kutakuta reedland, *Phormium* flaxland, kahikatea forest, *Coprosma* shrubland	Predicted long-term lake-ward shift of all vegetation communities. Increase in the width of raupo community likely. More rapid response by aquatic reedlands than by flaxland. No open water, hence no connectivity issues.

The potential changes in lake levels that would occur under the enhanced Scheme are likely to be subtle, but complex changes in species distribution and composition may occur that are difficult to predict. It is envisaged that initially some vegetation communities such as oioi reedland and *Phormium* flaxland that are more tolerant of longer periods of inundation may extend their distribution down the lakeshore where there are suitable sheltered, shallow, low profile lake edges. In the longer-term, other vegetation communities such as kahikatea forest may also shift towards the lake. In general, however, adverse effects on wetland vegetation communities are expected to be limited, particularly those with water sources other than the lake (i.e. streams or run-off) and larger wetlands that extend further inland away from the influence of the lake. Further, because rainfall at Lake Kaniere is high and reasonably well distributed throughout the year it will continue to be a key water source for Lake Kaniere's wetlands.

Invasion of wetlands by dryland species as a result of changes in lake levels is unlikely given that high lake levels will continue to occur in summer when the managed flow release for generation is lower and inflows are higher. Dryland species that are intolerant of inundation will not survive. Invasion by exotic species is also unlikely because, with the exception of the wetlands in the vicinity of Hans Bay, terrestrial exotic species capable of invading wetland habitats are either rare or absent.

Lower lake levels are also unlikely to result in increased access to browsing animals and introduced mammalian predators. Surface water, which usually provides an impediment to animal movement, is absent from all except the Hans Bay wetland and any changes in vegetation structure that could increase accessibility are expected to be negligible.

With the exception of the Hans Bay wetland, there is no permanent open water in any of the wetlands, hence there are few issues relating to connectivity. Periodic inundation during high lake levels will still occur, albeit less frequently, allowing the movement of organisms (plant seeds, fish etc.) into these wetlands. The small area of surface water in the Hans Bay wetland is limited in extent but provides some potential habitat for aquatic fauna. Lower lake levels are likely to result in a reduction in the depth of this surface water and some periodic loss of internal connection. Currently, there appears to only be surface connection to the lake when levels are high. High lake levels would continue to occur, although they may be slightly less frequent.

None of the wetland (or terrestrial) vegetation communities surrounding the lake are fire prone given the high rainfall in the region. The potential for an increased risk of fire (James *et al.* 2002) is not an issue here.

8.2 Kaniere River Avifauna

Kaniere River: Lake Kaniere to Proposed Wards Road Tailrace Discharge

The proposed KNF HEPS enhancement will divert up to 8 m^3/s from the Kaniere River between the lake outlet and the discharge point of the proposed Wards Road Power Station. Under the existing consent TPL must retain a minimum flow of 200 L/S past the weir and down the channel of the Kaniere River at all times. If water is diverted into the enhanced KNF Scheme, the median residual flow in the Kaniere River (0.33 m^3/s) will be very close to the proposed minimum flow (0.3 m^3/s). This is a reduction in the median flow of 5.2 m^3/s. This flow reduction will result in a mean reduction in water depth, velocity and channel and wetted perimeter width, an increase in daily fluctuations in water temperature, a decrease in available habitat for most aquatic species (macro-invertebrates and fish, with the exception of some native fish species with lower velocity preferences) and an increase in nuisance long filamentous algae growths (Ryder Consulting 2010).

Despite these predicted changes to the instream aquatic environment, the potential effects of the reduction in flow are unlikely to have significant adverse effects on the bird species that use this section of the river, particularly at the population level. This section of the river does not provide good quality habitat for water birds. It is uniformly fast flowing, confined to a single channel and full from bank-to-bank. Shags may feed in this section of the river from time-to-time, but it does not provide good habitat for waterfowl or other water bird species. The potential effects of the reduction in median flow are unlikely to have adverse effects on water birds. In contrast, a reduction in flow may be beneficial because it will more frequently expose substantially more riparian roosting habitat such as boulders, will reduce water velocities, and create more pools that could increase the accessibility of potential food resources for duck species.

Kaniere River: Proposed Wards Road Tailrace Discharge to McKays Weir

Whilst the proposed KNF HEPS enhancement will substantially reduce the average flow in the Kaniere River between Lake Kaniere and Wards Road if the existing KNF Power Station is decommissioned, it will restore the full flow of the river much further upstream than currently occurs under the existing KNF Scheme. Currently, the water that is diverted into the water race at the lake outlet is not returned to the river until it

passes through the Kaniere Forks Power Station approximately 9 km downstream. The enhanced Scheme will increase the median flow in the river by approximately 2 m^3/s, which is predicted to result in a reduction in habitat for all fish species, food producing habitat, and most invertebrate species relative to the existing situation (Ryder Consulting 2010). The bird habitat in this section of the river does not provide good quality habitat for water birds. Consequently, the potential effects of an increase in the median flow on water birds is likely to be negligible.

Kaniere River: McKays Weir to McKays Creek Tailrace Discharge

This section of the river provides some habitat for paradise shelducks, and probably limited feeding and roosting habitat for shags and other duck species.

The proposed enhancement to the MKY HEPS will result in a reduction in the median flow in the Kaniere River between McKays Creek Weir and McKays Creek Power Station discharge point (refer to TPL 2010a for more detailed information on the simulated changes in flow). This will result in a mean reduction in water depth, velocity and channel and wetted perimeter width and, consequently, an increase in daily fluctuations in water temperature, predicted habitat reductions for most aquatic species and a predicted increase in nuisance long filamentous algae growths (Ryder Consulting 2010).

Despite these predicted changes, the potential effects of the reduction in flow are unlikely to have significant adverse effects on the bird species that use this section of the river, particularly at the population level, because it is not a particularly important habitat for these wide ranging birds.

Kaniere River Below McKays Creek Power Station

Below the MKY HEPS discharge point the Kaniere River provides habitat for shags, ducks and shelducks (Sagar and Kelly 2005). Modelled flows do not differ substantially from the existing flows under the current Scheme as all the water is returned to the river (TPL 2010a). Consequently, the potential effects on water birds in this section of the river is likely to be negligible.

8.2.1 Fluctuating Water Levels in the Kaniere River

The existing operation of the Kaniere Forks and McKays Creek schemes does not include peaking and therefore does not typically result in daily flow fluctuations in the Kaniere River.

The enhanced scheme is, however, likely to be operated under a peaking regime when lake levels are low. Under this regime it is proposed that the KNF and MKY Power Stations will be operated with reduced flows overnight (between 0 – 50% output) and full output during the morning and afternoon peaks. Daily flow changes are therefore expected downstream of the existing McKays and proposed Wards Road power stations.

Generally, fluctuating water levels in rivers have the potential to affect water birds (positively or negatively), mainly by affecting nesting, roosting, and foraging habitat on riparian margins, and by affecting aquatic invertebrates that provide food for birds. The Aquatic Ecology Report (Ryder Consulting 2010) provides a more detailed discussion of the anticipated changes to the Kaniere River and instream habitats under a peaking regime. A peaking regime is unlikely to adversely affect the species that have been recorded in the affected sections of the river (shags, ducks and shelducks) because they are not an important feeding habitat for these wide ranging birds. Further downstream, any effects of peaking flows in the Kaniere River will be suppressed by the larger flow of the Hokitika River.

8.3 Kaniere Forks and McKays Creek HEPS Terrestrial Vegetation Communities, Habitats and Fauna

8.3.1 Proposed McKays Creek HEPS Enhancement

The effects on terrestrial ecological values relating to the MKY HEPS enhancement is divided into construction effects and long-term effects associated with habitat modification and removal. These are discussed in turn below.

8.3.1.1 Potential construction effects

The potential effects during construction are:

- Death and damage to plants and vegetation;
- Death of, or injury to, fauna (bats, lizards and invertebrates);
- Noise, dust and disturbance (from humans and machinery);
- Fire;
- Sediment run-off; and
- Accidental discharge of contaminants;

Each of these is discussed in more detail below. The following section is relevant to the effects of the proposed enhancement work along the existing alignment.

Additional potential effects relating to the proposed new section of water race are discussed separately below.

Existing HEPS Alignment

Death and damage to plants and vegetation

Death and damage to indigenous trees and plants within the construction envelope cannot be avoided, but the extent of the damage can be minimised by containing construction works to the smallest envelope possible. With the exception of the proposed new section of water race to bypass McKays Tunnel, the construction works associated with the proposed enhancement are confined to the existing modified habitat within the historic and current HEPS envelope.

The terrestrial habitats adjacent to The HEPS are either farmed and dominated by exotic species, or contain modified secondary vegetation that is generally of lower habitat value. No threatened or rare plants were observed during field investigations, and the habitat types adjacent to The HEPS are unlikely to have threatened or rare plant species. The primary rimu/kamahi forest in the Kaniere Farm CA between the start of the tunnel and McKays Power Station will not be affected.

Death of, or injury to, fauna

Invertebrates within the proposed construction envelope will be unable to move away from construction activities and may be killed. Similarly, if lizards are present, they may not be able to move fast enough to avoid being killed or injured. However, with the exception of the proposed new section of water race to bypass McKays Tunnel, the proposed modifications to the MKY HEPS are minor, and largely confined to the existing construction envelope. Further, the habitats adjacent to the MKY HEPS are unlikely to provide important habitat for lizards or invertebrates and it is unlikely that local populations would be affected given the availability of suitable habitat in the wider area.

Noise, dust and disturbance

Noise, vibrations and dust from contractors' machinery will only be for a short duration of time. Overall, these indirect effects of construction on fauna (and vegetation, e.g. dust) are not anticipated to affect populations and would only be a short-term nuisance for those individuals in close proximity to construction works.

Fire

Although the site is not particularly fire prone, there is still a risk of fire during construction. A large fire would extend well beyond the construction envelope and could adversely affect or destroy indigenous vegetation communities and habitats. The presence of work crews (some of whom may smoke), heavy machinery, and possibly "hot" activities, such as welding, will increase the risk of fire during construction. Appropriate measures to minimise this risk should be undertaken.

Sediment run-off

Sediment run-off during and following earthworks can adversely wetlands and other vegetation communities. Between the exit of the tunnel and the head pond area, the existing water race and vehicle track traverse the side of a slope that drops off steeply into an extensive area of kahikatea/*Phormium* flax swamp. TPL is proposing to sort and place the inorganic cut material from the water race widening works on the access road along this section and then re-surface it. Sediment control measures will be required to prevent sediment and stormwater run-off from entering the kahikatea/lowland flax swamp.

Accidental discharge of contaminants

The accidental discharge of contaminants, such as oil and petrol, can have adverse effects on terrestrial ecological values. Appropriate measures must be undertaken to prevent spills during construction and contractors should be required to have appropriate facilities and equipment at hand to clean up any contaminants.

Proposed New Water Race to Bypass the Existing McKays Tunnel

The following section is relevant to the proposed new section of water race only. The effects of the proposed enhancement work along the existing alignment are discussed separately above.

Death and damage to plants and vegetation

Construction of the proposed water race to bypass the McKays tunnel will result in the removal of trees and plants within, and possibly immediately adjacent to the construction envelope (Map 11). No threatened or rare plants were recorded within the construction envelope during field investigations, and threatened or rare plant species are unlikely to occur within these habitats. The effects of, and mitigation for,

vegetation removal within the construction envelope are discussed in more detail below under long-term effects (Section 8.3.1.2) and mitigation and monitoring (Section 9.3.1).

Death of, or injury to, fauna

The proposed construction activities along the new section of the McKays water race could potentially have adverse effects on bats, lizards and invertebrates that are additional to those discussed above in relation to construction within the existing HEPS footprint.

Mature forest in the wider area provides good habitat for bats. DOC surveys in the area, including several surveys along Lake Kaniere Road (Map 10) did not detect bats, although they could be present in the area.

Long-tailed bats roost in tree cavities during the day. Most of the forest along this section of the proposed water race is unlikely to provide suitable roosting trees for long-tailed bats; however, there are a number of trees that could provide roosts for long-tailed bats. The probability of bats being in these trees within the proposed construction envelope at the time of construction is very low. However, as they are classified as Nationally Endangered, the impact on the local bat population of felling a roost tree with resident bats would be high. For this reason, pre-construction monitoring for bats should be undertaken between September and February prior to the commencement of construction to ensure that bats are not roosting in trees that will be felled. This may also involve inspection of likely roost sites. If bat roost sites are located within the construction envelope, a programme should be developed (in consultation with DOC) and implemented to mitigate any adverse effects of the proposed works on roost sites.

Many invertebrates within the proposed construction envelope will be unable to move away from construction activities and will be killed. Similarly, if lizards occur within the construction envelope, they may not be able to move fast enough to avoid being killed or injured. Because the construction corridor is relatively narrow in relation to the abundance of similar habitats surrounding the alignment and in the wider area the proposed HEPS will potentially only directly affect a small proportion of individuals in the local population. Population level effects on lizards or invertebrates are therefore considered to be extremely unlikely.

Noise, dust and disturbance, fire, sediment-run-off and the accidental discharge of contaminants

Noise, dust and disturbance, fire, sediment run-off and the accidental discharge of contaminants could also affect the vegetation communities and fauna along the proposed new section of water race. The potential adverse effects of these construction related threats are discussed above in relation to the vegetation communities, habitats and fauna within and adjacent to the existing alignment. The potential effects are similar for the proposed new section of water race.

8.3.1.2 Potential long-term effects

The potential long-term effects on the terrestrial ecology of the site as a result of the proposed activity include:

- Habitat loss;
- Habitat fragmentation and edge effects;
- Weed establishment and spread;
- Loss of faunal habitats; and
- Barriers to dispersal and movement.

Each of these is discussed in more detail below. Again, the following section is relevant only to the effects of the proposed enhancement work along the existing alignment. Additional potential effects relating to the proposed new section of water race are discussed under a separate sub-heading below.

Existing HEPS Alignment

Habitat loss

The extent of the proposed work is largely confined to the existing, narrow, historically modified envelope of the MKY HEPS infrastructure. The proposed enhancement will still result in disturbance to, and in a few places the removal of, indigenous vegetation adjacent to the water race and existing HEPS infrastructure. This is described below for each of the specific areas where enhancement works are proposed.

No structural modifications to the race are required between the intake and the Coal Creek Flume. The proposed cleaning and smoothening of the invert and sides is unlikely to cause any terrestrial ecological issues. The vegetation along this stretch

of the canal is comprised of rough exotic pasture grasses, colonising gorse and manuka and regenerating native communities.

The proposed replacement of the existing Coal Creek Flume with a pipe bridge will result in some local disturbance and removal of the existing vegetation immediately adjacent to the existing flume. This vegetation is regenerating fernland and scrub within the historically modified construction envelope and is of low ecological value.

From Lake Kaniere Road to the head of the siphon and the boundary of the private land the existing water race passes through early successional secondary kamahi forest containing a diverse range of seral shrub and tree species, regenerating tree-fernland and several weed species including Himalayan honeysuckle. TPL is proposing to clean and smooth the race invert and sides along this section, with deposition of excavated material on the road embankment side of the canal. The presence of a vehicle track on the lower side of the water race means that the vegetation communities are already modified and fragmented. They are of low ecological value.

Between the start of the siphon over Blue Bottle Creek and the start of the tunnel through the Kaniere Farm CA the vegetation is a mosaic of grazed pasture grassland, gorse scrub and early successional hardwood species that are regenerating through gorse. TPL is proposing to smooth and locally deepen (by up to 0.5 m downstream of the Greens Creek junction) this section of the water race. This environment has been modified and highly fragmented by farming practices and is generally of low ecological value.

The primary rimu/kamahi forest in the Kaniere Farm CA between the start of the tunnel and the McKays Creek Power Station is of high ecological value. However, construction works associated with the proposed repair, refurbishment and enlargement of the tunnel will not disturb any of the forest above the tunnel's entrance or exit. Consequently, there will be no habitat loss or any direct adverse effects on terrestrial vegetation.

The water race between the exit of the tunnel and the TPL owned land on which the forebay and power station are situated lies within the Kaniere Farm CA (Map 3). The forest on either side of the existing water race and vehicle track is also of high ecological value (primarily because of its role in connecting the high value Kaniere Forks SR with the large area of forest to the south and east comprised of the Kaniere Farm CA and the Lake Kaniere SR). Proposed modifications to the water race between the exit of McKays tunnel and the proposed head pond include local

widening of up to 2 m on the cut side of the race and increasing the height of the road embankment.

With the exception of the removal of the narrow width of vegetation on the cut side of the race, the proposed works are confined to the existing HEPS envelope. The vegetation on the vehicle track is dominated by exotic grass species and is of low ecological value. The removal of up to 2 m of vegetation from the cut side of the water race along the 560 m of public conservation land equates to a permanent loss of up to 0.11 ha of indigenous modified 'edge' vegetation comprised of typical regenerating mixed hardwood scrub/forest. Its removal will shift the influence of edge effects up to 2 m further into the forest above the water race. Although this vegetation is "significant" under the WDC and WCRC criteria, it is of relatively low ecological value and the loss of up to 2 m of regenerating edge habitat is not considered to be particularly important in the wider context.

The proposed new head pond site was formerly regenerating tree-fernland and secondary kamahi forest, which has recently been cleared of vegetation and sprayed with herbicide. It is a highly modified environment. Construction of the proposed head pond will not create any issues from a terrestrial ecology perspective and no mitigation is required.

The penstock route runs a short distance down a steep terrace face covered by secondary kamahi forest. The vegetation on this terrace face was originally cleared for the installation of the existing penstock, and is fragmented by a 4WD access track and a foot path. It is of low to moderate ecological value. Rehabilitation of the penstock construction route (including weed surveillance and control) is recommended to mitigate the disturbance to this vegetation resulting from the installation of the new penstocks.

TPL are proposing to construct the new power station on a flat area of exotic grass and gravel immediately beside the existing McKays Creek Power Station. This area is of low ecological value. The construction of the power station will have no adverse effects on indigenous terrestrial ecological values.

Habitat fragmentation and edge effects

The proposed enhancement work along the existing alignment will not result in any further habitat fragmentation and is not anticipated to create, or exacerbate, existing edge effects to any great degree.

Weed establishment and spread

A potential adverse effect of the proposed construction associated with the MKY HEPS enhancement is the introduction and spread of weed species. Construction works will create areas of disturbed soil, an ideal environment for the establishment of weeds, some of which (e.g. gorse and ragwort) are already common in the farmed landscape. These are a potential seed source for further spread. Further, weed seeds or plant fragments could be imported onto the site from elsewhere by construction machinery, vehicles, humans and materials (i.e. soils and gravel from offsite).

The ecological effects of weed establishment in the pastoral, farmed environment are unlikely to be serious from an ecological perspective, but could be problematic for the landowner. The likelihood of weeds spreading into the more intact indigenous vegetation within the Kaniere Farm CA is also increased if construction works are undertaken along the water race between the McKays Tunnel exit and the power station. This could have detrimental effects on terrestrial ecological values and will need to be carefully managed. Consequently, best practice guidelines are recommended to prevent weed establishment and should include sourcing clean materials, promptly revegetating disturbed soil with appropriate vegetation cover, and implementing a weed monitoring and control plan.

Loss of faunal habitats

Loss of faunal habitats resulting from the proposed enhancement work along the existing alignment will be minor because construction works are largely confined to the existing, narrow, historically modified envelope of the MKY HEPS infrastructure.

Barriers to dispersal and movement

The proposed enhancement work along the existing alignment will not create any additional barriers to the dispersal and movement of organisms.

Proposed New Water Race to Bypass the Existing McKays Tunnel

The following section is relevant to the proposed new section of the McKays water race only. The effects of the proposed enhancement work along the existing alignment are discussed separately above.

Habitat loss

The proposed new section of water race will result in the removal of part of three vegetation communities. These vegetation communities and the extent of each that would be removed are shown in Map 11 and Table 8.2. More detailed descriptions of these vegetation communities are provided in Appendix 7. The gorse scrub extends from the start (eastern end) of the new section of the proposed race all the way to the boundary of the Kaniere Farm CA (Map 11). It has been modified by farming practices, is grazed by cattle and is generally of low ecological value. Mitigation for the loss of this vegetation community will not be necessary.

From the private land/Kaniere Farm CA boundary the proposed construction envelope passes through approximately 470 m of the Kaniere Farm CA, which is primarily secondary kamahi/quintinia forest, but includes a small area of regenerating soft tree fern – rough tree fern tree-fernland (Map 11).

Table 8.2: Vegetation communities along the proposed new section of the McKays water race and the extent in hectares directly affected by construction.

Vegetation type	**Total vegetation removed (ha)**	**Permanent loss (ha) (no onsite mitigation)**
Gorse scrub	1.8	1.1
Secondary kamahi / quintinia forest	1.7	1.1
soft tree fern – rough tree fern tree-fernland	0.2	0.1
Total vegetation directly affected	**3.7**	**2.3**

The proposed construction envelope is 40 m wide, of which 25 m would be permanently removed (R. Piddington *pers. comm.* 2010). This equates to a permanent loss (vegetation clearance that cannot be rehabilitated onsite) of approximately 1.1 ha of secondary kamahi/quintinia forest and 0.1 ha of soft tree fern – rough tree fern tree-fernland. The kamahi/quintinia forest is a significant vegetation community and off-set mitigation will be required to mitigate for this loss.

Of the 40 m width of the construction envelope 15 m will be available for rehabilitation following completion of construction works. Environmental conditions (mild temperatures and high rainfall) and a good local seed source will promote rapid regeneration. Stripping and storing topsoil, leaf litter and cleared vegetation for

redistribution over the areas to be rehabilitated is recommended as a means of promoting natural regeneration. However, mitigation planting will also be required along the length of the proposed new section of water race where secondary kamahi / quintinia forest and soft tree fern – rough tree fern tree-fernland is cleared. The purpose of the proposed mitigation planting is to supplement natural regeneration, rehabilitate the indigenous habitats that will be removed and reduce the adverse effects of increased edge habitat. Rehabilitation planting should aim to restore the affected vegetation to a state that is as close as possible to the existing vegetation communities. A *Vegetation Rehabilitation Management Plan* that incorporates the numerous aspects of this rehabilitation work will be required.

During site investigations two very large rimu (dbh up to 1.6 m) were found adjacent to the proposed construction envelope. In general, large forest trees provide important feeding, roosting and nesting habitat for forest birds, bats and important habitat for invertebrates. The felling of large habitat trees would result in the loss of important habitat and should be avoided.

Potential fill site locations for spoil from the new section of canal have been indicated by TPL. All of the proposed sites are on the private land to the east of the proposed new water race, which is dominated by gorse scrub. Observations during site investigations suggest that, from an ecological perspective, these areas are generally likely to be suitable for fill sites. However, it is recommended that further ecological input is provided into the final selection of all fill sites to ensure that there are no adverse effects on indigenous vegetation, habitats or fauna (including aquatic communities). TPL are proposing to contour and grass the fill sites to create improved grazing for the landowner. Given the probable low ecological values of the indicative fill sites, this is likely to be appropriate from an ecological perspective.

Habitat fragmentation and edge effects

Because the gorse scrub on the private land is already highly modified, the potential adverse effects associated with fragmentation are most relevant to the secondary kamahi - quintinia forest. This habitat type is also fragmented to some degree by a 4WD track. However, the proposed new section of canal will further fragment it. The effects generally associated with habitat fragmentation include a reduction in the overall area of core habitat (discussed above), division of populations into a meta-population of sub-populations, barriers to the dispersal and movement of organisms and increased edge effects (Begon *et al.* 1996).

The clearance of secondary kamahi - quintinia forest along the proposed new section of water race will increase the amount of edge habitat. Edge effects have

been extensively documented in the literature and include elevated radiation levels, air and soil temperatures, wind speeds and vapour pressure deficits. These abiotic effects result in complex changes in the composition of vegetation communities, the distribution of animals, species interactions and ecological processes (Murcia 1995). Several New Zealand studies (Young and Mitchell 1994; Davies-Colley *et al.* 2000; and Norton 2002) have attempted to quantify the extent to which edge effects penetrate into forest habitats, but the extent of the effect varies depending on forest type, edge orientation, edge age and the variable being considered (Norton 2002). In general, however, studies in New Zealand and elsewhere suggest that the extent of edge influences extend 50 – 100 m into forest habitats.

Edge effects are not considered to be an issue in the already fragmented, highly modified gorse scrub. The forested habitats adjacent to the proposed water race within the Kaniere CA are narrow and bisected by a 4WD track. As a result, they are already influenced by edge effects to varying degrees. Construction of the proposed new section of water race would create new forest 'edge' on both sides of the short 100 m section of the secondary kamahi/quintinia forest within the Kaniere Farm CA, but from here the proposed alignment runs along the boundary of the kamahi/quintinia forest and the regenerating soft tree fern – rough tree fern tree-fernland. This boundary is an existing edge. Construction of the water race through this section would result in the upslope shift of this edge by approximately 20 m. While construction of the water race may exacerbate existing edge effects, the effect of this is not likely to be a significant issue as long as rehabilitation planting and weed surveillance and control is undertaken.

Weed establishment and spread

Another potential effect of the proposed construction of the new section of water race is the introduction and spread of weed species. The extensive areas of gorse and other weeds such as ragwort on the adjacent private land are a potential seed source for further spread. These species are already abundant in the farmed landscape and their further spread within the existing farmland does not present any major issues from an ecological perspective. However, weed establishment and spread could have adverse effects on the ecology of the indigenous vegetation communities within the Kaniere Farm CA. Further, new weeds (seeds or plant fragments) could be imported onto the site from elsewhere by construction machinery, vehicles, humans and materials (i.e. soils and gravel from offsite). Construction works associated with the proposed new section of water race will create extensive areas of disturbed, bare soil, an ideal environment for weed establishment.

One of the indirect effects of the creation of edge habitat is the increased likelihood of the spread and establishment of weeds that can have adverse effects on indigenous communities. The spread of ecological weeds (e.g. wandering Jew or old man's beard) into the surrounding forest habitat could have significant detrimental effects and will need to be carefully managed. Best practice guidelines are recommended to prevent weed establishment and should include cleaning construction machinery prior to it entering the site, sourcing clean materials, promptly revegetating disturbed soil with appropriate vegetation cover, and/or mulch and implementing a weed monitoring and control plan. Weed surveillance monitoring and control should be incorporated into the *Revegetation Management Plan.*

Loss of faunal habitats

The direct removal of vegetation communities will result in a loss of habitat for the fauna that they support. The potential effects on birds and bats have already been discussed. Three, possibly four lizard species (two geckos and two skinks) could be present in the habitats along the proposed construction envelope. Two of these, the West Coast green gecko and speckled skink are classified as 'At Risk' (Declining) (Hitchmough *et al.* 2010). The indigenous invertebrate fauna of the gorse scrub is likely to be more depauperate and modified than intact indigenous vegetation communities but the secondary kamahi - quintinia forest will almost certainly support a diverse assemblage of terrestrial invertebrates representative of this forest type. However, it is unlikely that any of the invertebrate species within the proposed construction envelope are rare or threatened because both vegetation communities are well represented and widespread in the region and levels of endemism in the West Coast fauna are low (T. Shaw *pers. comm.* 2010). Because the construction corridor is relatively narrow, in relation to the amount of similar habitat adjacent to the construction envelope, population level effects on lizards or invertebrates are extremely unlikely. No specific mitigation (other than mitigation for loss of habitat through rehabilitation planting and off-set mitigation) for invertebrates or lizards is considered to be necessary.

Barriers to dispersal and movement

The existing MKY HEPS water race passes through the 430 m long McKays tunnel under a forested hill within the Kaniere CA. Because the water passes through this tunnel, a forest corridor (only bisected by a 4WD track) is maintained between the large area of forested land within the Kaniere Farm CA to the south and the Kaniere Forks SR (Map 3). The construction of the new section of canal and the clearance of vegetation along its length will create a potential barrier that may impede or completely prevent the movement and dispersal of lizards and flightless

invertebrates (as well the movement of some introduced mammals) between the indigenous forest on the northern and southern sides of the water race. There is insufficient knowledge of the dispersal ability of the terrestrial fauna along the alignment to assess the potential impact of the proposed water race as a barrier, but it is probably unlikely to affect the long-term dispersal of most species.

8.3.2 Proposed Kaniere Forks HEPS Enhancement

The effects on terrestrial ecological values relating to the proposed KNF HEPS enhancement is also divided into construction effects and long-term effects associated with habitat modification and removal. These are discussed below.

8.3.2.1 Potential construction effects

The potential effects during construction are:

- Death and damage to plants and vegetation;
- Death of, or injury to, terrestrial fauna (bats, lizards and invertebrates);
- Noise, dust and disturbance (from humans and machinery);
- Fire;
- Sediment run-off; and
- Accidental discharge of contaminants.

These have already been discussed in Section 8.3.1.1 in relation to the proposed McKays Creek enhancement, but are discussed in relation to the proposed KNF HEPS enhancement below.

Death and damage to plants and vegetation

The proposed KNF HEPS enhancement will result in the permanent removal of, and damage to, trees and plants within the construction envelope. No threatened or rare plants were recorded within the construction envelope during field investigations, and it is unlikely that any threatened or rare plant species occur in these habitats. The effects of, and mitigation for, vegetation removal within the construction envelope are discussed in more detail under long-term effects. Damage to trees and vegetation immediately adjacent to the construction envelope can be minimised by containing construction works to the smallest corridor possible and felling large canopy trees carefully and in a direction that will minimise collateral damage to vegetation outside the construction envelope. This is discussed in more detail in Section 9.3.2. (Monitoring and Mitigation).

Death of, or injury to, terrestrial fauna

Although bats have not been recorded in the vicinity of the KNF HEPS, there are recent and reliable records of long-tailed bats in the wider area (DOC unpubl. data) (Map 10). Long-tailed bats are aerial insectivores that favour forest edge habitats,

woodlands and riparian habitats for foraging (O'Donnell 2001). As the proposed KNF HEPS enhancement will increase the amount of edge and riparian habitat, it is unlikely that the proposal will adversely effect bat foraging and it is even possible that it could be enhanced. It is, however, also possible that there are roost sites within the proposed KNF construction envelope. The probability of bats being in roost trees within the proposed construction envelope at the time of construction is very low. However, given the conservation status of long-tailed bats, it will be important to ensure that trees with active roost sites are not felled. Pre-construction monitoring for bats should be undertaken between September and February prior to the commencement of construction to ensure that bats are not roosting in trees that will be felled. This may also involve inspection of likely roost sites. If bat roost sites are located within the construction envelope, a programme should be developed (in consultation with DOC) and implemented to mitigate any adverse effects of the proposed works on those roost sites.

Many invertebrates within the proposed construction envelope will be unable to move away from construction activities and will be killed. Similarly, if lizards occur within the construction envelope, they may not be able to move fast enough to avoid being killed or injured. Because the construction corridor is relatively narrow in relation to the abundance of similar habitats surrounding the alignment and in the wider area, the proposed HEPS would only directly affect a small proportion of individuals in the local population. Population level effects on lizards or invertebrates are considered to be extremely unlikely.

Noise, dust and disturbance

The effect of noise, vibrations and dust from contractors' vehicles are discussed in Section 8.3.1.1 in relation to the MKY HEPS. Similarly, they are unlikely to be a major issue here.

Fire

The risks and effect of accidental fire during construction are discussed in Section 8.3.1.1 in relation to the MKY HEPS. They are similar for the proposed KNF HEPS enhancement.

Sediment run-off

The impact of sediment run-off on terrestrial ecological values is unlikely to be an issue relative to the disturbance and loss of vegetation. As for the MKY HEPS, the

potential effects resulting from storm water and sediment run-off on aquatic communities are assessed in the Aquatic Ecology Report (Ryder Consulting 2010).

Accidental discharge of contaminants

The effects of accidental discharge of contaminants on terrestrial ecological values are discussed in Section 8.3.1.1 in relation to the MKY HEPS. The potential effects are similar for the proposed KNF HEPS enhancement.

8.3.2.2 Potential long-term effects

The potential long-term effects on the terrestrial ecology of the site as a result of the proposed activity include:

- Habitat loss;
- Hydrological changes and effects on adjacent vegetation communities,
- Habitat fragmentation and increased edge effects;
- Weed establishment and spread;
- Loss of faunal habitat; and
- Barriers to dispersal and movement.

Each of these is discussed in more detail below.

Habitat loss

The proposed KNF HEPS enhancement will result in the removal of ecologically valuable vegetation communities within the construction envelope including the canal and penstocks alignment, the temporary works and laydown area, power station and tailrace at Wards Road. These vegetation communities and the extent of each habitat that would be removed are shown in Table 8.3 and Maps 8 and 9. The vegetation communities are described in more detail in Appendices 4 and 6.

The proposed alignment of the KNF HEPS enhancement bisects approximately 1.7 ha of high value (rimu) - (miro) / kamahi - quintinia forest, which is contiguous with similar forest in the wider area. The majority of this occurs in the vicinity of Kaniere Landing (Map 8). The remainder occurs within the second proposed penstock option (Penstock 2) (refer to the Civil Engineering Report, TPL 2010c) and will only be cleared if this penstock is selected for construction. The other vegetation communities within and adjacent to the proposed construction envelope are more modified and include approximately 1 ha of (rimu) / mountain toatoa - quintinia –

southern rata forest, 0.2 ha of manuka scrub, the majority of which is within a proposed buffer storage area along the proposed canal and 0.3 ha of (silver pine) / manuka scrub on the poorly drained alluvial terrace in the proposed location of the tail race. A small area of weeping matipo (< 0.1 ha) occurs on a gently sloping, moderately drained alluvial terrace near Wards Road. A small part of this (< 0.1 ha) is within the proposed construction envelope.

Table 8.3: Vegetation communities along the proposed KNF HEPS enhancement alignment and the extent in hectares directly affected by construction.

Vegetation type	**Area (ha)**
(rimu) - (miro) / kamahi - quintinia forest	1.7
Secondary (rimu) / mountain toatoa - quintinia – southern rata forest	1.0
Manuka scrub	0.2
(Silver pine) / manuka scrub	0.3
Cleared, regenerating manuka / tanglefern shrubland (under the transmission line)	5.2
Myrsine scrub	< 0.1
Carex sedgeland (W)	0.1
Mingimingi shrubland	1.2
Mingimingi shrubland / *Carex* (W)	0.2
Silver pine forest	< 0.1
Phormium flaxland (W)	< 0.1
Total vegetation directly affected	**10.1**[#]

[#] Note that the actual amount of vegetation clearance required will be less than the figure shown here as this includes the vegetation within both KNF penstock routes. Only one of these penstock routes will be selected.
(W) = wetland vegetation

Within the Wards Road area (Map 9) a number of vegetation communities occur within or adjacent to the proposed location of the power station, parking and temporary laydown areas. These communities are:

- (Silver pine) / manuka scrub;
- *Carex* sedgeland;

- Mingimingi shrubland;
- Mingimingi shrubland / *Carex*;
- Manuka shrubland;
- Silver pine forest;
- *Phormium* flaxland; and
- *Phormium* flaxland / *Sphagnum*.

With the exception of the mingimingi shrubland and silver pine forest, these are wetland communities.

Of the vegetation communities within the Wards Road area, the *Carex* sedgeland, mingimingi shrubland, mingimingi shrubland / *Carex* and silver pine forest are within the construction envelope and would be permanently lost (Table 8.3). Although this area has been historically modified, it is still of high ecological value. Mitigation is recommended to mitigate for the loss of the wetland vegetation communities and habitats displaced by construction of the power station, parking area, laydown areas etc.

Of the vegetation communities listed in Table 8.3, all but the cleared, regenerating manuka / tanglefern shrubland under the transmission lines are relatively natural and unmodified. Rehabilitation planting and offsite mitigation is recommended to mitigate the loss of the remaining vegetation communities and habitats displaced by construction. This proposed mitigation is discussed in more detail in Sections 9.3.2 and 9.5.

The original vegetation community along the transmission lines has been cleared and is periodically cut to maintain an open corridor below the transmission lines. The resulting vegetation cover is highly modified from its natural state. Mitigation for further modification of this vegetation type as a result of the proposed KNF HEPS enhancement is not considered necessary.

A significant amount of rehabilitation planting will be required along the construction envelope. This should aim to restore the affected vegetation to a state that is as close as possible to the existing vegetation communities. A comprehensive *Revegetation Management Plan* that incorporates the numerous aspects of this rehabilitation work will be required. This plan should recognise that environmental conditions (mild temperatures and high rainfall) and a good local seed source will promote rapid regeneration, and that mitigation planting should aim to supplement natural regeneration, rehabilitate the indigenous habitats that will be removed and reduce the adverse effects of increased edge habitat. Stripping and storing topsoil,

leaf litter and cleared vegetation for redistribution over the areas to be rehabilitated is recommended as a means of promoting natural regeneration.

In places the construction envelope passes through primary forest that supports mature emergent and canopy trees. In general, large forest trees provide important feeding, roosting and nesting habitat for terrestrial fauna including birds and bats and important habitat for invertebrates. The felling of any large trees within the KNF construction envelope will result in the loss of important habitat. BML ecologists have identified and marked the locations of 'habitat trees' along the proposed KNF route. Further detailed design will be required to avoid as many of these mature native trees as possible.

Potential fill site locations for spoil from construction works have not yet been identified, although sections of the existing Kaniere Forks water race are being considered for fill disposal (R. Shelton *pers. comm.* 2010). It is recommended that further ecological input is provided into the selection of all fill sites to ensure that there are no adverse effects on indigenous vegetation, habitats or fauna (including aquatic communities). Rehabilitation will be required to ensure that fill sites are restored to a state that is as close as possible to the existing vegetation communities. This rehabilitation work should be included in the *Revegetation Management Plan* for the KNF HEPS enhancement.

Hydrological changes and effects on adjacent vegetation communities

Construction of the canal between Lake Kaniere and the proposed Wards Road Power Station has the potential to alter the hydrology of the vegetation communities both up and down slope of the canal, particularly the manuka scrub that the proposed canal route traverses. This could also alter the suitability of these habitats for fauna. Appropriate design and engineering solutions (i.e. flumes over streams, or culverts) will be required to minimise hydrological changes and ensure that vegetation communities and faunal habitats are not altered.

Habitat fragmentation and increased edge effects

The vegetation along the proposed KNF HEPS enhancement alignment is already fragmented to some degree by the transmission lines, Wards Road and the Kaniere water race and walking track. Because the proposed canal follows the cleared transmission line through the manuka scrub (Map 8), and the proposed access road from the Wards Road end is also within this cleared transmission line corridor, no further habitat fragmentation will occur along these sections of the proposed

construction envelope. However, construction works will fragment, or further fragment the following vegetation communities:

- Primary rimu-miro/kamahi - quintinia forest at Kaniere Landing, and downstream of Wards Road (if this penstock alignment is selected);
- A small area of secondary (rimu)/mountain toatoa-quintinia-rata forest between chainage 1650 and 1950, and within penstock option 1 (if this alignment is selected);
- *Carex* sedgeland, mingimingi shrubland, mingimingi shrubland / *Carex,* silver pine forest and *Phormium* flaxland in the vicinity of the Power Station at Wards Road; and
- (Silver pine)/manuka scrub that occurs within the proposed tailrace alignment.

The effects generally associated with habitat fragmentation, including edge effects, have already been outlined in Section 8.3.1.2 in relation to the MKY HEPS. The effects of fragmentation on the vegetation communities associated with the KNF enhancement are expected to be similar. Rehabilitation planting and off-set mitigation is recommended to mitigate the effects of this further fragmentation.

Weed establishment and spread

As was identified in relation to the MKY HEPS, a potential adverse effect of the proposed construction associated with the KNF HEPS enhancement is the introduction and spread of weed species into relatively unmodified and weed free indigenous habitats. In some of the areas that have previously been disturbed (i.e. the strip cleared for the transmission lines, the Kaniere water race walkway and part of the wetland at Wards Road), weed species such as gorse, cotoneaster, Himalayan honeysuckle and montbretia have already established. These are a potential seed source for further spread. Further, weed seeds or plant fragments could be imported onto the site from elsewhere by construction machinery, vehicles, humans and materials (i.e. soils and gravel from offsite). Construction works will create extensive areas of disturbed, bare soil, an ideal environment for weed establishment.

Again, the creation of edge habitat combined with an increased risk of the spread and establishment of weeds along the construction corridor means the likelihood of ecological weeds spreading into the relatively intact surrounding indigenous vegetation is also increased. This could have serious detrimental effects and will need to be carefully managed. As for the MKY HEPS, best practice guidelines are

recommended to prevent weed establishment and should include cleaning construction machinery prior to it entering the site, sourcing clean materials, promptly revegetating disturbed soil with appropriate vegetation cover, and/or mulch and implementing a weed monitoring and control plan. Weed surveillance monitoring and control should be incorporated into the *Revegetation Management Plan.*

Loss of faunal habitat

The direct removal of vegetation communities will result in a loss of habitat for the fauna that they support. The potential effects on bats have already been discussed above, and the potential effects on terrestrial birds are discussed in Section 8.4.2 Three, possibly four, lizard species (two geckos and two skinks) could be present in the habitats along the proposed construction envelope. Two of these, the West Coast green gecko and the speckled skink are classified as 'At Risk' (Declining) (Hitchmough *et al.* 2010). The habitats within the construction envelope almost certainly support a diverse assemblage of terrestrial invertebrates that are representative of the habitats that they occur in. However, it is unlikely that any of these are rare or threatened because there are no rare habitat types within the proposed KNF HEPS enhancement alignment and levels of endemism in the West Coast fauna are low (T. Shaw *pers. comm.* 2010). Because the construction corridor is narrow, and will only remove a small proportion of each the habitat types, population level effects on lizards or invertebrates are extremely unlikely.

Barriers to dispersal and movement

The existing KNF water race is approximately 1.5 m wide and in places the canopy has now closed above it. While the existing water race is likely to be an impediment to the movement of some flightless terrestrial species, construction of a 7 m wide canal and the clearance of vegetation along its entire length will exacerbate this effect. It is likely to impede or completely prevent the movement and dispersal of lizards and flightless invertebrates (as well as impeding the movement of some introduced mammals). The canal will create an isolated 63.5 ha 'terrestrial island' between the Kaniere River and the proposed canal, with the only potential crossing points being at Kaniere Landing and under the flumed penstocks at Wards Road. However, with up to 8 m^3/s being diverted out of the Kaniere River this is likely to facilitate the movement and dispersal of flightless terrestrial fauna across the Kaniere River and onto this 'terrestrial island'. There is currently insufficient knowledge of the dispersal ability of the terrestrial fauna along the alignment to assess the potential impact of the proposed canal as a barrier, but given the short length of the proposed canal in the context of the wider area, and the presence of a

similar, but smaller barrier in the existing KNF water race it is probably unlikely to have a more than minor effect.

8.4 Kaniere Forks and McKays Creek HEPS Terrestrial Avifauna

8.4.1 Proposed McKays Creek HEPS Enhancement

The effects on terrestrial avifauna is divided into effects during construction and long-term effects associated with habitat modification and removal. These are discussed in turn below.

8.4.1.1 Potential construction effects

The potential effects on birds during construction are:

- Death or injury of birds during construction works (e.g. during vegetation clearance);
- Destruction of nests, eggs and nestlings during the breeding season; and
- Noise and disturbance (from humans and machinery).

Death or injury of birds during construction works

All of the birds that occur within the area are mobile and mature individuals will be able to move away from construction activities into other suitable habitat. The death or injury of individual birds is considered unlikely and is not considered to be an issue.

Destruction of nests, eggs and nestlings during the breeding season

It is desirable to avoid construction works that require vegetation clearance during the spring/early summer breeding season in order to avoid disturbing nesting birds. However, it is recognised that from a practical sense this may not be achievable. This period is often the best time to undertake earthworks in order to minimise other effects such as sediment and stormwater run-off. The narrow construction corridor means nest abandonment or destruction would be limited and that any mortality would be of common and widespread bird species (with the possible exception of weka).

Noise and disturbance

Noise and vibrations from contractors' vehicles will only be for a short duration of time. This may disturb or displace some bird species in the surrounding area for the duration of construction works, it is unlikely to effect the local bird populations.

8.4.1.2 Potential long-term effects

The potential long-term effects on terrestrial birds as a result of the proposed activity include:

- Loss of feeding, roosting and nesting habitat;
- Habitat fragmentation and modification and corridor effects; and
- Barriers to dispersal and movement.

Each of these is discussed in more detail below. The following section is relevant to the effects of the proposed enhancement work along the existing alignment. Additional potential effects relating to the proposed new section of water race are discussed separately below.

Existing HEPS Alignment

Loss of feeding, roosting and nesting habitat, habitat fragmentation and modification, and corridor effects

With the exception of the proposed new section of water race to bypass the McKays tunnel, the proposed MKY HEPS enhancement will involve minor repairs, maintenance and local improvement of existing water race. This has the potential to result in a limited amount of disturbance to and/or removal of some feeding, roosting and breeding habitat for terrestrial birds. However, because the extent of this work is largely within the existing, narrow, historically modified envelope of The HEPS infrastructure, the adverse effects on terrestrial birds will be minimised.

The habitats adjacent to the existing MKY HEPS upstream of the tunnel are open pastoral habitats with regenerating gorse, scrub or early successional secondary hardwood forest. These vegetation communities are already fragmented and provide habitat for widespread and common introduced and native birds, although this section of the water race also provides habitat for western weka (Declining). The potential effects of the proposed enhancement on birds, including weka, are likely to be negligible given the minor nature of the proposed improvements and the availability of suitable habitat in the wider area.

The primary rimu/kamahi forest within the Kaniere Farm CA between the start of the tunnel and the McKays Creek Power Station is likely to support a similar suite of forest birds to those occupying similar habitats along the KNF HEPS alignment. The intact primary forest within the Kaniere Farm CA (above the tunnel) will not be directly affected by construction works.

Proposed modifications to the water race between the exit of McKays tunnel and the proposed head pond include local widening of up to 2 m on the cut side of the race and increasing the height of the road embankment. This will result in the removal of a narrow width of vegetation adjacent to the water race. The effects of this vegetation removal on terrestrial birds will be negligible.

The head pond area provides very poor habitat for native birds. The proposed penstock construction envelope is already fragmented by the existing water race and vehicle track and is of low-moderate habitat value as bird habitat. The proposed new power station site is of low habitat value. The proposed enhancement will not have a significant impact on the birds that use these areas.

Because the construction works are largely confined to the existing, narrow, historically modified envelope of the MKY HEPS infrastructure, the proposed enhancement work will not create any additional corridor effects.

Barriers to dispersal and movement

The proposed enhancement work along the existing alignment will not create any additional barriers to the dispersal and movement of birds.

Proposed New Water Race to Bypass the Existing McKays Tunnel

The following section is relevant to the proposed new section of water race only. The effects of the proposed enhancement work along the existing alignment are discussed separately above.

Loss of feeding, roosting and nesting habitat

The habitats potentially removed or indirectly affected by the proposed new section of water race are regenerating gorse scrub, secondary kamahi - quintinia forest and soft and rough tree fern tree-fernland. The gorse scrub is already fragmented and provide habitat for widespread and common introduced and native birds, although western weka (Declining) are also present in this vegetation type.

The kamahi - quintinia forest and tree-fernland are of moderate habitat value for a range of forest bird species, particularly more common species such as bellbird, brown creeper, grey warbler, New Zealand pigeon, silvereye, shining cuckoo, South Island fantail, tui and yellow-breasted tit, but also 'At Risk' species including long-tailed cuckoo (Naturally Uncommon) and western weka (Declining). This suite of forest bird species is typical of forests in the wider area and this habitat type is not critical to any of the species listed for particular life stages or the persistence of populations. Further, there are large areas of similar habitat in the surrounding area and in the context of the available habitat in the wider area, the construction envelope is relatively narrow. As such, the loss of this habitat in itself is not likely to have a significant impact on bird populations.

Habitat fragmentation and modification and corridor effects

The effect of habitat fragmentation on birds must also be considered. Habitat fragmentation can have a number of adverse effects (e.g. Begon *et al.* 1996, discussed in more detail under effects on terrestrial vegetation, habitats and fauna). Because the gorse scrub on the private land is already highly modified, the potential adverse effects associated with fragmentation are most relevant to the secondary kamahi - quintinia forest and tree-fernland. The secondary kamahi - quintinia forest is also fragmented to some degree by a 4WD track. Probably the most relevant effect of habitat fragmentation at this location is the creation of a corridor for the movement of mammalian predators. Predation by introduced mammals (particularly rats, mustelids (stoats in particular) and possums) is widely accepted as being the key agent of decline for New Zealand's forest birds (O'Donnell 1996, Brown *et al.* 1993). The width of forest clearance proposed for the proposed new section of water race is 40 m (15 m of which would be rehabilitated). This, and the width of the water race itself, mean that this feature would be a much more substantial corridor than the existing 4WD track. However, given mammalian predators are almost certainly widespread throughout the forest habitats in the area, and it is already fragmented to some degree, it is considered unlikely that the proposed enhancement would result in a significant increase in predation on forest bird species.

Barriers to dispersal and movement

Construction of the proposed new section of water race would effectively create a water barrier extending from the steel siphon to the McKays power station. The existing McKays tunnel does not provide a barrier to the movement of birds through this section of forest. This could potentially affect the movement and dispersal of birds that are either flightless or have poor powers of flight. Of the birds recorded

from, or likely to occur in, the vicinity of the proposed MKY HEPS water race, only the western weka (flightless) could potentially be affected. However, weka are strong swimmers (Heather and Robertson 1996) and the water race is not expected to impede the movement or dispersal of this species.

8.4.2 Proposed Kaniere Forks HEPS Enhancement

As with the MKY HEPS, the effects on terrestrial avifauna is divided into effects during construction and long-term effects associated with habitat modification and removal. These are discussed in turn below.

8.4.2.1 Potential construction effects

The potential effects on birds during construction are:

- Death or injury during construction works (e.g. vegetation clearance);
- Destruction of nests, eggs and nestlings during the breeding season; and
- Noise and disturbance (from humans and machinery).

These have already been discussed in Section 8.4.1.1 in relation to the proposed McKays Creek enhancement, but are discussed in relation to the proposed KNF HEPS enhancement below.

Death or injury during construction works

As for the MKY HEPS, all of the birds that occur in the area are mobile. Mature individuals will be able to move away from construction activities into other suitable habitat. The death or injury of mature individual birds is considered unlikely and is not considered to be an issue.

Destruction of nests, eggs and nestlings during the breeding season

The proposed HEPS construction envelope will result in the removal of habitats that provide nesting habitat for a number of bird species. As for the MKY HEPS, it is desirable to avoid construction works during the spring/early summer in order to avoid disturbing nesting birds. However, it is recognised that from a practical sense this may not be achievable. If construction works are undertaken during the breeding season, vegetation removal will result in the loss of some nests, and indirect disturbance to nests near the construction corridor may result in nest desertion and egg and nestling loss.

Noise and disturbance

As for the proposed McKays HEPS enhancement, noise and vibrations from contractors' vehicles will only be for a short duration of time. While this may disturb or displace some bird species in the surrounding area for the duration of construction works, it is unlikely to effect the local bird populations.

8.4.2.2 Potential long-term effects

The potential long-term effects on terrestrial birds as a result of the proposed activity include:

- Loss of feeding, roosting and nesting habitat;
- Habitat fragmentation and modification, and corridor effects; and
- Barriers to dispersal and movement.

These have already been discussed in Section 8.4.1.1 in relation to the proposed McKays Creek enhancement, but are discussed in relation to the proposed KNF HEPS enhancement below.

Loss of feeding, roosting and nesting habitat

The proposed construction envelope will bisect habitat for terrestrial birds between the lake outlet and the discharge point at Wards Road. This will result in the net loss of feeding, roosting, and breeding habitat for a number of indigenous forest bird species including common and widespread species such as bellbird, brown creeper, grey warbler, New Zealand pigeon, silvereye, shining cuckoo, South Island fantail, tui, yellow-breasted tit and yellow-crowned parakeet, 'At Risk' species including long-tailed cuckoo (Naturally Uncommon), western weka (Declining), kea (Naturally Uncommon) and 'Threatened' species such as New Zealand falcon (Nationally Vulnerable) and South Island kaka (Nationally Endangered).

All of the indigenous forest species recorded (or likely to occur within the habitats within construction envelope from time to time) are typical of forests in the wider area, the ED and beyond. There are large areas of contiguous forest in the surrounding area and in the context of available habitat, the construction envelope is relatively narrow. A significant area of the Hokitika ED (51,129 ha, 46.7%) is protected as public conservation land, and the majority of this is forest habitat. None of the habitat within the construction envelope is critical to any of the species listed for particular life stages or the persistence of populations. As such, habitat loss in itself is unlikely to have a significant impact on local bird populations.

In places the construction envelope passes through primary forest that supports mature emergent and canopy trees. In general, large forest trees provide important feeding, roosting and nesting habitat for forest birds. The felling of any large trees within the KNF construction envelope will result in the loss of important bird habitat. BML ecologists have identified and marked the locations of 'habitat trees' along the proposed KNF route (Map 12). Further detailed design will be required to avoid as many of these mature native trees as possible.

Another potential adverse effect of the proposed KNF HEPS enhancement is on South Island fernbird (Declining). This species has more specific habitat requirements than many of the other terrestrial bird species present and as a result is more likely to be adversely affected by loss of, or changes to, its habitat. Fernbirds are found in suitable short statured vegetation throughout Westland (Shaw, 2007). Barlow (1983) and Best (1985) note that fernbird are most abundant in wetlands with dense ground vegetation and emergent shrubs. In Westland, fernbird also occupy young regenerating forest communities, young plantation forests and gorse dominated shrublands (Shaw, 2007).

The proposed KNF canal has the potential to impact fernbird through direct habitat loss and by potentially changing the hydrology of the habitats that the proposed canal route bisects. Fernbird have previously been recorded along the KNF alignment (DOC unpubl.), and further observations during site investigations confirmed the presence of this species within the proposed construction envelope. During specific surveys for fernbird from count stations, four individuals were recorded in the wetland in the vicinity of Wards Road. Within the manuka scrub, fernbird appeared to favour the low vegetation cleared along the transmission line route (although not surveyed in detail, two birds were recorded along a 300 m section). The loss of approximately 5.2 ha of the human induced, low stature vegetation under the transmission lines and 55% (1.7 ha) of the Wards Road shrubland and wetland vegetation will affect the birds that occupy those territories. However, South Island fernbird are widespread and abundant on the West Coast (T. Shaw *pers. comm.* 2010) and the impact of this habitat removal will have no discernable impact on the population at the ED or national level.

Habitat fragmentation and modification, and corridor effects

As with the MKY HEPS, the effect of habitat fragmentation on birds must also be considered. The habitat through which the proposed construction envelope would pass is already fragmented by the existing water race and walking track, the cleared vegetation along the transmission line route and Wards Road. However, construction

associated with the KNF HEPS enhancement would further fragment some of the habitats along the alignment.

Again, the potential effect of habitat fragmentation for birds is the creation of corridors for the movement of mammalian predators. The width of forest clearance proposed for the upgraded water race (15-30 m) and the width of the water race itself mean that this feature would be a more substantial corridor than those that already exist. However, given that corridors for the movement of mammalian predators already exist, including the existing water race, and mammalian predators are almost certainly widespread throughout the forest habitats in the area, it is unlikely that the proposed enhancement would result in a significant increase in predation on forest bird species.

Barriers to dispersal and movement

Construction of a canal could potentially create a barrier to the movement of birds that are either flightless or have poor powers of flight. Of the birds recorded from, or likely to occur in, the vicinity of the proposed canal, only the western weka (flightless) and fernbird (a poor flier) could be affected. Weka are strong swimmers (Heather and Robertson 1996). Although reluctant to leave cover, fernbird will fly if forced to (Heather and Robertson 1996) and are capable of flights of up to 100 m (Best 1985). Consequently, the proposed 7 m canal is not expected to act as a significant barrier to the movement or dispersal of either species.

9 Mitigation and Monitoring

This section outlines the mitigation measures recommended to avoid, mitigate or remedy the potential adverse effects of the enhanced Scheme identified in Section 8 above. Where appropriate, recommendations for monitoring are also made.

9.1 Lake Kaniere

9.1.1 Avifauna

No mitigation or monitoring of water birds is considered necessary. The operation of the enhanced Scheme is not expected to have any significant adverse effects on bird habitats or the bird communities of Lake Kaniere.

9.1.2 Lake Kaniere riparian vegetation and wetlands

No mitigation or monitoring of the riparian vegetation and wetlands of Lake Kaniere is necessary. The operation of the enhanced Scheme is not expected to have any significant adverse effects on the riparian vegetation and wetlands of Lake Kaniere.

9.2 Kaniere River

9.2.1 Avifauna

No mitigation or monitoring is necessary with regard to the water birds of the Kaniere River. The operation of the enhanced Scheme is not expected to have any significant adverse effects on the bird communities of the Kaniere River.

9.3 Kaniere Forks and McKays Creek HEPS Terrestrial Vegetation Communities, Habitats and Fauna

9.3.1 Proposed McKays Creek HEPS Enhancement

Existing HEPS Alignment

To avoid, mitigate or remedy adverse effects of the proposed MKY HEPS enhancement on terrestrial vegetation communities, habitats and fauna the following measures are recommended:

1. To minimise damage to indigenous vegetation communities, particularly within the public conservation land, works should, where possible, be confined to the historically modified envelope of the MKY HEPS infrastructure. Where this is not possible construction works should be confined to the smallest construction envelope possible.

2. Areas of disturbed, bare soil are to be revegetated as rapidly and appropriately as possible. On private farmland disturbed areas should be re-sown in pasture grass species.

3. Best practice guidelines are recommended to prevent weed establishment and should include sourcing clean materials, promptly revegetating disturbed soil with seed from a certified source (within the grazed farmland area only) and undertaking weed monitoring and control as part of TPL's ongoing maintenance programme.

4. Management of storm water and sediment run-off following best practice techniques will be required to minimise the adverse effects of sediment run-off into the kahikatea/*Phormium* flax swamp at the toe of the steep slope between the exit of the tunnel and the head pond area. The effectiveness of storm water and sediment run-off should be monitored (refer to Aquatic Ecology Report (Ryder Consulting 2010)).

5. Rehabilitation of the penstock construction route (including weed surveillance and control) is recommended to mitigate the disturbance to the vegetation along the proposed alignment that will result from the installation of the new penstocks.

6. An Environmental Management Plan (EMP) should be prepared to manage the range of potential adverse effects associated with construction works such as sediment run-off, noise and dust, weed control and monitoring, fire and accidental discharge of contaminants, etc.

Proposed New Water Race to Bypass the Existing McKays Tunnel

Specifically in relation to the proposed new section of water race along the McKays water race:

1. To minimise damage to indigenous vegetation communities, particularly within the public conservation land, works should be confined to the smallest construction corridor possible.

2. Construction of the proposed new section of water race would result in disturbance to, and loss of, indigenous forest communities, fragmentation, and edge effects, the adverse effects of which may take decades to regenerate to a state that is close to the existing cover. Off-set mitigation is recommended to mitigate for permanent loss of secondary kamahi - quintinia forest within the Kaniere Farm CA. This is discussed further in Section 9.5.

3. Mitigation planting will be required along the construction route within the secondary kamahi - quintinia forest and tree-fernland to supplement natural regeneration, rehabilitate the indigenous habitats that will be removed and reduce edge effects. Preparation of a *Vegetation Rehabilitation Management Plan* that incorporates the numerous aspects of this rehabilitation work is recommended. This plan must include provisions for monitoring the success of rehabilitation planting and natural regeneration. To ensure the survival of rehabilitation plantings a programme to control herbivorous pests, such as hares and deer, will be necessary.

4. Detailed design and the input of an ecologist is recommended to avoid any large mature trees that have high inherent and habitat values.

5. Appropriate vegetation clearance methods must be used to minimise collateral damage to vegetation and habitats adjacent to the construction envelope. When felling canopy trees, careful planning of where a tree will fall and good felling technique should help minimise collateral damage to neighbouring vegetation. Contractors with proven tree felling skill and experience should be used. If no clear felling path can be chosen, trees should be felled in the direction of other trees marked for felling so as to minimise the damage to residual trees.

6. To promote natural regeneration along the section of water race that will require the removal of indigenous vegetation communities, topsoil, leaf litter and cleared vegetation should be stripped and stored so it can be redistributed over the areas to be rehabilitated.

7. Best practice guidelines are recommended to prevent weed establishment and should include sourcing clean materials, promptly revegetating disturbed soil with appropriate vegetation cover, and/or mulch. Weed monitoring and control should be incorporated into the *Vegetation Rehabilitation Management Plan*.

8. Pre-construction monitoring for bats should be undertaken between September and February prior to the commencement of construction to

ensure that bats are not roosting in trees that will be felled. If bat roost sites are located within the construction envelope, a programme should be developed (in consultation with DOC) and implemented to mitigate any adverse effects of the proposed works on roost sites.

9. Ecological input is recommended during the final selection of all fill sites to ensure that there are no adverse effects on indigenous vegetation, habitats or aquatic communities.

9.3.2 Proposed Kaniere Forks HEPS Enhancement

To avoid, mitigate or remedy the adverse effects of the proposed KNF HEPS enhancement on terrestrial vegetation communities, habitats and fauna the following measures are recommended:

1. The proposed KNF HEPS enhancement would result in substantial disturbance to, and the permanent loss of some indigenous vegetation communities, fragmentation, and edge effects. Where rehabilitation and natural regeneration can occur, it is likely to take several years to decades for the vegetation communities to regenerate to a sufficient state of cover (depending on the age and structure of the vegetation communities affected). Where primary rimu-miro / kamahi - quintinia forest is removed, it may take significantly longer (up to hundreds of years) for the vegetation to regenerate to a state that is close to the existing cover. Off-set mitigation is recommended to mitigate for permanent losses of the vegetation communities identified in Section 8.3.2.2 and is discussed further in Section 9.5.

2. Mitigation planting will be required along the construction route to supplement natural regeneration, rehabilitate the indigenous habitats that will be removed and reduce edge effects. Preparation of a *Vegetation Rehabilitation Management Plan* that incorporates the numerous aspects of this rehabilitation work is recommended. This plan must include provisions for monitoring the success of rehabilitation planting and natural regeneration. To ensure the survival of rehabilitation plantings a programme to control herbivorous pests, such as hares and deer, will be necessary.

3. Detailed design and the input of an ecologist is recommended to avoid large mature trees that have high inherent and habitat values.

4. Similarly, an ecologist should be involved in the detailed design stage regarding the location of the proposed Wards Road Power Station.

5. Appropriate vegetation clearance methods must be used to minimise damage to vegetation and habitats adjacent to the construction envelope. When felling large canopy trees, careful planning of where a tree will fall and good felling technique should help minimise collateral damage to neighbouring vegetation. Contractors with proven tree felling skill and experience should be used. If no clear felling path can be chosen, trees should be felled in the direction of other trees marked for felling so as to minimise the damage to residual trees.

6. To promote natural regeneration, where indigenous vegetation communities are cleared, topsoil, leaf litter and cleared vegetation should be stripped and stored so it can be redistributed over the areas to be rehabilitated.

7. Ecological input is recommended during the final selection of all fill sites to ensure that there are no adverse effects on indigenous vegetation, habitats or aquatic communities. Rehabilitation of fill sites should be incorporated into the *Vegetation Rehabilitation Management Plan.*

8. Best practice guidelines are recommended to prevent weed establishment and should include cleaning construction machinery prior to it entering the site, sourcing clean materials, promptly revegetating disturbed soil with appropriate vegetation cover, and/or mulch. Weed monitoring and control should be incorporated into the *Vegetation Rehabilitation Management Plan*.

9. Appropriate design and engineering solutions (i.e. flumes over streams, or culverts) will be required to minimise hydrological changes and ensure that vegetation communities and faunal habitats are not altered.

10. An Environmental Management Plan (EMP) should be prepared to manage the range of potential adverse construction related effects associated with the proposed activity such as sediment run-off, noise and dust, weed control and monitoring, fire and accidental discharge of contaminants, etc.

11. Pre-construction monitoring for bats should be undertaken between September and February prior to the commencement of construction to ensure that bats are not roosting in trees that will be felled. If bat roost sites are located within the construction envelope, a programme should be developed (in consultation with DOC) and implemented to mitigate any adverse effects of the proposed works on roost sites.

9.4 Kaniere Forks and McKays Creek HEPS Terrestrial Avifauna

9.4.1 Proposed McKays Creek HEPS Enhancement

To avoid, mitigate or remedy the adverse effects of the proposed MKY HEPS on terrestrial avifauna the following measures are recommended:

1. To avoid disturbing nesting birds and destroying nests, eggs and nestlings, the preferred timing for construction work is outside of the nesting period (i.e. undertake works from late February to September). However, it is recognised that from a practical sense this may not be achievable.

Specifically in relation to the proposed new section of water race along the McKays water race:

2. Although significant adverse effects on terrestrial birds are not anticipated as a result of habitat loss, fragmentation and edge effects, the mitigation recommended in Section 9.3.1 for terrestrial vegetation communities, habitats and fauna will also assist in mitigating adverse effects on terrestrial birds.

3. Detailed design and the input of an ecologist is recommended to avoid any large mature trees that have high habitat values for birds.

9.4.2 Proposed Kaniere Forks HEPS Enhancement

To avoid, mitigate or remedy the adverse effects of the proposed KNF HEPS enhancement on terrestrial avifauna the following measures are recommended:

1. To avoid disturbing nesting birds and destroying nests, eggs and nestlings, the preferred timing for construction work is outside of the nesting period (i.e. undertake works from late February to September). However, it is recognised that from a practical sense this may not be achievable.

2. The mitigation recommended in Section 9.3.1 for terrestrial vegetation communities, habitats and fauna will also mitigate the adverse effects of habitat loss, fragmentation and edge effects on terrestrial birds.

9.5 Off-set Mitigation for the MKY and KNF HEPS Enhancements

Despite the onsite remedial action proposed (Section 9.3), the proposed KNF and MKY HEPS enhancements will result in the permanent loss of approximately 4.9 and 1.1 ha of ecologically valuable vegetation communities and faunal habitats, respectively. Off-set mitigation is recommended to mitigate these permanent losses.

Because the ecological values that would be lost as a result of the proposed KNF and MKY HEPS enhancements are on public conservation land, any off-set mitigation package would need to be negotiated and agreed with DOC. TPL has had discussions with DOC regarding the development of a 'mitigation package' that may involve the creation of amenity areas and the implementation of predator and weed control programmes (R. Piddington *pers. comm.* 2010).

Predator and weed control programmes may be considered as a means of off-setting (or partly off-setting) the environmental losses that could result from the construction of the proposed KNF and MKY HEPS enhancements. A predator control programme, for example, could result in a net environmental gain by increasing the survival of birds, reptiles and invertebrates. However, it would need to be well designed, meet best practice guidelines, such as those used by DOC, and a long-term commitment to the programme would be required.

However, it is recommended that 'off-site mitigation' is also considered as part of a mitigation package. This would involve TPL acquiring land that is similar to those vegetation communities and habitats being removed (i.e. 'like for like') and not already formally protected. In order of preference, from an ecological perspective, this area, or areas, would be:

1. Within or adjacent to the contiguous area in which habitat loss will occur (to try and ensure there is no net loss of core area);
2. Within the same catchment; or
3. Within the ED.

Sites that could be considered as part of a mitigation package (in consultation with DOC) could include those with vegetation and habitats that are under-represented, threatened, in significant decline or have important corridor functions between key conservation areas etc. Off-site mitigation could also involve the protection and ecological restoration of more degraded habitats than those being cleared.

To ensure a net environmental/conservation gain, the size, condition and value of any potential areas proposed for off-set mitigation would need to be considered in