



# Hoteo River Catchment: Environment and Socio-economic Review

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# Hoteo River Catchment: Environment and Socio-economic Review

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Landcare Research contract report LC1761

# Executive summary

## Project and client

The Hoteo catchment, one of the Auckland Council Sustainable Catchment Programme's (SCP) rural catchments, has been prioritised for management with a focus on community initiatives to restore ecosystems in and around streams and rivers to limit erosion and sedimentation and to improve water quality. The Hoteo catchment has been selected as a priority catchment primarily because of the threat posed by river sedimentation to a key snapper breeding ground – sea grass beds situated in the Kaipara Harbour close to the mouth of the Hoteo River. This report has been prepared for Auckland Council as part of the SCP.

The aim of this project was to review and collate available environmental and socio-economic information for the Hoteo catchment; assess current and potential future issues for the catchment; and consider key knowledge gaps and future needs for sustainable catchment management. This review is designed to inform 10-year rural plans and 1 to 3-year project plans being developed under the SCP.

This report establishes the current biophysical, cultural, social, and demographic conditions in the catchment, and aims to identify current and future issues and key knowledge gaps in terms of biophysical and socio-economic information regarding the Hoteo catchment. Geographic Information System (GIS) mapping and combinatorial analysis have formed an important part of investigations underpinning this report.

## Background description: Hoteo catchment

Set within the Auckland regional context, the Hoteo catchment is a 405km<sup>2</sup>, geographically diverse rural catchment predominantly in pastoral agriculture and exotic forestry that drains to the Kaipara Harbour. The original land cover of the catchment has been highly modified. Loss of indigenous biodiversity has occurred as forests have been cleared and wetlands drained. Remaining streams, rivers, wetlands and forest provide critical habitat for indigenous plants and animals, some of which are regionally or nationally threatened. Hoteo landscapes also provide for multiple recreational uses.

The catchment has very low population density and a small resident population of around 2500. Most catchment residents are self-employed in the agricultural sector, with a smaller number working in a range of service sectors, mostly in Wellsford. Wellsford is the only town in the area, of which part falls within the Hoteo catchment. The land's productive capacity underpins the local rural economy. Traditional pastoral agriculture in sheep, beef, and dairying dominates the landscape. More recently, there has been an increase in recreation and tourism sector activities in the catchment and rural subdivision for lifestyle blocks has increased population in the catchment away from Wellsford.

## Key issues and knowledge gaps

Degradation of water quality and soil quality, loss of biodiversity, flood risk, risks to cultural heritage, and a number of social and cultural issues have been identified for the Hoteo catchment. Knowledge gaps have been identified in the areas of water quality, indigenous biodiversity, cultural heritage, community knowledge and land use and management.

## Recommendations

The following summary of recommendations has been developed in collaboration with SCP staff at Auckland Council, suggesting options for addressing identified issues and filling knowledge gaps.

1. Governance
  - Collaborate with relevant governance bodies of the Kaipara and Hoteo catchments
  - Acknowledge and ensure management is consistent with relevant Treaty settlement legislation
  - Identify and integrate with other work streams and projects in the Hoteo catchment
  - Include and respond to the relevant policies and strategies that relate to environment, land use biodiversity etc.
2. Erosion and sediment management
  - Develop more comprehensive estimates of sediment yields and sources
  - Target intervention for reducing sediment yield along the lower reaches of the Hoteo River and associated steep pasture land, and build on the work of Buikema (2012) to prioritise areas for riparian management
  - Investigate the risks of algal proliferation that could result from reducing sediment levels in the river
3. Indigenous biodiversity
  - Support and/or establish work to identify inanga spawning grounds and opportunities to protect and enhance them (working with the relevant biodiversity staff at Auckland Council)
  - Incorporate indigenous biodiversity management into sediment management programmes (e.g. riparian management could be designed to also enable protection of inanga spawning grounds; stabilisation plantings could include native species)
4. Cultural heritage and socio-economic
  - Establish a project that creates opportunities for mana whenua and residents to document and share their stories, and draw on this knowledge in catchment management and conservation efforts
  - Assist with the prioritisation and/or resourcing of an archaeological survey for cultural heritage sites in this area (working with the relevant cultural heritage team staff at Auckland Council)
  - Conduct or commission work to identify opportunities for diversified land use activities in the catchment, and investigate ways the SCP could support the catchment community to implement the more sustainable options

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## 1.0 Introduction

### 1.1 Sustainable Catchments Programme for the Hoteo catchment

The Sustainable Catchments Programme (SCP) is delivered by the Environmental Services Unit (ESU) at Auckland Council. The SCP was established in 2003 and has recently been expanded from three to six priority catchments (three rural and three urban) in the Auckland region.

The programme is underpinned by a collaborative model of freshwater management, working with stakeholders in its priority catchments to develop and implement stream restoration projects. The SCPs strategic objective is to:

*Contribute to the achievement of Council's stormwater, water quality (chemical and biophysical) and stream restoration outcomes through an integrated planning and implementation methodology delivering community based interventions into priority catchments.*

The types of interventions could include riparian and wetland restoration, walkways, interpretation signs and research projects. Linking up and leveraging off existing council, iwi and community activities is critical to the programme's success. Auckland Council therefore provides an integration and/or facilitation role within a catchment.

The SCPs environmental, community and programme objectives are:

#### 1. Environmental Objectives

- Contribute to Auckland being the world's most liveable city
- Contribute to enhancement of ecosystem services
- Assist in management of natural freshwater systems
- Establish freshwater values and aspirations with communities
- Enhance and increase Auckland's green infrastructure and networks
- Reduce yield of sediment to sensitive marine environments
- Manage riparian margins for improved biodiversity, amenity and connectivity
- Contribute to the enhancement of Hauraki Gulf ecosystems

#### 2. Community Objectives

- Agencies, mana whenua and the community work in effective partnerships
- Recognise our diverse communities, varied goals and aspirations, capacity and levels of interest and tailor the programme accordingly
- Foster sustainable, long-term community action, leadership and 'ownership'
- Deliver interventions that will engage communities over the long-term
- Promote creative and inclusive learning

#### 3. Programme Objectives

- Deliver interventions that will help achieve our environmental, community and programme objectives

- Develop a consistent approach and methodology for the planning and implementation of the SCP across the region
- Establish and implement a consistent and robust monitoring and evaluation framework for the SCP
- Adopt an adaptive management philosophy that provides for a structured, iterative process to decision making based on monitoring and evaluation
- Include principles of the Orders of Outcomes and Plan Logic in planning and implementation processes
- Achieve positive integration with other related Auckland Council programmes and plans
- Implement a programme that promotes the efficient use of ratepayer funds and provides value for money outcomes

The Hoteo catchment is one of the SCPs priority rural catchments. The catchment has been prioritised for sustainable catchment management with a focus on community initiatives to restore ecosystems in and around streams and rivers to limit erosion and sedimentation levels and improve water quality. It has been selected as a priority catchment primarily because of the threat sedimentation from the river poses to a key snapper breeding ground – sea-grass beds situated in the Kaipara harbour close to the mouth of the Hoteo River.

Sedimentation of the Kaipara harbour has been identified by the Integrated Kaipara Harbour Management Group (IKHMG) and Auckland Council as a key environmental issue for the harbour (IKHMG 2011b). The Hoteo catchment is the largest contributor of sediment to the Kaipara harbour in the Auckland region, although sediment delivery from the Hoteo River is 15 times less than that of the Wairoa River (Northland region) (Temple and Parsonson 2014). To reduce sediment entering the Hoteo River and subsequently the Kaipara harbour, the SCP have developed an erosion and sediment control plan (Temple and Parsonson 2014).

This report provides information supporting the initial steps of the Integrated Catchment Management (ICM) adaptive planning and management process (Fenemor et al. 2011), and the first order in the orders of outcomes approach to sustainable catchment management (Kilvington et al. 2011). The first order, ‘enabling conditions’, includes developing an understanding of the characteristics and issues of the catchment of interest.

This report establishes the current biophysical, cultural, social, and demographic conditions in the catchment, and aims to identify current and future issues and key knowledge gaps in terms of biophysical and socio-economic information regarding the Hoteo catchment. Geographic Information System (GIS) mapping and combinatorial analysis (outlined in Section 2: Methods) have formed an important part of investigations underpinning this report. The structure, contents and report were prescribed in the call for research proposals (RfP) distributed by Auckland Council before the project began, which were based on Boffa Miskell (2009).

This report, along with two other scoping reports, an iwi and stakeholder report, and an erosion and sediment control plan, have been commissioned to inform the SCPs 10-year

concept plan for working with stakeholders in the catchment. The concept plan will scope potential activities, partners, and delivery mechanisms for a 10-year collaborative work plan with local stakeholders in the area.

## 1.2 Hoteo catchment

The Hoteo is Auckland's largest catchment, situated at the Northern boundary of the Auckland region, with an area of 405km<sup>2</sup> and 28km of mainstream river length (ARC 2010). The catchment has been delineated into nine subcatchments, primarily for storm water management (Table 1). The Hoteo catchment drains southwest into the southern Kaipara harbour catchment (Appendix A – Map 1). The Hoteo River meanders mostly through rural hill country in pastoral farming, and exotic and indigenous forest.

This review of available information on the Hoteo catchment highlights a number of environmental issues of relevance to the SCP, these include: water quality degradation as a result of sedimentation and nutrients; soil conservation; indigenous biodiversity; flooding; cultural heritage risks; and socio-economic and community issues.

Four key sources of sediment have been identified in existing literature on the Hoteo catchment (Jessen et al. 1997):

- Overland run off from cultivated fields, pugged pasture discharge from farm tracks, forest tracks and unsealed roads
- Tunnel gully erosion
- Mass movement and ongoing erosion from mass movement faces, and redistribution of mass movement sediment downstream through the catchment
- Stream-bed scour and bank collapse along valley bottoms and flood plain channels during floods.

Most erosion and subsequent sedimentation occurs during flood events via bank scouring and overland flow. Erosion appears to be spread throughout the catchment, with higher losses of suspended sediment originating from riverbank erosion and floodplain sources than from upland areas (Jessen et al. 1997; Temple and Parsonson 2014).

Historic loss of indigenous biodiversity is also an important issue in the catchment. Stream restoration and land management changes resulting from the SCP will have the potential to contribute to indigenous biodiversity objectives.

## 2.0 Methods

To meet the aims of this project the following steps have been completed:

- a project initiation workshop was coordinated with council staff to introduce the project, establish key relationships, and identify data readily available from council
- existing, relevant information on the Hoteo catchment was reviewed and synthesised and a report has been produced that outlines information about the catchment's biophysical environment, socio-economic and socio-cultural demographics, and local scale planning context
- a combinatorial, spatially explicit database (method outlined below) has been compiled and analysed to determine historic land use trends and land under protection (e.g. QEII covenanted land, etc.)
- a mid-project workshop was coordinated with council staff to report on the project's progress and to discuss and identify key issues and potential future issues for the catchment
- key drivers of future landscape change within the catchment have been assessed. These include population growth, climate change, market demand for primary products, etc., and the possible implications for biodiversity, soil resources and primary production, and water resources
- knowledge gaps were documented and future research to help fill those gaps were recommended
- a final workshop with council staff was coordinated to communicate project findings and subsequently incorporate feedback from council staff into the final report.

The catchment boundary extent is the one used by Auckland Council and was supplied by Auckland Council to Landcare Research for the purposes of this review. All input spatial data layers were used 'as is' with no attempt made to correct errors that may exist.

Although all attempts have been made to ensure this review is comprehensive, not all information is included here as this is a summary of readily available information. Further detailed information is available in the reports used to compile this summary report.

The summary of issues and future issues and identification of knowledge gaps for the Hoteo catchment draws on analysis of the review of environment and socio-economic information for the Hoteo; on expert knowledge contributed by Auckland Council staff in the mid-project workshop held for the purposes of this project and via personal communication; and on the expert knowledge of Landcare Research staff in the areas of landscape ecology; soils; erosion and sediment management; integrated catchment management; and policy analysis.

### 2.1 Biophysical review

The summary of the biophysical environment of the Hoteo catchment has been based on a review of existing documents and data readily available for the catchment area. A literature review of reports on Hoteo catchment and environmental monitoring and other environmental research in the catchment was undertaken. An SCP stocktake of all documents relating to the SCPs six priority catchments was undertaken in 2013 by Andrew

Stewart Ltd (Bird and Sunich 2013). The SCP stocktake was consulted and utilised for all reports and documents related to the catchment. Two workshops were held with Auckland Council staff to establish key relationships to gather data held on the catchment. Auckland Council staff from a range of disciplines (e.g. soils, hydrology, and ecology and biodiversity) generously gave their time to provide data and personal knowledge of the catchment.

Geographic Information System (GIS) analysis was conducted using national and regional data sets. Analysis of national data sets available as GIS layers included: geology, soils, slope, elevation, rainfall, erosion severity, the New Zealand empirical erosion model, the Land Cover Database III, Land Use Capability, and the River Environment Classification layers. Analysis of regional data included assessment of flood levels, indigenous biodiversity sites and species records, and Rodney District bushlot covenants. Maps, produced by Municipal Design, are provided in Appendix A: Hoteo Catchment Maps.

Land-cover trends and interactions with land environments and protected areas were assessed by comparing Land Cover Database spatial data layers for the periods 1996/97, 2001/02, and 2007/08, and Land Environments level IV, NZ Land Resources Inventory spatial layers, Agribase, and QEII and DOC protected areas. To achieve this a combinatorial analysis method used in several previous studies (Rutledge et al. 2004, 2010; Walker et al. 2006, 2009) was used to combine and input spatial data layers for comparison and trend analysis. The method involved the following steps:

- Convert any vector (polygon) spatial data layers to raster (grid spatial data layers) with a 25-m grid cell size (0.0625 ha)
- Overlay and intersect the input spatial data layers
- Generate a look-up table that includes row entries for each combination of input data layer attributes
- Generate a new raster layer for which the cell values correspond to the unique combinations of the input data layers
- Import the resulting look-up table into a relational database (MS Access) for further querying and processing.

## 2.2 Socio-demographic, cultural and planning context reviews

The socio-demographic and cultural section has been collated through a desktop review of available data. Demography draws primarily on 2006 census data. Cultural Heritage Index (CHI) data and maps (Appendix A: Hoteo Catchment Maps) for the Hoteo catchment were compiled by Auckland Council's cultural heritage team for use in this report and later updated by Municipal Design. The planning context section summarises findings of a desktop review of national, regional and district level legislation and planning documents.

## 3.0 Biophysical environment

Many biophysical (as well as socio-cultural) factors contribute to the type and scale of environmental and resource management issues within a catchment. This section describes the geology, soils, slope, elevation, and climate of the Hoteo catchment and how these contribute to erosion and sedimentation in the Hoteo catchment. The section also provides descriptive information about the terrestrial and fresh water ecology, hydrology, and marine receiving environment of the Hoteo catchment.

### 3.1 Geology and soils

#### 3.1.1 Geology

The catchment is underlain predominantly by Waitemata Group sandstones and mudstones (Appendix A – Map 3) (Edbrook 2001; Jessen et al. 1997). Much of this is Pakiri Formation thick bedded, volcanic rich, graded sandstone and siltstone, with some areas of Hoteo Bed Formation thick bedded, graded, calcareous sandstone and mudstone. Almost the entire catchment is covered by a deep, moderately to completely weathered regolith (regolith is a layer of unconsolidated materials, such as broken rocks, dust, soils, and other materials, covering solid rock). The underlying geology of each subcatchment is described below (Table 1).

The Northern subcatchments Waiteitei, Waitapu, Whangaripo, and the central subcatchment Waiwhiu are predominantly underlain by sand and siltstones (Waitemata Group, Pakiri Formation). A small pocket of limestone (Northland Allochthon, Mahurangi Limestone) underlies Waiteitei, and a small pocket of sandstone underlies Whangaripo (Waipapa Group sandstone).

The Hoteo central subcatchment is predominantly underlain by sand and siltstones (Pakiri Formation). Along its western boundary Hoteo central is underlain by mudstones, sand and siltstones, and shale and limestone (Northland Allochthon Formation). Wayby subcatchment, close to Wellsford, is underlain by mudstones, sand and siltstones, shale, and limestone (Northland Allochthon Formation).

The Hoteo gorge is underlain by sand and siltstones (Pakiri Formation) and sandstone and mudstone (Hoteo Bed Formation). Kourawhero is predominantly underlain with sand and siltstones (Pakiri Formation), and mudstones, sand and siltstones, shale and limestone (Northland Allochthon Formation).

The lower Hoteo River subcatchment is predominantly underlain by sand and siltstones (Pakiri Formation). An area of land directly north of the river mouth is underlain by conglomerate made up of pebbles of a range of rock types in limestone and mudstone (Waitemata Group Matapoura conglomerate). Estuarine deposits underlie the river mouth, which are predominantly pumice alluvium made up of pumice, sand, silts and gravels. Alluvium deposits run along the river valleys of the Hoteo River and its major tributaries.

Some geological formations are more likely to contribute to sediment yield than others. In the Hoteo catchment unconsolidated sand and silt, found on catchment terraces in river plain

areas, as well as floodplain sands, silts and clays are the formations most prone to detachment by floodwaters and runoff (Temple and Parsonson 2014). These deposits are naturally unstable and bank slumping and bed scour along the river and tributaries are most likely where these deposits exist. Sediment control measures will be most effective if focused on areas where the geological formation and soils are most prone to erosion and sediment generation. Other geological formations do not contribute to sediment yield when unexposed to weathering; however, the soils above them vary in their contribution to sediment yield.

### 3.1.2 Soils

Jessen et al. (1997) summarised the soils of the catchment as being generally well developed (strongly weathered) and high in silt and clay; they further note that soils in the catchment are strongly aggregated with high organic matter. More than 90 per cent of the catchment's soil area is made up of four soil types – Puhoi, Omu, Whareora, and Kaipara Suite soils (Appendix A – Maps 4–12). Another eight soil suites are found in the Hotoe catchment, collectively making up less than 10 per cent of the catchment's soil area.

Puhoi soils (Mahurangi, Warkworth, Whangaripo, Atuanui, and Puhoi) are mostly Ultic. They range from clay loam to fine sandy loam in texture and have formed in the catchment's rolling to hilly and steep hilly areas above Waitemata Group Formation base rock. On rolling to hilly land Mahurangi, Warkworth and Whangaripo soils have formed. Mahurangi soil (Albic Ultic) is fine sandy loam in texture and is imperfectly to very poorly drained. Warkworth soil (Yellow Ultic) is clay, sandy clay loam in texture and is well to moderately well drained. Whangaripo soil (Yellow Ultic) is clay loam in texture and is imperfectly to very poorly drained. On steep land, Atuanui and Puhoi soils have formed above Waitemata Group base rock. Atuanui soil (Orthic recent) is clay loam in texture and is well to moderately well drained. Puhoi soil (yellow ultic) is clay loam in texture and is imperfectly to very poorly drained.

Omu suite soils (Omu, Okaka, Aponga, and Waikare) have formed on rolling to hilly land underlain by Northland Allochthon Formation base rock and are mainly ultic. The suite has clay subsoils overlain with topsoils ranging from clay (Aponga) to clay, silt clay (Okaka), clay loam (Omu) and silt loam (Waikare). All of the soils in the Omu suite are imperfectly to very poorly drained.

Whareora suite soils (Whakapara, Whareora, Waipuna, and Kara) are found in the flood plains and low terraces of the catchment having developed from alluvial deposits and are mainly recent. They have variable texture from sand to silt to clay and consequently vary from well drained to poorly drained.

Kaipara suite soils (Takahiwai and Kaipara) have developed in the estuarine areas of the Hotoe River and are mainly gley. These soils have developed from estuarine deposits, have a clay texture and are poorly to very poorly drained.

**Table 1 Hoteo catchment geology, soil, slope and elevation by subcatchment**

	Subcatchment (North–South)	Subcatchment area (km <sup>2</sup> )*	Dominant geology and soils	Slope and elevation
<b>Northern Subcatchments</b>	Waiteitei Stream	54	Sand and siltstones, Limestone	Strongly rolling to flat, Low elevation
	Waitapu Stream	39	Sand and siltstones	Strongly rolling to flat, Low elevation
	Whangaripo	46	Sand and siltstones, and Sandstone	Very steep to flat, High to low elevation
<b>Central Subcatchments</b>	Wayby	21	Northland Allochthon complex	Mostly rolling, Low elevation
	Waiwhiu Stream	38	Sand and siltstones	Very steep to strongly rolling, High to low elevation
	Hoteo central	59	Sand and siltstones, and Northland Allochthon complex	Very steep to strongly rolling in the east to rolling to flat in the west, High to low elevation
<b>Southern Subcatchments</b>	Hoteo Gorge	40	Sand and siltstones, and sandstone and mudstone	Very steep to strongly rolling, High to low elevation
	Kourawhero	73	Sand and siltstones, and Northland Allochthon complex	Very steep to rolling to flat, High to low elevation, mostly low river plain
	Lower Hoteo River	43	Sand and siltstones, conglomerate, and estuarine deposits	Mostly steep to rolling, flat at the river mouth, high to low elevation

\*The sum of subcatchment area is greater than the area of the Hoteo catchment due to rounding.



Soils most prone to erosion in the Hoteo catchment have been indicated to be:

- Whakapara soils, found along the flood plains and associated flat to undulating terraces (through catchment)
- Whangaripo series on central and southern hills and steep land (particularly under pasture)
- Atuanui steep land soils (found on steep land areas)

This also takes into account transport and storage capability as well as slope and land cover, in the empirical study by Jessen et al. (1997).

Soil quality is monitored by Auckland Council at four sites in the Hoteo catchment. Two sites are categorised as plantation forestry sites in the Mahurangi forest. These sites were last sampled in 2011 and soil results for the key seven soil quality indicators (pH, Olsen P, TC- total carbon, TN- total nitrogen, AMN- anaerobic mineralisable nitrogen, bulk density, and macroporosity) were all within recommended guideline ranges. Soil types at both sites were identified as Ultic soils (Whangaripo clay loam soil series).

The other two sites are pastoral (one dairy and one drystock farm). The dairy site was sampled in 2009 and the drystock site in 2010. Both of these sites suffered from soil compaction (measured by macroporosity). High Olsen P levels at the dairy site indicate that this soil may be over-fertilised. Soil types at both sites were identified as recent soils (Whakapara silt loam soil series) (Curran-Cournane 2012; Fraser and Stevenson 2011; Stevenson 2010).

The soil compaction findings at the two pastoral sites are consistent with soil compaction issues for pastoral land across the Auckland region. Curran-Cournane et al. (2013a) also found high Olsen P levels for pastoral land across rural Auckland. This indicates soil compaction and then high Olsen P levels are issues for pastoral land across rural Auckland.

## 3.2 Slope and elevation

The Hoteo catchment landscape varies from steep upland hills to flat river plains (Appendix A – Map 13). The catchment is predominantly a hill country catchment with about 65 per cent of land area having slopes greater than 16°. About 12 per cent of the catchment is made up of steep hills. In the north, steep to rolling hills flow into undulating hills and flat land in Waiteitei and Waitapu. The west of the catchment is dominated by steep hills, with the Dome ranges running through the Whangaripo, Waiwhiu, Hoteo central, and Kourawhero stream subcatchments. The east of the catchment is dominated by flat lands, and a large river plain dominates the landscape of the Kourawhero subcatchment in the west. Another area of lowlands sits at the mouth of the river, south of Hoteo gorge. The steepest terrain in the catchment is found in the south of the Hoteo gorge subcatchment near the settlement of Hoteo down to the river mouth.

Elevation throughout the catchment corresponds with slope as above. High elevations are found in steep land areas and low elevations dominate in the undulating to flat land in the catchment (Appendix A – Map 14). The highest elevations are at Mt Atuanui (Mt. Auckland)

and through the Dome ranges to Conical Peak. This steep hill country land runs into strongly rolling to rolling hill country and river plains. The largest areas of flat to rolling land are in the Waiteitei, Hoteo central, Wayby, and Kourawhero subcatchments.

The catchment falls 300m over the 30km from the Hoteo River's source at the head of the Waiwhiu stream down to its mouth at the Kaipara harbour. The most pronounced changes in elevation occur in the first 3km of tributaries to the main Hoteo River and again through the Hoteo gorge in the south of the catchment to the river mouth.

Buikema (2012) (Appendix A – Map 15) characterised four landscape 'units' for the Hoteo catchment: uplands (the Dome Ranges), foothills/rolling foothills, alluvial floodplains, and lowland coastal/estuarine plains (used throughout this report to discuss characteristics or processes occurring within the catchment):

- The uplands are steep (slope >26°) dissected ranges. Upland areas are found in the Dome ranges in the east of the catchment in the subcatchments of Whangaripo Stream, Wiawhiu Stream, and Hoteo central. Uplands also occur in the Hoteo gorge and lower Hoteo River (Mt Atuanui) subcatchments.
- Waiteitei and Waitapu subcatchments, the west of Hoteo central, Wayby, and Kourawhero subcatchments can all be characterised as foothills, with wide alluvial floodplains at their lowest elevation.
- Whangaripo stream subcatchment has a significant alluvial plain area running along the length of the stream.
- Finally the lowland/estuarine plain runs along the final 1–2 kilometres of the Hoteo River closest to the coast (near Mangakura) where the Hoteo River enters the Kaipara harbour (Buikema 2012).

Steeper and higher elevation land in the catchment, particularly where these areas also comprise soils that have higher erosion potential (less stable soils), are most likely to be dominant sources of sediment in the catchment. Observed erosion and erosion potential are discussed further in Section 3.4.

### 3.3 Climate

Climate in the catchment area is consistent with climate described for the northern climate zone (NIWA 2013) and for the Auckland region (Table 2) (ARC 2010). The northern climate zone is a subtropical region that experiences warm humid summers and mild winters. Prevailing wind is from the southwest, west, and northwest. Occasional tropical cyclones and strong storms can occur in the area bringing strong winds and heavy rain from the east or northeast. Summer daytime maximum air temperatures range between 22 and 26°C and can exceed 30°C, but rarely do. Winter daytime maximum air temperatures range between 12 and 17°C.

Rainfall in the catchment is influenced by and varies due to topography and airflow; for example, the South Kaipara peninsula to the west acts as a barrier to prevailing westerlies, reducing precipitation received particularly along the west coast of the catchment. Rainfall is monitored by Auckland Council at one site in the Hoteo catchment – 'Hoteo at Oldfields'.

Mean daily rainfall at Oldfield's is approximately 5mm and mean annual rainfall is 1600mm (Buikema 2012). Rainfall is dependable year round, but has a winter maximum and summer minimum.

Average annual rainfall isohyet analysis (Map 16: Hoteo Catchment Annual Rainfall Isohyets) for the catchment estimates highest average annual rainfall of 1600 mm, which occurs around the headwaters of the Kourawhero subcatchment, Kaipara Flats, Woodcocks and Hoteo. The east of the catchment is typically wetter than the west, with the higher elevation inland hills to the east receiving more precipitation than the low elevation coastal area in the west. In the North of the catchment rainfall average is around 1500 mm annually. Average rainfall decreases close to the coast, with the lowest annual rainfall occurring at the mouth of the Hoteo River and along the coast of the Kaipara harbour (ARC 2010; Harmsworth 1996).

**Table 2 Summary climate information Auckland region (ARC 2010) and summary rainfall information for Hoteo catchment (Oldfield's monitoring station)**

Long term averages for the Auckland region and Hoteo (ARC 2010; ARC 2008)	Average	Time period
Annual sunshine	2046 hours	1962–2007
Annual mean temperature	15.3°C	1963–2007
Annual mean wind speed	18km/h	1966–2007
Annual rainfall	1119mm	1963–2007
Daily mean rainfall (Hoteo @ Oldfields)	4.9mm	1978–2007
Average annual rainfall (Hoteo @ Oldfields)	1387mm	1978–2007

Winter maximum rainfall typically occurs due to sustained rainfall events, which feed annual peak river flows. Large scale intense rainfall events, such as a tropical cyclone hitting the area from the east or northeast can see as much as 225 mm fall in areas of the catchment in 24 hours (Appendix A – Map 32). Highest rainfall during peak events is estimated to occur in the headwaters of the Whangaripo subcatchment with less rainfall to the west across the catchment (Appendix A - Map 31).

Sediment discharge has been documented as being proportional to annual rainfall (Griffiths and Glasby 1985), indicating the importance of rainfall for erosion and sedimentation volumes in the catchment.

## 3.4 Erosion

In the Hoteo catchment rainfall is the key driver of erosion processes, including bank erosion, overland flow erosion, and mass movement slope failure. Rainfall events greater than 25 mm in the autumn, winter, and spring, and events greater than 50 mm in late summer when soil moisture levels are lower, are expected to result in erosion (Jessen et al. 1997). Underlying geology, soil type, slope, and land cover are key factors determining how much erosion occurs. Sediments eroded off the land can be relatively small (but on-going) volumes such as erosion that occurs via overland flow during a rainfall event, or can be in comparatively large, infrequent one-off volumes when mass movement slope failure occurs.

Once sediment is detached on land, slope, hydrological factors, land cover, surface roughness, and distance to the receiving waterway are determining factors in whether or not detached sediment reaches the receiving waterway. The spatial distribution and volume of erosion can be either measured in the field or estimated using an erosion model. The amount of sediment reaching a stream or marine receiving environment is not necessarily expected to be the same as the amount of sediment eroded on land because sediment may be deposited on land before it reaches a waterway. Sediment yield (the amount of sediment reaching the receiving environment) can also be measured in the field or estimated using a sediment yield model (Les Basher, 2014, Landcare Research, pers. comm.).

There are a number of sources of erosion and sediment information currently available for the Hoteo catchment. These include: Jessen et al.'s (1997) field-based study identifying sediment sources in the Hoteo catchment; The New Zealand Land Resource Inventory (NZ LRI) field-based map of observed erosion severity (Appendix A – Map 17); Auckland Council measured sediment yields (Curran-Cournane et al. 2013b; Hicks et al. 2009); sediment yield predictions based on the New Zealand Empirical Erosion Model (NZEEM) and the Catchment Land Use for Environmental Sustainability (CLUES) models; and Buikema (2012), which presents a GIS based erosion management approach prioritising where to conduct riparian restoration in the Hoteo catchment.

Jessen et al. (1997) is an important source of erosion and sedimentation information for the Hoteo catchment; however, it is important to note that this information is now nearly 20 years old. Land-use and other changes may have altered the state of erosion on the ground in the Hoteo catchment. Land-use change in the catchment since 1997 has been primarily a decrease in the amount of pasture land and an increase in exotic forestry (see Section 5, Land Use Change). The development of new information about erosion and sediment processes occurring in the Hoteo catchment as recommended in this report would usefully update current available information with a more recent assessment of the state of erosion and sedimentation.

### 3.4.1 Observed sediment sources in the Hoteo catchment

Jessen et al. (1997) identified sediment sources in the Hoteo catchment in late 1996, applying a rapid assessment methodology based on field observations and geomorphic principles, analysis of aerial photography, and a review of existing information about the

catchment. Concluding that erosion, and sediment transport, storage, and delivery occur within a normal range for a hilly catchment with mixed pastoral and forestry land use in the Auckland region, Jessen et al. (1997) argued that sediment generation in the Hoteo catchment principally occurs in four key areas (in order of greatest to lowest contribution to sediments reaching the Hoteo River and potentially Kaipara harbour):

- Stream banks of the lower reaches of the Hoteo River
- Stream banks within flood plains found throughout the catchment, except the lower reaches of the Hoteo River
- Pasture-covered steep land in the central and southern hills, found in the Whangaripo, Wayby, Hoteo central, Waiwhiu, Hoteo Gorge, Kourawhero and lower Hoteo River subcatchments
- Rolling land on fractured mudstone, found predominantly in the Hoteo central, Wayby, and Kourawhero subcatchments

Jessen et al. (1997) judged the stream banks of the Hoteo River and its major tributaries as the main sources of sediment in the catchment, given that stream banks in the Hoteo catchment are prone to bank collapse and bank scour during storm events in both winter and summer. The banks of the lower Hoteo River and its over-steep riparian slopes were seen as particularly significant sources of sediment in the river system.

Steep slopes (particularly those under pasture) in the central and southern hills in the catchment experience fairly infrequent landslips during large rainfall events. Jessen et al. (1997) concluded that because of their infrequency landslip would make relatively little overall sediment contribution in the long term. However, in the very long term it is landslip processes that are contributing sediment to the river, where it may be deposited, eroded and suspended over much longer timeframes (L Basher, 2014 Landcare Research, pers. comm.) and these large-scale, infrequent landslip events will be the ultimate contributors of sediment within the catchment.

Steep slopes under pasture in the central and southern hills (on Waitemata sediments with Whangaripo and Atuanui steep land soils) were reported as generating sheet wash during rainfall events greater than 25–50 mm. These areas are prone to sheetwash because of rapid runoff from steep slopes and poor pasture quality on drier north-facing slopes.

Rolling land on fractured mudstone (Hoteo central, Wayby, and Kourawhero subcatchments) under dairy farming land use was inferred to experience sheet wash erosion of fine silts and clays with rainfall events greater than 25–50 mm. In these areas Jessen et al. (1997) also report soil creep, tunnel gully, collapsed tunnel, rill, and small-scale gully erosion as possible.

Jessen et al. (1997) recommended interventions along the lower Hoteo and associated steep land under pasture as a priority for minimising sediment yields. They note that, with the exception of major stream channels, interventions in the upper catchment are likely to have less effect because of their relatively large sediment storage potential and lower potential for sediment generation. They also note that sediment generation due to stock-

treading damage may increase if dairy cattle stocking rates increase as a result of improved irrigation.

Further to this, Jessen et al. (1997) stressed that good land management practices in other areas (not identified as key sediment sources) are still important and contribute to reducing sediment yields in the Hoteo River system. For example, that *any relaxation of current management practices in forestry harvesting and roading in the central and southern hills could have a significant impact on sediment loads in the Hoteo River should a large rain storm strike during a vulnerable period in the forestry management cycle* (Jessen et al., 1997, p.10).

### 3.4.2 Observed erosion severity in the Hoteo catchment

Erosion severity has been mapped twice as part of the New Zealand Land Resources Inventory (LRI) survey. Erosion severity was updated in the second edition of the LRI, with fieldwork conducted between 1985 and 1990 (Harmsworth 1996). As well as being used to classify LUC, erosion severity mapping also provides a good understanding of the types of erosion processes occurring and their spatial variation. It is important to note, however, that mapped erosion severity is a one-off assessment, which does not measure erosion over time, and does not have the ability to measure annual erosion rates or average erosion rates. The LRI erosion severity assessment is also not an assessment of area or rate of erosion, it is a ranked unit based on the NZ LRI erosion classification (Harmsworth 1996). The full NZ LRI erosion classification can be found in Harmsworth (1996).

The LRI erosion severity assessment for the Hoteo catchment (Appendix A – Map 17) indicates negligible to slight erosion occurring throughout the catchment. Moderate erosion was recorded both along the river channel and river plain of the Whangaripo subcatchment in the north of the catchment and along the river channel and riparian slopes of the Hoteo gorge and lower Hoteo subcatchments along the lower reaches of the river in the south of the catchment.

### 3.4.3 Measured sediment yield for Hoteo River

Auckland Council began monitoring suspended sediment for the Hoteo catchment in 2010 that captures 268km<sup>2</sup> of the Hoteo catchment (Curran-Cournane et al. 2013b). Total suspended sediment yield for the monitoring period was 51748 tonnes, which equated to a specific sediment yield of 74.3 t/km<sup>2</sup>/yr.

At this point the record is short (<3 years), and of the 48 events included only 16 per cent were physically sampled, with 84 per cent of yields estimated using an event peak flow sediment rating that was developed for the catchment. Curran-Cournane et al. (2013b) report that because the largest quick peak event was not sampled, estimated yields using the rating could either over- or under-estimate the long-term yield. As the monitoring period increases, the sediment rating to estimate missed events will improve over time.

While the monitoring has been set up to capture storm events which have been shown to dominate long term sediment yields (Basher et al. 2011; Hicks et al. 2009, 2000), low

frequency events that occur at >5–10 year return periods have yet to be physically captured, which will become increasingly likely as the sediment record extends.

The sediment monitoring station is situated above the hilly area of the lower Hoteo River identified by Jessen et al. (1997) as being prone to bank erosion and riparian slips. Therefore developing an approach for monitoring suspended sediment yields for the lower Hoteo catchment would be useful.

The establishment of sediment monitoring on the Hoteo provides important baseline data and ongoing monitoring data that the SCP can utilise to monitor sediment levels in the river.

#### 3.4.4 Modelled sediment yield for Hoteo River

NZEEM (The New Zealand Empirical Erosion Model) predicts mean annual soil loss in a catchment based on annual rainfall, erosion terrain, and land cover (assuming a 10-fold reduction of sediment yield under tall woody vegetative cover compared with pasture). The model estimates the location and volume of sources contributing to river sediment and is recommended for use to: identify vulnerable land for soil conservation efforts that can minimise erosion and flood damage; and estimate the amount of avoided sediment that can be achieved by land-use cover change.

NZEEM predictions for the Hoteo catchment (Appendix A – Map 18) indicate low contribution to sedimentation from much of the catchment (<100 tonnes/km<sup>2</sup>/year). Substantial areas of the catchment are predicted to contribute in the vicinity of 100–300 tonnes of sediment km<sup>2</sup>/yr, particularly rolling and steep hills and river plains and banks (consistent with Jessen et al.'s (1997) assessment). Several areas are predicted to contribute higher amounts of sediment. These fairly localised areas of predicted high erosion are in the central rolling and steep hills in the Waiwhiu and Hoteo central subcatchments, the Kourawhero subcatchment, and the lower Hoteo River subcatchment.

The Hoteo central subcatchment is predicted to contribute most to sedimentation, with a mean annual sediment contribution rate of 260 tonnes/km<sup>2</sup>/yr. The Kourawhero stream subcatchment is predicted to have a mean annual contribution to sedimentation of 176 tonnes/km<sup>2</sup>, and the lower Hoteo River subcatchment, 152 tonnes/km<sup>2</sup>.

CLUES (Coastal Land Use for Environmental Sustainability Model) can be used to assess the effect of land use on water quality and socio-economic indicators. CLUES has been used to model a number of water quality indicators (nitrogen, phosphorus, total suspended sediment, E coli) entering the Kaipara harbour, including from the Hoteo. The analysis compared two land-use scenarios: pre-European land cover ca 1770, and 2002 land cover as recorded in 2002 in the Land Cover Database (Semadeni-Davies 2012).

Semadeni-Davies (2012) concludes that land-use change in the Kaipara catchment has had a profound effect on water quality. Land use was found to have a greater effect on nutrient levels than for sediments; however, sediment yields were on average seen to increase 3.5 times from the historic forested scenario to the recent pasture dominated scenario. Catchments with more forest, indigenous and exotic, were found to generate lower nutrient

and sediment loads. Semadeni-Davies (2012) also found that catchments dominated by dairy farming had higher nutrient yields, but not higher sediment yields. This indicates that dairy farming was not seen to increase sediment loads (or yields) more than other land uses.

Curran-Cournane et al. (2013b) notes that a recent assessment of CLUES for Auckland found that the relationship between CLUES-predicted yields and observed yields is poor; however, it is important to note that CLUES estimates long-term (30+ year) average annual sediment yields and most measured yields in Auckland are based on very short records of suspended sediment that do not cover the full range of flow or event recurrence intervals (L Basher, 2014, Landcare Research, pers. comm.).

### 3.4.5 Erosion and Sediment Control Plan for Hoteo Catchment

As part of the SCP, Auckland Council have developed an Erosion and Sediment Control Plan (ESCP) to help meet sediment reduction targets set in the Auckland Plan (Auckland Council 2012b), and to address concerns regarding sediment entering Kaipara harbour from the Hoteo catchment (Temple and Parsonson, 2014 ). The ESCP provides detailed information regarding erosion and sedimentation in the catchment that is summarised in this report. See the ESCP (Temple and Parsonson 2014) for more detailed information on erosion and sedimentation in the Hoteo catchment. Underlying information used to develop the Hoteo catchment ESCP plan is consistent with sources and data reviewed for the Environment and Socio-economic Review. Here we further augment the Hoteo Catchment Environment and Socio-economic Review by briefly outlining the recommendations of the Hoteo ESCP.

The ESCP details specific erosion control techniques that land owners may be able to adopt for a range of erosion processes on private property. For example, encouraging re-growth of aquatic plants, retaining natural channel form, limiting use of in-channel rock work, using erosion control fabric to protect assets such as bridges can all help limit stream channel scour. As well as specific intervention options, the ESCP recommends approaches to avoid erosion following exotic forestry harvest; the use of farm plans to implement erosion control on private farm land; riparian planting/restoration; and the maintenance of consented earthwork activity monitoring.

The ESCP identifies the importance of evaluating the effectiveness of interventions to reduce sediment yields, focussing on monitoring change to sediment yields a number of ways. For the first stage of the ESCP, Temple and Parsonson (2014) recommend that best management practices are tested in one or two subcatchments (Hoteo central and/or Whangaripo) over a 5-year period, and that specific targets for erosion and sediment reduction be set as part. For example:

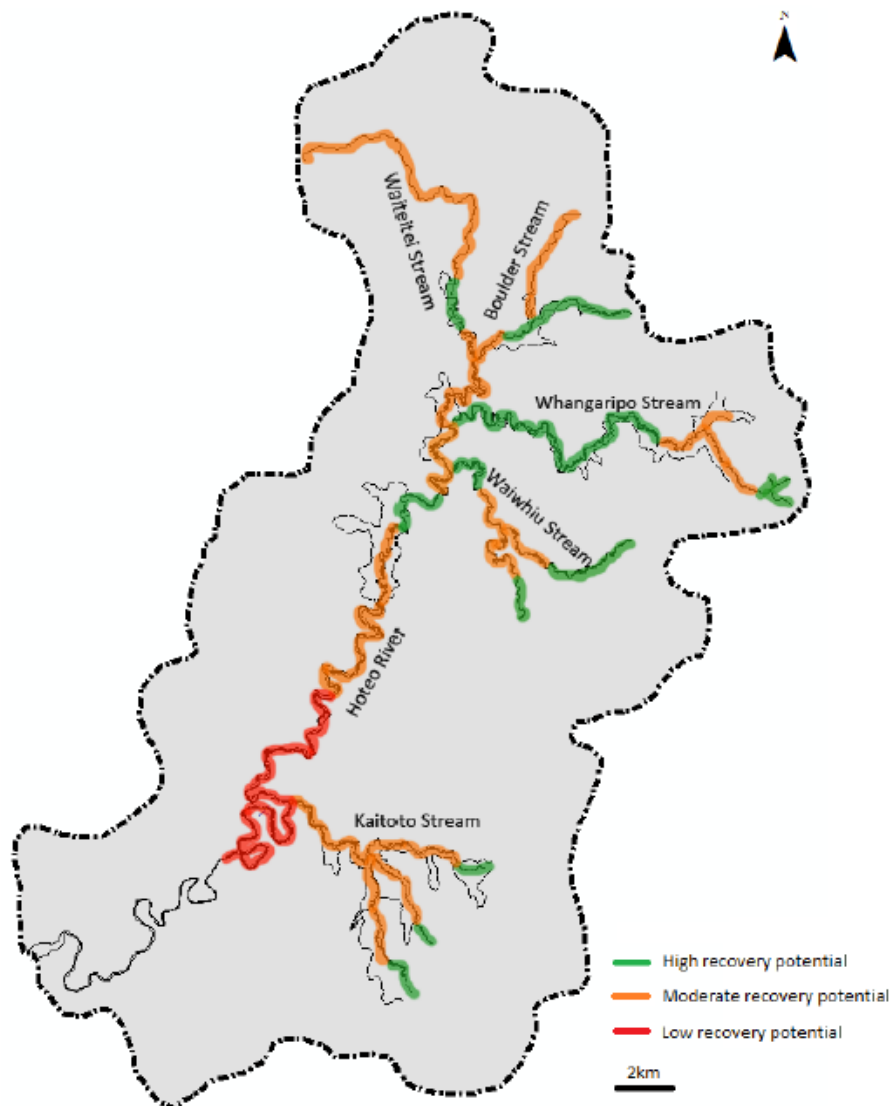
- 50 per cent landowners in the subcatchment are implementing sediment control practices
- 90 per cent permanent stream bank fenced and retired from grazing
- 40 per cent reduction in annual sediment load reaching Kaipara harbour



On completion and evaluation of stage one of the ESCP a second stage would be developed in consultation with key stakeholders (council, local landowners, etc.).

### 3.4.6 Riparian management recommendations for the Hoteo catchment (Buikema 2012)

The ESCP for the Hoteo catchment does not identify specific sites for riparian enhancement; however, Buikema (2012) developed a method to identify strategic riparian enhancement locations. Based on geomorphologic, spatial, and temporal analysis, Buikema ranks riparian areas as having either high, moderate or low potential for a reduction in bank erosion if riparian management is undertaken, thus indicating strategic locations for riparian management, e.g. Whangaripo stream and Waitapu stream (See Fig. 1).



**Figure 1 Ranking of likely effectiveness of riparian enhancement to reduce bank erosion along the Hoteo River and tributaries. Source: Buikema 2012.**

Figure 1 shows the ranking of likely effectiveness of riparian enhancement to reduce bank erosion along the Hoteo River and tributaries. Note that Buikema (Fig. 1) refers to the Kourawhero stream subcatchment as the 'Kaitoto stream'. The Kaitoto stream is one of the streams in the Kourawhero stream subcatchment. Further, where Buikema refers to Boulder stream, this report refers to Waitapu stream subcatchment. Boulder stream is a stream in the Waitapu stream subcatchment. A number of locations with good recovery potential can be seen additional to those highlighted by Buikema (2012), and long stretches of river bank throughout the catchment exhibit moderate recovery potential based on Buikema's analysis. Buikema (2012) emphasises the importance of field survey to identify sites for riparian enhancement and highlights the limitations of purely GIS based analysis for identifying the best sites for enhancement interventions.

### 3.5 Terrestrial ecology and biodiversity

The landscape of the Hoteo catchment today is highly modified. Vegetation cover is mostly made up of small fragments of indigenous cover, and exotic forest plantation set within a rural pastoral landscape. Very little of the original kauri forest remains and many of the indigenous fragments are regenerating kānuka and mānuka forest. Larger forest remnants are found along the steep hill country to the east of the catchment where the Dome forest and Omaha forest are situated. Mt Atuanui (Mt Auckland) in the lower Hoteo River subcatchment is the largest single forest fragment in the area. All ecosystems in this area (DOC's Rodney Ecological District) are extensively depleted, in particular freshwater wetlands and kauri forest. Indigenous species in the catchment have been significantly impacted by landscape modification and introduced species (Lindsay et al. 2009; Craig Pratt, 2013, Auckland Council, pers. comm.).

The Hoteo catchment falls within two Department of Conservation (DOC) ecological districts: the coastal edge of the catchment falls within the Kaipara Ecological District, and the remainder of the catchment falls within the Rodney Ecological District (RED) (Davis 2002; DOC 1995; Mitchell et al. 1992; MfE 2000, 2007). This review of terrestrial ecology and indigenous biodiversity of the Hoteo catchment incorporates information from the comprehensive surveys carried out by DOC for these ecological districts (Davis 2002; DOC 1995; Mitchell et al. 1992).

#### 3.5.1 Land Environments New Zealand

Land Environments New Zealand (LENZ) is a quantitative classification of New Zealand's terrestrial environments. LENZ identifies climatic, landform, and soil variables that play important roles in determining biological patterns. The system groups sites with similar environmental conditions. LENZ analysis provides information about New Zealand's ecosystems that can help with decision-making for a range of resource management issues, such as identifying priority areas for conservation and restoration; reporting on biodiversity and change to biodiversity in an area of interest; or investigating biosecurity risks based on

environmental factors likely to support particular invasive species. Leathwick et al. (2002a, 2002b) outline further examples of how LENZ can be utilised for decision-making.

The LENZ classification has been completed at four scales, LENZ Levels I to IV. Level I describes 20 environment types for New Zealand; Level II describes 100; Level III describes 300; and Level IV describes 500 environment types. In this section all the Level IV environments found in the Hoteo catchment are outlined and the four environments that dominate in the catchment are described. In the following section threatened LENZ environments in the Hoteo catchment are discussed.

Our analysis indicates that the Hoteo catchment is made up of 19 Level IV land environments, and 94 per cent of the catchment is made of four Level IV land environments – A6.1b, D1.1a, G3.1b, and A7.2a. Fifteen LENZ environments make up the remaining 6 per cent of the catchment area.

The Hoteo catchment is predominantly *Environment A – Northern lowlands*, at 79.5 per cent of the catchment. Environment A6.1b makes up 74 per cent of the catchment, which occurs on the rolling/undulating hills north of Auckland. This environment has warm temperatures, high solar radiation, and low annual water deficits. Deeply weathered sandstone is the most widespread soil parent material. Soils are imperfectly drained and have low natural fertility. A further 12 types of Northern lowlands A environments are found in the catchment: A4.1a; A5.1a, b, c, and d; A5.3a; A6.1a, c, and d; A7.1a; A7.2a; and A7.3a. Each of these land environments from the Northern Lowlands A group have the same general characteristics but will differ in terms of one or more variables, for example, temperature, soil fertility, slope, elevation or water deficit.

Environment A7.2a makes up 4 per cent of the catchment. Environment A7 occurs on gently sloping land at low to mid-elevation in Auckland. Climate is as with environment A6. Rhyolitic alluvium and tephra are the dominant soil parent materials, with smaller areas of younger basaltic rock, wind-blown sand, and loess. Soils in this environment are imperfectly drained and of low fertility.

Land Environment D1: Northern Hill Country makes up 12.9 per cent of the catchment, and 10 per cent of the catchment is Land Environment D1.1a, which has warmer temperatures than other D1.1 environments. Land Environment D1 is found on strongly rolling hills. The climate is warm with high solar radiation, low monthly water balance ratios, and slight annual water deficits. Soils are well-drained and of moderate fertility from andesite or basalt parent material.

Land Environment G3.1b makes up 6 per cent of the catchment. Land Environment G is characterised as Northern Recent Soils land. The climate is warm, with high solar radiation, moderate vapour pressure deficits, and low annual water deficits. G3.1b occurs on gently undulating flood plains with recently developed soils of low fertility from mixed alluvium. Soils are well drained.

One of the strengths of the LENZ classification system is its ability to compare areas with the same land environment characteristics. For example, a LENZ analysis could be conducted

for the Hoteo catchment to identify sites in the surrounding area that have the same characteristics of a chosen restoration site. Sites with existing successful restoration or mature ecosystems in place could then be used to develop restoration plans for new sites.

### 3.5.2 Threatened Environment Classification

The threatened environment classification provides broad-scale information (national scale) designed to assist with setting priorities for protection of indigenous biodiversity and for planning biodiversity protection and restoration activities (Walker et al. 2007). The threatened environment classification combines LENZ, the LCDB (Land Cover Database), and PAN-NZ (Protected Area Network NZ) data to identify areas where a high proportion of indigenous vegetation has been cleared and only small proportions are legally protected.

Each of the 500 land environments identified at LENZ Level IV is assigned one of six threat categories (Table 3). The first five categories are jointly referred to as threatened environments and these areas include some of the most reduced and least protected indigenous biodiversity in the country (Walker et al. 2007).

The threat classification for each of the 19 Level IV land environments identified in the Hoteo catchment is shown in Appendix A – Map 23. The Threatened Environments Classification identifies a number of acutely threatened and chronically threatened environments, in particular river plains and wetland areas. More than 5000 hectares of the catchment is classified as category 1 or 2, acutely or chronically threatened. Much (about 30,000 hectares) of the catchment is Level 3: At Risk, predominantly pasture land in rolling and steep hilly areas. And some areas of the catchment are Level 6: Less Reduced and Better Protected, in particular where protected forest remnants are situated.

**Table 3 Threat categories under the Threatened Environment Classification**

Category	Criterion	Name	Hoteo catchment hectares in each threat category
1	<10% indigenous vegetation left	Acutely Threatened	2,233
2	10–20% vegetation left	Chronically Threatened	2,925
3	20–30% vegetation left	At Risk	29,749
4	>30% vegetation left and <10% protected	Critically Under protected	36
5	>30% vegetation left and 10-20% protected	Under protected	97
6	>30% left and >20% protected	Less Reduced and Better Protected	5,294

### 3.5.3 Significant areas of indigenous biodiversity

The Rodney District Plan (Auckland Council 2011) identifies highly valued areas of a catchment in three categories: significant natural areas (SNA), highly valued landscapes, and geologically significant sites. The SNA methodology is based on the Rodney Ecological District survey completed in 1984 (Auckland Council 2011). No highly valued landscapes or geologically significant sites are identified for the Hoteo catchment. A number of significant natural areas are identified within the catchment, consistent with the updated Significant Ecological Areas (SEAs) identified in the draft unitary plan (Auckland Council 2013). The SEA assessment expands the older SNA assessment and updates information for the catchment, identifying a more comprehensive set of significant ecological areas.

The Proposed Auckland Unitary Plan 2013 identifies Outstanding Natural Landscapes (ONLs), Outstanding Natural Features (ONFs), and Significant Ecological Areas (SEA) in the Auckland region. In the Hoteo catchment 197 SEAs are identified (Auckland Council 2013). Detailed information was available for nine of the larger SEA within the catchment (Appendix A – Map 22):

- Ryan Road forest remnant
- Logue's Bush
- Pakiri Hill forest
- Omaha Ecological Area – Mt Tamahunga
- Dome forest Stewardship Area
- Hoteo River and Wayby Wetlands and Bush
- Woodcocks Knob forest
- Moirs Hill and Onehunga Stream Scenic Reserve
- Atuanui Stewardship Area (Mount Auckland).

The Hoteo River and Wayby wetlands are discussed in the freshwater ecology and biodiversity section below. Limited information was available for Woodcocks Knob forest, Moirs Hill, and the Onehunga Stream Scenic Reserve; discussion of these areas is omitted here for this reason. The other SEA of smaller size and/or with limited information available are also of significance for biodiversity within the catchment; however, information about them is not summarised here individually. Multiple rare and threatened species have been identified within SEA in the catchment.

#### 3.5.3.1 Ryan Road forest remnant

The Ryan Road forest remnant lies in a gully feeding a tributary of the Waiteitei stream in the north of the catchment. The remnant is regenerating forest representative of the surrounding area and contains the best example of a kahikatea–tōtara regenerating complex in the Rodney Ecological District (RED). This bush fragment is ranked as *potential* for its value as wildlife habitat, and supports a range of common forest birds. Biodiversity staff at Auckland Council stressed that the biodiversity values existent at this site mean water abstraction

through the construction of dams for irrigation at this site would be unsuitable (C Pratt, 2013, Auckland Council, pers. comm.).

### **3.5.3.2 Logue’s Bush (crown ownership)**

Logue’s Bush, approximately 82 hectares in size, is a Department of Conservation (DOC) scenic reserve located at the confluence of the Waiteitei and Waitapu streams. Land Tenure is mixed between the crown and multiple private owners (Appendix A – Map 22). This forest remnant is made up of kauri on its steeper ridges, broadleaf forest, kahikatea forest, and one of the best examples of lowland tōtara forest on alluvium in the RED. Logue’s bush has a high wildlife habitat rating, providing habitat for the regionally threatened species kākāriki.

### **3.5.3.3 Pakiri Hill forest**

Approximately 280 hectares of Pakiri Hill forest falls within the Hoteo catchment, forming the headwaters of the Whangaripo stream. Land tenure is held by numerous private owners. This isolated hill site is surrounded by intensive agricultural land making it an important habitat island within its surrounding agricultural landscape. The area of Pakiri Hill forest in the Hoteo catchment has two main forest types – mānuka scrub on lowland hill country and complex forest on lowland hills. The complex forest is characterised by kahikatea, taraire, rewarewa, tōtara and pūriri. This forest is home to common forest birds and the at-risk Hochstetter’s frog (Newman et al. 2010) has been identified in some of the streams in this area. The forest is rated moderate-high value as wildlife habitat in the RED area.

### **3.5.3.4 Omaha ecological area – Mt Tamahunga (Ngāti Manuhiri ownership)**

Approximately 83 hectares of Mt Tamahunga/Omaha Ecological Area falls within the Hoteo catchment, forming the headwaters of the Whangaripo subcatchment. Land tenure is held by numerous private owners. The area of forest in the Hoteo catchment is predominantly young regenerating kānuka forest. This forest is of significance as wildlife habitat, supporting a high diversity of common birds and Hochstetter’s frog. Rodney District Council (RDC) identified Mt Tamahunga as an outstanding Significant Natural Area (Auckland Council 2011).

### **3.5.3.5 Dome Forest stewardship area (crown ownership, partial)**

The Dome Forest stewardship area is approximately 840 hectares in area, with approximately 200 hectares of this falling within the Hoteo catchment, mostly in Waiwhiu, as well as a smaller area in Whangaripo subcatchment (Appendix A – Map 22). Ownership of the forested sites is mixed, with some in crown and some in private ownership. Dome forest is the largest grouping of forested sites in the RED.

This group of forested areas is significant as wildlife habitat and as representative of the original forest of the RED. The forest around Conical Peak is rated high value for wildlife habitat. These forests support a range of common forest birds as well as less common species such as kaka, tomtit, and kakariki. Significant forest classes found in the Dome forest include podocarp hardwood, rimu–kahikatea, and podocarp–hardwood forest.

Typically species in these forests include rewarewa, hīnau, tawa, and taraire. The forest has

one of the only large areas of virgin forest in the RED. Other sites in this area are regenerating mānuka and kānuka.

### **3.5.3.6 Atuanui stewardship area (Ngāti Whātua o Kaipara)**

The Atuanui (Mount Auckland) stewardship area is in the lower Hoteo River subcatchment. The area is approximately 370 hectares and is iwi owned (Ngāti Whātua o Kaipara) and co-managed with the Department of Conservation (DOC) (Appendix A – Map 22). The area is the largest area of indigenous forest in the RED and the largest forested area along the west coast between the Waitakere ranges and Waipoua. The forest is made up of complex lowland forest on hill country and taraire-dominated forest. The forest complex is typically a mix of species, with none dominating. The taraire forest is the best example of this forest type in the RED and its canopy species include pūriri, karaka, and kohekohe, with large emergent rimu above the canopy. Atuanui forest has important natural character values regionally and has been formally protected since 1887. It is notable for the continuous sequence of vegetation from the Hoteo estuary up to the summit (305 m) and for the presence of a rare orchid (*Yoana australis*). This forest has medium-high values as wild life habitat and provides a variety of habitats supporting a range of common forest birds. Its northern extent abuts the Hoteo River. This area of undisturbed vegetation at the river edge is home to the threatened banded rail, shags, and other waterfowl.

### **3.5.4 Small forest remnants and other protected areas**

Small remnants exist dotted throughout the landscape, many of which may be identified as SEAs. They may be on private land and may or may not be protected by the QEII covenant or the Rodney bushlot covenant.

Seven QEII covenants (total area 294 hectares) are recorded, as are 415 'bushlot' covenants (total area c. 1785 hectares). In 1984 Rodney District Council introduced its voluntary bushlot covenant policy, which allows new rural subdivision where new areas of privately owned bush and/or wetlands are protected by covenant (bush/wetland areas must meet certain criteria to qualify).

### **3.5.5 Threatened species recordings**

Records of threatened reptiles and amphibians held by Auckland Council record 91 sightings of 6 species between 1940 and 2012. Nearly all these are of the declining Hochstetter's frog in approximately 17 streams. The other recordings are of the green frog, relict pacific gecko, forest gecko, and copper skink. Threatened bird species information for the catchment held by Auckland Council comprises eight sightings of threatened birds, one for the Caspian tern and seven for the kākā. Both species are nationally vulnerable.

## **3.6 Freshwater streams, lakes and wetlands**

Plentiful rainfall and a large catchment area support a variety of freshwater environments, including surface water, rivers, lakes and wetlands, and groundwater resources. Surface waters and groundwater provide numerous services to people including water supply, food gathering, waste assimilation (the receiving and break down of human wastes, e.g. point

source discharges from factories into waterways, and diffuse source animal wastes from agricultural land), and recreational activities. The following sections summarise readily available information about the hydrology, water quality, freshwater ecology, and biodiversity for the Hoteo catchment.

### 3.6.1 Hoteo River and tributaries

Surface water in the Hoteo catchment is composed of rivers, small streams, small lakes, dammed water, and wetlands. The largest river in the Auckland region by both flow and catchment area, the Hoteo drains approximately 8 per cent of the Auckland region, and is a 7<sup>th</sup>-order river at its mouth (ARC 2010) (Based on the Strahler order system (US Army Corps of Engineers) a 7<sup>th</sup>-order stream occurs when two 6<sup>th</sup>-order tributaries merge. A 1<sup>st</sup>-order stream has no tributaries, a 2<sup>nd</sup>-order stream forms where two 1<sup>st</sup>-order streams merge, and so on. See ARC (2010 p. 140) for a full description of the Strahler order system. Based on NIWA's REC (River Environment Classification) system the Hoteo River is 5<sup>th</sup>-order at its mouth, highlighting that different interpretations of information about the river exist (Appendix A – Map 28).

The Hoteo forms at the confluence of the Whangaripo and Waiwhiu streams and meanders south for approximately 30km from its headwaters just northeast of Wellsford to its mouth in the southern Kaipara harbour near Mangakura. Its long-term (29-year data record) annual average discharge is 5.9m<sup>3</sup>/s. The river is fed by a multitude of small streams as well as the main tributaries, Waiteitei, Waitapu, Boulder, Waiwhiu, and Kaitoto streams. The streams in the uplands of the Hoteo are characterised by pools and riffles with silt and gravel substrate, and have grassed riparian areas with frequently occurring tōtara, kānuka, poplars, and willows. The lower Hoteo is characterised by shallow bedrock reaches followed by deeper pools and runs through steep hills in its lower reaches (Auckland Council 2012).

Much of the Hoteo River is identified as SEA, and nearly the entire river as an Outstanding Natural Feature of the Auckland region (Auckland Council 2013b). At its lower reaches, the river flows through the Hoteo gorge, which is identified as one of the REDs outstanding landforms.

Buikema (2012) categorised stream profiles using the river styles framework for the Waiteitei, Whangaripo, Wawhiu, Boulder streams, and the Hoteo. Streams in the Hoteo catchment fall into one of three river profile types: streams draining the uplands (e.g. Whangaripo and Waiwhiu) have steep, stepped profiles that flatten when they reach the foothills; streams rising in the foothills (e.g. Waiteitei) have smoother, concave profiles; and streams flowing predominantly across river plain have flat profiles. Most of the streams in the catchment flow across flat alluvial plains at some point.

### 3.6.2 River Environment Classification

The REC (River Environment Classification) system is used to identify stream characteristics and is helpful for building understanding of the river environments within the catchment for management options. REC analysis is presented in the map series 24–30 representing:



stream area, stream geology, stream climate, source of flow, stream order, valley landform, and stream land cover. Key summary points from the REC analysis are outlined here.

Throughout the catchment small streams draining areas of 50–500 hectares feed the main tributaries to the Hoteo River. The main tributaries mostly drain subcatchment areas of 5000–10 000 hectares and the main Hoteo River drains a land area of around 40 000 hectares (Appendix A – Map 24). Stream geology is predominantly soft sedimentary (Appendix A – Map 25) and climate is classified as warm-wet for all streams (Appendix A – Map 26). The majority of streams in the Hoteo Catchment are headwater streams of order 1 or 2, and the main trunk of the river is classified as 5<sup>th</sup> order (contradictory to Auckland Regional Council’s classification of the stream as 7<sup>th</sup> order (ARC 2010)) (Appendix A – Map 28). Appendix A – Map 29: Valley Landform represents stream slope as high, medium or low gradient and is found to be consistent with the river longitudinal profile analysis of Buikema (2012). High-gradient streams are found throughout the ranges to the east of the catchment and around Hoteo gorge and Atuanui Scenic Reserve in the south of the catchment, which are predominantly forested areas. These high-gradient streams grade to medium-gradient and low-gradient streams as they move through foothills and river plains. In the north of the catchment streams are medium and low gradient. The majority of streams run through catchments with pastoral land cover (Appendix A – Map 30). Streams running through catchments of exotic and indigenous forest are found in the central east of the catchment, mostly in the Waiwhiu and Hoteo central subcatchments where the ranges or uplands are found.

### 3.6.3 Hoteo River riparian vegetation

Riparian vegetation analysis intersecting stream channel length with land cover at the channel boundary found that 63 per cent of the Hoteo River and major tributaries have riparian vegetation (Table 4: Percentage stream length with riparian vegetation by subcatchment). Waiwhiu and Hoteo central have the greatest length in riparian vegetation. Waiteitei and Waitapu have the least stream length in riparian vegetation.

Table 4 Hoteo catchment: Percentage stream length with riparian vegetation by subcatchment

Subcatchment	% channel with riparian vegetation
Waiteitei	56
Waitapu	53
Whangaripo	60
Wayby	40
Hoteo central	77
Waiwhiu	96
Hoteo Gorge	66
Lower Hoteo River	54
Kourawhero	68
Total	63

### 3.6.4 Hoteo River hydrology

River water level and flow data have been collected for Hoteo at Gubb's for nearly 30 years and at Waiteitei Stream at Sanderson's for 17 years (Appendix A – Map 31). Mean daily flow at Sanderson's is 1.8m<sup>3</sup>/s (1996–2010 average), and 6m<sup>3</sup>/s at Gubbs (1982–2010 average) (Buikema 2012; Auckland Council 2010). Mean annual flood flow at Sanderson's is c. 50m<sup>3</sup>/s and at Gubb's c. 80m<sup>3</sup>/s. Bank full discharge is 102m<sup>3</sup>/s at Sanderson's and 185m<sup>3</sup>/s at Gubb's, which is a 5-year ARI (Annual Recurrence Interval) event at both sites. Maximum recorded discharge at Gubb's is 283m<sup>3</sup>/s, which represents a 25-year ARI event at this site. The 100-year ARI event maximum flow at Gubbs is predicted to be 496m<sup>3</sup>/s. Map 32 shows the 100-year ARI inundation event water levels across the catchment. Annual Return Interval (ARI) refers to the estimated time period between a flood event of the same or similar size and intensity (NIWA 2014). For example, water flow in the Hoteo River (at Gubb's) is estimated to reach 185m<sup>3</sup>/s once every 5 years.

#### *Flooding*

Flood events are a natural occurrence that can be expected along all river reaches. Flood events become a risk management issue when human activities and/or development are situated too close to the areas prone to inundation. Human activities and land-use change can both worsen flood peaks, for example through the removal of vegetation, as well ameliorate flood peaks, for example through revegetation. Predicted inundation levels for Auckland region have been modelled by Auckland Council (DHI Environment and Water 2009) (Appendix A – Map 32).

The depth and velocity of river water is dependent on water volume, river gradient and substrate. Channel morphology (i.e. shape) is dependent on geology and flood flows (i.e. flood flows tend to shape river channels (Charlton 2008). The Hoteo River is described as an incised, single-thread, sand-bed stream that is highly enriched with high flow variability (Temple and Parsonson, 2014). The highest flood level recorded at Gubbs monitoring station was about 10 m in July 1998 and the mean annual flood is about 7 m (Temple and Parsonson, 2014).

For the Hoteo River, high flows occur in July (low flows in February). The river has naturally high differences between base-flow conditions and flood events because the channel is constrained and the river has relatively narrow flood plains (Temple and Parsonson 2014). The river experiences over-bank flooding approximately once or twice a year. These annual flood events tend to spread across the floodplains in the middle catchment, but are confined within Hoteo gorge.

High water velocities during flood events cause channel scour and stream bank erosion. The ESCP summarises about flood events and bank erosion:

*The flood peak, and the duration of peak recession have a strong effect on bank erosion. How much of the suspended sediment gets re-deposited along banks, and how much get carried out to Kaipara depends on low flows. During low flows*

*coarse sediment quickly settles, but fine sediment (clay) remains in suspension for days.*

### 3.6.5 Lakes in the Hoteo catchment

The Hoteo catchment has a small number of lakes, of which Silver Hills Reservoir is the most notable (Appendix A – Map 31). Constructed in the early 1990s for use as an irrigation reservoir, Silver Hills has been categorised as having ‘fair’ ecological quality based on a macrophyte index score of 30 out of a possible 100. This score is reflective of the restricted depth of vegetation around the lake and the presence of the invasive pondweed *Potamogeton crispus* (de Winton and Edwards 2012).

Scores for lakes across the Auckland region ranged from 0 to 90. Of the 29 sites monitored for macrophyte ecological quality, 14 per cent are classified as having ‘excellent’ ecological quality; 10 per cent as ‘good’; 24 per cent as ‘fair’; 24 per cent as ‘poor’; and 28 per cent were non-vegetated. Of the lakes with scores under 50, reservoir lakes’ macrophyte communities are most limited by changes in water level, and natural lakes were found to be limited most by invasive weeds. Auckland Council note that relationships between lake state and surrounding land use are not able to be made based on the current monitoring data (ARC 2010).

Farm dams and ponds are more common than lakes in the catchment. The catchment has about 395 dams and small ponds, 33 of which are on-stream permanent dams. The total area of off-stream dams is about 30 hectares. The reservoir areas of dams in the Hoteo range in size from 9m<sup>2</sup> to 4000m<sup>2</sup>, with an average size of 830m<sup>2</sup>. The majority of dams and ponds are in the north and west of the catchment in the Waiteitei, Waitapu, Whangaripo, western Hoteo central, Wayby and Kourawhero subcatchments and lie on LUC class 3 and 4 land (Auckland Council 2012). Dams typically lower sediment yields downstream by trapping sediment (Thompson 2012).

### 3.6.6 Hoteo catchment wetlands

Freshwater wetlands in the Hoteo catchment have been severely depleted as they have been drained to create agricultural land. Remaining wetlands are small, scattered, and predominantly raupo reedlands. Remaining wetlands have been affected by grazing animals, farm run-off and invasive plants. Birds found in wetlands areas include ducks, teal, pukeko, dabchick, banded rail, crakes, fernbirds, bittern, and harrier. Little information is held regarding fish and aquatic invertebrates (C Pratt, 2013, Auckland Council, pers. comm.).

The Auckland Council Regional Plan: Air, Land, Water (Auckland Council 2010) identifies three wetland management areas in the Hoteo catchment: the Ingelton Road wetland and the Wayby wetlands. These are also identified as SEAs in the draft Auckland Unitary Plan (Auckland Council 2013). Ingelton Road wetland is characterised as swamp bordered by bush and the Wayby wetlands are raupo and kahikatea swamp. These wetlands are ranked moderate-high for their value as wildlife habitat and although small they provide habitat for a range of wetland wildlife including spotless crake and the threatened bittern, and regionally threatened fernbird, as well as common forest birds. These habitats are rare fragments that

remain in the RED district (C Pratt, 2013 pers. comm.; Auckland Council). However, in comparison with other significant wetlands in the DOC Auckland Conservancy, Hoteo's wetlands are not considered of high conservation priority (Lindsay et al. 2009).

### 3.6.7 Hoteo River water quality

The Auckland Water Quality Index (WQI) determines water quality by measuring seven water quality parameters: dissolved oxygen, pH, turbidity, ammonia, temperature, total phosphorus, and total nitrogen. These are used to assess the life supporting capacity of the river water at a site as excellent, good, fair, or poor. See Section 7: Hoteo catchment monitoring and research for a summary of river water quality and lake ecological quality monitoring for the catchment.

Water quality for the Hoteo River is reported as 'fair' based on a score of 66.3 for the Auckland Council Water Quality Index (WQI). For both forested and rural sites water quality results showed little change over the monitoring period 1995–2005 (ARC 2007a).

However, the River Water Quality Annual Report 2010 (Neale 2012) classifies the Hoteo River as having poor water quality in 2008, and good in the other 3 years reported on (2007, 2009, and 2010). The parameters that degraded water quality in the Hoteo River in 2008 were turbidity (to the greatest extent) and phosphorus levels (to a lesser extent). Turbidity in the river was higher due to sedimentation, most likely transported to the river during individual flood events that monitoring period. Sediment transported during individual flood events appears to impact the river's water quality class.

Reducing suspended sediment concentrations has been identified as a priority for improving water quality in Hoteo River; however, it is important to note that there is a risk that improving light penetration into the water column, as will occur with reducing sediment levels, could enable algal growth (Jason Julian, 2014, Texas State University, pers. comm.; Oliver et al. 1999).

### 3.6.8 Water use consents

The Hoteo catchment falls within Auckland Council's North West water resource management area, for which Auckland Council monitors and manages water abstraction. The water resource area has large surface water allocations for irrigation of dairy pasture, of which only 1.7 per cent of the annual allowance was used in the reporting period ending 2002 (ARC 2010). Hoteo catchment has one high use management stream – The Whangaripo (Auckland Council water abstraction monitoring for North West water resource management area). There are no flow-monitoring sites for the Whangaripo stream at this time (ARC 2008). Surface water is abstracted mainly from run-of-stream flow, lakes, and dams (Crowcroft and Bowden 2002).

Consented water abstraction for the catchment is for more than 1.3 million cubic metres per year, or approximately 15 400 cubic metres per day. Consents for surface water abstraction are primarily for agricultural purposes, in particular for irrigation. Surface water abstraction appears to be preferred over groundwater abstraction, for which a much smaller abstraction

volume is consented (outlined in the subsequent section), presumably because aquifers are low yielding or occur only intermittently. Auckland Council has water takes from Whangaripo stream and the upper Hoteo, which supply water for municipal use mostly for Wayby Valley, Kaipara flats, and Wellsford (ARC 2003).

### 3.7 Groundwater

Groundwater storage provides essential base flow to rivers and streams that support the surface water quantity, quality, and ecosystems (ARC 2010). The Hoteo catchment is underlain by groundwater that is a part of the Waitemata Group – sandstone and mudstone confined aquifer. Although the Waitemata Group sandstone and mudstone aquifer is categorised by Auckland Council as high use and vulnerable in shallow aquifer systems (ARC 2007b), groundwater abstraction is in fact not high use in the Hoteo catchment and for this reason is not monitored. Groundwater levels are monitored in 'high use management aquifers' only, of which there are none in the catchment. Groundwater quality is also not monitored in the catchment. No further comment can be made about groundwater quantity; however, ground water quality in the catchment can be inferred from monitoring conducted at Quintals Rd Bore and the Chenery Rd Bore (outside the catchment).

Quintals Rd bore tests a Waitemata Group – sandstone and mudstone confined aquifer in an agricultural catchment area, and Chenery Rd bore tests a Waitemata Group – sandstone and mudstone confined aquifer in an urban/residential catchment area. Groundwater quality at both deep bore sites is reported as excellent (ARC 2010). These are deep bores in confined aquifers (confined aquifers denote that a layer of rock or other impervious material sits between the surface and the water in the aquifer, protecting the water from contaminants) where the groundwater tested is old (100 or more years) and protected from overlying land use activities. Shallow groundwater may or may not be confined in the Hoteo catchment, and the younger, shallow groundwater may have lower water quality than that tested at the Quintals Rd and Chenery Rd sites because it is reached by land use contaminants (Sharon Vujnovich, 2013, Auckland Council, pers. comm.).

### 3.8 Aquatic ecology and biodiversity

The New Zealand Freshwater Fish Database maintained by the National Institute of Water and Atmospheric Research (NIWA) records survey data of native fish identified in New Zealand streams. The database records 232 freshwater fish sightings for the Hoteo catchment. The fish species recorded for the Hoteo catchment included longfin eel, kōura, common bully, shortfin eel, Crans bully, banded kōkopu, redfin bully, brown trout, torrentfish, gambusia, yelloweye mullet, and Australian longfin eel. Full details of each of the sightings, their location, and date can be obtained from Auckland Council.

Compared with many Auckland rivers, the Hoteo River is relatively long and the upper catchment relatively far from the coast. Important spawning grounds for juvenile migrating fish are expected to be in the estuarine area at the mouth of the river and in the lower reaches of the river close to the coast. Information about specific fish spawning grounds is not available. The river has significant recreational values for its whitebait fishery, being

possibly the only good whitebaiting spot in the Auckland region. Knowledge of key whitebait spawning grounds, the whitebait fishery, and potential environmental degradation of spawning grounds would enable the protection and management of those areas to ensure the preservation of the fishery.

Wetland remnants have been identified as SEA and provide habitat for some indigenous species, as noted in the previous section covering wetlands.

Habitat disturbance and modification is highlighted as a major pressure on biodiversity (ARC 2010). In the Hoteo catchment, streams running through agricultural pasture lands are the most likely to have degraded biodiversity values. Sedimentation of streams due to erosion of soils from agricultural lands and stream banks are of concern in terms of water quality and impacts on stream ecology in the catchment (Maxted 2005; Temple and Parsonson 2014). Further to this, activities that adversely affect stream ecology and biodiversity include channelization/excavation, removal of shading riparian vegetation, and stock-watering where stock are directly able to access the waterway (Zandvoort et al. 2009). However, Doehring and Young (2009) found that rates of aquatic ecosystem respiration in the river (just below Hoteo gorge) were 'healthy' to 'acceptable'. Variation was seasonal, with rates of algal growth occasionally marginally high in spring and autumn. These results are indicative of a healthy ecosystem.

### 3.9 Receiving marine environment: Kaipara harbour

The Kaipara harbour drains into the Tasman Sea north of Auckland. Kaipara is New Zealand's largest harbour, with a high tide surface area of approximately 847km<sup>2</sup> (Heath 1975, cited in NIWA 2012). NIWA (2012) describes Kaipara harbour as "...a complex drowned-valley barrier-enclosed type estuary located on the west coast of the Northland Peninsula" (Hume and Herdendorf 1988, cited in NIWA 2012). The northern Kaipara is characterised by deeply indented river and tidal tributaries. The southern Kaipara is characterised by intertidal sand flats, mudflats, mangrove forest, and small, sheltered embayments into which tidal creeks discharge (NIWA 2013).

Today's harbour formed about 6500 years ago when sea levels stabilised at the present level, and since then the harbour has been infilling with both marine and land based sediments that have created the sand banks and tidal flats that are seen today in the inner harbour (NIWA 2012). The harbour supports a range of estuarine environments (e.g. intertidal flats, sand barriers, and tidal river systems) and provides an important nursery ground for finfish (e.g. snapper). For example, the harbour is believed to support almost the entire snapper fishing industry along the west coast of the north island (Morrison et al. 2009, cited in NIWA 2012).

The IKHMG (2011a, 2011b) identified declining biodiversity and increasing sedimentation and poor water quality as two key issues for the harbour. Concern about the environmental well-being of the harbour is high and considerable efforts are being taken to understand the issues affecting the harbour and to develop effective management response to combat ecological decline. It is believed that terrigenous sediment dispersal and deposition are

causing adverse effects on the water quality and life-supporting capacity of the harbour, for example, there is an observed decline in the harbour fisheries.

Terrigenous sedimentation is a natural process but the rate at which sedimentation occurs has increased as human activities have changed land cover. Increasing sediment loads have occurred at the same time as large-scale deforestation. The first wave of deforestation occurred in the Kaipara harbour catchment following human arrival in New Zealand approximately 700 years ago.

A recent study found three rivers contribute most of the terrigenous sediment to the Kaipara harbour – the Kaipara, the Hoteo, and the Wairoa – and most of the sediment being deposited on the Kaipara harbour intertidal flats is delivered to the harbour by flood flows rather than by mean annual flow (NIWA 2012). Hoteo River sediments spread to the north and south from the river mouth. Dispersal may be driven by winds from the southwest and northwest while currents flow to the north. The impact sediments have on benthic communities is determined by where sediment is deposited in the harbour and also by sediment redispersal with tides and wave action (NIWA 2012). A key concern regarding sediment dispersal from the Hoteo River is its potential impact on an important snapper spawning ground close to the mouth of the river (Auckland Council, no date).

## 4.0 Socio-economic environment

### 4.1 Settlement patterns and cultural heritage

*The catchment takes its name 'Hoteo' or 'the calabash' from a specific place beside the Hoteo River just upstream of the junction with the Kaitoto Stream. In a traditional sense this name applied to the river between the confluence of the Waiteitei, Waitapu, Whangaripo and Waiwhiu streams, and the river mouth at Puatahi (ARC 1995).*

The calabash (or gourd) was valued as a food container, suggesting the Hoteo catchment was treasured as a container or area of an abundance of food resources. Although the wider catchment was not permanently settled by Māori, all the hills, peaks, ridges and waterways were named (ARC 1995), showing that tangata whenua had strong associations with the entire catchment. Even the smallest tributaries in the catchment had their own names, giving each a unique identity and *mauri* (spiritual essence). High points around the catchment provide reference points and boundary markers for local iwi. Tangata whenua still retain associations with these land and waterscape features and the traditions associated with them (ARC 1995).

The historical settlement and development of the Hoteo catchment is closely linked to the resources and access provided by the Kaipara harbour, with Māori settlement focused around the lower reaches of the Hoteo River (Appendix A – Map 33). Historically, the wider Kaipara harbour area has been regarded as the food basket of local Māori. Archaeological evidence shows that the lands surrounding the harbour were extensively settled and contested by Māori (Waitangi Tribunal 2006). According to Māori tradition, the name “Kaipara” originated in the 15th century, when, during a visit to his nephew in Pouto, the Arawa chief Kahumatamamoe was so impressed by the cooked root of the para fern that he gave the name Kai-para to the area (“kai” meaning food).

The mana whenua associations described here are based on the IKHMG (2010) publication *The World of Kaipara*, from which a map of mana whenua associations can be sourced and several other documents cited. IKHMG (2010) show three iwi as holding mana whenua in the Hoteo catchment – Ngāti Whatua, Ngāti Manuhiri, and Te Uri o Hau.

The land surrounding the southern part of Kaipara harbour, including the lower Hoteo area, was inhabited principally by people from a number of hapu referred to collectively as Ngāti Whātua (Waitangi Tribunal 2006). A recent settlement through the Waitangi Tribunal was led by ahi kā Ngāti Whātua o Kaipara, as the collective group of those “individuals descended from Haumoewārangi and a recognised ancestor of at least one of Ngāti Whātua Tūturu, Te Tāōū, Ngāti Rongo, Ngāti Hine, or Te Uri o Hau, and who exercised customary interests predominantly in relation to the area of interest of Ngāti Whātua o Kaipara at any time after 6 February 1840” (Ngāti Whātua Claims Settlement Bill 2012).

Ngāti Whātua o Kaipara has held mana over land, harbours, rivers, streams, lakes, and sea of the Kaipara area for many generations. Ngāti Whātua entered the lower Kaipara in the



mid-18th century to avenge the murder of ancestor Hau-moe-warangi, replacing by conquest iwi Waiohua/Te Kawerau/Nga-Riki (Alemann 1992). Ngāti Whātua o Kaipara's area of interest encompasses the southern Kaipara region, from South Head to Muriwai on the west coast, and from near Wellsford to the upper Waitematā harbour to the east (Ngāti Whātua o Kaipara Claims Settlement Bill 2012).

Te Uri o Hau are mana whenua in the north of the catchment. The many waterways that flow into the Kaipara harbour are the very life force of Kaipara Māori, and the harbour itself is held as the primary source of life and well-being of Te Uri o Hau (Environs Holdings 2011). Te Uri o Hau Settlement Trust is recognised as kaitiaki of the northern part of the Kaipara harbour and its resources as part of their Treaty of Waitangi Settlement (Wilson et al. 2006; Environs Holdings 2011).

Ngāti Manuhiri and Uriokatia have ancestral lands in parts of the north and north-east of the Hoteo catchment (ARC 1995). The Hoteo River was an important traditional resource of Ngāti Manuhiri and has particular importance as the home of the ancestor Manuhiri from which the hapu derives its name. Ngāti Manuhiri originally settled the entire Kaipara area in the late 17th century and since then have lived, cultivated, and fished along the Hoteo. The river also provided a valued transport route inland to Tomarata and Whāngaripo (Unitary Plan, Appendix 4.2.4 Treaty Settlement legislation statutory acknowledgements – Ngāti Manuhiri).

Fisheries and shellfish were dietary staples for Kaipara Māori (IKHMG, no date). Surveys of middens in the lower Hoteo area suggest cockle was the primary shellfish exploited in this area, along with oyster, mud snail, and occasionally scallop (Auckland Council 2013). *Tuna* (eels) are also likely to have been a valued food source, but no quantitative assessment of Māori harvest exists (Environs Holdings 2011). Hoteo is also known for kokopu (whitebait) (Campbell 2010).

In the wider Kaipara area, fishing for subsistence and trade between whanau and hapu was common. The importance of fish to the local economy continued throughout the 19th century. When European settlers first arrived, fish supplied by Māori was a key resource enabling their survival. Kaipara Māori were involved in commercial harvest of oysters and toheroa until 1969, and Kaipara harbour was recognised as a significant spat production area for New Zealand (IKHMG, no date).

The relationship between Māori and kaimoana (seafood) was regulated by *tikanga* (lore, custom), including both physical and spiritual dimensions, including *mana* (authority), law, ritual and use, and the concepts of *tapu* (sacred) and *noa* (ordinary and free from restrictions) (IKHMG, no date).

The Hoteo catchment has not been systematically surveyed, and no archaeological investigations have been undertaken. Some archaeological sites have been recorded but only on an ad hoc basis related to investigations for resource consent applications for development. Archaeological survey coverage of the catchment is very low because only four recorded surveys have taken place in relatively small areas (Appendix A – Map 35).

Available records suggest a rich legacy of Māori and European settlement, although most have not been evaluated or protected. In relation to the timber industry alone, there are numerous timber camps, bullock roads, driving dams, log booms, and several mill sites (ARC 1995).

The ARC Cultural Heritage Index (CHI) includes a total of 119 sites in the Hoteo catchment (Appendix A – Map 33). This includes 88 Māori archaeological sites, 20 of which are pā sites. Of these, only 14 are scheduled under the Auckland Council District Plan, Rodney Section, 2011 (Auckland Council 2013a). The sites are predominantly middens (48%) along the coastal margins and lower Hoteo River. The remainder are pits and/or terraces on ridgelines, settlements, and taro sites. Most of the sites are in the coastal margins and lower Hoteo River (80%). The distribution of sites in the remainder of the catchment is sparse. Of the 20 recorded pā sites in the Hoteo catchment, 16 are situated along the lower Hoteo within 500 m of the river, and seven of these extend up the Mangatu Stream (Appendix A – Map 34). An additional three pā sites are situated north of the Hoteo River mouth, all within 1km of the coast (Auckland Council 2013a). While only a few pā sites are more than 2km from the coast, their presence implies additional archaeological sites may be located inland. These records suggest settlement was focussed along the lower Hoteo River, and this area was being gradually modified before European settlement (Murdoch 1994).

European Heritage Sites identified on the Cultural Heritage Index make up the remaining 13 per cent of recorded sites, primarily consisting of 14 historic structures and early industry sites (such as West sawmill).

In 2001, when Auckland Regional Council identified priority sites for survey and assessment of cultural heritage resources within the Auckland region, the western part of the Hoteo catchment was identified as a priority area for survey (Appendix A – Map 36). Further analysis of the historical background of the catchment by Auckland Council's Cultural Heritage team shows that a 1-km buffer along the river should also be identified as a survey priority. These areas of the heaviest settlement have many sites, particularly middens, at risk of being destroyed by coastal erosion and stock damage, which could potentially result in the loss of these records of settlement.

## 4.2 Early land use

The interior and upper reaches of the Hoteo catchment remained largely in native bush and most of the waterways were largely unmodified until European settlement. However, Māori settlements and the cultivation and harvesting of food (e.g. kumara, gourds, yams), medicinal plants and building materials over several centuries resulted in gradual environmental modifications, particularly in the lower reaches of the catchment (ARC 1995), and along the length of the river (Auckland Council 2013a). The kiore (Polynesian rat) and kurī (Polynesian dog) introduced by Māori settlers from Pacific homelands are also believed to have had an impact on flora and fauna in the area (ARC 1995). In the western edge of the catchment, in what is now known as the Tauhoa area, undulating hills were cultivated over many years, with scrub and fern evident in the mid-19th century (ARC 1995).

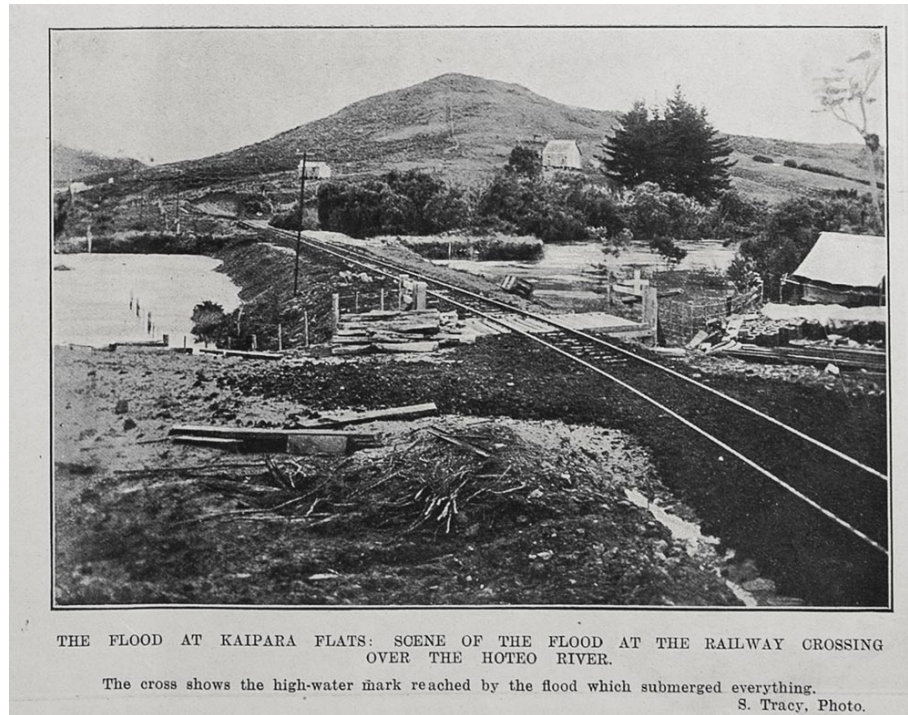
Puatahi, situated near the Hoteo River and adjacent to the Kaipara harbour, was a well-established Māori settlement when early European settlement began in the mid-19th century. Puatahi Marae (<http://www.naumaiplace.com/site/puatahi/home/welcome/>) observes the following ancestral links:

- Ko Mahuhu ki te rangi te waka
- Ko Kaipara te moana
- Ko Atuanui te maunga
- Ko Puatahi te marae
- Ko Ngati Rango me Ngati Rongo nga hapu
- Ko Ngati Whatua te iwi
- Tihei Mauri Ora

Atuanui, meaning “Great Deity”, is the Rodney District’s highest point, and, as shown in the *pepeha* above, was sacred to Kaipara Māori. Extensive earthworks are still visible, evidence of pā sites and fortifications. Renamed Mt Auckland by European settlers, the Atuanui State forest was logged but not burned off, and has been protected since 1887 (DOC 2012). This public reserve of 607 hectares includes the Mt Auckland walkway (Mabbett 1977), and is now administered by the Department of Conservation (DOC). Atuanui was returned to Ngāti Whātua o Kaipara in 2012 as part of a settlement for historical Treaty of Waitangi claims.

The first Crown land purchase occurred in 1844, enabling the first European settlement in 1849. European settlement began in earnest in the late 1850s, and within 30 years the whole catchment was occupied (Auckland Council 2013a). The Hoteo block was initially surveyed in the 1860s, and, following disputes between Ngāti Whātua and Superintendent Rogan, the government purchased the land for settlement. European immigrants were sold farm lots of up to 120 acres in the Hoteo district. Early settlers cleared scrub and native bush, usually followed by a burn-off and planting of grass seed (Mabbett 1977). By the 1880s, the catchment had been largely purchased by the Crown, with only the Puatahi and Mangakura Blocks located near the river mouth remaining in Māori ownership.

The timber industry was short-lived but made a dramatic impact on the landscape. During the early 1880s, “could be found pigeons by the thousand, the kaka, the tui and again of course, an army of wild pigs...the thump of the axe and maul, the buzz of the cross-cuts, the crash of falling trees, the tinkle of bullock bells” (Mabbett 1968:16, quoted in ARC 1995). Rich stands of kauri were milled and transported down the Hoteo River to the coast where it could be shipped to Helensville and railed to Auckland. Timber, flax, and kauri gum were also exported from the Kaipara harbour (Wright 1969). An estimated 12 million feet of timber was cut from the Waitapu subcatchment of the Hoteo, and a large amount was also extracted from the Wayby area (ARC 1995). As the timber industry of the area went into decline by the end of the 19th century, settlers turned increasingly to pastoral farming for income. Denuded hills resulted in many land slips, the most dramatic example of which is recalled from the flood of 1917 (Kaipara2kaipara, no date).



**Figure 2 Hoteo River flood damage, 31 January 1907.**  
 (Photographed by S.Tracy. Sir George Grey Special Collections, Auckland Libraries, ref# AWNS-19070131-13-5. Permission to reproduce this image was kindly given by Auckland Council Libraries.)

Original European settlers continued to develop the land into farms over the 20th century, and some of the original settler families remain in the catchment today. One resident, Reuben Watson, described growing up near the river in the late 1800s:

*In the year of 1888, I was seven years old. The kauri timber on a section of land lying at back of our old farm was owned by William Worker. The contractor... [Welton Brown]...undertook the job of felling and delivering the kauri logs to Nicklesons' Topuni mill. A wooden tramway was built and horses were used to pull the tracks...The horses were taken out of trucks on the crest of the hill and then the trucks ran down by gravitation the long slope as far as White's house, and then the horses were re-hitched and pulled to the top bank of the Whakapirau, the logs rolled into the stream, later rafted on high tides to mill (Johnston 2011).*

In relation to Tapu Bush, at the head of the river, Reuben Watson recalled:

*I cannot remember the correct year when the Tapu Bush started work, but I think 1890–1891 or there about. A loading ground and big shanty was made just across the Hoteo River and the first logs were hauled out and rolled into the stream, there waited for winter rains and floods. Hoteo was not a big river, but flowed through some rough country with many bends which held the water back and was in places quite a stretch of water and stayed sometime after rain*

*ceased...It was a dirty job keeping the logs in the stream, they often got stranded on small flats and had to be jacked back into the river (Johnston 2011).*

The Kaipara Flats area was early settled by Europeans, and continues to be one of the few minor settlements in the catchment. In 1858, it was first cleared of native timber and transformed into farmlands. A village with a school and library was established in 1878 (the school still exists today). A school was also situated at Mangakura. “Rach” Stevenson, born at Mangakura in 1887, recalled the immense Tauhoa forest stretching from coast to coast (Mabbett 1977).

In the late 19th century the government set aside gum fields on Crown lands in the Hoteo catchment, including at Kaipara Flats, Te Arai, and Wayby. These gum reserves were open to licensed diggers, many of whom were Yugoslav and other south-east European recent migrants (Mabbett 1977). A railway line was extended from Helensville through the Kaipara Flats in 1906 and to Wellsford by 1909, enabling the intensification of dairying and more economically viable sheep farming with easier access to lime and fertiliser, and transport of farm products to markets (Mabbett 1977). Farmer John Wyatt Thomson of Kaipara Flats gifted to the public “his well-known ‘Kauri Grove’ of six or seven acres on the old home farm” (Mabbett 1977, p. 336).

The greatest growth in pastoral farming occurred after World War II, with the completion of the metal roading network and improvements in farming technologies, which made farming in the hill country of the catchment more economically viable (ARC 1995).

Exotic forestry, an increasingly important activity since the 1970s, is situated in the middle and upper reaches of the catchment. The catchment also retains some of the largest blocks of native bush in the region, including Tamahunga (Omaha), Logues Bush, and Dome and Atuanui State forests, all set aside by the Crown as forest reserves in 1887 (ARC 1995). These tracts of indigenous forest are now administered by the Department of Conservation.

Sheep and cattle predominated through the farming heyday. More recently, dairy farming has increased somewhat and a trend towards farm aggregation has been observed. As well as farm aggregation a trend towards subdivision of farm lots for lifestyle blocks has also been observed by locals (Lees and Cole 2014). The catchment’s proximity to Auckland, the high cost of housing in the Auckland region, and diversification into nature-based tourism have all encouraged settlement by “lifestylers”.

As a large catchment traversed by many waterways, the Hoteo can too easily be viewed as merely a water source for farms and a major contributor to water-quality degradation in the Kaipara harbour. However, as this brief description of historical settlement and land use shows, the Hoteo catchment has long been highly valued – and therefore contested – for its rich land- and water-based resources and access routes.

The identity and well-being of local iwi are intimately linked with the Hoteo. Māori reverence and attachment to natural landscape features are evident in names of places and waterways, such as Atuanui or “Great Deity”, Kaipara for the “para” fern as a food source, and by naming every waterway and peak in the catchment, in an area named for the highly

valued calabash. European farmers with strong multi-generational links to the area are likely to have many stories in addition to those referenced above that reflect their intimate relationship with the place. Identification and acknowledgement of local affiliations and what has gone before are essential when engaging with local iwi, landowners, and other residents. It is anticipated that this brief review will contribute to this process of integrating local experiences, knowledge, and values into the SCP.

### 4.3 Demographic and cultural characteristics

The purpose of the socio-demographic review is to describe the existing residents of the Hoteo catchment and to identify significant demographic trends that shape the landscape. To achieve this, selected 2006 New Zealand census data have been extracted to build profiles of the Hoteo catchment population and its communities. These are compared with the wider Rodney District and Auckland region populations. Some more recent survey data are also used, as appropriate.

#### 4.3.1 Population distribution

Hoteo catchment has a usual resident population of 2649 residents. This represents 2.9 per cent of Rodney District's population and 0.2 per cent of the Auckland region. The Hoteo catchment's population density (0.07 residents per hectare) is lower than the Rodney district (0.12 residents per hectare), and considerably lower than the average for the Auckland region (2.5 residents per hectare) (Source: 2006 New Zealand Census).

Population distribution within the Hoteo catchment is described below in terms of two main settlement types: major residential settlements, and rural and coastal settlement (which rely on on-site wastewater disposal and treatment, with only limited growth anticipated). While there are small rural settlements in the catchment, census mesh blocks do not align closely enough to make analysis useful to describe the settlements. However, these small settlements are described in terms of physical and social infrastructure in the following section.

The major residential settlement in the catchment is Wellsford, which falls partially within and partially outside the Hoteo catchment. For this analysis, the Hoteo part of Wellsford (called Wellsford-Hoteo here) contains six census mesh blocks. Wellsford-Hoteo has a population of 468 people, which is 28 per cent of Wellsford's population (1671) and 18 per cent of the Hoteo catchment population (2649). Wellsford is the most densely populated and developed area within the catchment with a population density of 3 residents per hectare.

The wider Wellsford area unit is the basis for the Wellsford settlement data. Between the 2001 and 2006 census, the Wellsford population declined by 3.8 per cent (from 1737 to 1671); followed by a small increase by 2013 (to 1698) Projected population growth is for 2040 residents by 2031, which would represent a 17 per cent increase above estimated 2010 population over the next 27 years. Wellsford is not identified as a growth area in the Proposed Auckland Unitary Plan 2013, indicating that large-scale development and growth in the area are not expected or being signalled by planning.

Several small settlements are scattered throughout the catchment at very low densities. The rural population totals 2181 people, accounting for 82 per cent of the total catchment population. The population density of the rural areas is 0.05 residents per hectare.

#### 4.3.2 Community profile

Community profiles have been sourced from an analysis of age composition, household income, employment status, tenure of residency, income sources, occupations, and means of travel to place of work for the Hoteo catchment population, mostly based on the 2006 census data. See Appendix 2: Catchment Demographic Profile Comparison for further detail.

**Age and gender:** The Hoteo catchment population distribution among age ranges is consistent with Rodney district. Relative to the wider Auckland region, the catchment has a slightly higher proportion of people aged 40–60 and >60. The catchment has equal numbers of men and woman residents.

**Ethnic origin:** Ethnicity of the Hoteo catchment resident population is predominantly New Zealand European; 12 per cent are Māori; and 14 per cent claim Māori descent. The proportion of Māori residents is slightly higher than that of Rodney district, which has 8.7 per cent Māori residents, and is close to that for the Auckland region (11%). The highest concentration of Māori residents is around the Wellsford settlement. The Hoteo catchment lacks the ethnic range of other areas of the wider Auckland region, with Pacific Island people accounting for only 1.9 per cent, and Asian accounting for 1.5 per cent (compared with 14.3 per cent and 19 per cent for the Auckland region, respectively). Ministry of Education ethnicity data show that New Zealand European predominate at Kaipara Flats and Tomarata Schools, whereas Wellsford School and Rodney College (both in Wellsford) have higher proportions of Māori students (Wellsford School 48% Māori, Rodney College 29% Māori).

**Household income:** While 12 per cent of households have very low incomes (<\$20,000), which is consistent with Rodney and Auckland figures, 27 per cent of households have high incomes (>\$70,000), which is lower than the proportion for Rodney (34%) and Auckland region (37%). It should be noted that these figures are indicative only, due to Statistics NZ random rounding because of the number of respondents in each mesh block.

The New Zealand Deprivation Index (NZDep2006) combines 9 variables from the 2006 census for each mesh block in New Zealand to provide a measure of the level of deprivation in an area (Salmond et al. 2006). The NZDep2006 index of deprivation ordinal scale ranges from 1 to 10, where 1 represents the areas with the least deprived scores and 10 the areas with the most deprived scores. This information is most useful to examine variation across a larger area than the Hoteo catchment – such as at a regional scale – because catchment population numbers are small and there is such variation in socio-economic status at a catchment scale. Comparisons at a catchment scale are provided here to give a general picture of variation across the catchment. Mesh blocks in the Hoteo catchment range from 1 to 10 on the NZDep2006. Two mesh blocks near Warkworth are ranked as 1 on the deprivation index, and 2 mesh blocks in Wellsford are ranked as 10.

The Ministry of Education's data on school decile ratings are regularly updated and provide more recent data than the 2006 census. Decile ratings for schools, whereby decile 1 schools are in low socio-economic areas, decile 10 in high socio-economic areas, are based on data such as household income. In the Hoteo area, decile ratings show a wide diversity across the catchment, and within Wellsford. Rodney College and Wellsford School are graded at decile 5 and 4 respectively. Tauhoa (just outside the Hoteo catchment) and Tomarata Schools are decile 7, and Kaipara Flats is decile 9. This suggests small proportions of children in the rural parts of the Hoteo catchment, and high proportions of children from parts of Wellsford, come from low income families, consistent with income data for the catchment.

**Employment status:** There are a higher proportion of Hoteo residents working fulltime than for the Rodney district and the Auckland region (54, 48, and 49% respectively). A fairly consistent proportion of residents are in full-time, part-time, not working, and unemployed categories throughout the catchment. However, there are higher proportions of full-time workers in the Wellsford and surrounding areas, reflecting work opportunities in the settlement. A slightly higher proportion of Hoteo residents work part-time than in Rodney district or the Auckland region, which corresponds to a slightly lower proportion of people in the Hoteo catchment recorded as "not working".

**Sources of income:** In the Hoteo catchment, a higher proportion of residents are self-employed than in Rodney, and particularly in relation to the wider Auckland region, reflecting the agricultural nature of the area. Those who receive benefits/superannuation or interest/dividends as their primary source of income make up a slightly smaller proportion of the Hoteo catchment population than in Rodney or Auckland.

**Occupation:** Almost one-fifth of the Hoteo catchment's working population works in the agricultural sector, considerably more than in Rodney or Auckland. This reflects the rural character of the Hoteo catchment. There are fewer people in professional, managerial, and clerical roles than in Rodney or Auckland.

Business demographic data (Statistics NZ 2012), which record businesses rated as "economically significant", identify 503 businesses in the Hoteo catchment, with a total of 750 employees. The 1:5 ratio of businesses per employee indicates that the four categories of business most prevalent in the catchment are likely to be sole traders who may employ a small number of people. These include agriculture, forestry, and fishing (183 businesses); rental, hiring, and real estate services (79 businesses); construction (70 businesses); and professional, scientific, and technical services (24 businesses). These categories account for 70 per cent of businesses in the catchment, and employ 24 per cent of the total number employed in recorded businesses. Businesses that employ proportionally more people than these more prevalent categories include wholesale trade; retail; accommodation and food services; transport, postal and warehouse; health care and social assistance; education and training; and financial and insurance services.



**Travel to work:** A much higher proportion of the Hoteo catchment population work from home than in Rodney or Auckland. Residents who do not work at home are very reliant on private or work-related transport to travel to work.

**Tenure – years at address:** The Hoteo catchment population has similar proportions of tenure at the current address as for Rodney district and the Auckland region, although Hoteo has a slightly higher proportion living at the same address for 10 years or more.

#### 4.3.3 Current settlement modes

The Hoteo catchment is composed almost entirely of rural communities. The only exception is part of the Wellsford settlement. Local residents identify eight main areas and communities, including Te Arai, Tomarata, Whangaripo, Dome, Wayby, Kaipara Flats, Kaipara Hills, and Mangakura (Lees and Cole 2014). A community profile of the Hoteo part of Wellsford has been fitted to census mesh block units. However, because the Hoteo fits to the water catchment area rather than the community settlement of Wellsford, this community profile is situated and described as part of the wider Wellsford settlement.

#### 4.3.4 Major residential settlements

According to local tradition, the name Wellsford is an acronym based on the surnames of the first European families who settled in the region – Watson, Edger, Lester, Levet, Simpson, Foster, Oldfield, Ramsbottom, and Dibble. Wellsford, described as a rural service town (AC District Plan: Operative Rodney Section 2011), is located at the junction of State Highways 1 and 16, about half-way between Auckland and Whangarei. Housing in Wellsford is predominantly in a suburban layout, clustered around the main street. In the Wellsford-Hoteo part of Wellsford, land on either side of State Highway 1 is zoned Residential M (medium density), based on a minimum allotment size of 600m<sup>2</sup> and allowing for one dwelling per site.

This part of Wellsford also includes a small section of retail zoning nearest the township, with a service station, fast food, the Wellsford District Library, St Johns, public toilets, and the Wellsford police station, Wellsford War Memorial Recreation Reserve and Centennial Park. Some land is zoned industrial. Wellsford is identified as a centre that requires future planning focus to manage business growth and to ensure a thriving economic base and employment (Rodney Local Board Plan 2011). There is a trend in the wider Rodney district for couples with children to move to the district from more unaffordable parts of Auckland, contributing to changes in the district's population structure (Rodney District Community Report 2008). Although the Rodney District Council (2010) categorised Wellsford as an area where growth management and resources were required, so far the township's population has remained stable.

#### 4.3.5 Residential rural community

Almost all the areas of the Hoteo catchment outside of Wellsford are zoned General Rural and are occupied by rural farm properties and residential lifestyle homes.

A small settlement exists at Kaipara Flats, clustered around the intersection of Kaipara Flats Road and Old Woodcocks Road. This settlement is zoned Residential M (Township Policy

Area), based on a minimum allotment size of 800m<sup>2</sup>, with allowance for a second minor household unit on a site. There are approximately 47 individual properties in the Residential M zone. The settlement is divided into different mesh blocks with large parts of surrounding countryside, making it difficult to provide a useful community profile of the settlement. The settlement includes the Kaipara Flats School and a sports field. Nearby is the Kaipara Flats airfield. Kaipara Flats was identified by Rodney District Council as a locality with the ability to absorb additional development without compromising the rural or 'special' character of the district, while recommending that residents' aspirations and concerns be considered (Rodney District Council 2008c).

Tauhoa is another small settlement situated just outside the catchment. Like Kaipara Flats, Tauhoa is categorised as a Rural Community Service Village (Planning Rodney 2008a), meaning that it includes little residential area but provides some social infrastructure (including school, community hall) for the surrounding rural area including the Hoteo catchment. Tauhoa School was established in 1879. The current roll is 56 per cent European and 44 per cent Māori.

While no quality of life information is available at the catchment scale, data for the wider Rodney district suggest a high degree of satisfaction with the rural lifestyle and the natural beauty of the place. Having space, peace and quiet, a clean environment, and natural beauty were very important to Rodney rural property owners surveyed in 2008 (Nexus Planning and Research 2008). Other characteristics also seen as important were the presence of animals and wildlife, work-related reasons, and family/friendship ties.

A 2006 survey by the Rodney District Council shows that a high proportion of people in the wider Rodney area report a sense of community (Rodney District Council 2008b, p. 12). For the small proportion (8%) who did not, lack of communication and events within the neighbourhood were the most common reasons, which is likely to have resonance in the Hoteo. It also suggests a need for activities that bring residents together, useful to consider in the development of engagement processes. The 2006 survey also indicates that just over half of Rodney district have a sense of pride in the place, mostly related to the wealth of green spaces, or proximity to beaches or harbours. Acknowledgement of the importance of the local environment to residents' quality of life is recommended during engagement processes for the SCP.

Just as residents enjoy the rural lifestyle in Rodney, a 2008 survey also shows that 40 per cent of residents are concerned about the loss of the 'country look and feel' of the place that can occur as residential areas are developed. Residential development in rural areas can change the look and feel of the landscape as well as increase land values. Increasing land values can make agricultural activities less economically viable, threatening traditional agricultural practices, and impact on the rural economy and rural land use (Nexus Planning and Research 2008). However, the survey also showed considerable demand from existing landowners to subdivide their land, and that 34 per cent welcome further development. As these differences are not a result of differences between farmers and lifestylers, caution is

necessary when assessing dualistic categorisation of local people during engagement processes.

#### 4.3.6 Infrastructure and services development

This section outlines major roading, water supply and wastewater disposal, open spaces, and community facilities in the Hoteo catchment.

The Hoteo catchment is traversed by State Highway 1, the major route north for residents, visitors, business, and freight. There are currently no safe passages for alternative forms of transport (foot, cycle). Intercity rail and bus services cross the Wellsford settlement but do not provide commuter services, resulting in residents being highly reliant on private or business vehicles.

The Hoteo catchment is also crossed by State Highway 16 near the coastline to the west, providing a secondary route to travel north of Auckland to Wellsford. The rest of the catchment is serviced by a road network, most of which are unsealed, that links small settlements and residential properties. The Hoteo River, while historically an important transport route, is only accessible via private properties, the Atuanui Scenic Reserve, and crossing main highways and link roads. This limits human access and so provides a measure of protection to the waterway, although stock access is a more pressing problem for the river and its tributaries. Two quarries operate within the catchment: Rodney Aggregate Supplies (Matakana Valley Road) and Millbrook Quarry (Whangapiro Valley Road) – both produce aggregate.

Wellsford has reticulated water and wastewater systems, both of which require upgrading to meet current and future demands. The rest of the Hoteo catchment is not serviced with water supply and wastewater disposal, so is reliant on on-site collection and dispersal. Wellsford's water is sourced from the Hoteo River (Rodney District Council no date), which is under pressure from sediment runoff and discharges. A change to bore water has been suggested, although existing shortfalls in water supply and expected population growth mean that careful planning for water supply and waste water disposal is required (Rodney Local Board Plan 2011).

The water treatment plant is located at Wayby Valley Road, from where the water is piped to the town reservoir at Matheson/Worthington Road. Wastewater is piped from properties to an oxidation pond treatment plant, and after treatment is discharged via a wetland into a small tributary of the Hoteo River downstream (Rodney District Council, no date).

Public open space resources (Appendix A – Map 37) in the Hoteo catchment comprise a mixture of active and passive recreation areas. In the western reaches of the catchment, Atuanui Scenic reserve and Tauhoa Scientific Reserve provide recreational and conservation space, as do the Dome forest and other smaller forested areas in the eastern parts of the catchment.

While social infrastructure is limited in the Hoteo catchment, its natural resources are highly valued as cultural, ecological, recreational, and tourist spaces. A wide range of recreational

activities are available (e.g. walking, kayaking, bird watching, horse trekking, hunting, fishing), some of which are provided or serviced by small home-based businesses. The ways that these business operators understand, value, and use the natural environment will be useful to inform the Sustainable Catchment Programme.

Wellsford is well served with netball courts and sports fields, although these require development and expansion to meet the needs of youth and adults. Schools are served by school buses. While Wellsford is well served in terms of social and recreational community facilities, very little exists in the rest of the Hotoe catchment. As a result residents need to travel by private vehicle to Wellsford or Warkworth for supplies, recreation, healthcare, and other essential services. Centrality of services and facilities also has benefits in terms of providing a meeting point for residents and a locality for communication of upcoming events.

The following community facilities are identified within the Hotoe catchment:

- Sports fields at Wellsford and Kaipara flats, netball courts, bowls club, golf club, athletics club, soccer club and tennis club at Wellsford
- Primary schools at Kaipara Flats, Tomarata and Wellsford (most with halls and pools)
- Secondary school at Wellsford
- Aero club at Kaipara Flats
- Community halls at Wellsford, Woodcocks, Kaipara Flats, and Whangapiro
- Library at Wellsford
- Museum at Wellsford (Albert and District Museum)
- Public toilets at Wellsford
- Retail and service centre at Wellsford
- CAB, Plunket, and Healthcare centre at Wellsford
- Several Churches at Wellsford, one church at Woodcocks
- Marae at Puatahi
- River boat ramp on State Highway 16
- Cemeteries at Kaipara Flats and Wellsford

## 5.0 Land use, land cover, and land-use trends

This section summarises information on historic land use, land use capability, land cover and land cover trends.

### 5.1 Land cover and land use capability

The Hoteo catchment has a long history of human settlement, use, and modification of the landscape. There is limited historical information for the Hoteo catchment, at least partially because this area was developed later and to a lesser degree than the Wairoa River area to the north and Kaipara to the south (Ryburn 1999). Qualitative work to map vegetation cover in the area exists that looked at land survey records from the mid to late 19th century (Beever 1981). More recently a vegetation model has been developed to predict the pre-human vegetation of New Zealand (Leathwick et al. 2001, 2003). The following assessment of pre-human vegetation cover of the catchment has been made based on personal communication with Auckland Council staff (C Pratt, 2013, Auckland Council, pers. comm.), predicted pre-human vegetation cover (Leathwick et al. 2003), and assessments made by Ryburn (1999) and Beever (1981). Limitations with some of the analysis exist. Beever (1981), for example, notes that the accuracy of his pre-European settlement land cover map for the lower Northland region is dependent on the accuracy of the more than 600 survey plans of the area that were analysed for information on vegetative cover, e.g. the assessment assumes that the survey plans were made before major modification by European settlers.

Before human settlement the catchment was predominantly in forest cover (Appendix A – Map 19; Beever 1981). There were originally four dominant forest types in the area: kauri, podocarp/broadleaf/kauri, broadleaf and coastal forest, and freshwater wetland and wetland forest (Lindsay et al. 2009). Steep inland areas were in dense forest, which included kauri forest dominating on hillcrests and upper slopes, grading to podocarp/broadleaf/kauri forest (Beever 1981). This mid-slope forest was a mix of rimu, tōtara, miro, northern rātā, tawa, taraire, kohekohe, and nikau. Lower slopes and coastal areas were dominated by broadleaf and coastal forest, which included kahikatea, mataī, pūriri, and puketea species. Some areas were in scrubland. Fern and mānuka were present in the inland forests and scrubland. Low-lying swamp land near the river mouth would have been kahikatea forest with puketea, swamp maire, kiekie, supplejack, and *Gahnia xanthocarpa*. At the coast and estuary, forest would have given way to saltmarsh and mangrove forest. Freshwater swamplands would have had harakeke (flax), raupō, rushes, and rush-like plants called wīwī.

The original indigenous cover of the Hoteo catchment has largely been cleared – in the early days deforestation was undertaken to harvest wood resources in the catchment. Most of the area's high value logs were cleared by the late 1800s. Clearance continued through the 20th century to establish pastoral farming and very small areas of horticultural cropping. The late 20th century (1970s onwards) saw the establishment of exotic forestry plantations in the catchment.

Based on LCDB III analysis (2008/09), the Hoteo catchment today is a rural catchment predominantly in pasture-based agriculture (Appendix A – Map 20). Approximately 57 per cent of the catchment is high-producing exotic grassland, 20 per cent exotic forest, 3 per cent harvested forest, 15 per cent indigenous forest, and 4 per cent mānuka/kānuka. Small areas of a range of other land cover types are also found in the catchment including lakes and ponds, developed area/settlement, transport infrastructure, urban park/open space, gravels, open mine or dump, and mangrove.

Assessing land cover by subcatchment (Table 5), the most common land cover in the northern Hoteo subcatchments Waiteitei and Waitapu is pasture. The northern subcatchment Whangaripo has mixed land cover with 55 per cent pasture, 31 per cent indigenous land cover, and 10 per cent exotic forestry. Whangaripo also has 17ha (0.4% subcatchment area) of surface mine/dump, the only area of surface mine/dump in the Hoteo catchment. This is Millbrook Quarry, which has been operating and supplying construction in the area for over 50 years. Wayby subcatchment is predominantly exotic pasture (89%). The Hoteo central and Waiwhiu subcatchments are predominantly exotic forestry (43% and 40%, respectively). The southern Hoteo subcatchments are predominantly exotic pasture, but have a mix of cover between pasture, indigenous forest, and exotic forest. The lower Hoteo River is the only subcatchment with a substantial area of mangrove (40 hectares or 1% subcatchment area).

Forestry in the catchment is predominantly in subcatchments with steep ranges. From the landscape unit perspective outlined by Buikema (2012) (Appendix A – Map 15), these are the uplands areas of the catchment in and around the Dome Ranges. Waiwhiu, Hoteo central, and Kourawhero subcatchments have the largest areas of exotic forestry. Waiwhiu, Whangaripo, Kourawhero, and lower Hoteo subcatchments have the largest areas of indigenous forest.

The Land Use Capability (LUC) system classifies land according to its ability to sustain continuous production. Assessment of the land's ability to sustain continuous production is based on a number of factors, including landform, soil, and erosion potential among others (Newsome et al. 2008). There are eight LUC classes: 1–4 are classed as arable and have relatively flexible land-use capability; 5–8 are classed as non-arable and have increasing limitations for production (Lynn et al. 2009). See Lynn et al. (2009) for a full outline of the LUC classification system methodology and definitions of LUC classes.

**Table 5 Percentage land cover type by subcatchment (LCDB III 2008/09)**

Catchment regions Subcatchment / land cover	Northern			Central			Southern			Catchment Total
	Waiteitei	Waitapu	Whangaripo	Wayby	Hoteo central	Waiwhiu	Hoteo gorge	Lower Hoteo	Kourawhero	
Pasture*	85	86	55	89	37	4	58	70	53	57
Exotic forest**	2	<1	10	3.5	43	40	18	11	29	20
Forest – harvested	-	-	<1	<1	3	18	3	1	3	3
Indigenous forest***	11	12	31	5	9	32	9	14	10	15
Mānuka/kānuka	<1	<1	2	<1	7	6	11	1	4	4
Urban/Built-up	-	<1	<1	1	<1	-	-	<1	<1	<1
Urban parkland/ open space	<1	-	-	<1	<1	-	-	-	<1	<1
Infrastructure	-	-	-	-	<1	<1	-	-	<1	<1
Lake and pond	<1	<1	-	-	<1	-	<1	<1	<1	<1

\*Pasture includes high and low producing exotic pasture

\*\*Exotic forest includes deciduous hardwoods and exotic forest

\*\*\*Indigenous cover includes indigenous forest and indigenous broadleaf hardwoods

The Hoteo catchment has no LUC class 1, 2, 5 or 8 land (Table 6). Class 3 or Class 4 land make up 36 per cent of the catchment – arable land that is suitable for cropping, pasture or forestry, but has moderate limitations for these activities. Class 4 land is less suitable for cropping. Class 3 land, 7206 hectares (18%), has either soil wetness or erosion limitations, most likely due to poor soil drainage and/or regular flooding events. Erosion limitation is most likely due to either erosion susceptibility or past erosion damage. Class 4 land makes up 7380 hectares (18%), most of which has erosion limitations and a very small amount that has soil property limitations (i.e. shallowness, stoniness, etc.). Class 6 land makes up 58 per cent (23 396 ha) of the catchment, nearly all of which has erosion limitations. Class 6 land is characterised as non-arable with moderate limitations for use under perennial vegetation such as pasture or forest. Class 7 land, 2388 hectares (.06%), has erosion limitations, and is characterised as non-arable land with severe limitations for use as pasture or forest. The remainder of the catchment area is estuary, river, or town.

**Table 6 Hoteo Catchment Land Use Capability**

LUC Class	Area (ha)	% Catchment Area
3	7206.53	17.79
4	7380.31	18.22
6	23396.66	57.77
7	2388.59	0.06
Estuary	27.71	.07
River	9.30	.02
Town	92.99	.23
Total	40502.11	100

## 5.2 Land cover trend analysis

The New Zealand Land Cover Database v3 (LCDB III) allows comparison of land cover between three periods: 1996/7, 2001/02, and 2007/08 (Table 7). A combinatorial analysis method has been used to intersect LCDB III with LENZ, NZ LRI, Agribase, and protected areas spatial data to assess land cover trends over these three periods, as well as interactions with land resources and protected areas.

Between 1997 and 2002 high producing exotic pasture (HPEP) decreased from 22 000 to 21 638ha (1.6%). Most of this change (350 ha) is in transfer from HPEP to exotic forestry. Between 2002 and 2008 HPEP decreased from 21 638ha to 21 589 ha, overall between 1997 and 2008 HPEP decreased from 22 000 to 21 589ha (about 1.9%).

The greatest changes to catchment land cover between time periods were increases in exotic forestry. Between 1997 and 2002 exotic forestry increased 1216ha (17%), from 5868 to 7084 ha. Most of this was change from low-producing exotic pasture (LPEP): 775ha of



LPEP and 350ha of HPEP transferred to exotic forestry, while smaller transfers from other land cover categories were from forest-harvested, broadleaf indigenous hardwood (BIH), gorse and broom, indigenous forest, and mānuka/kānuka, totalling about 90 ha.

**Table 7 Land Cover Database (LCDB) class area in hectares for Hoteo catchment 1996, 2001, and 2008**

LCDB3 Class	LCDB3 Name	Area (ha) 1996	Area (ha) 2001	Area (ha) 2008
1	Built-up Area (settlement)	62.125	62.125	62.125
2	Urban Parkland/Open Space	37.375	37.375	37.375
5	Transport Infrastructure	11.4375	11.4375	11.4375
6	Surface Mines and Dumps	16.9375	16.9375	16.9375
10	Coastal Sand and Gravel	0.1875	0.1875	0.1875
20	Lake and Pond	24.5625	24.5625	24.5625
22	Estuarine Open Water	24.25	24.25	24.25
30	Short-rotation Cropland	21.5625	21.5625	21.5625
33	Orchard Vineyard and Other Perennial Crops	7.6875	17.6875	17.6875
40	High Producing Exotic Grassland	22039.6875	21638.8125	21589.5
41	Low Producing Grassland	831	48.625	43.25
45	Herbaceous Freshwater Vegetation	2.5	2.5	2.5
46	Herbaceous Saline Vegetation	44.4375	44.4375	44.4375
47	Flaxland	1	1	1
51	Gorse and/or Broom	91.375	69.0625	56.5625
52	Mānuka and/or Kānuka	1375.3125	1394.125	1391.9375
54	Broadleaved Indigenous Hardwoods	863.25	867.625	899
64	Forest – Harvested	27.5625	1752.25	1278.75
68	Deciduous Hardwoods	15.0625	15.0625	15.0625
69	Indigenous Forest	4930.8125	4914.1875	4914.1875
70	Mangrove	288.8125	288.8125	288.8125
71	Exotic Forest	7620.1875	7084.5	7596

The rate of exotic forestry land cover increase more than halved over the 2002 to 2008 period. Between 2002 and 2008 exotic forestry increased 512ha (c. 7%), from 7084 to 7596 ha. Between 2002 and 2008 1278ha exotic forest transferred to forest-harvested; however, 1743ha of harvested forest changed to exotic forest.

Between 1997 and 2008 indigenous forest cover decreased by 16ha (0.3%), from 4930 to 4914 ha. All this change is accounted for by transferral to exotic forestry. LCDB is derived from satellite imagery, which is also ground-truthed through field survey; however, it is unclear whether or not deforestation of indigenous forest has occurred or this drop in indigenous forest area is due to a correction to the satellite imagery analysis in the updated LCDB. Further field investigation would be required to determine the cause of indigenous forest loss.

Built up area/settlement cover did not change between 1997 and 2008, indicating that urban growth or development in this catchment has been negligible over the last 16 years.

No changes were picked up by the LCDB between 1997 and 2008 in the following areas: coastal sand/gravel, deciduous hardwood, estuary/open water, freshwater and saline vegetation, lake/pond, mangrove, short-rotation crop land, surface mines/dumps, transport infrastructure, and urban parkland/open space.

Intersecting LCDB III and QEII protected area data found that, as expected, almost no land cover change occurred on the 294ha of land under QEII covenant. Nearly all QEII covenanted land in the Hoteo catchment is in indigenous forest cover or regenerating indigenous forest, and no change occurred to these land cover categories over the period 1997–2002. Intersecting LCDB III and DOC protected area data found that of the 1393ha of land recorded as DOC protected, nearly all was in indigenous land cover (forest, kānuka/mānuka or mangrove) and that no land cover change occurred between 1997 and 2002.

### 5.3 Factors affecting land-use patterns

Land use in the Hoteo catchment has changed over time with local, regional, national, and global influences. The legacy of land use in the catchment has a strong influence both on current land-use patterns in the catchment and on potential future change. Factors influencing land use and land-use change include economic market forces at all scales, local and national governance, population change and distribution, land ownership, and cultural trends.

Hoteo catchment is predominantly an agricultural and commercial forestry catchment. Global economic market influence has the potential to shift land use further into activities such as dairy and forestry, depending on global demand and prices, and global and national governance factors, for example the New Zealand Emissions Trading Scheme (ETS) and other international greenhouse gas (GHG) policies. Local policies to protect and enhance indigenous biodiversity could potentially protect land from traditional commercial activities for development.

Between 1996 and 2006 Hoteo catchment's population increased by about 37 per cent. Hoteo's growth rate is slightly higher than Rodney District's and considerably higher than Auckland region's (22%). Population in Wellsford has been fairly stable through this period. Social infrastructure has not grown to accommodate this population growth. Population

growth has been mainly in the rural areas near Warkworth and Wellsford, which is expected as a result of the increasing rural subdivision to create lifestyle block rural-residential development. Rural residential development and the affordability of land in the Hoteo catchment relative to the wider Auckland region could be potential drivers of increasing pressure on rural land near townships.

Land is predominantly in private ownership in all subcatchments of the Hoteo catchment. Publicly owned land (crown or council owned) can be seen in Map 37: Hoteo Catchment Open Space Land Tenure, and a full break down of land ownership (private or public) is given in the ECSP (Temple and Parsonson, 2014, p.17)

Information on current and future economic trends for the catchment is not readily available. Some analysis has been conducted for the Rodney District (Rodney District Council 2009), particularly on rural subdivision trends. The areas defined in the analysis that cover the Hoteo catchment were found to have low levels of rural subdivision relative to high rural subdivision areas, and the rural area was summarised as wealthy, while the Wellsford area was summarised as less affluent.

However, development patterns have also been influenced by the Rodney District Plan 'bush lot' subdivision rule 7.14.3, which states that subdivision consent may be granted by council where significant areas of biodiversity are legally protected (Property Economics 2009; Rodney District Council 2009, 2011). Anecdotal commentary from Auckland Council staff has indicated that this rule has resulted in unplanned and ad hoc development. For example, land is subdivided (usually for development) where bush lots that can be protected exist, rather than where new subdivision and development might best be positioned from a broader scale planning perspective.

Subdivision of rural land for rural-residential development has been identified as an important land-use issue within the catchment in recent years, even though rates of subdivision are low in comparison to some other Rodney areas. Rural subdivision can have multiple impacts including temporary or permanent loss of productive soils (depending on the type of development), reverse sensitivity effects related to the appropriateness of the residential development for a rural setting, and pressure on agricultural activities as land values increase potentially making agriculture less economically viable.

Some of Auckland city's satellite areas are popular tourist and holiday areas – attracting development for bach settlements, 'boutique' agricultural and business activities, and new residential development (Zandvoort et al. 2009). These are more commonly on the east coast; for example, Warkworth, Leigh, Matakana, Omaha, and surrounding areas have experienced development and diversification of agricultural and tourism activities. These trends appear to be occurring in the Hoteo catchment, but to a much lesser degree. The catchment remains a more traditional farming catchment and Wellsford has remained predominantly a rural service town as opposed to a tourist destination.

Based on the review of literature and data analysis conducted, and input from Auckland Council staff during the workshops held for this project, we summarise the following points regarding land-use change in the Hoteo catchment:

- Increasing exotic forestry activity – predominantly in transfer from low producing exotic grassland to exotic forestry
- Corresponding decrease in area under pasture
- Increasing rural subdivision for lifestyle blocks
- A trend towards farm amalgamation, which has resulted in fewer agricultural sector employees
- Expansion and diversification of tourism and tourism-related activities
- Relatively static urban development and a little new residential development or settlements.

## 5.4 Agriculture and horticulture

The catchment is predominantly in agricultural land use for pastoral farming. There are approximately 130 beef farms, 67 sheep and beef farms, and 12 sheep farms. Beef farms make up about 14 per cent sheep and beef farms 22 per cent, and sheep farms 3 per cent of the catchment area. There are approximately 37 dairy farms in the catchment (52 farm IDs in LCDB; however, these are not all farms). Dairying makes up about 15 per cent of the catchment area, and is located predominantly in the North (Temple and Parsonson 2014).

The catchment population is predominantly rural residents living and working on farms rather than in rural settlements or in Wellsford. Although Statistics NZ data (rural mesh blocks) for the catchment appear relatively affluent, pressures on farmers are expected to increase and include, increasing industry standards and requirements in all areas of production; pressures to increase economic farm sizes; and impacts of the new Auckland Unitary Plan. Climate pressures, for example, drought, flooding, and climate change, are also expected to be drivers of land use and management practices in the future.

The Hoteo catchment has not traditionally been an area with large-scale horticultural production. Diversification of farming practices where soil and climate allow could increase the ability of the catchment as a whole to withstand external pressures on the beef, sheep, and dairy industries. It is unclear whether horticultural activities may increase in the catchment.

There are approximately 138 lifestyle blocks in the catchment over 1556 ha, making up about 3.8 per cent of the catchment area. Views on the impacts of rural subdivision on the catchment vary. Rural subdivisions can potentially increase catchment revenue (Rodney District Council 2009) as well as potentially increase amenity, social, cultural, and environmental values within the catchment. The potential to develop catchment-scale resilience to external shocks may also be increased by the diversification of activities resulting from rural subdivision. However, numerous issues related to rural subdivision are also noted, including loss of high-quality land for production; reverse sensitivity effects;

increased pollution; and loss of rural landscape values. Hart et al. (2014) provide a comprehensive review of rural subdivision issues and local government responses.

#### 5.4.1 Forestry

Exotic forestry plantations were introduced in the catchment at a commercial scale in the 1960s. The area in exotic forestry increased rapidly in the late 1990s, but slowed in the late 2000s. Most new exotic forestry has been converted to forestry from low and high producing pastureland (Table 7 LCDB class area in hectares in Hoteo catchment 1996, 2001, and 2008.).

Today, approximately 24 per cent of the Hoteo catchment is in exotic forestry plantation (Map 20: Hoteo Catchment LCDB III), and is the predominant land use in both the Hoteo central (43%) and the Waiwhiu (40%) subcatchments. The Waiwhiu stream and Kourawhero stream subcatchments also have sizeable areas of commercial exotic forestry. Isolated stands of commercial exotic forestry are also found in the Hoteo gorge and lower Hoteo River subcatchments.

Forestry practices are generally associated with both improvements of and negative impacts on ecosystems and the services they provide. Although not recorded as sites of significance for biodiversity, exotic forests also provide habitat for indigenous species as well as important ecosystem services, in particular erosion control, by stabilising steep slopes. On the other hand, potential increases in sedimentation during and after harvesting have been raised as an issue, as have pesticides used in forestry activities that can also pollute waterways and affect water quality. Forestry also decreases water yield as forests uptake surface and ground water, which can become an issue in catchments with high demand and competition for water supply.

Exotic forestry is of high importance in the Hoteo catchment in terms of slope stabilisation; however, careful planning for harvest is required, preferably at the time of establishment of forests. Management practices in forestry operations can impact significantly on sediment generation and transport, and management practices can vary widely from operation to operation. Auckland Council staff noted that several large blocks of forestry will be reaching maturity in the near future, and the environmental impacts of harvest of these forested areas needs to be considered. Jessen et al. (1997) noted the importance of maintaining high practices standards for forestry (and agriculture) in the catchment to ensure the contribution of sediment from these sectors is minimised.

MPI (Ministry of Primary Industries) reports that the largest area of exotic forestry in the catchment, a large block of land through the Dome ranges, is owned and managed by Matariki Forests. Matariki Forests is owned by three investment firms, including 40 per cent ownership by Rayonier. Matariki Forests own the third largest exotic forestry area in New Zealand (MPI 2009).

#### 5.4.2 Tourism

The Hoteo catchment has not traditionally been a tourist destination, although the forested areas in the Atuanui Walkway and Dome Valley have long been valued as recreational spaces. These reserves and the coastal area in the catchment provide opportunities for swimming, tramping, bird watching, hunting, fishing, and horse riding. More recently, the natural beauty and resources of the area have provided the basis for diversification into tourism activities, including Kourawhero Country Lodge (6km from Warkworth), Horse Riding Warkworth (Dome Valley), the Rodney Aero Club (Kaipara Flats), and the Kaipara2kaipara Experience (based in nearby Glorit), which offers horse trekking and a 3-day walk that traverses the Hoteo catchment.

As these tourism activities are based on the use and enjoyment of the natural environment and are small scale, it is unlikely they threaten the environment. They also have the potential to develop support for SCP initiatives.

#### 5.4.3 Quarrying

Two quarries operate in Whangaripo subcatchment in the headwaters of the Hoteo catchment: Millbrook Quarry and Rodney Aggregates' Whangaripo quarry. The Millbrook Quarry (Wharehine) has the Huipapa stream running through it and Rodney Aggregates has the Kotekote stream running through it. Both are tributaries of the Whangaripo stream. Quarrying has the potential to impact on sedimentation in the Whangaripo and Hoteo Rivers; however, it is unclear to what extent the quarries currently contribute to sedimentation.

Both quarries are required to monitor sedimentation in nearby streams to meet their resource consent conditions. Additional monitoring to what is required under resource consent has also been initiated through Ngāti Manuhiri and Wai Care; however, results showing the impact of the quarries on water quality are not yet available. Further work to gather information from the two quarries and Ngāti Manuhiri has been recommended by the Iwi and Stakeholder Report completed as part of the SCP work in Hoteo catchment (Lees and Cole 2014).

#### 5.4.4 Residential development and subdivision

While rural-residential blocks have been subdivided to create smaller blocks, there has been little residential development in the catchment in recent years. There have been subdivisions on the fringes of Wellsford (and nearby Warkworth), made possible by allowance for conservation bushlots from marginal farmland. A key issue in terms of development in the catchment has been identified as ad hoc rural subdivision.

## 6.0 Governance context: Hoteo catchment

The governance context for environmental management in the Hoteo catchment and Kaipara harbour is of relevance to the SCP. This includes the national-, regional-, and district-level policy framework relevant to the SCP in the Hoteo catchment, outlined in this section. Additional to this is the governance context operating in the Kaipara harbour, which is outlined in this section, based on the work of IKHMG (2010).

### 6.1 National level policy framework

#### 6.1.1 Te Tiriti o Waitangi (The Treaty of Waitangi, 1840)

Te Tiriti o Waitangi (The Treaty of Waitangi, 1840) enables the legitimate establishment of the national government of the British Crown in New Zealand, while acknowledging the ongoing rights and privileges of Māori, including the ownership and chieftainship over their lands, natural resources, and taonga.

Te Tiriti (The Treaty) sets the underlying foundation for relationships between the Crown and iwi/hapū in regard to freshwater resources. Because the implementation of freshwater management is devolved by the Crown to New Zealand local government, Te Tiriti provides the underlying foundation for local government and iwi/hāpu relationships in regard to freshwater resources. Tāngata whenua involvement in freshwater management is central to meeting the Crown's obligations under Te Tiriti, as well as addressing tāngata whenua values and interests across social, cultural, environmental, and economic well-being in regards to freshwater management (New Zealand Government 2011).

#### 6.1.2 Ngāti Whatua o Kaipara Claims Settlement Act 2013, Te Uri o Hau Claims Settlement Act 2002 and Ngāti Manuhiri Claims Settlement Act 2012

Treaty settlement legislation (e.g. Ngāti Whatua o Kaipara Claims Settlement Act 2013, Te Uri o Hau Claims Settlement Act 2002, and Ngāti Manuhiri Claims Settlement Act 2012) imposes duties on local government (and iwi/hapū), including recognising the traditional, historic, cultural, and spiritual associations iwi/hapū have with the Kaipara harbour and catchment ecosystems (IKHMG 2011) as well as the role iwi/hapū have as kaitiaki in the area.

For example, Te Uri o Hau Claims Settlement Act 2002 records the Crown's agreement to restore Te Uri o Hau's access to traditional foods and food gathering areas (IKHMG no date). The Ngāti Manuhiri Claims Settlement Act 2012 acknowledges Ngāti Manuhiri for cultural, spiritual, historical, and traditional association with the Hoteo River, Mount Tamahunga and Tohitohi o Reipae (the Dome). Such recognition creates obligations on the part of the local government authority to identify, understand, and give effect to iwi and hapū significant sites and cultural land and seascapes in planning and policy. Both these settlements are reflected in statutory acknowledgements included in the Auckland District Plan: Rodney Section (2011).

### 6.1.3 Local Government Act 2002 and Resource Management Act 1991

The Local Government Act 2002 (LGA) and the Resource Management Act 1991 (RMA) establish the overarching legislative framework for local government powers and responsibilities in New Zealand.

The LGA sets out the purpose, role, and powers in of local government in New Zealand, which is the enabling of local-scale democracy and the promotion of community well-being. The LGA acknowledges the need for local government to consider the well-being not only of today's community but also of future communities. This necessarily entrenches the concept of sustainability as an underlying principle, and also as a clear link to and compatibility with the RMA.

The RMA addresses the use, development, and protection of New Zealand's natural and physical resources. It has a single purpose, which is to promote sustainable management of natural and physical resources (Section 5). All decision making under the RMA must give effect to the purpose of the Act.

### 6.1.4 New Zealand Coastal Policy Statement (2010)

The New Zealand Coastal Policy Statement (NZCPS) sets the framework for coastal management in New Zealand. All statutory documents under the RMA that sit within the NZCPS must take into account the policy provisions outlined in the NZCPS.

The objectives set for the coastal environment in the NZCPS focus on ensuring the following are taken into account and managed:

- The principles of Te Tiriti o Waitangi (The Treaty of Waitangi)
- Natural systems and their functioning
- Natural character
- Public open space and recreation opportunities
- Coastal hazards
- International obligations in the coastal environment and coastal marine area.

Policy 21 of the NZCPS focusses specifically on water quality, including a number of levers requiring the maintenance and improvement of water quality. Policy 22 focusses specifically on sedimentation, including the requirement to reduce sediment loadings through controls on land use activities (NZCPS, p. 22). The NZCPS (as well as the NPS Freshwater) also requires an integrated approach between freshwater and coastal water management is adopted. The work of the SCP is consistent with this approach.

### 6.1.5 National Policy Statement on freshwater (2011)

The NPS Freshwater Management 2011 sets out a national-level framework for freshwater governance. The NPS establishes the central importance of iwi/hāpu involvement in freshwater management as well as directing local government to manage water in an integrated and sustainable way. The NPS also directs local government to set environmental flow levels and freshwater quality limits and targets for all water bodies.



The Environmental, Strategy and Policy team and the Coastal, Land, Air and Water team at Auckland Council are designing the programme of work that will address the requirements of the NPS Freshwater. This work is underway and initiation of programme implementation is expected in the next year. Several other water-quality-focussed water programmes are also underway within Auckland Council, including the Water Strategic Action Plan and the Water Programme of Action.

#### 6.1.6 Other relevant legislation

Numerous other Acts of legislation also have relevance to the SCP; of particular note are the New Zealand Historic Places Act 1993, the Conservation Act 1987, and the Fisheries Act 1996. For example, the aim of the Historic Places Act is to identify, protect, preserve, and conserve the historic and cultural heritage of Aotearoa New Zealand. The RMA identifies the sustainable management and protection of heritage as a matter of national importance (RMA, Section 2). The Act requires that any development or activity that might be associated with registered heritage sites is required to have an archaeological authority from the Historic Places Trust to oversee any interaction with those sites (e.g. modification, damage or destruction to those sites). The Historic Places Trust may also be a stakeholder regarding heritage management matters under the SCP in the Hoteo catchment.

## 6.2 Multi-scale governance framework: Kaipara harbour

Kaipara harbour falls under multiple iwi/hapū, and central and local government authorities. Multiple legislation, policies, and planning instruments are all in operation – at times with conflicting underlying values and approaches across multiple management scales– which results in a fragmented and often conflicting legislative framework (IKHMG 2010).

The iwi/hapū holding mana whenua in the Kaipara catchment are Te Iwi o Ngāti Whatua (mana whenua and mana moana Kaipara harbour and catchment), Te Roroa, Te Parawhau, Ngāpuhi and Ngāti Hine (mana whenua in northern parts of the Kaipara catchment), and Te Kawerau a Maki (mana whenua in the south-western Kaipara catchment) (IKHMG 2010).

The main government agencies are Auckland Council, Northland Regional Council, Kaipara District Council, Whangarei District Council, the Department of Conservation (Northland and Auckland Conservancies), and the Ministry for Primary Industries (MPI).

Concerns about the Kaipara have been community driven (IKHMG 2011). The elders of the iwi/hapū of the Kaipara harbour met in 2005 to discuss management and restoration of the Kaipara harbour. Out of this concern for the *mauri* of the Kaipara harbour and meeting of the catchment's elders the IKHMG was developed. The IKHMG brings together all the various organisations responsible for environmental and resource management in the Kaipara harbour and catchments under an integrated Māori and western knowledge framework for integrated management of the Kaipara.

The Kaipara Harbour Joint Political committee was established in 2012 to provide oversight and support for the activities of the IKHMG. A representative from each of the following groups make up membership of the joint political committee are: Te Runanga o Ngati

Whatua, Nga Maunga Whakahii o Kaipara Development Trust, Te Uri o Hau Settlement Trust, Ngati Whatua o Orakei, Te Roroa Whatua Ora Trust, Auckland Council, Rodney Local Board (Auckland Council), Northland Regional Council, Kaipara District Council, and Whangarei District Council.

### 6.3 Regional level policy framework

Following the amalgamation of Auckland's regional and district councils in 2010, Auckland Council has produced Auckland region's first spatial plan – The Auckland Plan – and a proposed Unitary Plan that will replace all previous regional and district plans.

At the time of writing, Auckland region is in a transition period between its first generation Regional Policy Statement, regional and districts plans to a new planning format – the Auckland Unitary Plan. The Proposed Auckland Unitary Plan was notified in September 2013. During this transition both sets of plans are relevant and hold legal weight. For reference, the Proposed Auckland Unitary Plan outlines the legal status of operative and proposed plans in its introduction.

#### 6.3.1 The Auckland Plan 2012

The Auckland Plan (2012b) sets the broad strategic direction for Auckland for the next 30 years. Of particular relevance to the SCP in the Hotoe catchment are directions, targets, and priorities set around: Māori, Auckland's environment, and rural areas.

The Auckland Plan expects that The Treaty of Waitangi and customary rights will be honoured (Auckland Plan Chapter 2). The Auckland Plan aims to keep rural Auckland *productive, protected and environmentally sound* (Chapter 9, p. 220) and sets targets limiting rural subdivision in productive areas, and aiming to increase the value added to the Auckland economy by rural sectors by 50 per cent by 2040.

The Auckland Plan sets numerous strategic directions for Auckland's environment under four priority areas:

1. Valuing our natural heritage
2. Sustainably managing natural resources
3. Treasuring our coastline, islands and marine reserves, and
4. Building resilience to natural hazards

Directives for valuing our natural heritage are focussed on acknowledging, identifying, and protecting significant natural heritage, ecosystems, and indigenous biodiversity of the region.

Directives for sustainably managing natural resources are focussed on reducing pollution, including a series of freshwater quality directives. For example, Directive 7.8 is to *establish freshwater values and aspirations with communities and make freshwater an identifying feature of Auckland*; Directive 7.9 is to *set limits for minimum water quality and maximum water take*; and Directive 7.10 is to *manage land to support the values of waterbodies by protecting them where they are high and reviving them where they are degraded* (Auckland Plan, pp. 187–188).

Directives for treasuring our coast and marine environment focus on protecting coastal and marine areas with high values, and establishing marine spatial planning.

Directives for building resilience to natural hazards are focussed on avoiding development in areas with high natural hazard risks.

Targets set for Auckland's environment that are of particular relevance to the SCP include:

- Ensure no loss in the area of significant landscape, natural character and natural features
- Reduce the overall yield of suspended sediment to priority marine receiving environments from 2012 levels by 15 per cent by 2040
- Ensure no regional extinction of indigenous species and a reduction in the number of 'threatened' or 'at risk' species from 2010 levels by 50 per cent by 2040
- Increase the proportion of residents who understand their risk from natural hazards and are undertaking measures to mitigate or reduce their risk from 2011 levels to 80 per cent by 2040
- Reduce the vulnerability of identified ecosystems by ensuring 95 per cent probability of each ecosystem type being in a viable state by 2040 (Auckland Plan, p. 174).

Enabling development to accommodate projected population growth for Auckland is another of focus area of the Auckland Plan. The plan outlines a compact growth plan with redevelopment and increasing population density in existing urban and suburban areas being key means of meeting housing demand. Extensions to the rural urban boundary (RUB) where greenfields development will be enabled are also outlined; however, the plan does not identify any areas for growth within the Hoteo catchment. A sudden increase in housing development or population is not anticipated for the Hoteo catchment, given the direction for growth indicated in the Auckland Plan. Having said this, the level of development required to accommodate projected growth in the Auckland region may increase demand for numerous natural resources in the Hoteo catchment and surrounding area, for example, agricultural and horticultural produce, water supply, wood products (forestry), aggregate (quarrying services), and holiday/recreation services.

### 6.3.2 Regional policy statements and plans

#### 6.3.2.1 Auckland Regional Policy Statement 1999 and regional plans

The Auckland Regional Policy Statement (RPS) (1999), and Proposed Unitary Plan: Regional Policy Statement (2013) are both relevant to all activities within the Auckland region, until the Proposed Unitary Plan becomes operative, at which point existing regional and district plans will no longer operate. The Proposed RPS represents the direction of policy for the region is going and is legally relevant once notified, even though it is not yet operative.

The Auckland RPS (1999) sets the direction for priority of regionally significant natural resource issues and sustainable management as directed by the RMA (1991). The use of non-statutory management tools is provided for by the RPS, for example, Structure Plans and Catchment Management Plans.

The RPS identifies key natural resource management issues of regional significance and sets objectives, policies, and methods to achieve integrated management that enables development while sustainably managing natural and physical resources. The RPS identifies that most of the pressures on natural resources in the Auckland region stem from development (housing, business, and industrial development as the city grows). Much of the RPS is aimed at managing the impacts of development on natural resources, for example, setting broad strategic objectives, policies, methods, and anticipated outcomes for matters of significance to iwi, heritage, the coastal environment, water quality and quantity, natural hazards, and soil resources.

For example, Auckland's regional vision for water quality is that the water quality in the region will be safe for swimming; that fishing and shell fish gathering will continue to be enjoyed by all (recreational and commercial); and that ecosystems will function well. Reducing sediment and contaminant discharges are identified as key means of achieving this vision.

Beneath the Auckland Regional Policy Statement sit numerous regional plans, including the Regional Plan: Air, Land, and Water; the Regional Plan: Coastal; the Regional Plan: Sediment Control; and the Regional Plan: Farm Dairy Discharges.

The Regional Plan: Air, Land, Water sets the objectives, policies and rules for the disturbance of streams and stream banks, and includes provisions to promote sustainable management of rural land, biodiversity and water quality.

The Regional Plan: Sediment Control sets the objectives, policies, and rules for land disturbance including forest harvesting.

The relevance of each of the above-mentioned regional plans to the SCP is detailed in Zandvoort et al. (2009) in relation to the Whangateau catchment – this policy context is applicable to the SCP in the Hotoe catchment.

### **6.3.2.2 Proposed Auckland Unitary Plan 2013: Regional Policy Statement and regional objectives, policies and rules**

The Proposed Auckland Unitary Plan will replace a suite of regional plans, including the RPS; the Regional Plan Air, Land Water; Regional Plan: Dairy Farm Discharges; the Regional Plan: Coastal; and the Regional Plan: Sediment Control (the proposed Unitary Plan also replaces all district plans operative in the Auckland region).

The proposed Auckland Unitary Plan: Regional Policy Statement (2013) sets out Auckland's second generation RPS. While the proposed RPS is not yet operative, some of provisions are legally effective from date of notification in September 2013 (see Section 4.3, Proposed Unitary Plan, p16).

The RPS sets out the following regionally significant resource management issues:

- Quality urban growth
- Economic well-being
- Protection of historic heritage, special character and natural heritage

- Issues of significance to Mana Whenua
- Sustainable management of natural resources, coastal environment and rural environment
- Responding to climate change

The Unitary Plan: RPS sets objectives, policies, and methods regarding each of these key management issues. For example, the RPS sets the following objectives (summarised) for freshwater quality:

- Mana Whenua participate in freshwater decision making and management
- Mana Whenua values, mātauranga and tikanga (related to freshwater) are recognised
- Natural, social, economic and cultural values of freshwater are safeguarded
- Freshwater quality is maintained and restored where it has been degraded
- Freshwater is allocated to support natural and cultural values, as well as to make efficient use of water for economic, social and cultural uses
- Water use per capita in Auckland region is reduced
- Stormwater runoff and wastewater discharges have minimal effects, and existing adverse effects are reduced overtime.

Methods to achieve these objectives and the policies that sit beneath them are primarily set as the development and implementation of rules to manage the use and development of the land to avoid damage or degradation to freshwater values.

The Proposed Unitary Plan sets out regional objectives, policies, and rules. Of particular relevance to the SCP are objectives, policies, and rules set regarding:

- earthworks and sediment generation
- vegetation management
- mineral extraction
- rural production discharges
- natural hazards
- flooding
- water quality
- water quantity, allocation and use
- subdivision
- regional zones
- rural zoning, economy, and character

Many of the objectives, policies, and rules also have the potential to affect or influence the activities of residents in the Hotoe catchment.

To view the Proposed Regional Policy Statement, Regional and District Plan Maps of zoning and overlays visit: <http://acmaps.aucklandcouncil.govt.nz/unitaryplan/FlexViewer/index.html>.

### **6.3.2.3 Auckland Council's Indigenous Biodiversity Strategy 2012**

Auckland Council's Indigenous Biodiversity Strategy 2012 sets the strategic approach for integrated indigenous biodiversity management across Auckland region. The Strategy is aligned with the Auckland Plan, and sets out a broad vision and 8 core objectives for indigenous biodiversity in the region. The Auckland Unitary Plan is aimed to align with the Auckland Plan and Indigenous Biodiversity Strategy.

Auckland Council's vision for indigenous biodiversity is developed around four themes:

- Healthy and diverse ecosystems
- Engagement, understand and guardianship of Auckland's indigenous biodiversity
- Recognition and management (for indigenous biodiversity gains) of the ecosystem services supported by indigenous biodiversity
- Integrated management for indigenous biodiversity gains.

### **6.3.3 District level plans**

This review of the Rodney district planning context includes an overview of the operative plan (Auckland Council District Plan: Operative Rodney Section 2011), the Proposed Unitary Plan: District objectives, policies and rules (2013), and comparisons between the operative and proposed plans, particularly as these relate to freshwater management, rural land use, and activities.

#### **6.3.3.1 Operative District Plan: Rodney Section 2011**

The Rodney District Plan was notified in November 2000. Parts of it have progressively been made operative since January 2009, and the plan was made operative in its entirety in July 2011. The District Plan is a regulatory method to manage the effects of land use within the Rodney district and includes issues, objectives, policies, and rules for activities in a set of identified zones.

Most of the Hoteo catchment is covered by the General Rural Zone provisions. The Wellsford and Kaipara Flats settlements are zoned for residential use. There are small pockets of land zoned for Open Space. The Kaipara Flats Airfield is zoned as a special zone, with activities associated with aviation. The lower Hoteo River is zoned Inland Water Protection, the mid to upper reaches are zoned Inland Water General, and in the upper reaches, the land bordering the river is zoned Open Space 1 (Conservation). The area adjacent to the Kaipara harbour is zoned General Rural and is part of the West Coast Policy Area.

#### *General Rural Zone*

The General Rural Zone includes large properties, with low density settlement, and a predominance of natural features over human made features. In the Hoteo catchment, farming activities are predominant. Rural-residential development can occur only where the scale and intensity of settlement can avoid adverse effects on the character and amenity of the environment and provide significant environmental benefits through restoring and protecting natural areas (bush, wetland) or rehabilitating land.

Subject to compliance with the relevant development controls, the following are provided for as Permitted Activities within the General Rural Zone: erection/demolition of buildings and household units; farming; childcare facilities (up to 10 children); clean fill sites up to 200m<sup>2</sup>; farm airstrips; farm stay or homestay; forestry (except within Significant Natural Areas); greenhouses (subject to size restrictions); home occupations; horse riding schools or training; one household unit per site; one additional household unit on large sites used for agriculture; up to 6 household units on Māori land; outdoor recreation (not involving buildings more than 25m<sup>2</sup>); pig keeping; planting of trees for amenity or conservation purposes; poultry keeping; prospecting and exploration for minerals (not involving use of explosives); sale of products of home occupations (subject to controls); extensions of existing urupā on Māori land; temporary events (up to 3 days). All other activities in the zone require resource consent, enabling the council to impose conditions to avoid, remedy or mitigate the environmental effects of such activities.

A maximum height restriction for dwellings of 9 m applies, with no height limit for non-residential buildings. A maximum building coverage applies (ranging from 35% per cent for small sites to 2000m<sup>2</sup> plus 10 per cent of the net site area for large sites). Setbacks for yards are 10 m for the front and side yard, and 6 m for the rear. A shoreline yard of 50 m applies.

General subdivision can only be carried out where the minimum site size of new lots will be 120 ha; otherwise, subdivision in the General Rural Zone for smaller lots is primarily restricted to subdivisions that also protect ecological features. Subdivision is provided as a restricted discretionary activity where: a natural area is protected; esplanade reserve is created; public open space is added to; or for providing for household units on Māori land. Subdivision using the significant enhancement planting or land rehabilitation provisions is a discretionary activity. All other subdivision is non-complying.

#### *West Coast Policy Area*

The West Coast Policy area is a sub-section of the General Rural zone. It includes areas that are identified as having higher landscape sensitivity and amenity values than other parts of the General Rural Zone. The policy area has tighter controls on buildings and activities than the General Rural zone.

#### *Residential and Open Space Zones*

Wellsford is primarily zoned Residential Medium Intensity with a minimum site size of 600m<sup>2</sup> and maximum site coverage of 35 per cent Kaipara Flats is primarily zoned Residential Township Policy Area with a minimum site size of 1500m<sup>2</sup> and maximum site coverage of 500m<sup>2</sup> or 35 per cent (whichever is less). Pockets of land in the catchment are also zoned Open Space, including the Atuanui Scenic reserve, Tauhoa Scientific Reserve, Dome forest, and other small nearby forested areas. In specific exotic-forested areas there is allowance for quarrying and recreation activities (e.g. horse trekking, motor sports).

### *Inland Water Zone*

The Inland Water Zone includes the beds and water of lakes, rivers, and streams, including fresh and tidal waters. The zone does not apply to any stretches of rivers or streams that are in the Coastal Marine Area. The zone has controls on any activity that affects water quality, water quantity, soil conservation, or creates or worsens natural hazards. Most activities require resource consents. The Inland Waters Protection Zone recognises particular environmental values which require special treatment, and therefore restrictions are placed on the type and timing of activities that can occur within this zone. The Inland Waters General Zone has controls on activities to deal with the impacts of structures on waterways, landscape values and the disturbance of wildlife, as well as native vegetation removal.

The Hoteo River is one of the longest waterways in the Auckland region. The Auckland Council District Plan: Operative Rodney Section 2011 (Chapter 11: Inland Waters) recognises significant estuarine and extensive freshwater values associated with the river. In particular, the Atuanui Stewardship Area remains in full forest with significant natural values. Additionally, estuarine habitat extends to Tarakihi Rapids and is ranked as regionally significant wildlife habitat up to that point. These areas contain threatened banded rail, as well as a variety of wetland birds, especially ducks and shags, and are identified as one of the most important galaxiid breeding sites in the Auckland region. The relatively undisturbed river adjoining Mt Auckland forest is recognised for protection, as is the podocarp forest on the riparian river margin that is now rare in the Auckland region.

#### **6.3.3.2 Proposed Auckland Unitary Plan: District objectives, policies and rules**

The Proposed Auckland Unitary Plan specifies region-wide rules regarding rural production discharges; and lakes, rivers, streams, and wetland management that hold relevance for establishing a sustainable catchment programme in the Hoteo catchment.

The Plan lists all permitted rural discharge activities and controls for permitted activities (Chapter H, Section 4.10). For example:

- dairy farm effluent discharge to land is a permitted activity as long as discharges do not result in run off to a waterway; or surface ponding lasting more than 3 hours; or exceed nitrogen from effluent application rates set in the plan (vary according to soil type);
- a range of rural activity discharges that do meet permitted activity controls are discretionary activities to which resource consent conditions can be applied; and
- dairy farm effluent discharge to a waterway is a prohibited activity.

The Plan outlines numerous rules regarding activities in (on, under and over) rivers, streams, lakes, and wetlands. Controls require resource consent (or prohibit) any activity that results in: any greasy film, scum or foam, change of colour, objectionable odour, pollution rendering the water unsuitable for stock drinking water, or adverse effects of aquatic life in the waterway. Controls also require resource consent for, or prohibit, activities that: increase flood risk; result in erosion or instability; site machinery in the river bed; use explosives in the river bed; mix construction materials within 10 m of the river bed; or result in any destruction,



damage or modification to any scheduled historic heritage sites, or scheduled sites and places of significance to mana whenua.

Conservation planting is a permitted activity as long as it meets the above conditions, and plantings must not be invasive or pest species. Channel clearance activity status depends on where and how much clearance is being completed.

Overlay rules regarding historic heritage, mana whenua, and natural heritage also hold relevance for Hoteo catchment activities.

### *Hoteo Catchment Zoning*

Zoning under the Proposed Unitary Plan 2013 is similar to the operative District Plan: Rodney Section, with some important exceptions. Most of the Hoteo catchment will be zoned Rural Production, which is comparable to the current General Rural Zone. Parts of Wellsford, including an area situated in the Hoteo catchment (south of Port Albert Road), are a new Countryside Living Zone. A small area in the Hoteo catchment that is adjacent to the Kaipara harbour will be a Rural Coastal Zone, comparable to the existing West Coast Policy Area. To view the district plan zones and overlay layers visit <http://acmaps.aucklandcouncil.govt.nz/unitaryplan/FlexViewer/index.html>.

### *Rural Production Zone*

The Rural Production zone is the main zone for rural production and related rural services and industries. The zone seeks to maintain the productive capacity of the land, its natural and amenity values, and its rural character.

More permissive rules for rural production activities will be introduced, including a removal of limitations on the size of greenhouses and in relation to intensive farming. Restrictions apply to visitor accommodation, garden centres, storage units, and restaurants accessory to farming (where the primary business is farming).

There are new development controls on various activities, notably keeping stock out of waterways. Stock on land categorised as “intensively grazed production land” (stocking rate equal to or exceeding 18 stock units per hectare) must be excluded from lakes, Coastal Marine Areas, permanent rivers, and streams. This is to be achieved within 5 years of notification, and within 10 years for intermittent streams. Various controls have also been introduced in relation to poultry farming, intensive farming, forestry, greenhouses, animal breeding, produce stalls, manufacturing, dwellings, home occupations, markets, quarries, and mineral prospecting.

New development controls have been introduced. The existing restriction on building coverage will be removed. However, limits to impervious surface are proposed in the Rural Production zone, permitting no more than 10 per cent of site or 5000m<sup>2</sup> (whichever is the lesser). A new maximum height of 12 m for accessory buildings applies; the maximum of 9 m for dwellings is retained. Rules for yards remain at 10 m for front yards, and 6 m for side and rear. A new 20-m front yard will be introduced for sites adjoining arterial roads. Riparian

yard will be reduced to 20 m, and lake yard to 30 m. Buildings housing animals must be at least 50 m from the boundary.

Subdivision opportunities are reduced in the Rural Production zone, compared with the existing District Plan: Rodney Section as a result of the philosophy of no net increase in the number of rural lots. There is a new minimum site area of 150ha for a basic subdivision of a large site. Otherwise all subdivision can only occur through Significant Ecological Areas (SEAs) protection and the title must be transferred to the Countryside Living Zone or Rural and Coastal Settlement. Lots can also be amalgamated and the titles transferred to other rural areas. SEAs require a minimum area of 5ha indigenous bush, 0.5ha wetland, or 3ha for threatened areas. The new zone also removes subdivision opportunities for protection of SNA and wetlands and for Significant Enhancement Planting, Public Reserve Creation, and Land Rehabilitation.

#### *Countryside Living Zone*

The Countryside Living zone allows for smaller lot subdivision in rural areas with restrictions on some rural activities. Minimum lot size of 2ha applies to this zone. This zone, including a small area adjacent to Wellsford, is a “receiver” site for transferable titles. Using these titles enables the minimum lot size to be reduced. Land-use controls are the same as in the Rural Production zone. Farming is permitted but there are restrictions on other rural productions activities, such as greenhouses, intensive farming, and forestry. Commercial activities are also restricted, including storage and lock-up facilities, restaurants, camping grounds, and clean fill. Visitor accommodation has an activity status of Discretionary. Development controls include the introduction of a requirement for achieving pre-development flows in terms of impervious surfaces, and a limit on building coverage to 7.5 per cent of the site or 1000m<sup>2</sup> (whichever is the lesser).

#### *Rural Coastal Zone*

The Rural Coastal zone is a rural production zone but as there are high amenity and landscape characteristics, it has restrictive rules on some rural activities. Farming is permitted, but restrictions apply to other rural production activities such as greenhouses, intensive farming, and visitor accommodation. Land-use controls are the same as for the Rural Production zone. Development controls include the introduction of a limit to impervious surfaces at 10 per cent of the site or 5000m<sup>2</sup> (whichever is the lesser), and restrictions on building coverage to 7.5 per cent of the site or 1500m<sup>2</sup> (whichever is the lesser). Subdivision rules promote the reduction in the number of sites in the zone. No general subdivision is allowed unless it protects SEAs or occurs through title amalgamations. All titles created must be removed from the zone. The zone is not a receiving area for any transferable titles from SEA protection or amalgamation.

#### 6.3.4 Non-statutory legacy documents

A number of non-statutory legacy documents developed by the former Rodney District Council provide useful context regarding the Hoteo catchment and wider Rodney District. These plans are non-statutory so do not hold weight in a legal sense as do the Auckland

Plan, Rodney District Plan, and Proposed Unitary Plan. They should be considered as reference material for issues and past strategic planning for the district.

#### **6.3.4.1 Vision Rodney and Planning Rodney**

Vision Rodney: Rodney's Community Outcomes 2008 (Rodney District Council 2008c) and Planning Rodney (Rodney District Council 2008a) are high-level strategic planning documents prepared by the former Rodney District Council. Vision Rodney describes future outcomes regarded as desirable by residents of the district, such as economic prosperity and healthy environments. Planning Rodney is the planning tool created to deliver the outcomes identified in Vision Rodney, in particular the conceptual future as "Distinctive towns and villages set in a stable rural landscape and a well-protected natural environment". The plans do not encourage large-scale residential development, and do not plan for water and wastewater services in small rural settlements such as Kaipara Flats and Tauhoa.

#### **6.3.4.2 Rodney District Council Rural Strategy 2010**

This strategy was developed, in consultation with residents and other local stakeholders, to provide the incoming Auckland Council with an overview of rural issues for the Rodney district. The strategy includes aspirations for rural futures, methods for achieving them, and perceived shortcomings related to current planning policies. A desire to retain a 'country look and feel' and prevent the sprawl of towns and villages was identified. Key issues raised that had relevance to the Hoteo catchment were the need for restrictions to subdivision in rural areas; the need to reconsider trade-off of subdivision in return for environmental conservation and related mitigation works; pressures and changes in the rural economy; and regulatory impediments to rural business.

#### **6.3.4.3 Other existing plans**

Other plans that relate to the Hoteo, relate to Wellsford: the Wellsford Catchment Management Plan (1994), Wellsford South Catchment Management Plan (1996); Wellsford Town Centre Development Plan (2008), and the Wellsford Structure Plan (March 2000).

## 7.0 Hoteo catchment monitoring and research

An outline of research and monitoring relevant to the Hoteo catchment is provided in this section. This includes Kaipara harbour research and Hoteo catchment research and monitoring, as well as a number of other research projects that may have relevance for the Hoteo catchment.

### 7.1 Kaipara harbour research

#### *Integrated Kaipara Harbour Management Group (IKHMG)*

The Hoteo catchment receiving environment, the Kaipara harbour, is New Zealand's largest estuarine ecosystem. It has multiple environmental values including fisheries, cultural and spiritual significance, recreational activities, biodiversity, and landscape amenities. The Kaipara harbour falls under multiple governance organisations and groups including Ngāti Whātua o Kaipara, Te Uri o Hau, Northland Regional Council, Auckland Council, district councils, the Department of Conservation, and others. The IKHMG was established in 2005 by Māori tribal elders to facilitate integrated management and kaitiakitanga of the harbour and its catchment, and interagency cooperation. The integrated management approach developed and being adopted for the Kaipara harbour combines two approaches, Mātauranga Māori and western science and knowledge. This approach forms the basis for future research, planning, policy development, and management of the Kaipara ecosystems, harbour, and catchment (IKHMG 2011a). The IKHMG define integrated management of the harbour as *a process utilising both traditional Māori philosophy and western science philosophy to manage the Kaipara as an interdependent system. Management is cross-sectoral and activities are coordinated across all levels.*

IKHMG manage a number of existing resources, including a database of over 1000 publications related to the Kaipara harbour and catchments. Visit <http://www.kaiparaharbour.net.nz/Publications> to access the publications database. IKHMG also administer a database of maps and data for the Kaipara. Visit <http://www.kaiparaharbour.net.nz/MapsAndData> to access the maps and data database.

IKHMG have completed a significant research project detailing the history and issues of the Kaipara harbour and catchment area (IKHMG 2010).

IKHMG have developed an integrated strategic plan of action, 2011–2021, for the harbour and its catchment. The plan outlines five long-term objectives for management of the harbour and the actions to achieve them:

- Protect and restore native biodiversity
- Restore sustainable use of fish and invertebrate stocks
- Protect and restore the *mauri* of the Kaipara
- Increase understanding of climate change impacts
- Promote socio-economic opportunities.

IKHMG are also involved in a number of key research programmes to achieve the objectives set by the group. Recent research and research currently underway for the Kaipara harbour have an important contribution to make to the SCP programme in the Hoteo catchment in terms of the marine environment, as well as important aspects of the harbour catchment, which includes the Hoteo.

#### *NIWA-led research programme*

In collaboration with IKHMG, the National Institute of Water and Atmospheric Research (NIWA) is leading a major multidisciplinary Ministry of Business, Innovation and Employment (MBIE) funded research programme, *Management of Cumulative Effects of Stressors on Aquatic Ecosystems*, in the Kaipara.

The project aims to:

- advance understanding of the effects of multiple contaminant stressors (fine sediments, nutrients and heavy metals) on estuarine ecosystems
- understand and develop predictive models of the effects of fine sediment on estuary water clarity
- extend our ability to build source-to-sea models
- improve models for predicting the dispersal of contaminants by river plumes that discharge into estuaries, and
- develop methods and tools to support limits-based management of estuaries.

The project involves monitoring stations in the Hoteo catchment and immediate receiving environment in the southern Kaipara, and another monitoring station in the Wairoa River catchment and immediate harbour receiving waters in the northern Kaipara. A sediment transport model for the entire harbour is also being developed as part of this research programme.

The programme is being run in collaboration with the Clean Water Productive Land programme led by AgResearch to link research into contaminant dispersal and effects with research into critical source areas in the catchment. The programme links with Landcare Research's work on sediment generation and implementing regional policy for catchment management and iwi freshwater values. The programme is also linked with Ngāti Whatua o Kaipara to operationalise an iwi estuarine monitoring toolkit – Nga Waihotanga Iho, and to develop cultural report cards for the Kaipara.

The first major output from the programme has been work to trace sediment dispersion across the harbour (NIWA 2012) using isotopic tracers to build a picture of sources of sediment for the harbour. This work can now be used to inform recommendations for targeting mitigation in the catchment that can most effectively reduce sedimentation in critical habitats in the harbour. The next stage of the project is research entitled *Multiple effects of fine suspended sediment from the Kaipara harbour catchment*. This project aims to link fine sediment levels with water quality to better understand the environmental effects of fine sediment.

### *Texas State University-led research projects*

A number of collaborative research projects are underway, led by Jason Julian of Texas State University. The Hoteo catchment is a key case-study catchment in each of the following studies:

- assessment of cross-scale interactions among climate change, land use change and river water quality (2014–2016) utilising sophisticated geovisualisation tools to analyse high-resolution datasets of land use and water quality
- investigation of land management impacts on water quality in New Zealand across political boundaries (2013–2015)
- investigation of the influence of catchment characteristics and land use change on optical water quality in New Zealand rivers.

### *Cardno ENTRIX stream bank erosion study*

Cardno ENTRIX has been commissioned by Auckland Council to conduct an assessment of channel and bank stability of the Hoteo River system with the aim of identifying and rehabilitating active bank erosion that may be contributing to sediment loads delivered to the Kaipara harbour.

## 7.2 Hoteo catchment monitoring

Further to monitoring undertaken in the Hoteo catchment as part of the NIWA-led research programme outlined above, Auckland Council has established numerous regional environmental monitoring programmes for which data collection sites sit within the Hoteo catchment. This is to meet councils' RMA (Resource Management Act) obligations to monitor the state of the environment, for which they are required to produce 5-yearly regional State of the Environment reports. Additionally, Auckland Council produces technical reports of environmental monitoring and research and 'environmental report card' summaries. This section provides a brief summary of key monitoring undertaken in the Hoteo catchment.

Soil quality monitoring (SQM) is conducted at four sites in the Hoteo catchment.

Climate data are monitored at two sites in the Hoteo catchment, Hoteo at Oldfields, and Hoteo at Kaipara Flats.

Auckland Council is monitoring exotic forest before and after harvesting to assess the effect of forest harvesting on erosion rates. This research, it should be noted, is being conducted outside the Hoteo catchment. Auckland Council identified that sedimentation following the clearance of a 205-hectare area of plantation forestry in the nearby Weiti forest block, Okura, could have adverse environmental effects. A project has been established to monitor sedimentation rates pre- and post-harvest at this site (Auckland Council 2013). The information derived from this research may be of use in terms of understanding sedimentation risks from deforestation in the Hoteo catchment and similar monitoring in the

Hoteo catchment may also be important. More information about this research is available on the Auckland Council website.

Terrestrial biodiversity information is held in a number of Auckland Council databases, including: Significant Ecological Areas; threatened reptiles and amphibians; threatened birds; LENZ threatened environments; sites of special wildlife interest; and protected areas (QEII, DOC, and Rodney bushlots). Terrestrial biodiversity is monitored as part of the regional Terrestrial Biodiversity Monitoring Programme (TBMP). A total of 21 sites lie with the Hoteo catchment – 9 forest sites and 12 wetland sites. A total of 400 forest and 220 wetland sites are monitored regionally with a 20 × 20-m forest plot approach recording indigenous flora and fauna, pest species, and condition data. All plots are measured on a 5-year cycle with first re-measure due in 2014/15.

Water levels and flow are monitored for the Hoteo at Gubbs, Waiwhiu, and Waiteitei (Appendix A – Map 31). NIWA also have a river monitoring site along the Hoteo River for which data may be available on request. Water quantity is monitored in respect to rainfall, surface water flow levels, groundwater levels, and abstraction or use levels to enable sustainable water management under the Auckland Regional Policy Statement (ARC 1999) (ARPS) and the Auckland Council Regional Plan: Air, Land and Water (ARC 2010) (PARP: ALW). Auckland Council has defined 8 water resource reporting areas (ARC 2008). The Hoteo catchment falls within the 'North-West' water resource area.

River water quality for the Hoteo River is monitored by Auckland Council at Gubbs monitoring station. This site is part of the water-quality monitoring network designed to represent regional water quality of the Auckland region. Data are collected for the site monthly (Auckland Council 2012a). Water quality is determined by measuring seven water quality parameters: dissolved oxygen, pH, turbidity, ammonia, temperature, total phosphorus, and total nitrogen. These are used to assess the life-supporting capacity of the river water by combining the results of monitoring into the Water Quality Index (WQI) that allows water quality to be summarised as excellent, good, fair, or poor. Water turbidity is now being monitored by Auckland Council, at the Gubbs monitoring station. Auckland Council also monitors sediment volumes at Gubbs.

Community water quality monitoring is also conducted within the catchment. There are 10 Wai Care testing sites in the catchment, and a further 3 are to be established in the near future. Wai Care has community water quality monitoring programmes, for which monitoring is conducted by volunteers from the community.

Lake ecological quality has been monitored by Auckland Council at one lake in the Hoteo catchment – Silver Hills Reservoir. Silver Hills is monitored for lake ecological quality by developing an index based on measures of the species distribution and abundance of its macrophyte (submerged aquatic plants) community mentioned earlier. The indicator measured at Silver Hills Reservoir is 1 of 5 lake environmental state indicators monitored by Auckland Council in the region. The other 4 indicators are not monitored at Silver Hills Reservoir or in the Hoteo catchment (ARC 2010).

Groundwater quantity and quality are not monitored in the Hoteo catchment. Sites were selected regionally, based on the area tested having high groundwater use and intensive land use; the integrity of existing bores; long-term bore accessibility, and to ensure geographic spread and aquifer representativeness (ARC 2007b). In terms of the assessment criteria for the establishment of monitoring sites, the Hoteo area is not considered a high water use area and the catchment is not at high risk of groundwater pollution. Based on the criteria for selecting the monitoring sites around the region, this does not appear to represent a significant gap in environmental monitoring data. It is considered that the bore sites for the Waitemata aquifer are representative of water quality for the Hoteo catchment (S Vujnovich, 2013, Auckland Council, pers. comm.).

Freshwater ecology and biodiversity information is limited. The freshwater fish database administered by NIWA records sightings of freshwater fish nationally.

Socio-demographic and economic information for the catchment can be extracted at the mesh-block level from the 2012 Statistics New Zealand Census data. Other information exists at the Rodney district scale but is not directly linked to Hoteo catchment, and thus cannot be disaggregated for catchment scale analysis.



## 8.0 Summary of catchment values

A summary of potential Hoteo catchment 'values' is provided in this section, based on the descriptive information provided about Hoteo catchment in previous sections of this report. Some values are based on recognised sites of significance, such as Significant Ecological Areas (SEA), which are assumed to be of high ecological value nationally or regionally. Other values are implied through historical, cultural or ecological data summarised in previous sections of this report.

These do not represent catchment values as identified by the Hoteo catchment community. It is recommended that identification of Hoteo catchment values is undertaken as a part of the SCP work with the residents, stakeholders, and mana whenua of the Hoteo catchment. The summary of values presented here could be used to inform and/or justify SCP initiatives from a regional or national perspective, and could also usefully be the starting point for community level conversations about the catchment and its values.

### 8.1 Biophysical

Most of the Hoteo catchment is in private ownership and in use for primary production. The natural land resource of the catchment is critical to the economy and livelihoods of the Hoteo communities, and the geology, soils, and climate of the catchment allow for a range of productive land uses to be successfully practised, in particular pastoral agriculture and exotic forestry. The catchment has relatively large areas of steep and erosion prone hill country that is utilised for exotic forestry, while rolling hill country and river plains areas are in use for pastoral agriculture.

The original land cover of the catchment has been highly modified, and very little of the kauri forest that once covered the catchment remains. Patches of forest still standing represent important remnants of indigenous biodiversity and support a range of flora and fauna. Within the catchment 197 SEA are identified (Auckland Council 2013). Larger areas of remnant forest include Atuanui (Mt Auckland) forest reserve, Ryan Road forest, Logue's Bush, Pakiri Hill forest, and part Mt Tamahunga (Omaha ecological area). Atuanui, the largest area of indigenous forest in the Rodney Ecological District (RED), includes a continuous sequence of vegetation from the coast to the hills peak, is home to a rare orchid, and provides habitat for a range of common forest birds. The rare Hochstetter's frog is found in Mt Tamahunga streams and the forest is home to a range of forest birds.

The Hoteo is Auckland's largest catchment, feeding Auckland's largest river system. Plentiful rainfall and a large catchment area support a variety of freshwater environments, including surface water, rivers, lakes and wetlands, and ground water resources. Groundwater and surface water provide numerous services to people, including water supply, food gathering, waste assimilation, and access for recreational activities.

The Hoteo River is recognised as an outstanding natural feature, and parts of the river and wetlands are recognised as SEA. The river and river edge provide habitat for a range of water fowl including the threatened banded rail. The Hoteo gorge is identified as one of the

REDs outstanding landforms. The small numbers of remnant wetlands are critical in retaining wetland habitat in the area, which have been severely depleted. Various freshwater species have been identified in the streams of the catchment.

#### Key values

- 15 per cent of the catchment has indigenous forest cover
- Approximately 4 per cent of the catchment is protected under DOC or QEII designations, as well as Rodney bushlot designations scattered throughout the catchment.
- Important habitat provision by the river system and the fragmented set of forest remnants, that support a wide range of common flora and fauna and a number of rare and threatened species
- Numerous Outstanding Natural Landscapes (ONL), Outstanding Natural Features (ONF), and Significant Ecological Areas (SEA).

## 8.2 Human economic

The productive capacity of Hoteo catchment land, particularly pastoral agriculture and exotic forestry, underpins the economy of the catchment area. The more fertile soils of the alluvial plains and rolling hills are developed for pastoral agriculture, while the uplands areas with steeper slopes have been utilised for exotic forestry. Wellsford and the nearby township of Warkworth provide service hubs for the largely rural catchment.

In recent years pastoral agriculture has seen a slight decline, while exotic forestry has grown within the catchment. The potential for further expansion of exotic forestry may be an important economic opportunity within the catchment. Another area of development has been rural subdivision for lifestyle blocks.

The beauty, isolation, waterways, and forested areas provide opportunities for tourism and outdoor recreation. Diversification of activities within the catchment is a key area for human economic development, and growth in tourism and recreation activities may be another important development sector for the Hoteo communities.

Most community facilities, retail, schools, and healthcare in the Hoteo catchment are clustered in Wellsford, with few facilities and services elsewhere. The rural landscapes and waterways provide recreational activities for residents. For example, the Hoteo is regarded as one of the only good spots in the Auckland region for whitebait fishing.

#### Key values

- Productive capacity of the catchment for agricultural activities
- Increasing rural subdivision for lifestyle development – economic opportunities to diversify land uses and increase catchment income, often from high income earning families moving out of Auckland
- Agriculture, retail, and social services provided at Wellsford (and nearby Warkworth)
- Development of recreational activities associated with the natural beauty of the waterways, peaks, forested areas, and rural landscape. Wellsford provides social infrastructure for Hoteo catchment communities

- The rural character of the catchment is valued by its residents
- Important whitebait fishery provides food as well as highly valued recreational activity
- Natural beauty, harbour, waterways, peaks and forested areas provide recreational spaces

### 8.3 Cultural heritage

The Kaipara harbour, waterways, and land-based resources provided the basis for historical settlement and related cultural attachments to the catchment. Historic Māori settlement is reflected in layers of archaeological sites, trees, vegetation patterns, land modifications, place names, and human memories that overlay the catchment. For local iwi, identity, *mauri* or spiritual essence, and sense of well-being are derived and intimately linked to the natural features of the environment. While almost all land in the catchment went out of Māori ownership during early European settlement, these relationships to the catchment, and sense of kaitiakitanga or guardianship over it, remain.

Multi-generational farming families in the Hoteo catchment have attachments to the catchment through land-based production and rural communities. Family and community pioneering stories of logging, gum digging, and developing land for farming are fundamental to the cultural heritage of farming communities.

#### Key values

- Rich cultural heritage associated with the Kaipara harbour, Hoteo River and tributaries, and landscapes
- Māori identity and sense of wellbeing intimately linked to these local environmental features
- Landscapes include rich layers of historical places and areas that reflect early Māori and European heritage
- Historical settlement, use of marine and waterway resources, and land-based production has resulted in a sense of kaitiakitanga or guardianship towards these natural features

## 9.0 Issues identification

In this section current and potential future issues affecting the Hoteo catchment are outlined. Identification of issues is based on the preceding information gathered in the review of environmental, socio-economic, cultural, and demographic information readily available for the catchment. Issues identification was also informed by a workshop held with Auckland Council staff as part of this review, during which staff in attendance were asked to discuss key issues facing the Hoteo catchment.

Hoteo catchment issues have also been prioritised based on the objectives of the SCP and in collaboration with SCP staff at Auckland Council. Identified issues are reported here in order of their relative importance in relation to the stated objectives of the SCP and its focus in the Hoteo catchment on *community initiatives to restore ecosystems in and around streams and rivers to limit erosion and sedimentation*.

### 9.1 Water quality

Key issues

- Bank erosion, overland flow erosion, and mass movement slope failure during flood events increasing sedimentation in Hoteo River
- Adverse effects of sedimentation on: freshwater ecosystems; marine ecosystems of Kaipara harbour; and cultural and recreational values associated with the river
- Potential for future increased phosphorous loads as phosphorous moves through the sub-aerial system
- Potential for future increased nitrogen loads and sedimentation with any intensification of farming practices (e.g. increased stocking rates)
- Potential for future algal growth due to nutrient levels as sediment levels are reduced (reducing the light limitation to algal growth imposed by high turbidity)

Overall, water quality in the Hoteo River might be summarised as 'good' (classes are excellent, good, fair and poor), with the river gaining a class of 'good' for 3 out of the last 4 years reported on (2007, 2009, and 2010); however, water quality was reported as 'poor' in 2008. The poor water quality result in 2008 is explained by increased sediment and phosphorous levels measured in the river. Maximum turbidity in 2008 was approximately four times higher than the other three reporting years. Increased sediment and phosphorous levels probably occurred as a result of a number of flood events occurring that monitoring year (Temple and Parsonson 2014).

IKMHG (2010) have identified declining biodiversity as a key issue in the Kaipara harbour and sediment loading from rivers and streams as a key driver of biodiversity decline. Key issues identified by IKMHG (2010) regarding sedimentation delivered by the Hoteo River, include:

- Adverse impact on the important snapper nursery in seagrass beds just landward of the Hoteo River mouth

- Smothering of bottom-dwelling organisms, e.g. shellfish, which can subsequently affect fisheries
- Potential for adverse impact on mana whenua cultural sites such as pa and burial sites
- Potential to restrict navigation

In the Hoteo catchment rainfall is the key driver of erosion processes, including bank erosion, overland flow erosion, and mass movement slope failure. In the autumn, winter, and spring rainfall events greater than 25 mm, and events greater than 50 mm in late summer when soil moisture levels are lower, are expected to result in erosion (Jessen et al. 1997). Underlying geology, soil type, slope, and land cover are key factors determining how much erosion occurs.

Jessen et al. (1997) concluded that erosion, sediment transport, and sediment storage and delivery occurring within a normal range for a hilly catchment with mixed pastoral and forestry land use in the Auckland region. They also determined that sediment generation in the Hoteo catchment occurs principally in 4 key areas (in order of greatest to lowest contribution to sediments reaching the Hoteo River and potentially Kaipara harbour):

1. Stream banks of the lower reaches of the Hoteo River
2. Stream banks within flood plains found throughout the catchment, except the lower reaches of the Hoteo River
3. Pasture-covered steep land in the central and southern hills, found in the Whangaripo, Wayby, Hoteo central, Waiwhiu, Hoteo gorge, Kourawhero and lower Hoteo River subcatchments
4. Rolling land on fractured mudstone, found predominantly in the Hoteo central, Wayby, and Kourawhero subcatchments

Sediment sources are irregularly distributed throughout the subcatchments of the Hoteo and there is no worst subcatchment or sediment source that can be identified as critical; however, Auckland Council (Temple and Parsonson 2014) identifies specific priority sites for effective erosion control in the catchment. Minimising soil erosion has multiple benefits as it retains soil resources for productive uses that would otherwise be lost; can improve freshwater quality by reducing sedimentation with the potential to improve biodiversity and ecosystem functions; and can improve indigenous biodiversity where interventions involve stream restoration and riparian planting.

Semadeni-Davies (2012) concludes that historic land-use change in the Kaipara catchment has had a profound effect on water quality. Land use was found to have a greater effect on nutrient levels than for sediments; however, sediment yields were on average seen to increase 3.5 times from the historic forested scenario to the recent pasture-dominated scenario using the CLUES model. Catchments with more forest, indigenous and exotic, were found to generate lower nutrient and sediment loads. Semadeni-Davies (2012) also found that catchments dominated by dairy farming had higher nutrient yields, but not higher sediment yields. This indicates that dairy farming was not seen to increase sediment loads (or yields) more than other land uses.

Nutrient levels in the river have not been identified as a critical issue for the Hoteo; however, soils under pasture were identified as having high nutrient levels. Auckland Council staff noted that deep ground water is unlikely to be affected by land-use practices in the Hoteo catchment, whereas shallow groundwater may be, thus shallow groundwater testing maybe justified. Nitrogen levels in the Hoteo River have not exceeded acceptable ranges; however, phosphorous does occasionally exceed accepted ranges. These exceedances are likely to be associated with flood peaks when sediment levels are high, as sediment is the main transport agent for phosphorous from the land to waterways. Scientists working in the catchment have noted the potential future risk of nutrient related algal growth as turbidity is decreased (J Julian, 2014, Texas State University, pers. comm.).

## 9.2 Soil conservation

### Key issues

- Loss of productive soils as a result of erosion
- Soil compaction

Erosion not only leads to sedimentation in the Hoteo River, it represents a loss of soils resource from the land. Identifying critical areas of erosion that are a result of human land use and management practices is essential to adopting soil conservation practices to prevent the loss of soils. A co-benefit of any work to reduce sedimentation in the river will be soil conservation.

Soil compaction has also been identified as an issue in Hoteo catchment. Two forestry sites monitored for soil quality have been found to be within recommended guideline ranges; however, two agricultural (one dairy and one drystock farm) sites monitored for soil quality were found to have low macroporosity, indicating compacted soils. High Olsen P levels at the dairy site indicate this soil may be over-fertilised.

These results indicate that any future increase in stocking rate as a result of increasing demand for production and/or the introduction of irrigation to more farms in the area could lead to further soil compaction issues.

## 9.3 Indigenous biodiversity

### Key issues

- Historic loss of indigenous biodiversity – protection of remaining indigenous biodiversity and restoration and enhancement of indigenous biodiversity following the historic large-scale modification of the catchment
- Any future loss of indigenous biodiversity – potential for future decline in remaining indigenous biodiversity if protection and restoration measures are not undertaken

Historic loss of indigenous biodiversity may be the most critical environmental issue facing the catchment, and habitat disturbance and modification are highlighted as major pressures on biodiversity (ARC 2010). Habitat loss, disturbance, modification and fragmentation, and introduced species are the key threats to biodiversity in the Auckland region (Department of Conservation 2012).

In the Hoteo catchment, 15 per cent remains in indigenous forest cover and a further 4 per cent is in regenerating mānuka and kānuka forest. Numerous SEA and outstanding natural features have been identified, which are protected from development under the Proposed Auckland Unitary Plan. Forest remnants throughout the catchment represent the forest that once covered the catchment and provide critical habitat for a range of fauna, some of which is threatened. Climate change may pose risks to freshwater ecology as water temperatures increase, and increased drought has the potential to impact adversely on terrestrial biodiversity.

Approximately 4 per cent of the catchment is protected under DOC or QEII designations, and further pockets of indigenous forest are protected as Rodney bushlots. However, a significant area of area in indigenous forest cover and/or regenerating mānuka/kānuka appears to remain unprotected. Important gains for indigenous biodiversity could be achieved through protection of these areas of indigenous biodiversity.

The Auckland Plan and proposed Unitary Plan set clear policy direction for the conservation of indigenous biodiversity. The Auckland Plan sets targets of no loss of identified SEA and ONA, and no regional extinction of indigenous species and a 50 per cent reduction in the number of 'threatened' and 'at risk' species by 2040. SEA and ONA are identified in the Proposed Auckland Unitary Plan and are protected from development and activities that would reduce or damage the area in SEA or ONA.

In terms of freshwater environments, streams running through agricultural pasture lands are the most likely to have degraded biodiversity values. Sedimentation of streams due to erosion of soils from agricultural lands and stream banks are also of concern in terms of water quality and impacts on stream ecology in the catchment (Maxted 2005; Temple and Parsonson 2014). Further to this, activities that adversely affect stream ecology and biodiversity include channelization/excavation, removal of shading riparian vegetation, and stock watering where they are directly able to access the waterway (Davies-Colley and Parkyn 2001; Temple and Parsonson 2014).

## 9.4 Flooding

### Key issues

- Key driver of erosion processes
- Potential to damage farmland, disrupt farming and endanger stock

While the Hoteo River experiences regular flood events, these are not expected to put people or property at risk. This makes flood risk in the Hoteo catchment comparatively low and a low priority for management response (e.g. flood protection works on the river), although flooding is cited as an issue by landowners. At the same time, flooding is the key driver of erosion in the catchment.

Flood peak volume and duration influence the degree of bank erosion, and low flows influence deposition of suspended sediment either within the river system or in the Kaipara

harbour. During low flows coarse sediment settles quickly and fine sediment (clays) can remain in suspension for days.

Land management responses can be implemented to decrease the erosion potential of flood water in the catchment (as outlined in the ESCP). Flood peaks could potentially be reduced by large-scale revegetation of the catchment; however this large-scale land-use change is not expected to occur in the near term.

## 9.5 Cultural heritage

Key issues

- Need to recognise and integrate iwi claims settlement acts into Auckland Council activities as per each settlement act
- Cultural heritage sites are at risk because they have not been identified

The Resource Management Act 1991 requires “recognition and protection of the heritage values of sites, buildings, places, or areas” in the catchment. However, these places and sites have not yet been identified in any definitive way in the catchment because it has not been systematically surveyed. Any large-scale earthworks, development activity or erosion within the catchment has the capacity to impact adversely on historic areas. Land 1km from the coast and waterways (Hoteo River) has been identified as a high priority for survey (Appendix A – Map 36).

Archaeological investigations have not been undertaken in the catchment. Archaeological information could add value to understanding the pre-European Māori environment and use of resources, and could be used to inform catchment planning for environmental outcomes. Cultural heritage sites are potentially threatened by erosion, flooding, and land-use change. Conservation management is needed to protect such sites, but there is a lack of knowledge about cultural heritage sites in the catchment (Auckland Council 2013).

Ensuring that historic cultural ties to place are maintained provides an opportunity to develop relationships that could foster environmental stewardship or kaitiakitanga as part of the SCP.

## 9.6 Socio-economic and community

Key issues:

- Potential increasing pressure on environmental outcomes with land use change (e.g. increase in dairy farming)
- Potential risk to rural economy and rural character due to changing land tenure and management
- Potential risk to rural economy due to external shocks (economic, social, environmental)
- Potential future pressure on water supply to Wellsford
- Need to ensure social and physical infrastructure keeps up with population increase, and that better public transport options are provided



Auckland Council expects Auckland's population to increase by 1 million people in the next 30 years. While no rapid increase in population is expected for the Hoteo catchment, there is potential for increasing demand on production in Hoteo's rural sector. Increasing extent or intensity of agricultural production in the catchment will increase pressure on environmental factors, including water quality, water supply, and biodiversity. For example, Jessen et al. (1997) noted that any increase in the intensity of dairy farming (e.g. as a result of increasing stocking rates) could result in increased pugging and subsequent erosion. Increased dairy stock also has the potential to increase nutrient leaching to waterways in the catchment.

Land tenure and management has been changing in the catchment. Changes in farm ownership dynamics, such as shifts away from owner-manager to hired managers (Lees and Cole 2014), will potentially result in a loss of long-standing farm families (the "5<sup>th</sup> generation" farmers) and different attitudes and land management practices.

Growth in Hoteo catchment between 1996 and 2006 is associated predominantly with an increase in lifestyle blocks concentrated on the outskirts of Wellsford and Warkworth. The Rodney bushlot subdivision rule, while protecting sites of remnant biodiversity, has allowed subdivision to occur in a spatially ad hoc manner without necessarily having regard for the impact of rural subdivision on the rural character of the catchment, or reverse sensitivity impacts of lifestyle blocks on adjacent farms in rural areas. Additionally, social and physical infrastructure has not kept up with increased population.

These types of changes represent both risks and opportunities for the catchment. For example, this report has noted the diversification of land use that has resulted from increasing tourist activities as lifestyle block owners have looked to non-agricultural sources of income. Diversification can build resilience within the local economy to cope better with external shocks, for example, if international commodity prices impact negatively on farmer income, there will now be other businesses in the community that are less at risk from that type of external shock and can help keep the rural economy functioning during difficult periods.

The catchment economy has been highly dependent on sheep, beef and dairy farming, and exotic forestry. Tourism activities have been increasing in the catchment in recent years. This small range of activities, all of which are highly vulnerable to climate (e.g. drought), global market shocks and national and sectoral policy, could make Hoteo communities vulnerable to external shocks and changes (economic, social and environmental). External shocks include global commodity price drops and climate change impacts. While business operators in the Hoteo catchment need to be aware of and manage risks for external shocks to the economy and environment, the catchment's close proximity to Auckland (and its large economy and labour market) means the community is also well placed to absorb and/or cope with shocks and changes. Further, recent growth in exotic forestry and tourism sectors has the potential to reduce that vulnerability by diversifying activity within the catchment; and further economic diversification may help build resilience to external shocks into the local rural economy.

While large population increase is not signalled in the Proposed Auckland Unitary Plan, some population increase in the catchment is expected by 2040, particularly around Wellsford, and this is expected to put pressure on Wellsford's water supply. Surface water flows, water quality, and water ecological quality are monitored regionally to ensure land-use activities and water abstraction do not adversely affect water quantity or quality. Streams can be affected by water abstraction, but the greatest influence on flow levels is generally local weather conditions. It is particularly important to ensure abstraction does not adversely affect the environment during the summer and early autumn months, when surface water flow levels are at their lowest and demand is at its highest.

## 10.0 Identification of critical knowledge gaps

In this section critical knowledge gaps are identified based on the descriptive information presented in previous sections of this report, as well as on review and input from experts at Landcare Research and Auckland Council. However, further investigation to understand what might be critical gaps from the perspective of the Hoteo community may be of importance in the context of development of the SCP.

Many Auckland Council staff noted during the review conducted for this report, that while some sites for regional monitoring sit within the catchment, the Hoteo has not been a priority catchment for environmental research – most likely due to its relatively large size, low level of development and population, and the fairly acceptable results received for indicators of the state of the environment. This has resulted in gaps in research and knowledge within the catchment as identified by Auckland Council environmental research staff. A whole catchment perspective on an appropriate monitoring plan is desirable and the SCP programme offers an opportunity for that focus.

As can be expected, the Hoteo catchment is included in all national databases. National-scale geology, soils, climate, land cover, and mesh-block-scale population and socio-economic (census NZ) information are available for the catchment. However, the following knowledge gaps were identified in relation to biophysical and socio-economic information.

### 10.1 Water quality

Sedimentation is the key pollutant causing reduced water quality in the Hoteo River. To achieve sediment reductions an understanding of the catchment processes and best practice response options is required. This understanding is initiated by this report and the ESCP (2014); however, a number of critical gaps in knowledge are identified below.

#### 10.1.1 Sediment

Critical source areas for sediment delivery to the river need to be identified before sediment reduction targets can reliably be set. Understanding catchment erosion processes and critical source areas will also contribute to establishing soil conservation needs in response to loss of productive soils via erosion. Understanding the potential impacts of sediment reductions and more light penetrating the river water column on algal growth in the river may be required.

The Hoteo catchment sediment monitoring station (Hoteo @ Gubbs, location shown on Map 31) is part way up the river, and thus does not represent sediment yield for the entire Hoteo River catchment. The station is situated above the hilly area of the lower Hoteo River identified by Jessen et al. (1997) as being prone to bank erosion and riparian slips. As the monitoring period increases, the reliability of the results will become more robust; however, developing an approach to acquiring data on suspended sediment for the lower Hoteo River would also be useful for determining sediment yield for the Hoteo River.

Curran-Cournane et al. (2013b) recommend that future work explores model options for Auckland region and suggests a number of current studies (e.g. Basher et al. 1997; Curran-

Cournane et al. 2013b; Hicks et al. 2009; Hoyle et al. 2012) could now be used to calibrate an empirical model selected for predicting sediment yield for Auckland catchments. Curran-Cournane (2013b) also recommends that future monitoring work focusses on monitoring for change in sediment yield, especially given the Auckland Plan target to reduce sediment yield by 15 per cent from 2012 levels by 2040.

SedNetNZ is a sediment modelling tool that could be used to identify sediment sources in the Hotoe catchment. SedNetNZ is a hybrid empirical/physical-based model built on a relatively simple physical representation of hill slope (landslides, sheetwash, gullies, earthflows) and channel processes (stream bank erosion, floodplain deposition) at a river-reach scale. It provides spatially distributed, time-averaged (multi-decadal) estimates of both erosion rates and sediment yield. This enables users to target management actions effectively to improve water quality, and helps plan catchment management actions by identifying the relative importance of processes supplying sediment and nutrients to the river network, and hotspot areas of each source. SedNetNZ estimates could be ground-truthed through a combination of aerial photo analysis and field surveys.

Harvesting of exotic forest blocks has the potential to dramatically increase sediment loading to receiving water courses. Several areas of forest in the catchment are expected to reach maturity in the near term. Information about forestry in the catchment (forest block ownership, age, and expected maturity dates) has not as yet been collated for the catchment. This information can be retrieved from forest owners and Auckland Council consents data and forest specialists who could be engaged in the SCP to help ensure impacts of forest harvesting are minimised.

There was a lack of farm-specific information for the catchment to form part of this review. Farm-specific information may be able to be retrieved from Auckland Council's consents team, farm advisors, and through working with farmers in the catchment.

### 10.1.2 Groundwater

Groundwater quality is not monitored in the catchment; this is not considered a critical gap for deep groundwater, but it may be important to understand the impact of land use on shallow groundwater, which is more vulnerable to infiltration from land based pollutants than deep aquifers. Lake ecological quality is monitored for just one indicator out of the five that Auckland monitors at other sites.

### 10.1.3 Water quantity

The Whangaripo stream is categorised as a high-use management stream in terms of water abstraction; however, no flow-monitoring site exists at the stream. If water supply for Wellsford and/or for agricultural activities in the rest of the catchment comes under increasing pressure in the future it may be important to have a record of flow-monitoring on streams used for water supply, in particular, at this stage, for the Whangaripo stream.

## 10.2 Indigenous biodiversity

### 10.2.1 Baseline biodiversity information for the catchment

Baseline indigenous biodiversity data may be collected and then monitored to assess changes as initiatives are implemented in the catchment. Community-based freshwater indicators exist that can be administered and implemented by the community, for example the freshwater cultural health index (CHI).

### 10.2.2 Inanga spawning grounds

The Hoteo River is known to provide habitat for inanga spawning grounds; however, little or no information about these spawning grounds or the impacts of changes in water quality on them has been collected. Knowledge of where inanga spawning grounds are along the river is needed to identify and protect key spawning areas. Freshwater ecologists at Auckland Council could lead this work and conduct a survey of spawning grounds.

### 10.2.3 Prioritising protection and conservation efforts

LENZ ecosystem-based analysis can be used to compare and prioritise sites for protection, conservation, and restoration efforts. However, more detailed analysis for the Hoteo catchment is required to make recommendations about where protection, conservation, and restoration should be targeted.

## 10.3 Cultural heritage, community knowledge, land use and management

### 10.3.1 Cultural heritage

The Hoteo catchment has not been systematically surveyed, and no archaeological investigations have been undertaken. Auckland Council's cultural heritage team highlight this as a key knowledge gap for this area and have identified priority areas for survey (Appendix A – Map 36).

### 10.3.2 Local knowledge and history

There is significant opportunity to contribute to and develop the SCP in the catchment via knowledge creation through participatory research or projects to enable the sharing of history and stories with local residents in the catchment. Development of information about pre-European Māori and early European settlements could enable the integration of traditional, environmental, cultural, spiritual and historical knowledge into conservation and catchment management initiatives.

Recreational use data are limited. Engagement with tourism and recreation operators as well as council and DOC sites is necessary to develop knowledge regarding recreational use in the catchment.

### 10.3.3 Land tenure

There is a need to develop understanding of land tenure in the catchment, particularly along the river. Land may be under a number of different land tenure titles that could have

relevance to SCP projects, including Conservation Act part 4a marginal strips, Treaty of Waitangi protection clauses; and tidal reach for determining riparian planting.

#### 10.3.4 Catchment and farm scale information

Detailed catchment-scale farm information and rural economic analysis would be beneficial to the development and implementation of the SCP in the catchment. Detailed information is needed at the farm scale, including developing understanding of the drivers of decision making for farmers, and engagement with farmers to understand specific characteristics of environmental management interventions on their land. In addition, it may be that some farm-scale data exist for the catchment (e.g. rates database and resource consents surveying); however, such data are not readily available and require resources and support to access, compile, and analyse.

#### 10.3.5 Climate change impacts and adaptation assessment

No catchment-specific climate change impacts and adaptation options assessment was readily available for use in this review. Support for the catchment communities to develop a climate impacts and adaptation plan (includes an assessment) is recommended by international studies as a key step in building resilience to climate change impacts in the future.

#### 10.3.6 Community engagement in environmental activities

Gathering information about the willingness to participate in SCP initiatives and other environmental programmes and why may be required by the SCP, especially if there is resistance to engagement with SCP initiatives.

## 11.0 Summary and recommendations

The Hoteo catchment has been prioritised for sustainable catchment management with a focus on *community initiatives to restore ecosystems in and around streams and rivers to limit erosion and sedimentation levels*. A key driver for action in the Hoteo catchment is its current and potential future impact on Kaipara harbour, particularly the impact of sediment delivery on the harbour's ecosystems and important species (e.g. the snapper spawning grounds in the sea grass beds at the mouth of the Hoteo River). Specific priority areas and options for SCP initiatives will be developed with Hoteo communities and will be informed by the background information collated for the catchment, of which this report is part.

Based on existing terrestrial and freshwater environmental monitoring (i.e. not focused on marine impacts) results available for this review, rates of erosion in the Hoteo catchment are not considered unusual. Erosion, sediment transport, sediment storage, and delivery occur within a normal range for a hilly catchment with mixed pastoral and forestry use in the Auckland region. However, successfully limiting erosion in Hoteo catchment will contribute to the restoration of Kaipara harbour, and thus to the protection and enhancement of a wide range of critical environmental and cultural values associated with the harbour, including multiple outstanding natural landscapes and features, and threatened species and environments. Erosion management in the Hoteo catchment can also contribute positively to freshwater ecology and indigenous biodiversity.

The original land cover of the catchment has been highly modified. Once almost all densely forested, today the Hoteo catchment is predominantly privately owned farm and exotic forestry with small areas of remnant forest, and small areas of publically owned parks and infrastructure, such as roading and railway tracks. High loss of indigenous biodiversity has occurred as forests have been cleared and wetlands drained.

Approximately 15 per cent of the catchment remains in indigenous forest cover and a further 4 per cent in regenerating mānuka/kānuka forest. Remaining streams, rivers, wetlands and forest provide critical habitat for indigenous plants and animals, some of which are regionally or nationally threatened or rare. Significant ecological areas, natural features, and landscapes have been identified in the catchment, indicating the high ecological values for many parts of the catchment. Hoteo also has multiple recreational values provided by the landscape.

Steeper slopes in the catchment have been utilised for forestry, with mixed farming, particularly sheep and beef drystock farming on hilly land, and some areas of dairy farming in flatter areas, e.g. river plains). The dominant land cover changes that have occurred since the early 1990s have been an increase in area under exotic forestry, and a slight decrease in pastoral land cover.

Exotic forestry provides an opportunity to minimise erosion while achieving productive land use on often marginal land, as well as providing numerous ecosystem services such as habitat, water purification, and increased water storage capacity in the catchment (reducing

flood peaks). However, exotic forest harvest cycles represent periods of vulnerability to erosion when combined with a flood event.

The catchment has a rich cultural heritage associated with Kaipara harbour, the Hoteo River, tributaries, and landscapes. This heritage is the basis from which mana whenua and long-term farming communities derive their identity and strong attachment to place. The rural character of the landscape is highly valued by Rodney residents, and concerns about changing and losing this have been expressed. Trade-offs between existing catchment values and development will need to be considered carefully, and the Proposed Auckland Unitary Plan attempts to create a constructive framework to enable this.

There is one small town (Wellsford) and several small rural settlements in the catchment. Urban development has been limited over the last 15 years. The Rodney District Plan enabled ad hoc development (mostly lifestyle blocks) in the rural environment where indigenous biodiversity could be protected (Rodney Bush Lot Rule 7.14.3). The Proposed Auckland Unitary Plan 2013 attempts to overcome ad hoc lifestyle block development in the rural landscape by establishing a lifestyle block development zone close to Wellsford.

The catchment has very low population density and a small resident population. Only limited growth has been indicated by the Proposed Auckland Unitary Plan 2013, making risks due to increased development low; however, once the motorway extension to Wellsford is complete development patterns in the catchment may begin to change at a faster rate. There is also potential for redirected growth in the wider Auckland region to increase demand for products and services provided by the Hoteo catchment. Rising demand for goods and services from the catchment has the potential to put pressure on ecosystems. Overall, there is only minor variation in demographic themes between different parts of the Hoteo catchment, except as it relates to population growth, which has been concentrated around the settlements of Wellsford and nearby Warkworth.

## 11.1 Recommendations

The following recommendations have been developed in collaboration with SCP staff at Auckland Council, and are based upon the review of information, summary of issues, and gap analysis conducted for this project. As well as this, the objectives of the SCP (Section 1: Introduction) have been used as a basis for developing these recommendations.

### 11.1.1 Governance

Particular regard should be made by the SCP to the acknowledgement of Treaty settlement legislation relevant within the Hoteo. Working with iwi/hapū in the Hoteo catchment will be crucial for a successful SCP in the Hoteo catchment.

The IKHMG and the Kaipara Harbour Joint Political Committee are components of any operation in the Hoteo catchment, given the catchment forms part of the greater Kaipara catchment and is intimately linked with Kaipara harbour activities. Working with the IKHMG and Kaipara Harbour Joint Political Committee forms a fundamental component of any work in the Hoteo catchment.



Ensuring other work being undertaken in the catchment is identified, acknowledged, and engaged is a requirement of the SCP establishing in the Hoteo catchment, for example, working closely with those at Auckland Council responsible for responding to the NPS Freshwater and other water programmes underway, particularly if they begin work in the Hoteo catchment. Work to address the NPS Freshwater objectives and policies will have a direct relationship to and influence on the work of SCP.

The SCP will need to take account of the various directives set in the Auckland Plan. The SCP is also in a position to contribute actively to numerous targets set in the Plan. In particular, the SCP can establish its programme to demonstrate its contribution to the reduction in overall sediment yield to the Kaipara harbour (the target is a 15% reduction from 2012 levels by 2040), and establish sustainable land-use and management practices that take into account the possibility of increasing demand on agricultural production, recreation opportunities, and housing development as Auckland's population grows.

The SCP has the opportunity to contribute positively to achieving the vision and objectives set in Auckland Council's Indigenous Biodiversity Strategy and freshwater-focussed work implementing response to the NPS Freshwater. For example, riparian restoration along the river, together with protection of fish-spawning grounds along the river and in the Kaipara harbour, has the potential to protect and enhance terrestrial and freshwater biodiversity in the catchment. The community engagement, education, and implementation-focussed approach of the SCP also has the opportunity to increase engagement, understanding, and guardianship of the Hoteo catchment's indigenous biodiversity by its residents.

#### 11.1.2 Erosion and sediment management

Interventions to reduce sediment yield from the Hoteo River entering Kaipara harbour are likely to be most effective if targeted along the lower reaches of the Hoteo River and associated steep pasture land, while interventions in the upper reaches of the catchment are likely to be less effective (Jessen et al. 1997; Temple and Parsonson 2014). However, the ESCP (2014) highlights that land management techniques to reduce erosion will be demonstrable throughout the catchment. Temple and Parsonson (2014) suggest the Whangaripo and Hoteo central subcatchments as appropriate areas to demonstrate a range of land management practices to reduce erosion.

Temple and Parsonson (2014) correctly highlight the importance of evaluating the effectiveness of interventions to reduce sediment yields and provide examples of targets that could be set for the catchment (e.g. 40% reduction in annual sediment load reaching the Kaipara harbour) against which progress can be measured. However, before reliable targets for sediment reduction can be set, and for the development of appropriate response measures, the SCP needs to have confidence in estimated sediment yields and sources.

The development of information about erosion and sediment processes occurring in the Hoteo catchment is recommended and would usefully update current available information (e.g. Jessen et al. 1997) with a more recent assessment of the state of erosion and sedimentation. The establishment of sediment monitoring at Gubbs monitoring station on the

Hoteo River will be able to provide baseline data on sediment levels in the river; however, we recommend that developing methods to determine sediment yield for the lower Hoteo will also be important, particularly if this area is prioritised for erosion-management interventions.

Exotic forest harvest cycles represent periods of vulnerability to erosion when combined with a flood event. Information about the catchments forest blocks, harvest cycles, and erosion being completed at present will help ensure erosion management to minimise this risk.

Following this, management practices that are practical, affordable, and effective will need to be identified with land owners. To prioritise riparian zones for action the SCP can build on the work of Buikema (2012), which comprehensively details riparian physical characteristics and vegetation along the Hoteo River. Buikema (2012) highlights two strategic locations where riparian management has a high potential to reduce bank erosion – the Whangaripo and Waitapu streams (Fig. 1).

It is recommended that the SCP investigate further the implications of sediment reductions in the river on nutrient related issues. High sediment (high turbidity) levels in the river may be limiting the growth of algae that can result from nutrient enrichment. As more light reaches the water column, nutrient levels may have a greater impact on algal growth water quality.

#### 11.1.3 Indigenous biodiversity

Measures to limit erosion and sedimentation align closely with recommended approaches for improving indigenous biodiversity along Hoteo River (terrestrial and freshwater). For example, riparian management could be utilised to protect and enhance inanga spawning grounds.

Maxted (2005) found that lack of riparian vegetation was a significant factor in the low ecological health of all streams and rivers in the region. Maxted (2005) recommends that for rural areas such as the Hoteo catchment full restoration of degraded streams is possible with improved riparian management following the Riparian Zone Management Guidelines (ARC 2001). Riparian management needs to be tailored to suit the geography and flooding potential of sites. For best ecological restoration gaining canopy cover with native vegetation is the recommended goal (Maxted 2005).

#### 11.1.4 Cultural heritage, socio-economic and community

Creating opportunities for mana whenua and residents to document and share their stories and find points of commonality and agreed upon catchment conservation priorities could help shape future catchment management and conservation efforts. Further, collaboration with the various groups in the catchment presents significant opportunities to integrate traditional environmental, cultural, spiritual, and historical knowledge into conservation and catchment management.

To protect and learn from cultural heritage sites, archaeological sites need to be identified and a systematic survey undertaken to identify priority sites. Threats to priority sites need to be identified so that conservation management can occur. A comprehensive framework for such investigations needs to be developed.

There is a need to develop understanding of land tenure in the catchment to enable riparian restoration projects, particularly along the river. Land may be under a number of different land tenure titles that could have relevance to SCP projects, including Conservation Act Part 4a marginal strips, Treaty of Waitangi protection clauses, and tidal reach for determining riparian planting.

#### 11.1.5 Socio-economic and community

Farmers in the catchment have expressed concern about economic strain and the potential for this to limit environmentally beneficial behaviour (Lees and Cole 2014) (i.e. adoption of erosion management practices). Working with farmers to better understand drivers of environmental behaviour and change may be critical to gaining engagement in SCP programmes. A catchment group could be established to facilitate this engagement and research.

There are numerous opportunities in the catchment for diversified land uses and activities, and for Māori land and harbour uses that could be identified and supported by the SCP. For example, this review suggests that tourism and recreational opportunities are now being taken up as business opportunities. Surveying and engaging with business operators, many of whom are local land-owners, would usefully augment knowledge about activities, issues, and opportunities within the catchment. Recreational providers and users may also be critical to the development and implementation of the SCP because of the tangible impact improved environmental conditions can provide their businesses.

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## Appendix A Hoteo Catchment Maps

Hoteo catchment analysis – list of maps.

Map 1	Hoteo Catchment and Subcatchments
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Map 3	Hoteo Catchment Geology
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Map 5	Soils: Waitapu Subcatchment
Map 6	Soils: Whangaripo Subcatchment
Map 7	Soils: Wayby Subcatchment
Map 8	Soils: Hoteo Central Subcatchment
Map 9	Soils: Waiwhiu Subcatchment
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Map 13	Hoteo Catchment Slope
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Map 21	Hoteo Catchment LUC (Land Use Capability)
Map 22	Hoteo Catchment Indigenous Biodiversity Sites
Map 23	Hoteo Catchment Threatened Environments Classification
Map 24	Hoteo Catchment Stream Area (REC)
Map 25	Hoteo Catchment Stream Geology (REC)
Map 26	Hoteo Catchment Stream Climate (REC)
Map 27	Hoteo Catchment Source of Flow (REC)
Map 28	Hoteo Catchment Stream Order (REC)

Map 29	Hoteo Catchment Valley Landform (REC)
Map 30	Hoteo Catchment Stream Land Cover (REC)
Map 31	Hoteo Catchment Environmental Monitoring Sites
Map 32	Hoteo Catchment 1-in-100 Year Inundation Water Level
Map 33	Hoteo Catchment CHI (Cultural Heritage Index) Sites
Map 34	Lower Hoteo River CHI Sites
Map 35	Hoteo Catchment CHI Archaeological Surveyed
Map 36	Hoteo Catchment CHI Priority Areas for Survey
Map 37	Hoteo Catchment Open Space Land Tenure

## APPENDIX B CATCHMENT DEMOGRAPHIC PROFILE COMPARISON

HOTEO CATCHMENT													
AGE (YEARS)		HOUSEHOLD INCOME		EMPLOYMENT STATUS		TENURE-YEARS AT ADDRESS		SOURCES OF INCOME		OCCUPATION		TRAVEL TO WORK	
<20	31%	<20K	12%	FULL TIME	54%	>5 YEARS	55%	WAGE / SALARY	34%	MANAGER / CLERICAL	20%	PRIVATE	68%
20-40	22%	20-70K	45%	PART TIME	17%	5-10 YEARS	16%	S/EMPLOYED	20%	PROFESSIONALS	18%	PUBLIC TRANSPORT	-
40-60	31%	70K>	27%	NOT WORKING	27%	10 YEARS>	23%	INTEREST/DIVIDENDS	17%	TRADES	11%	BIKE / WALK	4%
60>	16%	N/S	16%	UNEMPLOYED	2%	N/S	6%	BENEFITS / SUPERANNUATION	20%	SERVICES	11%	OTHER	2%
								OTHER	9%	AGRICULTURE	19%	WORK FROM HOME	26%
										OTHER	20%		
RODNEY DISTRICT													
AGE (YEARS)		HOUSEHOLD INCOME		EMPLOYMENT STATUS		TENURE-YEARS AT ADDRESS		SOURCES OF INCOME		OCCUPATION		TRAVEL TO WORK	
<20	29%	<20K	12%	FULL TIME	48%	>5 YEARS	56%	WAGE/SALARY	36%	MANAGER/CLERIC AL	29%	PRIVATE	66%
20-40	22%	20-70K	40%	PART TIME	15%	5-10 YEARS	17%	S/EMPLOYED	17%	PROFESSIONALS	26%	PUBLIC TRANSPORT	6%
40-60	30%	70K>	34%	NOT WORKING	31%	10 YEARS>	21%	INTEREST/DIVIDENDS	19%	TRADES	17%	BIKE/WALK	5%
60>	19%	N/S	14%	UNEMPLOYED	2%	N/S	6%	BENEFITS/SUPERANNUATION	23%	SERVICES	12%	OTHER	16%
								OTHER	5%	AGRICULTURE	7%	WORK FROM HOME	7%
										OTHER	9%		

AUCKLAND REGION													
AGE (YEARS)		HOUSEHOLD INCOME		EMPLOYMENT STATUS		TENURE-YEARS AT ADDRESS		SOURCES OF INCOME		OCCUPATION		TRAVEL TO WORK	
<20	30%	<20K	11%	FULL TIME	49%	>5 YEARS	55%	WAGE/SALARY	43%	MANAGER/CLERICAL	30%	PRIVATE	66%
20–40	31%	20–70K	34%	PART TIME	13%	5–10 YEARS	17%	S/EMPLOYED	11%	PROFESSIONALS	30%	PUBLIC TRANSPORT	5%
40–60	26%	70K>	37%	NOT WORKING	30%	10 YEARS>	20%	INTEREST/DIVIDENDS	16%	TRADES	14%	BIKE/WALK	4%
60>	13%	N/S	18%	UNEMPLOYED	4%	N/S	8%	BENEFITS/SUPERANNUATION	22%	SERVICES	13%	OTHER	13%
								OTHER	8%	AGRICULTURE	2%	WORK FROM HOME	13%
										OTHER	11%		

1) Household income figures are indicative because Stats NZ uses random rounding.

2) 'Other' occupation includes "Plant and machine operators and assemblers" and "Elementary occupations (including residential)".