Auckland Regional Council

09

OUR REGION, OUR FUTURE

State of the Auckland Region

Auckland Regional Council
TE RAUHĪTANGA TAIAO

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Acknowledgement

The project team wishes to acknowledge the dedication of the various field teams who over the past 20 years have battled through intermittent periods of fine weather, rain, hail and snow to collect the data for this report.

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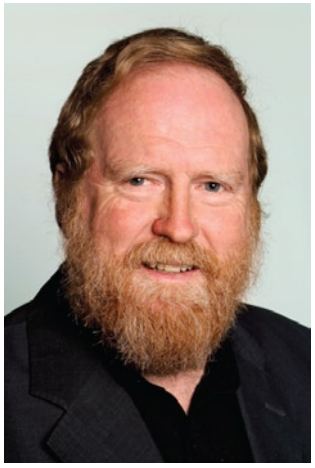

It is with great pleasure that I introduce the latest State of the Auckland Region report.

This report presents as complete a picture as is currently possible of the state of the region's air, land, water and biodiversity. It is a picture built up over decades from the Auckland Regional Council's extensive monitoring and research programmes coupled with the knowledge of other agencies. The report will provide the new Auckland Council with information to help it adapt to ongoing and new environmental challenges.

Regular snapshots of the environment's status are important because they help local government make decisions in areas such as the management of urban growth and rural productivity, and the protection of open spaces, landscapes and biodiversity.

The Auckland Regional Council is responsible for managing Auckland's natural resources and contributing to the sustainable development of the region. In doing this our challenge is to manage the effects of a growing population and expanding urban area on Auckland's natural resources, production systems, air quality and cultural heritage.

This report is the third in a series produced since 1999. It's the last the Auckland Regional Council will produce and represents the legacy of the councillors who worked hard to establish the State of the Region programme. It is also represents the work of many people past and present for whom the care and stewardship of the region's environment is an abiding passion.

The extent and comprehensiveness of our knowledge about Auckland's environment owes a lot to the foresight of the people involved in the 1985 Waitangi Tribunal deliberations on claims brought by Nganeko Minhinnick and Te Puaha ki Manukau on the Manukau Harbour and environs.

The tribunal determined that action was needed to clean up the harbour and there was not enough information to assess the impact of development. The resulting Manukau Harbour Action Plan led to the establishment of research and monitoring programmes in 1987. These were later extended to include other areas in the region.

I wish to acknowledge the contributions of my colleagues and to thank all involved in preparing the 2009 State of the Auckland Region report.

Cr Paul Walbran

Chair – Regional Strategy and Planning Committee
Auckland Regional Council

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Executive summary

Purpose of the report

The Auckland Regional Council (ARC) prepared this report as a requirement under Section 35 of the Resource Management Act (1991). The report takes stock of the monitoring of the Auckland environment, the challenges it faces and how they are being addressed. To monitor the environment, the ARC uses data from its own monitoring programmes and works with other government agencies, educational institutes and network utility operators. Two previous *State of the Environment* reports were produced in 1999 and 2004.

Characteristics of the Auckland region

The region covers about 16,141km^2, about 2 per cent of New Zealand's total land mass. Of this, around 4,518km^2 is mainland, 1800m^2 coastline and 11,117km^2 (69 per cent) is sea. Auckland has abundant freshwater, three main shallow harbours and numerous islands. Weather is dominated by low pressure systems originating in the Tasman Sea to the west providing abundant rain and a mild climate. Four large cities in the region make up the region's urban area – the largest in New Zealand.

Three main driving forces cause environmental pressure in the region – population growth, economic growth and consumption and consumerism.

Population growth is the primary driving force for change in the region. Auckland's population is predicted to grow from 1.3 to 2 million by 2035, with 90 per cent living in urban areas. In turn, this affects economic growth and resource efficiency. The region is New Zealand's largest manufacturing base, having nationally strategic transport and distribution functions. Auckland is a major employment and commerce centre, with associated active production, resource use, environmental effects, and consumption. Auckland is driven by urban activity – despite 90 per cent of land in the region being rural, the agricultural sector is in long-term decline.

The pressures of population and economic growth feed consumption in the region. High rates of employment, perceived land wealth, available credit and price reductions have all accelerated Auckland household consumption. The ARC acknowledges these driving forces through the Auckland Sustainability Framework (ASF). It works with several other groups to promote sustainable development of the region, with the ASF setting out a long term vision, goals and shifts to deal with forces driving change.

Consumption and production pressures on Auckland's resources

These pressures affect Auckland's resources in the following ways:

Changes to land use and intensification continue. Pasture covers near half of the region's land, with most in sheep or cattle farming, followed by dairy and rural residential use, while urban areas cover 10 per cent, with 70 per cent of this in residential use. Rural land continues to fragment at the edges of the Metropolitan Urban Limits due to rural residential subdivision. Residential density has increased and growth has expanded the urban area with a loss of rural land and increase in impervious areas.

Water use appears relatively stable. Surface water from the Waitakere and Hunua Ranges provides the majority of the region's water supplies by volume. Consent holders used 76 per cent of water allocated under consent; more than in 2002 but less than during 2003-5. Applications for groundwater bores have increased over recent years as land not serviced by water supply becomes occupied.

Projections for future energy use without efficiency measures show a 65 per cent increase by 2031. Over half the energy currently used in the region is taken up by transport. Around half of transport energy is used on road transport and around a third on aviation. Non-transport energy is taken up by electricity, coal and gas, with around 70 per cent of non-transport energy used by industry and commerce, and 30 per cent by households.

Solid and liquid wastes are increasing. Solid wastes sent to landfills from the region have increased by a third since 2003/4. Much can be attributed to population growth, but solid waste disposal per person has also increased. Available recycling data indicate recycling increased with variable results. The quality and quantity of liquid wastes are strongly related to both rural and urban land uses. 133 million m^3 of wastewater is treated each year but non-point sources of contaminants discharge to waterways across the region through stormwater. Agricultural production continues to produce liquid wastes that degrade streams in rural areas. Land used for business generates more suspended sediment, zinc, copper and *Enterococci* bacteria than residential land; however, the sheer extent of residential land across the region contributes a larger overall tonnage of suspended sediment to stormwater networks.

Urban areas contribute most of the total regional air emissions despite representing only 10 per cent of the total land area. Motor vehicles produce the vast majority of transport-related emissions, with home heating using solid fuels also a considerable source. Industrial sources are the second biggest source of other air contaminants.

Transport currently contributes significant air emissions and non-point source liquid wastes, and increasing population and need for transportation will further exacerbate these volumes of contaminants.

The ARC uses a range of regulation methods, strategies and policies to address consumption and production pressures, drawing on a range of statutory plans and regional initiatives. It monitors the effects of environmental pressures to understand the extent and rate of changes to the environment.

State of the region's environment and biodiversity results

Results from monitoring the Auckland environment show the following effects on the region's resources:

→ Air quality – Transport contributes the greatest source of air pollution with winter domestic fires also significant. Air quality standards and guidelines are exceeded for levels of PM_{10} and $PM_{2.5}$ particulates and NO_2 at peak traffic sites, although annual PM_{10} levels have decreased over time, recently levelling off. PM_{10} particulates cause the worst health problems, particularly from diesel combustion. Air pollution health costs are at least $547 million each year. Levels of PM_{10} and $PM_{2.5}$ particulates and NO_2 need to be reduced drastically. Levels of CO, SO_2, ozone, benzene and lead currently comply with air quality standards and guidelines.

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- Land resources – Land is monitored for stability, soil disturbance and bare soil along with soil quality and sediment loss. Unstable land surfaces cover around half the region, with a third in stable surfaces, and the remainder extensively modified urban areas. Soil showed disturbance at nearly half of all sample areas, around a third due to land use activities. Dairy and horticulture land uses had the lowest number of sites meeting soil quality standards, while native vegetation had the highest. Soil quality issues of most concern are low macroporosity (indicating compaction) and high Olsen P (indicating high chemical fertility). Modelling of sediment yields (losses) indicates yields from forested and urban areas are well lower than pasture. Variation in sediment yield is due to catchment rainfall, mean slope and land use.
- Freshwater quality in rivers, lakes and groundwater – Most Auckland rivers are small, and over half flow through native forest. River water quality and ecological health are strongly related to land use in the surrounding catchment, with native forest catchments having the best water quality and urban catchments having the worst. Urban river water quality improved from 1995-2005. Auckland lake water quality is degraded from nutrient enrichment, but microbiological lake water quality is good compared with national recreational guidelines. Ecology of lakes is impaired, probably due to the presence of exotic species. Groundwater quality is generally good or excellent, although some aquifers rated fair or poor.
- Marine areas – These are monitored for water quality, bathing beach contamination, sediment and shellfish contamination, and ecological quality. Overall, coastal waters showed improved water quality. Open coast marine sites have the best water quality, while sheltered marine sites have the worst, receiving contaminants and sediment loads from surrounding land and suffering low flushing capability. Beaches within the Metropolitan Urban Limits more regularly experience levels of microbiological contaminants that could potentially harm human health.
- Terrestrial biodiversity is monitored through investigating native land cover, habitat loss, fragmentation and condition, threatened species, and plant and animal pests. Despite Auckland's small size, it contains a large proportion of New Zealand's threatened species. Assessment of indigenous areas found about half in very good or good condition, with the remainder in poor or very poor condition. Fragmentation of native habitats and the impacts of invasive mammal and weed species were major determinants of condition.

Integrated management is required to manage land, freshwater and marine environments against combined environmental pressures. Responses include developing targets to reduce PM_{10} emissions, clean fuels and vehicle management, controlling sediment from land use and disturbance, controlling agricultural discharges, managing contaminated sites and urban pollution, controlling water use, stream enhancement and improving urban stormwater discharges and riparian management, lake restoration, controlling use of coastal space and protecting and enhancing terrestrial biodiversity.

Natural hazards

These pose risk to the Auckland region in the form of geological (earthquakes, volcanic eruptions), climatic (cyclones, floods, droughts, tornadoes, landslides) and coastal hazards (coastal erosion and flooding, tsunami). Impacts of hazards are planned for to lessen the risks and effects. Between 2004 and 2008 the region suffered a range of natural climatic hazard events costing millions of dollars in damage. Climate change could increase the frequency and intensity of these events. Geological hazard events could have significant economic impacts, so advance preparation is important. Ongoing planning, civil defence management and education, along with information gathering, provide the best management of hazard risks.

Heritage values

The region has a rich array of historical and land-based heritage places, areas and items. Preservation and protection is undertaken through monitoring and surveying new and existing sites and areas. Numbers of heritage resources recorded has increased steadily over the last decade. Ongoing land surveys are important. Due to lack of research and monitoring, the condition or extent of regional heritage values is not clear.

Conclusions

Controlling the effects on the region's environment depends on decoupling negative effects from population and economic growth from production and consumption, requiring resource efficiency through technology and behavioural change.

Many negative trends continue despite regulation. Environmental management also requires careful planning, community and landowner engagement, public investment, inducements and initiatives. Costs and benefits of interventions need fair and equitable allocation. Results will take time to emerge.

Current priorities largely match critical issues identified in this report. Most financial resources have gone on transport management, specifically public transport. Considerable resources went on managing regional parks, followed by stormwater management and growth management strategies.

In the future, the quality of some resources looks similar, but pressures will show. Gains made so far vary. Those due to technology will be permanent but others are vulnerable, relying on behavioural change, natural system response and organisational priority setting.

Looking ahead, it is clear that some environmental gains will be seen within an overall gradual decline. Easy improvement opportunities are exhausted, so the next decade should focus on controlling at source, and requiring extraction of best environmental dividend. An effective partnership with central government will be vital. While controlling resources, consideration needs to be paid to social and economic pressures, along with the potential impacts of climate change. Auckland governance reform offers the opportunity to more effectively address many difficult historical issues.

Clear regional goals and priorities need establishing for a long-term sustainable future, because Auckland is worth the effort.

1.0

Introduction

Introducing the purpose, scope and structure of this report. This section also contains a useful overview of the natural environments and physical characteristics of the Auckland region, and the major environmental changes that have occurred since human settlement and the projected impacts of climate change on the Auckland region.

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Introduction – State of the Auckland region

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Photo: Auckland city from Mt Victoria, Devonport. (Source: Shutterstock).

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Introduction

About this report

Why the need for this report?

As the population of Auckland grows, the work of maintaining and improving the quality of the land, air, freshwater and marine environments and safeguarding the rich biodiversity of life within them becomes an increasingly important and challenging task for Aucklanders.

Many agree that the environment here in the Auckland region is wonderful. We want to safeguard all that is good and improve those aspects that have been impacted over the years.

This report is a stocktake of the environment; the challenges we face and how they are being addressed. It outlines the major social and economic forces that put pressure on the region's environment and it discusses those pressures. It presents the latest results from our environmental monitoring programmes and other sources, and presents them in a single document. It also highlights current and potential environmental issues, recent changes and long-term trends, and, wherever possible, outlines the implications for the future.

All of this knowledge in one place can help councils shape effective plans and policies for the future, and target and integrate efforts towards achieving the long-term objective of a sustainable region.

This report is also required under Section 35 of the Resource Management Act (1991) which requires monitoring of the state of the environment and the effectiveness and efficiency of council's actions in relation to the environment.

Audience and scope

This report is a useful compendium for anyone seeking data, research and information. Scientists, environmental practitioners and government workers will find it useful. The report's companion summary document picks out some of the main findings of this report and is great for anyone looking for an overview of the state of the Auckland region.

This report:

- → outlines the social and economic factors that put pressure on the natural environment in the Auckland region,
- → shows how these pressures impact the environment through the use of land, water and energy and the production of waste,
- → provides a snapshot of the state of the land, air, marine and freshwater environments, biodiversity and historic heritage,
- → describes our current knowledge about the natural hazards that threaten the region,
- → contains case studies to highlight some of the environmental problems, monitoring programmes and restoration work being done,
- → identifies positive and negative environmental changes detected since previous reports and, wherever possible, identifies any long-term trends,
- → aims to raise public awareness of current and potential environmental issues, their causes, and any actions required to lessen their effect.

This report does not contain detailed scientific data (this can be found in the technical publications referenced at the end of some chapters and is available through council websites), also it does not discuss climate change beyond outlining the predicted consequences for the region's environment.

At the time of writing, changes to regional governance structures were taking place in the Auckland region. Much of the data gathered for this report is geographically linked to current council boundaries and occasionally refers to local councils in existence at the time of writing.

Previous State of the Auckland Region reports

Two previous reports have been published:

- → State of the Auckland Region Report 1999.
- → State of the Auckland Region Report 2004.

Information sources

In addition to the ARC's extensive environmental monitoring programmes, the council also works with other government agencies and uses their data. They include crown research institutes and the following Government departments: Department of Conservation, Foundation for Research, Science and Technology, Ministry of Agriculture and Forestry, Ministry of Economic Development, Ministry for the Environment, Ministry of Fisheries, Ministry of Health, Ministry of Research, Science & Technology, Statistics New Zealand, New Zealand Historic Places Trust, Te Puni Kōkiri and other regional councils.

At a regional level, the ARC works with the Auckland University of Technology, Auckland Regional Public Health Service, Auckland/Waikato Fish and Game Council, Massey University, mana whenua, Unitec, the University of Auckland, Waikato University, the New Zealand Archeological Association, Watercare Services Ltd and all other network utility operators (e.g. Ecowater and Metrowater), and all the district and city councils in the Auckland region.

Environmental indicators

If we can understand the natural processes that occur in the environment, and how and why they are changing, we can better manage and protect the environment and make the correct decisions for the future. In essence, the better our data, the more useful they will be.

Along these lines, in 2007, MfE defined a new set of core national environmental indicators. These came out of concerns that different aspects of the environment were monitored in different areas, and monitoring methods often differed between regions and districts, it was therefore difficult to build up an overall picture of the environmental health of the country.

The new environmental indicators help standardise monitoring – different regional authorities and government departments throughout the country can monitor the same aspects of the environment using a common standard. This means that regional data can now be compared to data from other areas and the same area can be compared over time to detect sudden changes as well as long-term trends.

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These indicators are precise measurements of individual physical, chemical or biological aspects of the environment. For example, air quality is measured by the amounts of five pollutants: PM_{10} particulates, nitrogen dioxide, carbon monoxide, sulphur dioxide and ground-level ozone. However, some aspects of the environment (such as the marine environment) are more difficult to monitor than others and/or do not have appropriate core national environmental indicators; in these cases, we use indicators that are specific to the Auckland region.

In addition, as our knowledge of the environment and scientific technology has improved, monitoring methods have changed accordingly. This means that it is not always possible to directly compare the latest environmental data with earlier results that may stretch back over several decades.

The driving forces, pressures, state, impacts and responses (DPSIR) reporting model

This report is structured using the internationally recognised DPSIR reporting model (Figure 1). This model enables complex social, economic, historic and scientific information from many different sources to be woven together in a simple and concise format.

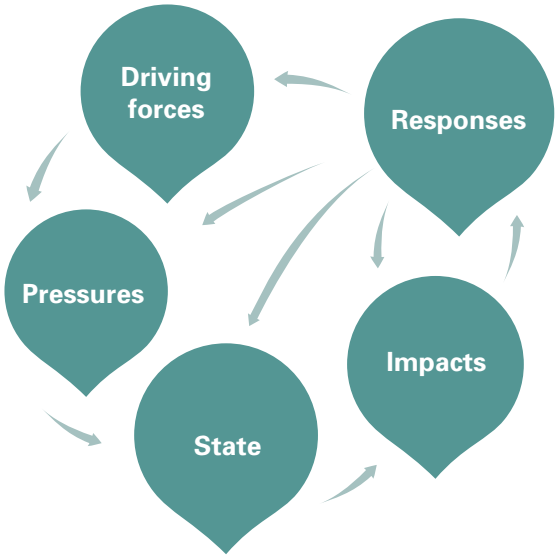

FIGURE 1 The DPSIR reporting framework.
(Source: European Environment Agency, 1999).

The DPSIR reporting model identifies the various human activities that, individually and collectively, create driving forces. An Auckland example is population growth. The pressure this driving force exerts on the environment includes a greater need for housing and infrastructure, so rural land is subdivided and new housing is built. This can impact the environment and result in changes to its state. For example, existing ecosystems are destroyed or severely impacted as land is cleared for housing; sediment levels in the rivers and harbours rise as a result of building activity and the increase in urban area leads to more air, soil and water pollution.

Society can respond by developing and implementing policies and legislation aimed at protecting the environment by minimising negative impacts.

This report is divided into six main parts:

- Part 1 – Introduction.
- Part 2 – Driving forces. This outlines the various social and economic factors that contribute to environmental pressures in the Auckland region.
- Part 3 – Pressures. This describes the types of environmental pressures that arise in the Auckland region as natural resources are used and waste is produced. Changes and long-term trends in environmental pressures are outlined.
- Part 4 – State of the environment and biodiversity. This uses indicators to assess the state of the land, air, marine and freshwater environments and biodiversity in the Auckland region and discusses the future implications. It also outlines our responses in terms of environmental management plans and policies.
- Part 5 – Natural hazards and historic heritage. This summarises our current state of knowledge about the natural hazards that threaten the Auckland region and reports on natural hazard events. It also examines the state of our knowledge concerning the historic heritage within the Auckland region.
- Part 6 – Conclusion and recommendations.

The Auckland region

Overview

The Auckland region (Figure 2) covers about 16,141km^2 of both land and sea. It stretches from Wellsford in the north to Pukekohe in the south and beyond Great Barrier Island in the east, and contains about 2 per cent of New Zealand's total land mass.

Despite its relatively small size, the Auckland region offers a wide variety of landscapes, numerous sandy beaches, harbours and open coast. The abundant resources and mild climate have encouraged human settlement in the past and continue to do so today. In 2006, about 1.3 million people, roughly one-third of the national population, lived in the Auckland region.

Land and sea

The Auckland region contains:

- **About 4518km^2 of mainland.** The underlying rock consists mostly of soft sandstones and mudstones (known as Waitemata Formation) with some areas of hard greywacke and volcanic basalt. Most of the land consists of low but occasionally steep hills with patches of native bush, exotic forest and scrublands. Some of the low-lying areas, such as Te Henga on the west coast, still contain their original wetland vegetation. Large areas of native bush cover the high Waitakere Ranges and the Hunua Ranges.

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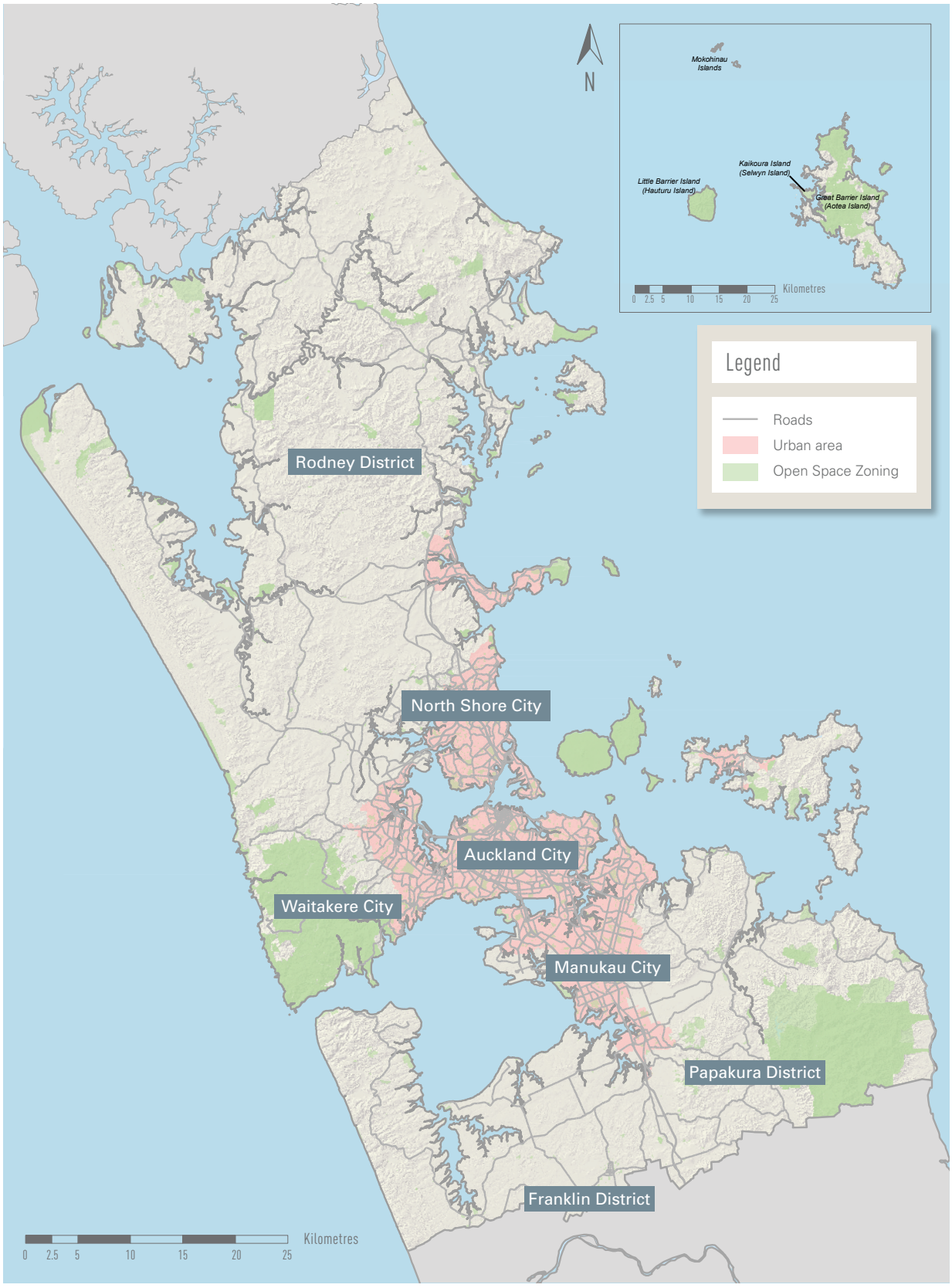

FIGURE 2 The Auckland region, 2009. (Source: ARC).

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- **Abundant freshwater**. The numerous streams, lakes, and rivers that enhance the landscape contain only a fraction of the freshwater resource. Most of the freshwater is hidden underground and seeps slowly through the ground to re-appear in springs, ponds, lakes, streams and rivers. Most rivers are relatively short, but together they make up approximately 16,500km of permanent waterways. The flow through a variety of environments ranging from native bush and exotic forest to rural pasture and urban areas. Freshwater is stored in ten artificial reservoirs in the Waitakere Ranges and the Hunua Ranges. Hot geothermal springs are found at Waiwera and Parakai.
- **About 1,800km of coastline,** split almost equally between the west and east coasts. The rugged west coast is exposed to the prevailing winds that work with the strong currents and powerful tides to constantly shift the fine black sand, resulting in spectacular wide surf beaches, lagoons, spits and dunes often set against a backdrop of high cliffs. In contrast, the more heavily populated east coast is fairly sheltered with white and golden sand beaches, often fringed by low cliffs and sprawling pohutukawa trees.
- **About 11,117km² of sea** (about 69 per cent of the Auckland region). The Tasman Sea begins at the exposed west coast, while the east coast opens onto the island-studded, sheltered Hauraki Gulf that leads into the Pacific Ocean. While most of the marine habitats are in water more than 20m deep, about 2,400km² of marine water is less than 20m deep and there is over 600km² of intertidal area. Estuaries, harbours and small inlets make up two thirds of the coastline in the Auckland region. In addition, there are four marine reserves, but these cover only a fraction (0.2 per cent) of Auckland's sea area.
- **Numerous islands** are important refuges for native biodiversity and are popular recreational fishing, diving, boating, sailing and tourism spots. Together, the islands contain about 506km² of land, and range from tiny rocks to some that are large enough to support permanent populations, such as Great Barrier Island and Waiheke. Others, such as Tiritiri Matangi, have been made into predator-free nature reserves.
- **Three large main, shallow harbours.** The Waitemata Harbour on the sheltered east coast has become the main commercial port for the Auckland region and Auckland City developed around it. On the west coast, commercial development of the Manukau and the Kaipara harbours has been severely limited by treacherous offshore sand bars, making them hazardous to shipping. The consequent lack of commercial development has meant that the Kaipara, in particular, is relatively unspoilt even though it is one of the largest harbours in the southern hemisphere. It supports a variety of marine ecosystems and also contains huge expanses of intertidal flats that provide feeding grounds of international significance for seabirds.
- **Urban areas.** Centered between the Waitemata and Manukau harbours is the largest urban area in New Zealand, containing about 90 per cent of all the people in the Auckland region. The remaining 10 per cent live in small scattered townships, rural communities, isolated dwellings and coastal settlements.

Weather and climate

The isthmus on which Auckland sits means the weather in the region is unpredictable and can change within a few hours. It can also differ locally due to variations in height above sea level, distance from the sea and the type of land cover.

The region's weather is dominated by low pressure weather systems originating in the Tasman Sea. These generate the prevailing west to south-westerly winds and can also produce strong wind gusts, rough seas and persistent rainfall, particularly during winter.

During summer and autumn, the Auckland region can also be affected by storms that originate in the tropics to the north of New Zealand. These can produce short periods of high winds, high seas and heavy rainfall.

In winter, the daytime air temperature ranges from 12 to 17°C. In summer, the daytime air temperature ranges from 22 to 32°C but rarely reaches 30°C. NIWA data show the long-term averages:

- Annual sunshine: 2,046 hours (1962-2007)
- Annual mean temperature: 15.3°C (1963-2007)
- Annual mean wind speed: 18km/h (1966-2007)
- Annual rainfall: 1,119mm (1963-2007)

The 2008 results (Source: NIWA) were:

- Annual sunshine: 2,180 hours
- Annual mean temperature: 15.4°C
- Annual mean wind speed (2007): 16.6km/h
- Annual rainfall (Mangere): 1,226mm

Auckland's mild, wet, climate has defined the ecosystems that have developed here. It is influenced, to some degree, by the El Niño Southern Oscillation (ENSO).

ENSO weather patterns are associated with two states: La Niña and El Niño. During the El Niño state, the Auckland region tends to experience stronger, more frequent westerly winds and more rain in summer; in winter, the winds tend to be southerly, bringing colder conditions. During the La Niña state, north-easterly winds are more common and tropical storms and cyclones are more likely to occur. The strong winds and high rainfall associated with these tropical storms and cyclones can generate coastal erosion, landslides and flooding (see Chapter 5.1 for more information).

ENSO weather patterns are known to influence some freshwater and marine ecosystems, and can result in changes to the composition and stability of these biotic communities. For example, some species living in the sediment of the Manukau Harbour show patterns that correlate to the climatic variations associated with ENSO.

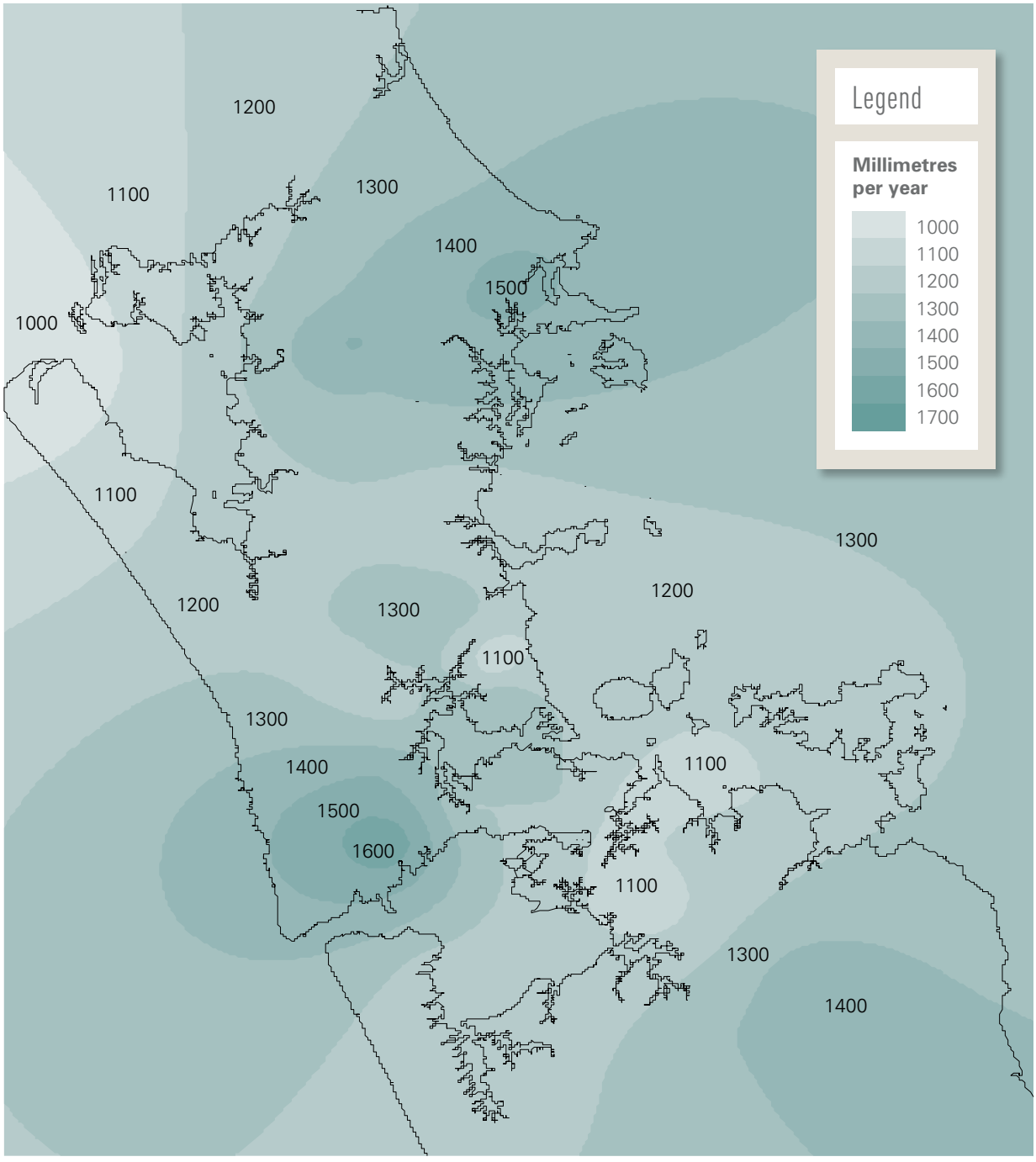

FIGURE 3 Average annual rainfall across the Auckland region (mm/year) 2004-08. (Source: ARC).

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Box 1 Climate Change

'Climate change' is the change in climate that can be attributed directly or indirectly to human activities that alter the composition of the global atmosphere. It is in addition to the natural variations in climate that are currently understood.

Current knowledge and moderate projections suggest that the Auckland region could experience pronounced short, medium and long-term climatic variations including:

- increased average temperatures
- more hot days during summer
- lower average annual rainfall
- increased droughts
- lower soil moisture
- increased evaporation rates
- more frequent heavy rainfall events
- more frequent westerly winds
- a rise in sea-level
- large storm surges.

These predicted changes are likely to have a range of direct and indirect impacts on the Auckland region. Some of the most significant in terms of their social, economic and environmental impact are:

- Changes to the water supply due to increasing periods of drought as well as more severe droughts. Most of Auckland's water is supplied by the reservoirs in the Waitakere and Hunua Ranges or from the Waikato River, and the opportunities to increase the large-scale water supply and storage capacity for the Auckland region are limited.
- An increased frequency of heavy rainfall events. As climate change increases the number of drought events, it is also expected to produce more frequent heavy rainfall events that increase the risk of flooding (and their associated social and economic impacts).
- An increase in the number of hot days. This may lead to photochemical smog reactions producing toxic compounds such as ozone and peroxyacetyl-nitrates (PANs), and cause an orange colouration of the air.
- Changes to the geographical range of some species, and to the composition and structure of some ecosystems. Biodiversity is critical to life on earth and ecosystems provide essential environmental services such as erosion control, carbon sequestration and crop pollination. Climate change will affect many species and ecosystems and its impact will depend on the magnitude of change, the sensitivity of a species to climate and its adaptability. Some species may be forced to shift the timing of lifecycle events, migrate outside their normal geographic range, or change their morphology and/or behaviour.
- Increasing susceptibility to threats from invasive species and organisms, and increasing exposure to sub-tropical diseases such as malaria and dengue fever. The Auckland region is especially vulnerable to these threats as it is a major point of entry for international shipping, airlines and imported goods. It has also had limited historical exposure to disease. If these threats are not controlled or avoided, they could cause significant risk to human health. The national and regional economies could also be impacted due to New Zealand's economic dependence on horticulture, agriculture and forestry.
- Severe damage to the Auckland urban economy due to a dramatic decline in agricultural or primary sector outputs. The national economy depends on a relatively stable climate to produce resource-based outputs and, although Auckland's urban economy might seem less vulnerable to climate change than rural regions, links between the urban and rural economies mean that any decline in agricultural or primary sector outputs will damage the economic performance of the Auckland region.

Whatever measures are taken now to reduce greenhouse gas emissions, the levels already in the atmosphere are expected to continue affecting and changing the global climate over the lifetime of the next generation. This means that, as well as working to reduce emissions, the global community needs to prepare for the effects of climate change and adapt to its projected impacts. The longer that it takes to reduce greenhouse gas emissions, the greater the changes and impacts will be.

The capacity of the Auckland region to adapt and respond to the risks, uncertainties, challenges and opportunities that will arise from climate change will be shaped by several related factors. These include the amount and speed of climate change, degree of public and institutional knowledge, level of commitment towards reducing greenhouse gas emissions, access to suitable technology, the health and resilience of ecosystems, and the amount of skills and resources available in the Auckland region.

Monitoring and research has a role to provide information to assist climate change adaptation and mitigation and to ensure that actions taken avoid adverse impacts on ecosystems.

It is the responsibility of central and local government to make polices that protect Auckland from the effects of climate change, attempt to slow it and make the most of any opportunities it brings.

Introduction

History of environmental change in the Auckland region

Before human settlement, most of the Auckland region was covered by evergreen forest. A dense tangle of tree-ferns, young trees, shrubs and lianas intertwined below the tree canopy, and a variety of ferns, mosses, fungi and lichens thrived in the cool, damp shade amidst the litter of leaf mould and decaying vegetation at ground level. A broad fringe of coastal forest swept down to the twin coastlines with their wide expanses of flat sandy beaches, extensive dunelands, rocky foreshores and spectacular cliffs. Elsewhere, shrublands of manuka and kanaka flourished wherever the soil was too poor for forest, while small lakes and wetlands formed in waterlogged ground. Auckland's many small volcanoes added to the unique landscape and habitat diversity.

Abundant rainfall throughout the year nurtured the lush vegetation and replenished the groundwater. Tiny forest streams merged into small rivers and then into larger rivers. These flowed into sheltered estuaries and five harbours, whose tidal fringes were often covered by low mangrove forest or bordered with salt marsh vegetation.

The mild wet climate enabled an incredible diversity of life to flourish on the land, in the forests, rivers and wetlands, along the coastlines, and in the estuaries and surrounding seas; all woven together within finely balanced ecosystems that had developed in harmony with the natural environment over millions of years.

A long period of geographic isolation meant that New Zealand was devoid of land mammals, apart from three types of small bat. Instead birds, insects, amphibians, reptiles, freshwater and marine invertebrates and other creatures had evolved, adapted or survived in this unique and ancient environment. As a result, much of the vegetation and many of these species are found only in New Zealand (or only in the Auckland region) and are the reason why the country is renowned internationally for its outstanding and valuable biodiversity.

New Zealand was permanently settled sometime around the thirteenth century by a wave of Polynesian explorers and pioneers. The influence of humans since then, both Māori and European, has had a dramatic and lasting impact on every aspect of the natural environment and its ecosystems. For example, by 1770 about half of the bird species were estimated to be extinct through a combination of over-hunting, habitat destruction and predation. Around the coast, the seal population was decimated within two hundred years of human settlement and has not yet recovered.

Early settlers were attracted to the Auckland region because the forests, rivers, coastline and sea provided a variety of food, while the warm climate and fertile soils were excellent for crop cultivation. Widespread Māori settlement took place, particularly around the Auckland isthmus. Many of the volcanic cones were cleared of native forest and then terraced to provide suitable sites for dwellings, crop cultivation and storage. European settlement began in the 1830s with traders attracted by the wealth of native timber, and the population has continued to expand ever since. Auckland was declared the capital city in 1840 and rapidly developed into the country's busiest commercial port. Most of the original foreshore along the Waitemata Harbour has been reshaped, reclaimed, or somehow modified by settlement since then.

As new settlements were established across the Auckland region, numerous other species were driven into local extinction or became increasingly rare. This was due to the destruction and modification of habitat, the introduction of exotic plants and birds, deliberate hunting, and predation or destruction by various new mammal species.

By the 1870s a logging and sawmilling industry was extracting areas of mature timber in the Auckland region. Only a few parts of the Waitakere Ranges, the Hunua Ranges and some of the offshore islands in the Hauraki Gulf remained relatively untouched. Areas that had been cleared of native forest were developed into pasture, while wetlands were drained to create more agricultural land. Sheep and dairy farming became increasingly important, especially after the introduction of refrigeration in the 1880s. Orchards and vineyards were established in the west, and horticulture expanded into areas that are now part of suburban Auckland. Agricultural production intensified over the previous century with widespread use of fertilisers and increasing numbers of stock. As a result, the groundwater, rivers and lakes started to become overloaded with excessive nutrients.

The land cover was progressively changed by human settlement from native forest into rural pasture and urban areas. The enormous changes in land use, particularly over the past two centuries, produced large amounts of sediment that washed into the sheltered estuaries, irrevocably altering habitat and leading to a rapid expansion of mangrove forest.

In the late nineteenth century, horses, coastal shipping and railways were the primary means of transport. Horse trams in Auckland City were replaced by electric trams in the early 1900s and these grew in popularity until competition from buses and increasing car ownership led to their closure in the 1950s. Both the railways and the growing network of roads required large amounts of aggregate and ballast and, until the 1950s, most of this was quarried from local volcanic cones and lava fields. Some were destroyed completely and at least half were modified.

1.0

Introduction

The expansion of industrial and urban areas led to environmental degradation of the Manukau Harbour. Public concern initiated the Mangere Wastewater Treatment Plant which opened in 1960. This was recently upgraded to improve effluent quality and the oxidation ponds and sludge lagoons were removed, restoring them and 13km of shoreline to the Manukau Harbour. The Tamaki estuary also suffered heavily from industrial and urban pollution and increased sedimentation.

Looking to the future

Today, despite the enormous modifications that have resulted from human settlement, the Auckland region still contains some relatively pristine areas that merit protection (such as the Hunua Ranges, the Waitakere Ranges and some islands in the Hauraki Gulf). In addition there are also remnants of pristine vegetation. These are important as wildlife links, corridors and habitats. Their scarcity make them all the more valuable.

Between them lies the modern world characterised by urban expansion, growing numbers of vehicles, increased impervious surface area, intensified agriculture and aquaculture, and increasing use of energy and natural resources. This has happened despite an increasing awareness of the aesthetic, economic, cultural and scientific value of the natural environment.

Although many of the environmental problems in the Auckland region are a legacy of the past, others are more recent, including:

- → ongoing input of sediment into our aquatic environments
- → absence of riparian vegetation alongside rivers
- → poor air quality with resulting health impacts
- → intensification of agriculture
- → biosecurity issues
- → habitat fragmentation.

The ARC is attempting to address these key environmental problems in partnership with individuals, community groups, iwi, district councils and other government agencies.

The environment, climate and variety of business, education and job opportunities within the Auckland region continue to attract new residents. It is estimated that 2 million people may be living in the region by 2035. Thoughtful planning for the future, based on a better understanding of the environment and the impacts of urban growth, industrial activities and rural land use change, is essential to avoid repeating or compounding past mistakes.

Achieving the balance between protection of the natural environment and its resources whilst providing for the social, cultural and economic needs of Aucklanders both now and in the future is an enormous challenge. This is especially so when set within the broader context of Auckland's role in the New Zealand economy, constant and rapid developments in technology, and increasing standards of living. Achieving this goal, in order to produce a durable and sustainable solution for the future, is the single greatest challenge that we are attempting to meet today.

The ARC hopes this document and its companion summary get people thinking about their environment, how special it is and how much help it needs. The ARC hopes the messages contained herein reach not only the people that make the big decisions but those of us who live here, love the place, and are therefore also its most important guardians,

'Kia whakatomuri te haere ki mua'

'To walk into the future our eyes must be fixed on the past'

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2.0

Driving forces in the Auckland region

Population growth, economic growth and increased consumption are the three main forces at work in this region causing environmental pressures.

2.0

Driving forces
in the Auckland region

Contents 2.0

Photo: Spaghetti Junction, Auckland. (Source: Shutterstock).

Driving forces

Introduction

Driving forces can be described in different ways and there are complex inter-relationships between them. For the purpose of this report, we group and discuss the driving forces that affect the Auckland region under the following headings:

→ population growth and change

→ economic activity and growth

→ consumption and consumerism.

Forces of change and growth are inter-related and inter-dependent – they inform, create and shape each other. While this report focuses on the resultant pressures and impacts at the local level, the broad drivers of change and growth are part of a much wider national and global context, and are not necessarily unique to the Auckland region.

The links between population change, economic activity and environmental degradation are well recognised, and work is underway at the local and global level to separate the measurement of economic growth, consumption, environmental pressures and adverse environmental impacts. The strategies, policies and regulations of the Auckland Regional Council (ARC) are a key part of that effort in the Auckland region.

Population growth and change

A primary driving force of change in the Auckland region is population growth.

The Auckland region has experienced consistent population growth for well over a century and is the fastest growing region in Australasia. Half of New Zealand's population growth between 2001 and 2006 was in the Auckland region, which increased by 144,000 people to a total population of 1.37 million (one third of the national population) (Figure 1).

The majority of the population in the Auckland region (90 per cent) live in the urban area.

Causes of population growth

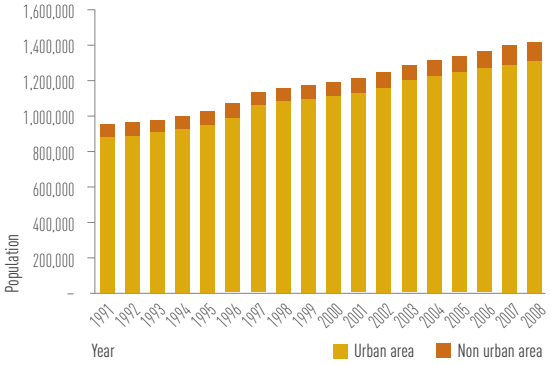

FIGURE 1 Population growth in the Auckland region 1991-2008 (Source: Statistics New Zealand).

Growth and change in the population of the Auckland region has two sources:

→ natural increase (births minus deaths)

→ migration: both internal migration (when people move into and out of the Auckland region from elsewhere in New Zealand) and international migration (when people arrive from overseas to live here or leave the country to live overseas).

The contribution of these components to overall growth varies over time, as shown in Figure 2. Natural increase is a steady contributor while net migration patterns vary. Between 2001 and 2006, just over half (55 per cent) of the region's population increase resulted from net gains in migration (both internal and international) and just under half (45 per cent) was due to natural increase.

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Driving forces

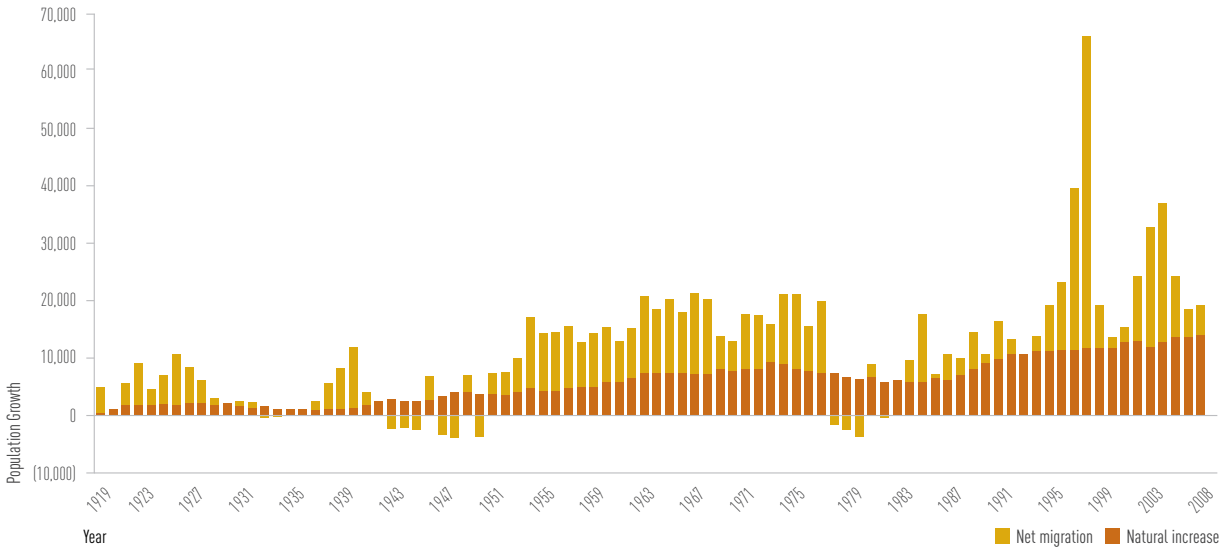

FIGURE 2 Components of population growth in Auckland region (1919 – 2008).
(Source: Statistics New Zealand: Census of Population and Dwellings, Births and Deaths).

Notes: The natural increase series presents December years prior to 1987, March years from 1987 to 1993 and June years after 1993. Net migration is calculated as the residual of total population less natural increase. The apparent large increase in contribution from net migration in 1997 is to be treated with caution as it emerges in part from the change in count from March to June years in 1997. Data before 2003 relates to the Auckland urban area only.

Natural increase

Although population growth in the early years of European settlement was dominated by immigration, natural increase became a steady contributor to population growth as the population became established.

In the Auckland region, natural increase in the population is sustained by the substantial proportion of people of working and family formation age, and by significant numbers of Pacific and Māori (who tend to have relatively higher fertility rates than other groups).

External migration

Changes to the national immigration policy over the last few decades have resulted in a move away from a policy based on migrants from preferred source countries towards a policy that focuses on individual skills and experience. These policy changes partly explain the large increases in net migration that were recorded between 1996 and 1997.

The changed immigration policy also resulted in more migrants arriving from non-traditional source countries such as India, Taiwan, Korea, Fiji and, in particular, China. This diversity has transformed the ethnic and cultural makeup of the Auckland region. By 2006, the region was home to over 150 ethnic groups, and over a third of residents were born overseas.

Two thirds of New Zealand's Asian and Pacific populations live in Auckland. This concentration has encouraged the growth of culturally-specific institutions and support services, which may continue to entice new migrants to settle in Auckland.

Internal migration

Traditionally there been a net gain to Auckland from other regions as the population of New Zealand has 'drifted northwards'. However, at the start of the twenty-first century the Auckland region experienced a net loss to other regions. Between 2001 and 2006, about 16,700 more people moved from Auckland to other parts of New Zealand than moved into the region. It should be noted however, that this loss is relatively small compared to the scale of all movements and the scale of overall population change (a 12.4 per cent growth overall), and was offset by a surge in international migration. The greatest net losses from Auckland were to the neighbouring regions of Northland, Waikato and Bay of Plenty.

Internal migration patterns are age specific, and there is still significant migration of younger people into the region for education and employment opportunities.

In line with this, there has also been some concentration of movement into the central city following the intensification of high density apartments, and conversely movement to 'countryside living' areas on former rural land close to the urban fringe.

Driving forces

Age/sex structure

Figure 3 shows that although the age/sex structure of the population in the Auckland region is broadly similar to the national structure, all age groups between 15 and 49 years are over-represented, especially those between 15 and 30 years. This reflects the prominence of the Auckland region as a centre for immigration, study and employment, and as an attractive location for young families. This in turn, drives household composition patterns and housing demands.

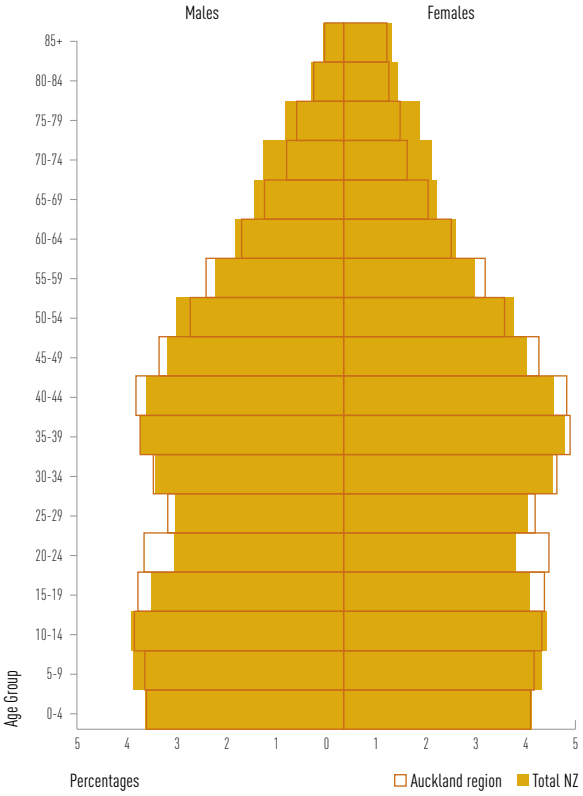

FIGURE 3 Age/sex structure of Auckland region compared with New Zealand (2006).
(Source: Statistics New Zealand: Census of Population and Dwellings).

Household size

The average number of people per dwelling in the Auckland region declined steadily from the 1950s to the mid 1980s (dropping from 3.6 persons per household in 1956 to 3 in 1986). This was driven by social changes including more people living alone, delays in the onset of childbirth, declining birth rates, increased life expectancy and more single-parent families.

Between 1986 and 2006 household size has remained consistently in the 2.9 to 3 persons per household range. Although many of the social trends driving smaller household sizes have continued, they have been offset by an increase in household size (to the point of overcrowding) in some parts of urban Auckland, particularly among Pacific communities – a trend attributed to cultural attitudes and economic conditions.

Future growth

Population growth is anticipated to continue into the foreseeable future.

The latest ARC medium series population projections indicate that the regional population could reach two million by 2035 – an increase of around 500,000 people or 40 per cent more than our current population of 1.37 million. Predictions show that the rate of growth may slow if fertility rates remain below replacement ratio.

Economic growth and resource efficiency

Another fundamental driving force in the region is economic activity (that is, the production and distribution of goods and services) and a co-related imperative for growth and cost efficiency. Auckland is a major centre of employment and commerce, and economic activity in the region is significant. The region is the nation's largest manufacturing base and it functions as a nationally strategic transport and distribution hub.

Economic activity is a driver of environmental pressure for several reasons:

- → the production of goods creates a demand for resources in the form of raw materials (e.g. wood, fibre, oil, aggregate, minerals and their derivatives) for manufacturing processes
- → resource use and adverse environmental effects from air, road and rail transport around and through the region
- → production and consumption inevitably generates various types of liquid, gaseous and solid wastes that need disposal (see Part 3).

Not all forms of economic growth produce the same level of environmental pressure because the nature of the economy can, to some degree, influence the extent of this pressure. For example, economic growth based on heavy industry is far more likely to produce a greater local environmental pressure than economic growth based on the provision of financial services. The nature of the urban economy in the Auckland region and the changes within it are, therefore, another factor that determines the nature and extent of environmental pressure.

Centre of employment

At February 2008, manufacturing, retail trade, and professional, scientific and technical services were the three most significant industries in the Auckland region in terms of numbers employed (Figure 4). Manufacturing and retail trade were also the largest industries in New Zealand in 2008, reinforcing the fact that Auckland, as the largest city and region in the country, plays a significant role in the national economy.

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Driving forces

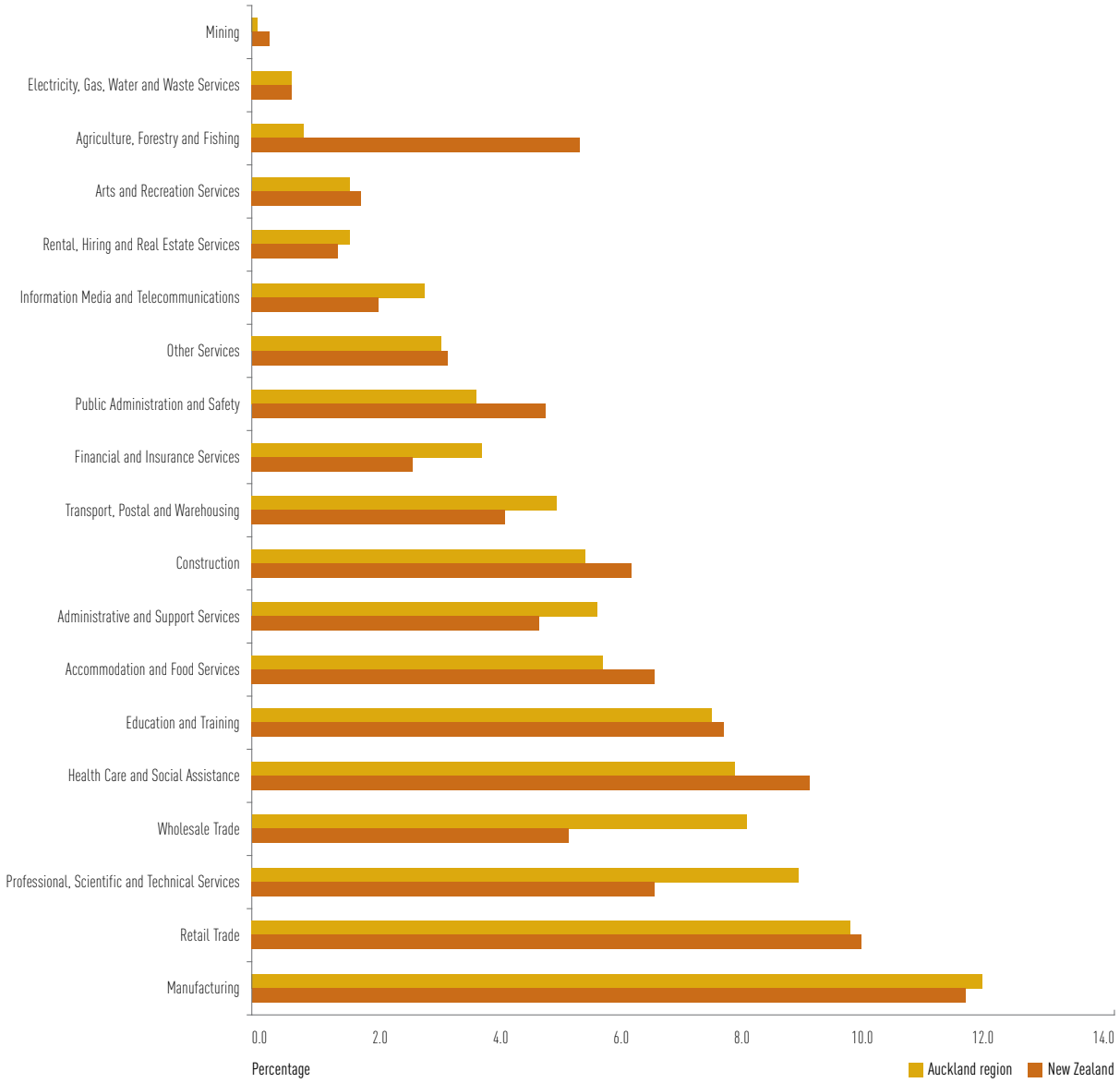

FIGURE 4 Employment in the Auckland region and nationwide, by industry sector, February 2008. (Source: Statistics New Zealand: Business Demography data).

Auckland is home to a number of big firms and organisations – just over one third (33.8 per cent) of all employees in the Auckland region were working in businesses with 100 or more employees, particularly in electricity, gas and water supply, communication, health (District Health Boards) and government (council) sectors. However, small-size enterprises dominate the employment market. Almost four out of every five (87 per cent) business units had five or less employees (particularly those in the finance and insurance, and property and business sectors). This figure also includes a large number of business units (approximately 136,290) that had no employees (many of these will be self-employed).

Growth areas

Auckland's economy has experienced rapid growth in recent years and has consistently grown at a greater rate than the rest of New Zealand for much of the last ten years. Employment has been high, with labour force participation at 68.5 per cent to the year end December 2009, translating into a workforce of approximately 677,000 people.

Over 36,000 new businesses were established in the Auckland region between 2000 and 2008 (an increase of 29 per cent). The most significant sectors of growth were:

- → rental, hiring and real estate services (+12,619)
- → finance and insurance (+6,936)
- → professional, scientific and technical services (+6,511)
- → retail trade (+2,118).

Driving forces

Although the Auckland region's economy has experienced growth in service-type industries (that is, businesses that service the needs of a growing population), it is more oriented towards high value-added manufacturing and the business and finance services sectors than the rest of the country. With respect to contributions to GDP, the following industries are more important to the regional economy than they are to the national economy:

- → finance
- → communication services
- → air transport and services to transport and storage
- → machinery and equipment manufacturing
- → rubber, plastic and other chemical manufacturing
- → sheet and fabricated metal production manufacturing.

In addition, air transport and services to transport and storage, as well as printing, publishing and recorded media provide comparatively high contributions to the regional economy in terms of regional GDP and employment. As would be expected, Auckland's regional economy is comparatively under-represented in the primary production sector.

In line with national trends, and driven in large part by international trends, Auckland is coming out of a period of sustained economic and population growth and is currently experiencing an economic slowdown. The longer-term nature and effects of this slowdown are yet to be realised, but in the shorter term there has been a particularly acute contraction in the construction, property and retail sectors and unemployment figures are beginning to rise.

The Auckland region's economy does not operate in isolation and is influenced by global and national socio-economic drivers including global 'boom and bust' cycles, international regulatory policies and initiatives, monetary systems, and competition from external markets.

Auckland's role as an international hub and gateway

Auckland is the first port of entry for most international visitors and migrants. Faster and cheaper air travel has created a surge in international travel over the last few decades and a boom in the tourism industry, which has fed into the regional economy. In 2007, there were an estimated 2.18 million international visitors to the Auckland region and 16.3 million international visitor nights. Auckland International Airport in Mangere is the busiest port of entry for international passengers into New Zealand, with 69 per cent of all international visitors (in the year ended December 2008) arriving there.

Significant volumes of international trade also pass through Auckland and it is the country's third-largest export cargo port by value. In the year ended June 2007, $4.4 billion of exports passed through Auckland International Airport, representing 81.5 per cent of New Zealand's air-freighted exports, while Ports of Auckland Limited is New Zealand's largest international seaport, handling 37 per cent of the total container trade and 840,993 TEU (Twenty-foot Equivalent Unit – the international standard of measure of containers) in 2007/08.

Around two thirds of New Zealand's imports and one third of its exports (by value) pass through the seven wharves operated by the Ports of Auckland. Six wharves are on the Waitemata waterfront near to the Auckland Central Business District and the other is at Onehunga on the Manukau Harbour. Container and freight handling is supported by road, rail, air and sea links to the rest of New Zealand, and about 14 per cent of employment in the Auckland region is in distribution (wholesale trade, transport and storage).

There has also been a renaissance in cruise ship holidays and Auckland is gearing up to become a major visitor destination as well as the busiest passenger exchange facility in New Zealand. In 2007/08, a record 73 cruise ships visited Auckland ports, accounting for about 6000 international arrivals. Plans are underway to develop additional passenger terminal facilities along the Waitemata Harbour's edges and to encourage visits to the Auckland region.

The overall growth in tourism across the region, both international and national, has led to the active promotion of some areas as tourist destinations, particularly in the coastal areas and to the north but also within Auckland city. Although this promotion will create local economic opportunities it also creates an increased demand for goods and services that may put pressure on resources.

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Driving forces

Auckland's rural economy

The majority (90 per cent) of the land area within the Auckland region can be described as rural. The Franklin lowlands, the areas immediately south-west of the Auckland urban area and much of the Auckland isthmus itself are naturally fertile with rich soils of volcanic loam, and the whole of the Auckland region has abundant rain and a mild climate.

These favourable characteristics meant that, traditionally, the Auckland region had a strong agricultural economy with particular emphasis on market gardening, horticulture and other types of intensive farming. Dairying and other types of pastoral farming were also major sectors. However, the agricultural sector has been in a long-term decline in both relative and absolute terms in the Auckland region, for example GDP from the agricultural sector decreased from $419.6 million to $399.7 million between 1994 and 2005 (in 1996 dollars). A similar trend was seen in the level of employment in the agricultural manufacturing sector (those businesses making machinery and equipment for agriculture) which declined by 48 per cent over the same period in the Auckland region.

These two declining trends contrast with a 154 per cent increase in employment in the rural servicing sector (those businesses offering services such as fertiliser spreading, crop harvesting and fencing to the agricultural sector) between 2000 and 2008 in the Auckland region, especially when compared with the national growth rate of just 77 per cent. The rural servicing sector now employs around 1420 people across the Auckland region and possibly reflects a decline in the traditional 'do-it-yourself' farming community and an increase in part-time, non-professional farmer/land owners who make more use of contractors.

Rural production tends to be highly dynamic, with changes being driven by the same forces that drive change in all commercial activities – the need to remain economically viable in evolving market conditions.

In the Auckland region, rural land users face high costs associated with land ownership, with the average pastoral (non dairy) farms typically selling in the 2002 to 2006 period for 2.6 times the cost of the national average for pastoral land. Sale prices of all categories of rural land are higher, not just in comparison to the national average, but also in comparison with neighbouring regions (Figure 5). The value of rural land (as determined by Quotable Value Limited) mirrors sale prices.

FIGURE 5 Rural land values in Auckland, Waikato and Northland 2008. (Source: Enfocus Ltd., based on data from Quotable Value).

These high land values mean that rural producers in the Auckland region may need to produce their goods more efficiently, sell into high value niche markets and/or increase productivity per hectare by increasing inputs and/or by focusing on higher value products (such as intensive horticulture or factory farming) in order to earn a commercial rate of return equivalent to that achievable in other regions.

The alternative method of meeting the high cost of rural land ownership is to cross-subsidise rural production costs with off-farm income. This means that land owners hold or acquire land, knowing that it will not provide a commercial rate of return. This may not be problematic from a landowner's perspective if they have income from other sources (such as part-time employment or other business interests) to allow the property to be held as a non-independent unit.

Notwithstanding the potential for cross-subsidising the cost of land ownership, the high cost of land (coupled with the high demand for residential opportunities in rural areas) often creates a strong incentive for divestment of parts of farms through subdivision and sale of land.

The driving forces behind change in the rural economy and rural production translate into various environmental impacts, particularly as a result of changes in land use and fragmentation (see rural land use change in Part 3).

Driving forces

Resource efficiency and decoupling

The extent to which economic growth drives environmental pressure is also determined by resource efficiency (the amount of resources consumed to produce one dollar of GDP). If the growth rate in resource consumption is lower than the growth rate in GDP, the resource efficiency is improving (and vice versa).

The ratio of resource consumption to GDP is known as resource intensity. Ideally, from both an environmental and economic perspective, resource consumption would be decoupled (made independent) from GDP growth, meaning that an economy would grow but with less strain on the environment than it did in the past.

This section looks at energy intensity, water intensity and waste intensity. In each case, the intensity is an indication of how much of that resource is used (or how much waste is created) for each unit of GDP created.

A similar measure is the per capita consumption (the rate of resource consumption per person).

By looking at both the resource intensity and the per capita resource use over time, it is possible to determine the extent to which consumption is being driven by economic growth compared to population growth.

Figure 6 shows a steadily increasing trend in the amount of energy that is being consumed on an individual basis, within the Auckland region over time. This undoubtedly results from an increasing number of energy-consuming appliances and increased vehicle use. However, the energy intensity of the economy has shown a moderate decline on average over the past decade. This positive sign suggests the Auckland region is managing to increase its GDP without the same increases in energy use that were required in the past. This improvement is probably due to the changing nature of the economy and the fact that recent growth has come from service-related sectors such as property and business services rather than from energy intensive sectors such as heavy manufacturing.

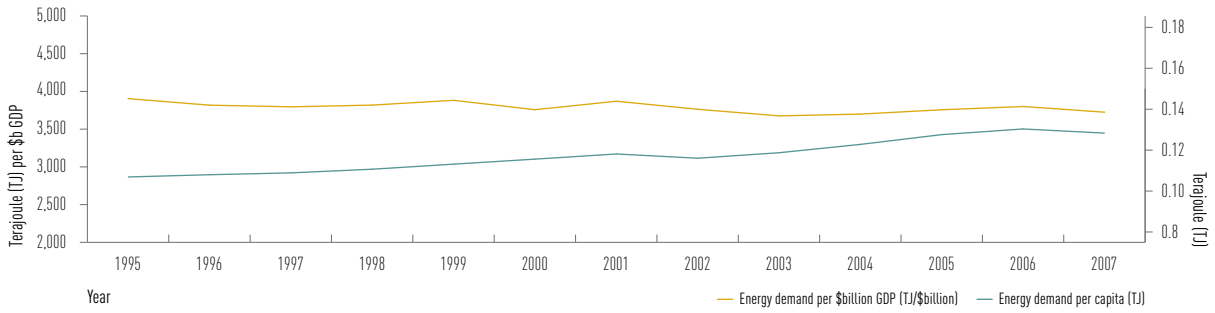

FIGURE 6 Regional energy demand 1995-2007. (Source: Enfocus Ltd., based on data from Market Economics Ltd.).

However, Figure 7 shows that the amount of solid waste produced has not decoupled from economic growth and is, in fact, increasing more quickly than either GDP growth or population growth.

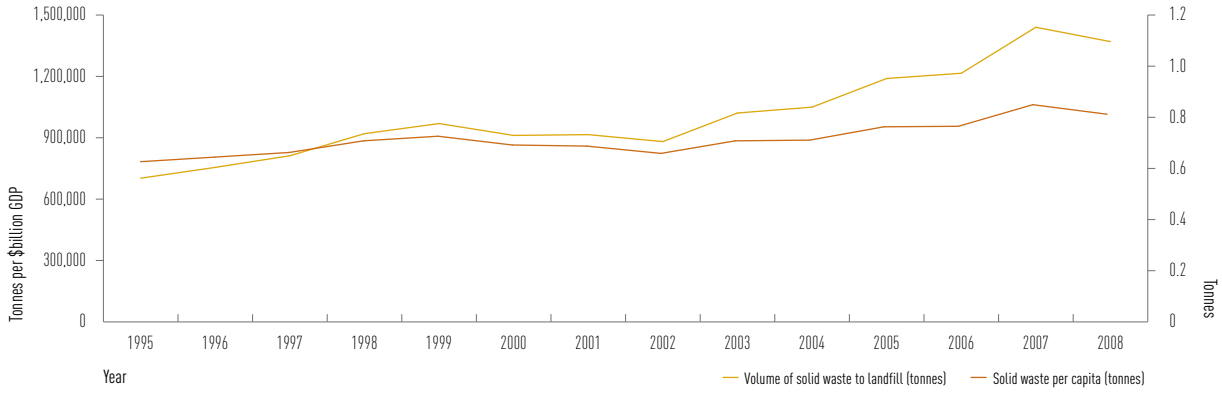

FIGURE 7 Regional solid waste sent to landfill 1995-2008. (Source: Enfocus Ltd., based on data from territorial authorities).

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Driving forces

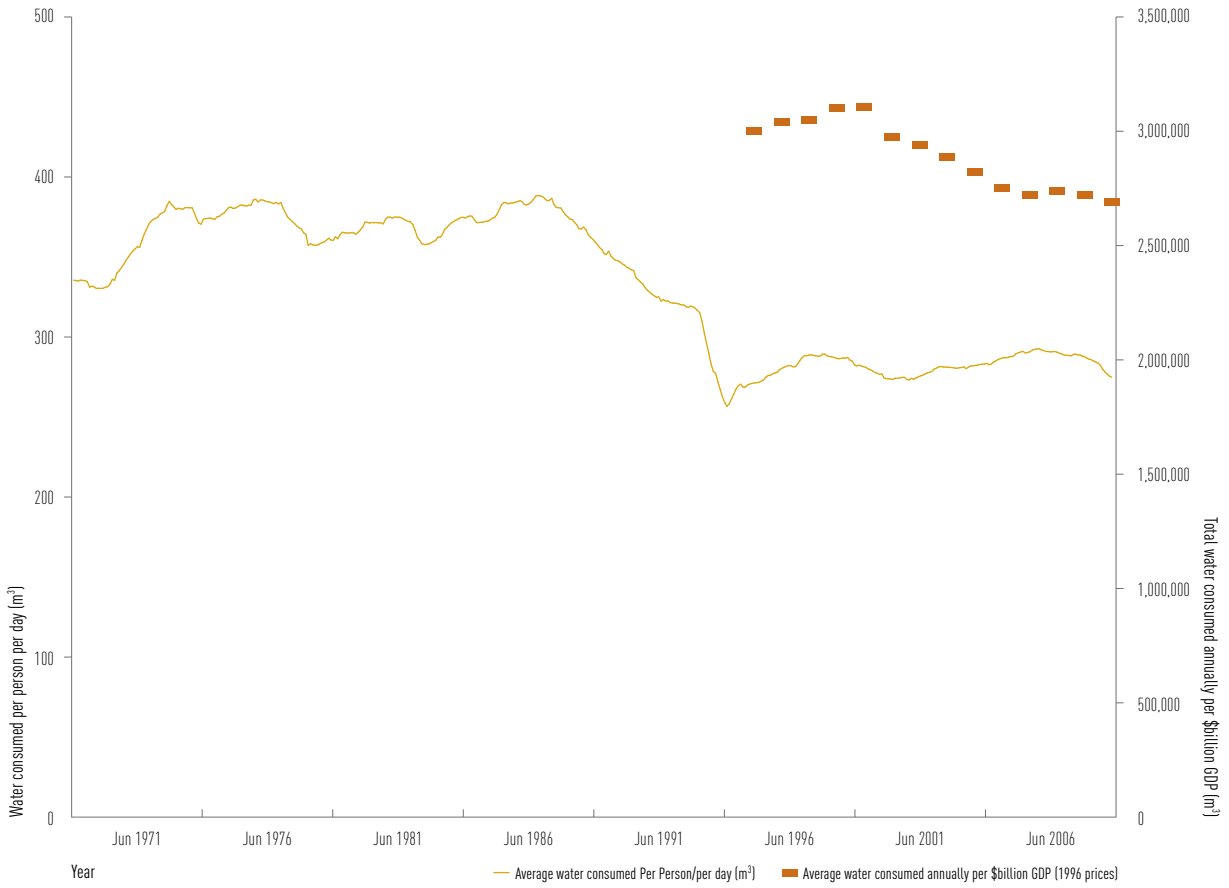

FIGURE 8 Average water consumption per capita between 1971-2006. (Source: Enfocus Ltd., based on data from Watercare Services Ltd.).

The trends for bulk water supply are more encouraging. Figure 8 shows that the amount of bulk water consumed on a per person basis dropped significantly during the early 1990s due to drought events, and the introduction of water meters. Since then per person consumption has remained relatively steady at around 300 litres per person per day over the decade to 2008. This means that the reticulated water consumed in the Auckland region has increased at the same rate as the population since the mid 1990s.

Water consumption on a per unit of GDP basis ('water intensity') has also decreased steadily over the past seven years. That decrease reflects a decline in water intensive industries (such as meat works) and a relative increase in low water consuming industries such as retailing and services.

The decline in water consumption per person over the past three years reflects gains made in reducing leaks in the water reticulation infrastructure as a result of investment in leak reduction.

Consumption and consumerism

In any fast-growing metropolitan area such as Auckland, population and economic growth results in greater overall consumption demands, at the individual, household, business and industry level. For example demand rises for water, energy, fuel, resources and food. In the Auckland region, much of these resources and products are imported into the region from other regions or overseas, and must be distributed, creating even more demand for energy and infrastructure. These goods and products must also be disposed of, creating ongoing demand for waste services.

Further to this, the rise of 'consumerism' in the post-war years has exacerbated general consumption levels – that is, the purchase of goods and services in excess of basic needs, often fuelled by a perception that the acquisition and possession of material goods equates to personal happiness. This perception is driven by advertising and marketing and the availability of mass-produced, affordable goods.

Driving forces

Within the New Zealand context the underlying drivers of consumerism are diverse but, for the purpose of this report, we have highlighted four:

- high rates of employment
- the wealth effect
- availability of credit
- price reductions in consumer goods and services.

These are discussed briefly below.

High rates of employment

Auckland has enjoyed relatively high rates of employment during the recent economic boom. Labour force participation was 68.5 per cent at the year end December 2009 (this has contracted with the global economic recession) and employment has been full.

The median annual household income increased from $47,892 in 2000 to $65,780 in 2007. This 37 per cent increase in dollar value represents an actual increase of 15 per cent after adjustments for inflation.

The wealth effect

The 'wealth effect' refers to an increase in spending that accompanies an increase in perceived wealth. This perception encourages people to spend and consume goods and services at greater rates than they would otherwise. In Auckland, as in other parts of New Zealand, this effect has been strongly associated with the over-reliance of investment in housing as a long-term savings and investment strategy.

The recent boom in the Auckland housing market saw house prices double between March 2003 and 2008, rising at a rate of around 20 per cent per year at the peak in late 2003 and early 2004.

Availability of credit

It is only possible to act on the perception of increased wealth, and to spend and consume goods and services, if people have access to cash or credit facilities.

The Reserve Bank reported in December 2008 that the outstanding total debt of households for the whole of New Zealand had increased more than six times in dollar terms since 1990. As a percentage of households' disposable income, household debt peaked at over 160 per cent early in 2008, nearing three times the level in December 1990.

Increasingly easy access to credit has been noticeable over the past decade and has only been checked recently by the 2008/09 global credit crisis.

Prior to this recent check, banks were offering 100-per-cent-plus mortgages which helped fuel the housing market. This encouraged speculation in both property development and property investment. These factors encouraged increased housing consumption (often in second, holiday or investment property) and increased the amount of land used for residential development (with associated increased pressures on the environment).

The availability of credit also had a more pervasive influence. Many mortgages were allowed to operate as flexible credit facilities, encouraging people to purchase household goods and other items 'on the mortgage'. New types of financial institutions sprang up to cater for poorer credit risks. Major retail chains encouraged debt-funded consumption by offering cheap in-store credit deals ('buy now, pay later'). Aggressive marketing and social pressure to acquire the latest goods and services were also factors in encouraging high levels of consumption.

Price reductions

The final driver behind the rise in consumption is the relative decline in the cost of many consumer goods. In New Zealand, this decline can be traced back to the removal or reduction of import restrictions in the late 1980s and early 1990s that opened up the economy.

As a result, many local manufacturing businesses disappeared under competition from overseas manufacturing centres (particularly in Asia) with their economies of scale and lower labour and production costs. This enabled a wide range of much cheaper products to flood into the New Zealand market.

Opening up the economy has, undoubtedly, made a new range of goods affordable for many more households and has provided benefits in terms of enhanced comfort, entertainment, personal satisfaction and well-being. However, this increased level of consumption has also increased pressure on the environment. Notable pressures are the increase in solid waste that requires disposal (as cheaper goods are discarded and replaced more rapidly) and the increase in energy use associated with greater ownership and use of motor vehicles and electrical appliances.

The increased affordability of consumer goods and services has also been driven by major global factors such as technological innovation, new and more efficient business models, the emergence of China as a global manufacturing centre, globalisation and free trade, and the extended period of relatively cheap oil since the mid 1980s (despite a price spike between 2006 and 2008).

Rate of household consumption

These drivers of consumption combined over the past decade to accelerate the growth in household consumption to such an extent that it overtook the growth rate of New Zealand's GDP in 2005. In other words, the rate at which households increased spending on consumer items exceeded the rate at which the economy grew. This growth in consumption only tailed off in 2009, following the arrival of the global recession in 2008.

Household consumption expenditure data presented by the Ministry for the Environment indicate that spending by the average New Zealander between 1997 and 2008 had risen 47 per cent (after adjustments for inflation). Major growth in spending occurred on household goods (53.7 per cent), clothing and footwear (45.5 per cent), and food and beverages (30.1 per cent). Spending in all categories had risen over the past decade but the sharpest rises occurred since 2002/03 (although there has been modest reduction in the growth rate since 2006).

Table 1 over the page shows that the average household in the Auckland region spends 9 per cent more, each week, on goods and services than the average New Zealand household.

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Driving forces

TABLE 1 Comparison of average weekly household expenditure in Auckland and New Zealand (figures are rounded). (Source: Statistics New Zealand: Household Economic Survey 2007).

Category	All regions $/2007	Auckland region $/2007	% Auckland region spend exceeds national average
Food and beverages	182	202	11
Clothing and footwear	33	36	9
Housing and household utilities	224	247	10
Household goods and services	51	51	0
Transport	136	149	9
Communication	31	34	10
Recreation and culture	97	95	-2
Other goods and services	214	241	13
Total net expenditure	**956**	**1,046**	**9**

House size

Another indicator of increasing consumption is the growth in average house size across the Auckland region. Figure 9 shows that the average floor area of single dwellings built in Auckland since 1992 has grown steadily from about 140m^2 in 1991 to a peak of 220m^2 in 2006.

In contrast, the size of multi-unit dwellings has not increased on average (and actually decreased for a period) but these type of dwellings made up less than a third of new dwellings built over this period and are a relatively minor proportion of new housing.

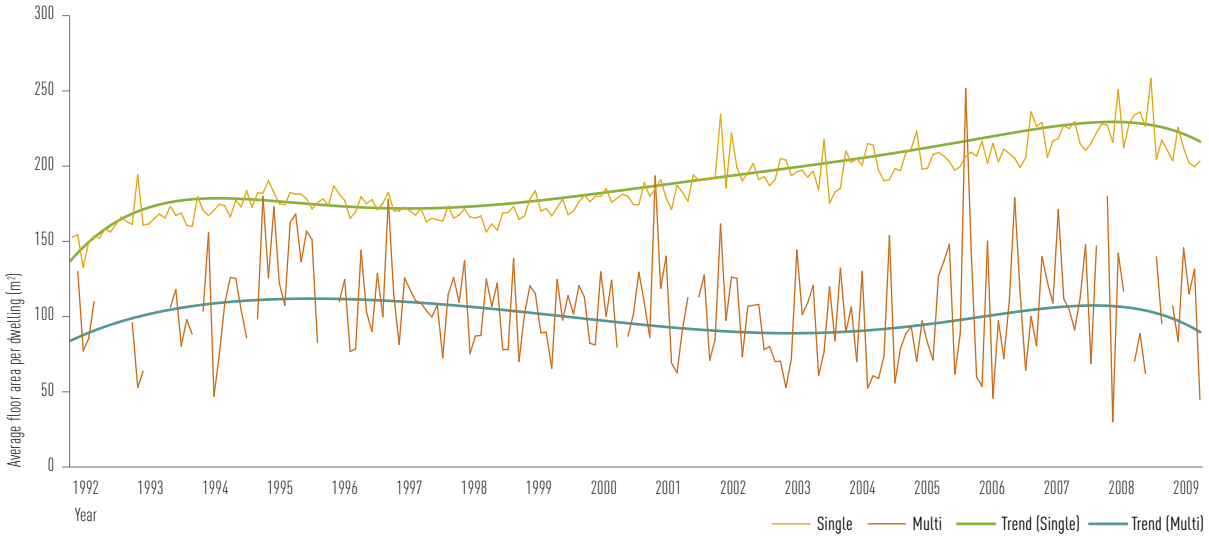

FIGURE 9 Changes in the floor area of single dwellings and multi-unit dwellings in the Auckland region 1992-2009. Gaps in the multi-unit dwelling data show periods when no consents were issued. (Source: ARC, based on data from Statistics New Zealand: Building Consents).

Mobility

The level of car ownership has increased across the Auckland region, with 17 per cent of households now having three or more vehicles compared to 14 per cent just five years earlier. In addition, vehicle engine sizes and fuel consumption are both trending upwards (see Indicator 18 and Transport in Part 3).

We are also driving more. In 2007 the average Auckland resident drove an extra 275km a year compared to 2000. This increased driving distance was additional to a higher general use of public transport.

Driving forces

Conclusion

The Auckland region has recently experienced a period of high population growth, high employment, a strong economy and a booming housing market. Although rates of growth have slowed in the last 12 months as a result of the global economic crisis, the region continues to be a magnet for residents, migrants, tourists and business, all of which continue to drive environmental impacts and pressures, as will be discussed in the next section.

Many of these impacts and pressures are related directly to land use, housing development and transportation. They arise from the need to develop, maintain and extend the transport infrastructure (roads, rail, sea ports and airports) and include the associated exposure to new pest species arriving as a result of overseas trade and tourism.

Auckland's continued role as the country's dominant manufacturing base, particularly for high value goods, also has a range of environmental impacts associated with the production and disposal of liquid, gaseous and solid wastes (including hazardous waste) although these pressures are small by international standards.

Trends in population growth, and in the urban and rural economies are driving environmental changes. For example the drive to increase productivity often means an increase in farm inputs (e.g. fertiliser and irrigation). Diversification into more intensive, higher value production creates similar environmental pressures, often in the form of increased discharges of contaminants to land, air and water. The alternative – allowing subdivision and development of rural land – can have its own impacts and can reinforce and amplify the causal problems of the high costs of land ownership.

How the ARC recognises the driving forces

Auckland Sustainability Framework

The Auckland Sustainability Framework (ASF) was developed in 2007, a collaborative venture led by the ARC but involving all the region's councils, government agencies, mana whenua and academic, business and community sectors.

Acknowledging the forces driving change in our environment, the ASF sets out a long-term (100 year) vision, eight goals and eight acknowledged "shifts" (from the way we have been doing things) that need to be made to promote the sustainable development of the region. The framework sits above, guides and integrates all other policies for the region. It is aimed at ensuring all the region's agencies and change agents see – and hopefully share – a common goal that serves as a touchstone for the development and implementation of their various individual strategies and plans.

The five key challenges identified are:

- → the need to respond to climate change
- → the need to do more with less (reducing consumption and resource use)
- → capitalising on global economic change
- → managing population growth and demographic change
- → addressing social disadvantage.

The goals focus on economic, social and environmental matters including the desire for a unique and outstanding environment but, consistent with the notion of sustainability, environmental considerations are woven throughout all goals. Emphasis is placed on social dimensions and sustainable economic development in the belief that these dimensions are interdependent with environmental quality.

From a purely environmental perspective the ASF emphasises reducing our ecological footprint, building a carbon neutral future and creating prosperity based on sustainable practices. Ten priority "strategic responses" are identified including building a compact urban form, integrating public transport and land-use, developing an emissions free transport system and implementing sustainable building methods.

The ASF has no legal status but all the region's councils supported its development and support its implementation which is to be assisted by the Regional Sustainable Development Forum (a committee of the ARC with representatives from the region's councils and central government) and demonstrated through One Plan (pg 86). In addition, an ASF Tool Kit has been developed to help guide other organisations to apply the framework to their projects.

The ASF contains a range of indicators to gauge how successful implementation is across each of the eight goals. The ARC published a headline indicator report in 2008.

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Driving forces

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2.0

Driving forces

3.0

Pressures: consumption and production

Part 2 introduced the three major driving forces that operate in the Auckland region. It showed how social, economic and environmental changes are linked, often resulting in pressures on the environment.

Environmental pressures come from individual and collective consumption and production consumption of natural resources in order to create various types of goods and services, and production of air pollutants, solid and liquid wastes.

This part explores the main types of consumption and production in the Auckland region, and their implications for the environment.

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Pressures – consumption and production

Contents 3.0

Contents 3.0 continued

Photo: Market gardens, Auckland. (Source: ARC).

Pressures: consumption and production

Introduction to pressures

The three major driving forces in the Auckland region are population growth, economic activity and growth and increasing consumption. These have led to pressures on the environment because, as explained in Part 2, production and consumption usually generate some form of adverse effect.

The specific pressures arising in the Auckland region result from the following types of human activities:

- use of the land and marine area for buildings, transport, primary production and recreation
- consumption of water to meet domestic, agricultural and industrial needs
- generation of air pollutants, liquid and solid wastes
- capture, storage, transport and use of energy
- transportation of people, goods and services into out of and around the region.

Pressures can affect a range of ecological, cultural and social values. This part describes and quantifies the extent of these pressures on the environment in the Auckland region.

Land use, land use change and intensification

Key findings

- Pasture is the most extensive type of land cover in the Auckland region, covering just under 50 per cent of the land area. Most land in the Auckland region is used for sheep and beef farming followed by dairying and rural residential (lifestyle).
- The urban area covers about 10 per cent of the land, and 70 per cent of the urban area is residential.
- Between 1987 and 2006, the residential density of the urban area increased 24 per cent to 25.7 people per hectare. Most of this population growth was accommodated by a 23.7 per cent expansion of the urban area from 40,000 to 49,500 hectares. Loss of prime agricultural land to urbanisation over this period occurred at an average rate of 333.4 hectares per year.
- The impervious surfaces within the Auckland Metropolitan Urban Limits (Figure 2 in Part 1) increased from 39 per cent in 2000 to 42 per cent in 2008.
- Livestock numbers (including dairy cows) are declining. However, the average size of dairy herds, and stocking rates, are increasing.
- There has been a loss of orchards in the Auckland region but an increase in market gardening. Overall, horticultural land use increased by 210 hectares between 2002 and 2007.
- Rural subdivision continues to occur, and fragmentation of rural land is most intense around the Metropolitan Urban Limits in the south-east and in the northern coastal areas.
- An average of 8.9km of streams are subject to stream bed disturbance (on a scale that requires a consent) each year.

Introduction

The way that land is used is one of the most important determinants of the nature and extent of the environmental pressures faced in the Auckland region. Land uses (e.g. horticulture, housing and industry) give rise to environmental pressures, either directly or indirectly. For example, land uses can:

- result in large areas of impervious surfaces that increase the amount of stormwater and its contaminant load
- involve regular land disturbance, leading to increased sediment discharge
- result in soil loss or degradation
- have long-term impacts on traffic generation (e.g. increased traffic as a result of a major new retail centre) leading to increased vehicle emissions
- lead to the introduction of exotic plants and animals that may modify native ecosystems and landscapes.

Although most land uses are associated with a level of continuous pressure on the environment, changes from one type of land use to another can produce specific short-term or one-off pressures. For example, the transformation of rural land to urban often leads to a pulse (increase) in sediment flushed into the aquatic environment, as well as loss of native vegetation and, possibly, aspects of historic heritage (see Indicator 6 and 7 in Chapter 5.2).

Another type of pressure results when existing land uses are intensified. Within the Auckland region, land uses are constantly changing and evolving in response to the driving forces discussed in Part 2. Not only does the Auckland region experience changes in the types of land use activities undertaken (e.g. changes from horticulture to residential) but it also experiences changes in the intensity of land uses.

In summary, land use, land use change and intensification have a wide range of implications for the environment. These are discussed in the following sections.

Land use monitoring programmes

The ARC does not maintain a formal or systematic monitoring system of land use pressures. However, it subscribes to a number of key external databases including the Land Cover Database (LCDBII), Agribase and Agricultural Production Survey. These collect data using different methods and at different dates and, therefore, are not always comparable. Nevertheless, these databases and other data sources allow us to investigate particular pressures when required, in order to develop and evaluate our policy responses. We also monitor land availability within the Metropolitan Urban Limit (MUL) to ensure an adequate land supply for residential and business use and development.

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Pressures: consumption and production

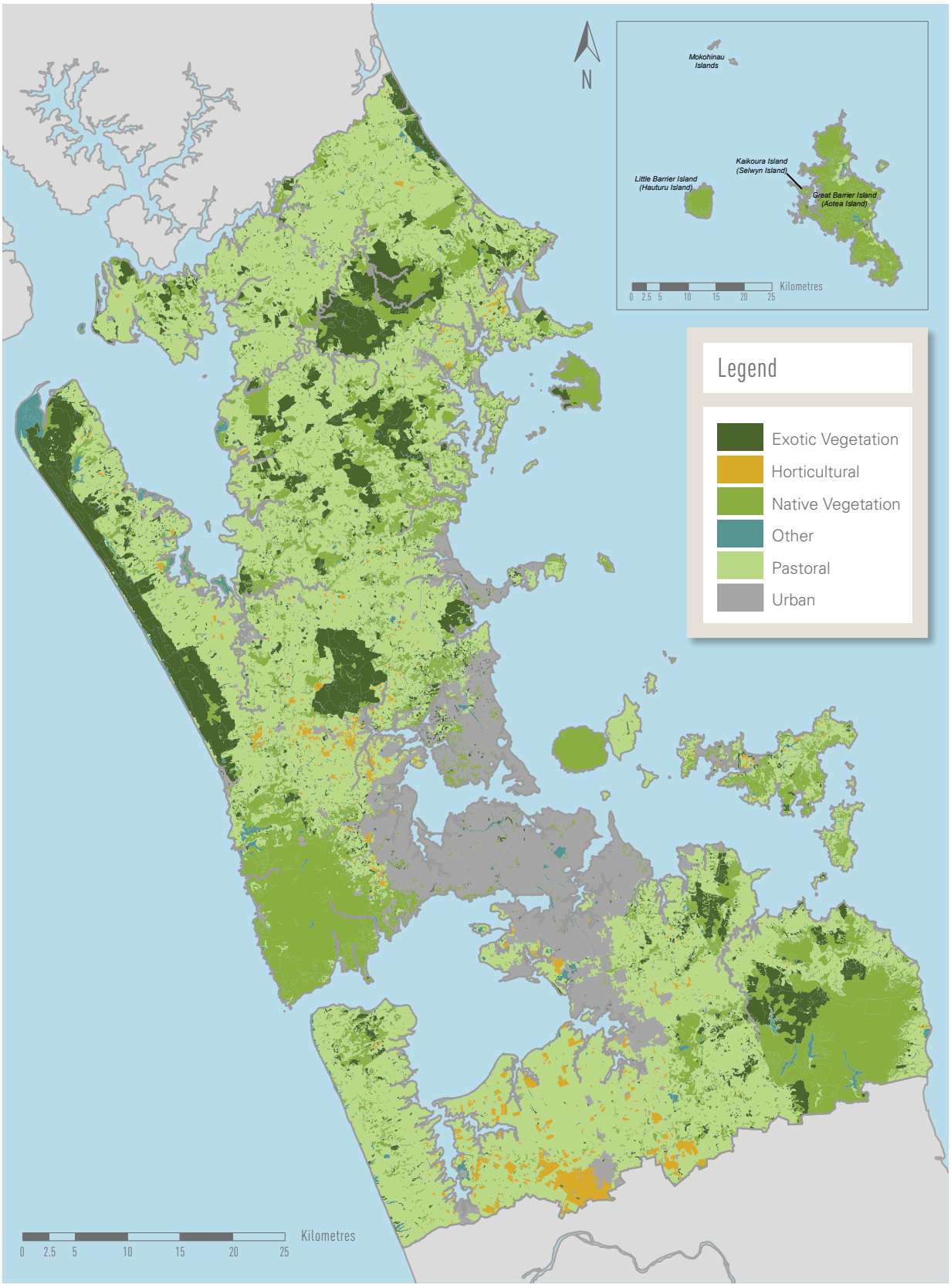

FIGURE 1 Land cover classified by dominant class: urban, pastoral, horticultural, exotic vegetation, native vegetation and other. (Other includes lakes, rivers, mines, landfills, etc.), 2004. (Source: MfE).

Pressures: consumption and production

Land cover and land use

Indicator 1: Land cover

Satellite imagery was used to classify land cover into six classes. The 2002 land cover data are the most recent available for the Auckland region. Figure 1 shows that in total, urban land cover (including settlements outside the main urban area) accounted for about 50,000 hectares or 11 per cent of the total land area in 2002. Pasture is the most extensive type of land cover (49.6 per cent) but it declined by about 2,000 ha (0.8 per cent) between 1997 and 2002.

The amount of land used for horticulture (1.8 per cent) has remained relatively static over the last decade although horticultural land use has varied, with losses in some areas countered by gains in others. Planted forest increased slightly to 10.8 per cent between 1997 and 2002 but fluctuations are likely to occur due to harvesting and planting cycles.

In 2002, native vegetation accounted for 27 per cent (about 134,700 hectares). This represented a decrease of about 170 hectares since 1997.

Indicator 2: Land use

The type of land cover is a good indicator of the activities being undertaken on the land (and, therefore, the types of land use pressures created) but is not, by itself, sufficient to convey the true nature and intensity of these pressures.

TABLE 1 Urban land uses in the Auckland region, 2004. (Source: Market Economics Ltd., 2008).

Urban land use	Land use activity	% of Auckland region
Industrial	Food and beverage production	0.2
	Chemical, plastic and non-metallic mineral product manufacturing	0.2
	Metal products, machinery and equipment manufacturing	0.3
	Other manufacturing	0.3
Commercial	Wholesale and retail trade, accommodation, restaurants and bars	0.3
	Finance, insurance, property and business services	0.1
	Government administration and defence	0.1
	Education, health, personal and community services	1.3
	Transport services	0.6
	Other services	0.3
Residential	Residential	7.2
Total % of urban land cover		**11**

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Pressures: consumption and production

Rodney district contains the most extensive areas of dairy, sheep-beef and livestock farming (60 per cent), followed by Franklin district (23 per cent) and Manukau district (9 per cent). Franklin district contains 82 per cent of the region's market gardens, making it an important area for this type of land use activity. Just under half of the horticulture (market gardening, orchards, floriculture, nursery, viticulture and cropping) occurs within the Franklin district. Rodney district also contains a considerable amount of land used for horticulture (28 per cent) with orchards, floriculture, nurseries and viticulture dominant (Table 2).

TABLE 2 Total farmed area (hectares) by rural land use activity and territorial authority. (Source: Agribase 2009).

Land use activity	Rodney District	North Shore City	Waitakere City	Auckland City	Manukau City	Papakura District	Franklin District	Total
Market gardening	320	4	41	4	101	39	2,316	**2,825**
Orchards	825	13	262	14	85	119	439	**1,757**
Floriculture	140	2	38	5	49	24	77	**335**
Nursery	171	0	87	0	58	36	50	**402**
Viticulture	281	0	63	462	38	3	8	**855**
Cropping	458	0	37	5	132	74	633	**1,339**
Dairy	25,166	0	52	0	2,290	373	19,709	**47,589**
Sheep-Beef	98,074	445	2,334	8,620	16,234	3,843	26,933	**156,484**
Other livestock	3,816	95	277	70	1,088	363	2,214	**7,923**
Lifestyle	10,814	868	2,332	705	1,531	1,120	3,782	**21,154**
Unknown	6,287	133	566	554	1,633	915	2,774	**12,862**

Urbanisation

Development associated with population and economic growth has transformed land for housing, economic, social and cultural purposes, as well as for transport networks and other infrastructural requirements.

Between 2001 and 2005, the number of dwellings increased by about 8,800 each year. Our current population projections suggest that an estimated 240,000 additional dwellings will need to be built by 2035.

Historically, much of the urban growth occurred on the urban fringes. Developing rural land for urban use affects both the natural and physical environment and the existing urban area. Effects include removal of vegetation cover, alteration of the existing topography and landforms, increased pressure on streams, and congestion on transport routes.

The landform modifications and earthworks undertaken during urbanisation often result in degradation or complete removal of the soil. Although the uplifted soil is often relocated and reused, its productivity can be degraded due to structural changes and compaction.

For these reasons, changes in the type and density of housing is a useful indicator of the impact of urban growth on the environment, as increased density reduces the need for expansion of the urban area into rural areas.

Indicator 3: Change in urban housing and density

Pressure to develop rural land has been strong over the last decade and is likely to continue in the future; however, there have been some changes to Auckland's urban form. Traditionally, housing stock in the Auckland region has been dominated by detached houses.

In 2006, 75.6 per cent of the occupied dwellings were detached houses and 23.9 per cent were flats or apartments (up from 21.1 per cent in 2001). The majority of the 98,450 occupied flats and apartments were in low-rise buildings (52 per cent were in one storey, 37 per cent in two or three storey and 10 per cent in higher rise buildings), had one or two bedrooms (70 per cent) and were located mainly in the North Shore, Auckland and Manukau cities.

In 2006, 16 per cent of the population in the Auckland region lived in flats and apartments. Around 18,000 higher-density homes have been built since 2001, making up about one third of the new housing stock between 1996 and 2006.

From 1990 to 2009 the overall density of the urban area is estimated to have increased from 20.7 to 25.7 people per hectare, a 24 per cent increase over 19 years (Figure 2).

Pressures: consumption and production

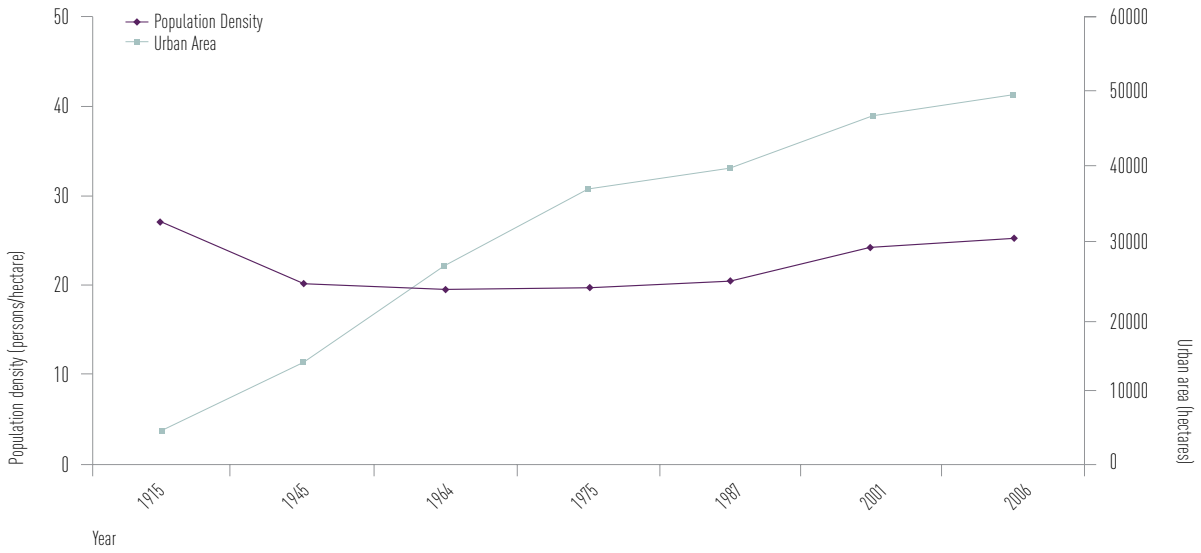

FIGURE 2 Changes in the population density and size of the urban area in the Auckland region, 1915-2006. (Source: ARC).

Indicator 4: Location of housing development

The other indicator of pressure on the 'greenfield' environment is the amount of housing development occurring at the urban fringes compared to existing urbanised areas.

For the overall distribution of housing growth and increasing numbers of dwellings on the urban fringes and in the central business district (CBD) between 2001 and 2006 (Figure 3). This shows that, despite the changes in housing preferences and housing densities discussed in Indicator 3, in absolute terms the greatest number of new dwellings continue to be at the urban fringes.

Most of the urban population growth between 1987 and 2006 was accommodated by a 23.7 per cent expansion of the urban area from about 40,000 to about 49,500 hectares (Figure 2).

Indicator 5: Soil loss to urbanisation

The productive capability of land is assessed using the Land Use Capability (LUC) classes. The classes are a measure of the land's capacity for sustained productive use and take into account physical limitations, soil conservation needs and management requirements. There are eight classes, ranging from Class I (flat land with good soil and few limitations) to Class VIII (land with severe physical limitations).

In the Auckland Regional Policy Statement (ARPS), Class I land is referred to as 'elite' while 'prime agricultural land' collectively covers Class I, II and III land. The loss of soil in these classes represents land well suited to agricultural or horticultural use, but also land that is attractive for residential development.

Between 2001 and 2006, urban development replaced elite land at a rate of 23.9 hectares per year; an increase from 4.5 hectares per year between 1987 and 2001. Prime agricultural land was lost at a rate of about 333 hectares per year: an increase from 228 hectares per year between 1987 and 2001.

Overall, this represents a 5 per cent loss of elite land and a 4.9 per cent loss of prime agricultural land between 1979 and 2006. (Table 3).

TABLE 3 Conversion of prime agricultural land to urban use between 2001-06. (Source: Landcare Research and ARC).

LUC class	Hectares in urban area (2001-06)	Rate (hectares/yr)
I	119.4	23.9
II	941.1	188.2
III	606.4	121.3
Total	**1666.9**	**333.4**

Indicator 6: Extent of impervious surfaces

Aerial photography and satellite imagery were used to estimate the extent of impervious surfaces within the Metropolitan Urban Limits and urban expansion areas defined in the Auckland Regional Growth Strategy (ARGS). Information from 2000 and 2008 was used to allow the changes over time to be assessed. (Table 4 and Figure 4).

In both surveys, Auckland City had the highest extent of impervious surfaces but there was little change between 2000 and 2008. Similarly, there was little or no change in North Shore City and Waitakere City. In contrast, Manukau City and Papakura district both showed large increases (10 per cent) in impervious surfaces between 2000 and 2008 and these can be seen clearly in Figure 4. As a result, the overall extent of impervious surfaces in the Metropolitan Urban Limits and urban expansion areas increased from 39 to 42 per cent.

In some cases, the extent of impervious surfaces decreased from 2000 to 2008 due to the establishment of parks, open spaces and a growth in urban vegetation following large scale subdivision where bare soil is planted.

Pressures: consumption and production

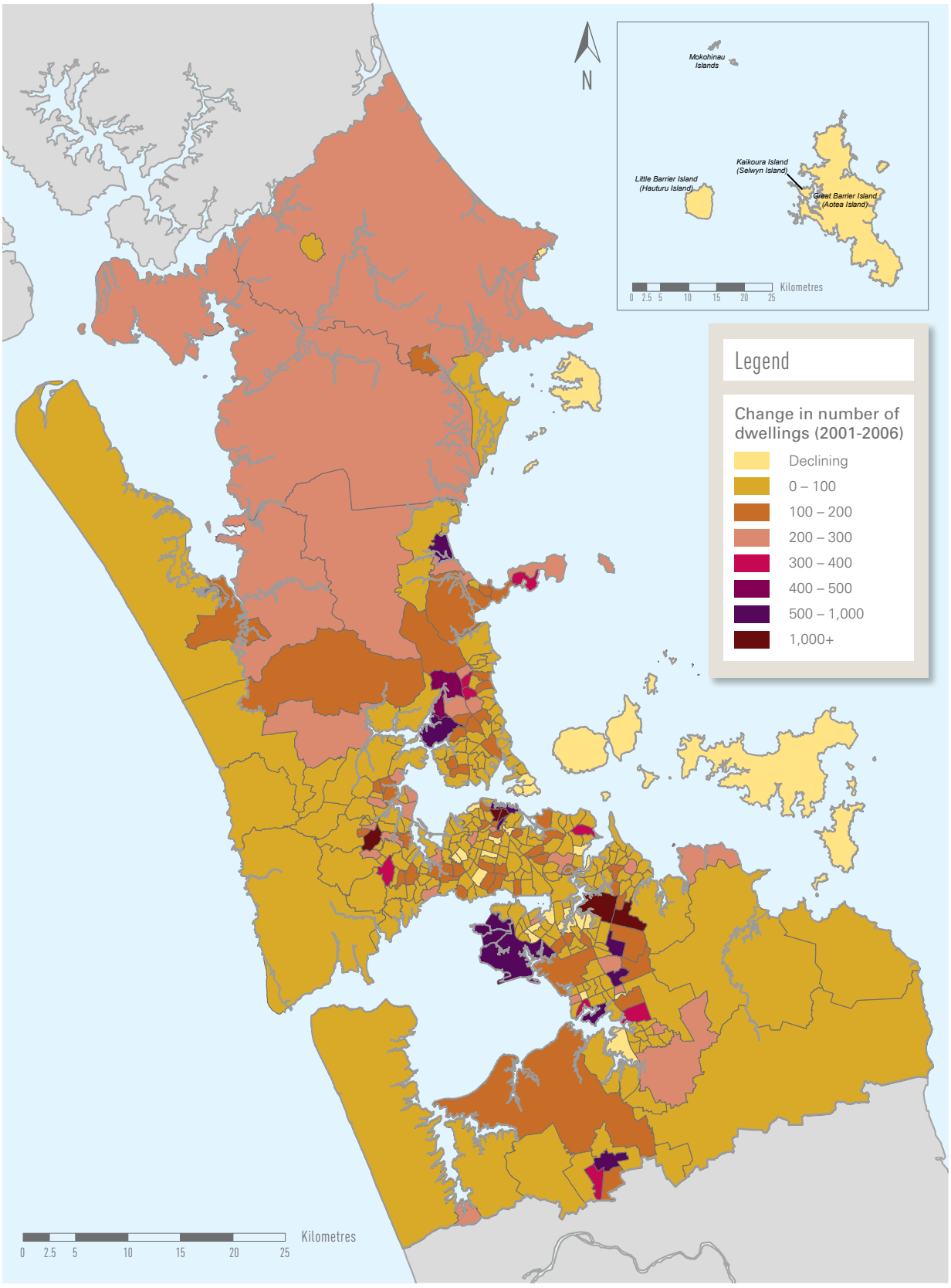

FIGURE 3 Changes in the numbers of dwellings by Census Area Unit, 2001-06. (Source: Statistics New Zealand).

Pressures: consumption and production

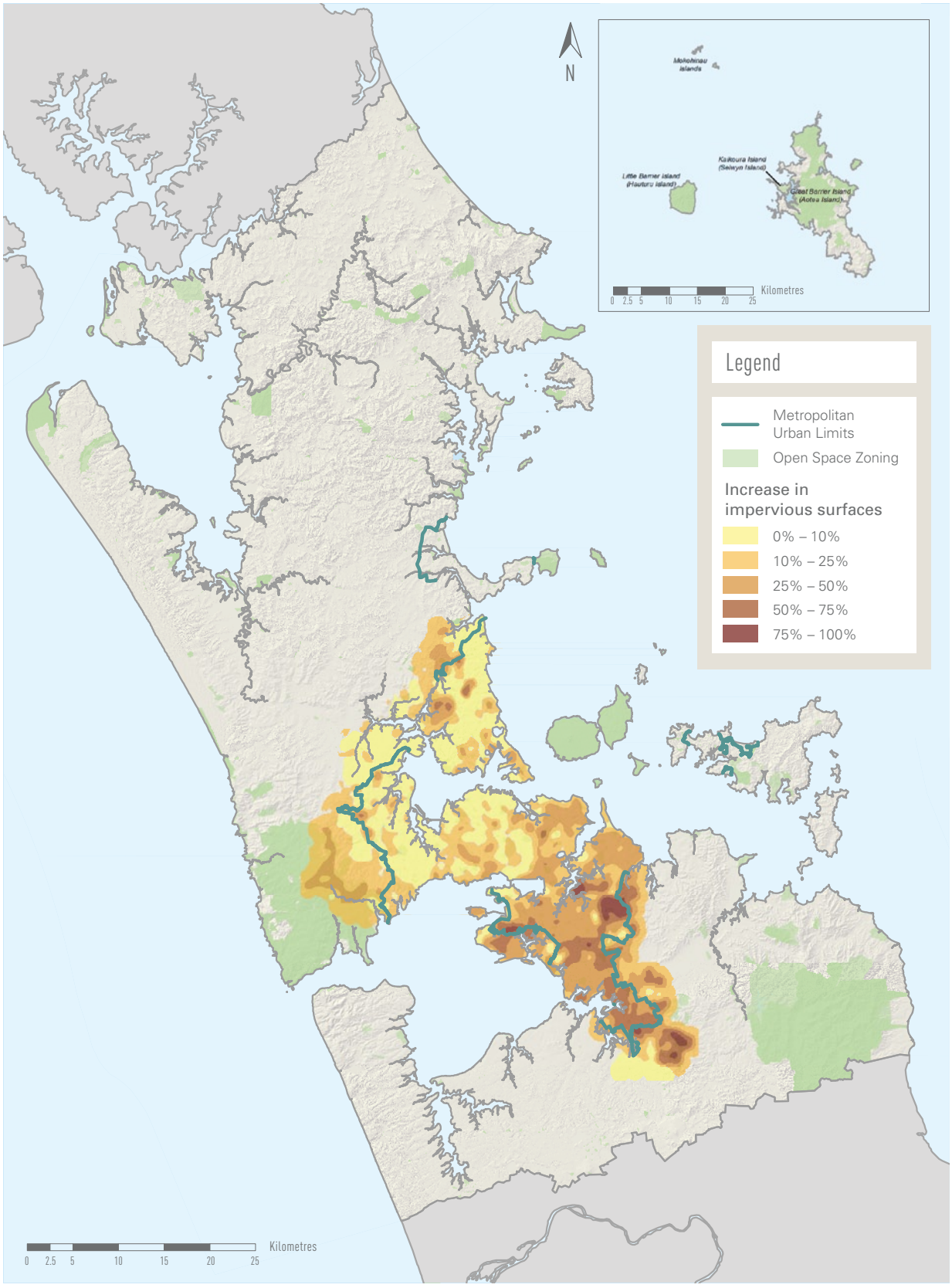

FIGURE 4 Increases in the extent of impervious surfaces in the Metropolitan Urban Limits and urban expansion areas. (Source: Landcare Research and ARC).

3.0

Pressures: consumption and production

TABLE 4 Extent of impervious surfaces in 2000 and 2008. (Source: Landcare Research).

Territorial authority	Area mapped (hectares)	% impervious	
		2000	2008
Auckland City	15,376	48	50
Manukau City	14,910	39	49
North Shore City	10,584	37	36
Papakura District	3523	27	37
Waitakere City	9198	32	29
Total	**53,649**	**39**	**42**

Rural land use change

Indicator 7: Livestock numbers

The rural economy in the Auckland region is changing. The most noticeable change over recent years has been the decline of pastoral activities, particularly sheep and beef farming, and dairy farming.

The number of beef cattle, dairy cattle and sheep in the Auckland region declined by 16, 23 and 28 per cent respectively between 2002 and 2008 (Figure 5). Despite this, pastoral farming remains an important part of the rural economy in some parts of the Auckland region.

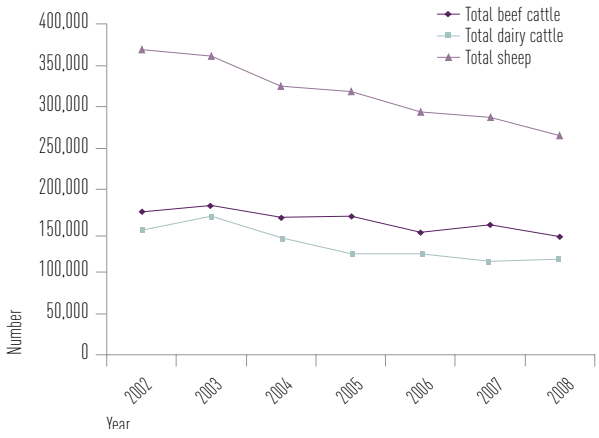

FIGURE 5 Numbers of livestock within the Auckland region, June 2002-08. (Source: Statistics New Zealand).

Indicator 8: Intensity of dairying

Data from the Livestock Improvement Corporation suggest that, since 2002, the number of dairy farms decreased by 33 per cent and the number of effective hectares in dairying decreased by 24.5 per cent.

Despite the decline in cows, farms and land area devoted to dairying, the intensity of production appears to be increasing on the remaining dairying farms. The size of the average dairy farm is increasing. This is reflected in data that show the average herd size increased 21 per cent between 2002 and 2008. Table 5 shows that the average stocking rate also increased (by 5 per cent) over this period.

TABLE 5 Dairy farming area, herd size and stocking rates within the Auckland region. 2002-08. (Source: Livestock Improvement Corporation).

	Effective farming area (hectares)	Average herd size	Average stocking rate (cows/ hectare)
2002	61,393	199	2.34
2003	59,762	205	2.33
2004	56,846	216	2.39
2005	53,650	221	2.40
2006	50,381	224	2.41
2007	48,358	233	2.43
2008	46,361	240	2.46
% change 2002-08	-24	21	5.0

Indicator 9: Horticultural land use

In contrast to pastoral farming, horticulture remains a strong rural activity in the Auckland region. Between 2002 and 2007, an additional 210 hectares were devoted to horticulture (a 2 per cent increase).

The main trend was a decline in orcharding, with all major fruit crops showing declines in terms of the area under cultivation between 2002 and 2007. However, Table 6 shows that the area under cultivation for vegetable production appeared to increase by about 25 per cent over the same period. There were some large changes in the type of crops being grown, probably in response to market factors (such as the price of particular products) and the need to rotate crops for soil health and pest management.

In addition, there is evidence of increasing intensity of production in horticulture, with the construction of large greenhouse facilities in Franklin and Rodney districts, and increased employment in plant nurseries and vineyards.

Although there is little data, it is unlikely that market gardening has expanded at the expense of orcharding. It is more likely that land formerly used for orcharding has been urbanised or changed to rural residential (lifestyle blocks), with market gardening expanding onto land formerly used for pasture.

Pressures: consumption and production

TABLE 6 Area (hectares) under cultivation, by crop type, 2002 and 2007. (Source: Statistics New Zealand).

	2002	2007	% change
Orchard crops	1,996	1,374	-31
Vegetable crops	4,227	5,294	25
Other (including flowers)	2,460	2,224	-9
Total	**8,683**	**8,892**	**2**

Indicator 10: Rural subdivision in potentially sensitive areas

Although the majority of residential development in the Auckland region has occurred within the urban area, there has also been residential growth in some coastal and peri-urban areas that may be sensitive. (Table 7).

Four categories of ecological features were used to measure the pressure of rural subsidiaries. There has been a steady increase in the number of land parcels within each category. Although the number of land parcels can change without any accompanying changes in land use and intensity, the data are an indicator of the potential increase in pressure on ecological features and sensitive areas.

TABLE 7 Number of land parcels located close to important ecological features between 1998 and 2008. (Source: ARC).

Year	Parcels above aquifers	Parcels within 200m of native vegetation	Parcels within 1km of the coast	Parcels within 200m of wetland
1998	110,570	145,538	219,455	4,732
2001	117,427	152,174	229,058	4,765
2004	122,456	157,566	236,839	4,749
2008	129,856	166,014	247,280	4,797

Indicator 11: Rural fragmentation

Rural fragmentation is the ongoing subdivision of rural land that leads to increasingly smaller land parcels. It occurs when large land parcels used for agriculture are subdivided into small and more intensive production units, hobby farms or lifestyle blocks for residential use. Rural fragmentation increases settlement density and also excludes land uses such as pastoral farming that require large land parcels.

Figure 6 shows an increase in the number of land parcels across each size category between 1998 and 2008, with the greatest increase (36 per cent) in the one-to-two hectare category. There was a corresponding decline in the number of land parcels over eight hectares.

Figure 7 shows the density by location of land outside the Metropolitan Urban Limits that has been subdivided into smaller land parcels (less than eight hectares). The areas that have undergone the greatest increases in density are those to the immediate north, west and south-east of the city, as well as areas that are close to major transport routes. The coastal area around Omaha has undergone major fragmentation.

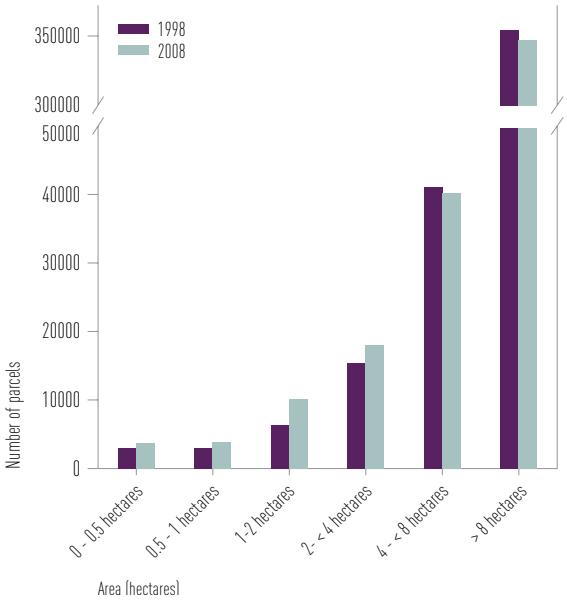

FIGURE 6 Number of land parcels by size (hectares), 1998 and 2008. (Source: Landcare Research and ARC).

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Pressures: consumption and production

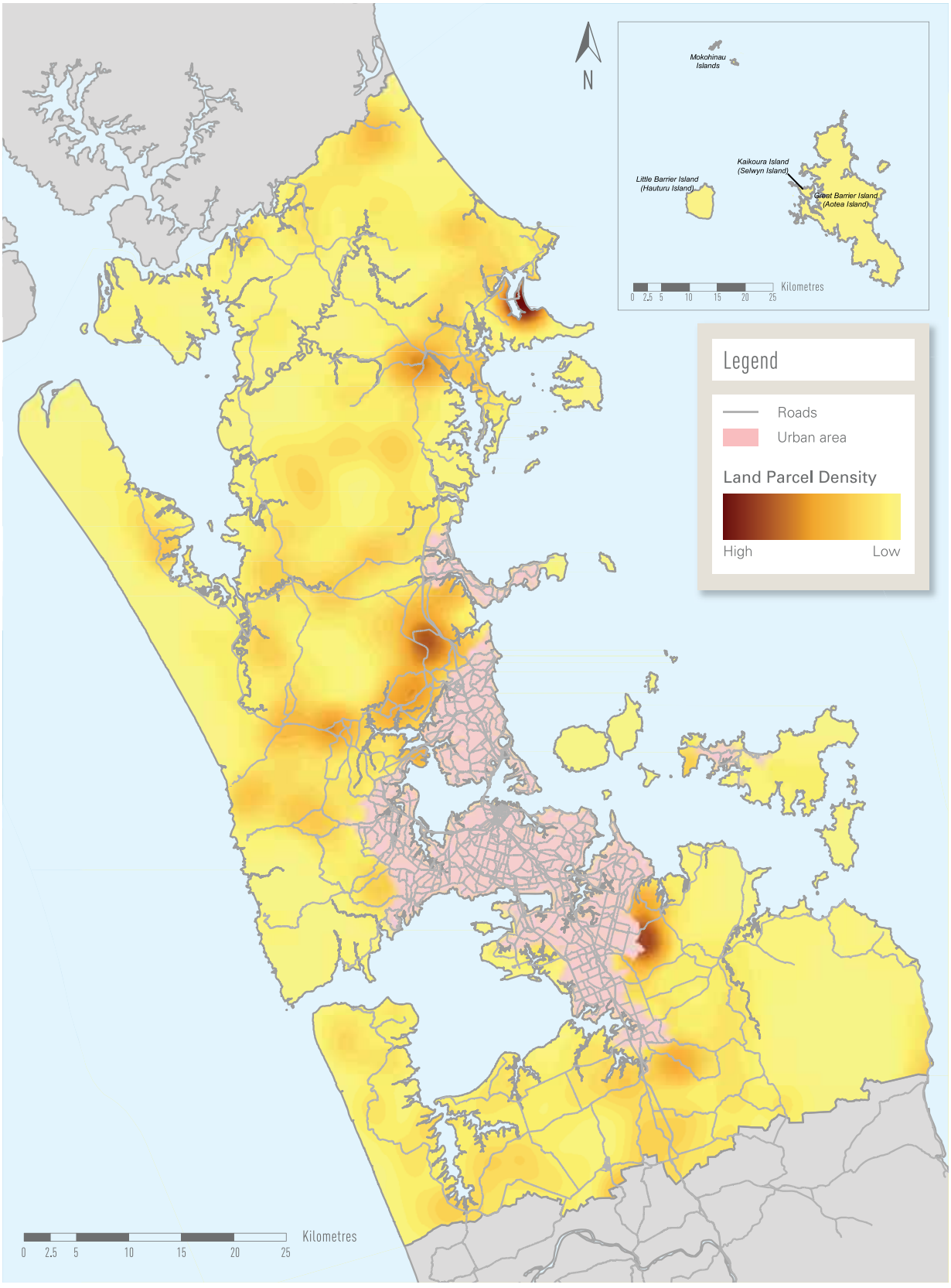

FIGURE 7 Land parcel densities outside the urban area, 2008. (Source: ARC).

Pressures: consumption and production

Land and stream disturbance

Indicator 12: Land disturbance associated with building and infrastructure development

In the urban and peri-urban parts of Auckland, earthworks associated with building projects are a major cause of soil disturbance. Earthworks typically strip the vegetation and topsoil from the land surface and recontour the site so that it is more suitable for the proposed land use. During this process, the soil is compacted, buried or displaced. The increased sediment that is generated from earthworks can be flushed into rivers, where it can have adverse impacts on the water quality of freshwater and marine environments.

Figure 8 shows the location of major earthworks during February 2007. Most, but not all, were associated with the preparation of land for housing, roading and other urban development. Earthworks associated with major highway projects (such as the motorway extension from Orewa to Puhoi) are shown, with other large clusters at the urban fringes of Silverdale, Albany, west Auckland, Flatbush and Hingaia as well as those at some inner-city development nodes such as Mt Wellington. Earthworks associated with development pressure in the rapidly growing satellite towns of Pukekohe in the south and Orewa in the north are also visible. Overall, about 400 hectares of land was subject to earthworks at this time.

Many other earthworks are undertaken, either as permitted activities or with consent required only from the local city or district council. These are not shown on Figure 8 so the actual amount of land subject to earthworks is likely to be higher.

Indicator 13: Stream disturbance

Stream disturbance often accompanies urban land use and expansion. Common stream disturbances include piping, lining and channelling. In rural areas, streams are often 'cleaned', where vegetation and sediment are removed from the channel to 'improve' the water flow, channels straightened and culverts installed to allow the passage of stock and vehicles. Damming is also common, both to ensure a reliable supply of water for irrigation and for amenity value. All of these activities can have various adverse effects on the water quality, ecology and flood management.

Between 2000 and 2008, about 80km of streams (an average of 8.9km each year) were subject to a resource consent for stream disturbance. (Table 8). This figure does not include the large number of stream disturbance activities that can be undertaken without a resource consent. Consequently the total amount of stream disturbance in the Auckland region is underestimated.

TABLE 8 Length of streams subject to consent for disturbance, 2000-08. (Source: ARC).

Financial year ending	Stream length (m)
2000	9,197
2001	11,368
2002	11,961
2003	11,035
2004	7,058
2005	12,159
2006	7,146
2007	3,669
2008	7,146

Rural land use and soil disturbance

Rural land use is the largest contributor to soil disturbance. Activities such as vegetation removal, farming of steep countryside, and extensive cultivation lead to poor soil structure and increased sediment generation.

Rural land uses create related pressures on the soil and water quality from activities such as:

- → intensive cropping leading to depletion of soil nutrients and organic matter
- → the application of fertilisers that affect water quality through excess nutrient runoff into rivers and leaching into groundwater
- → soil compaction from stock treading and vehicle traffic.

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Pressures: consumption and production

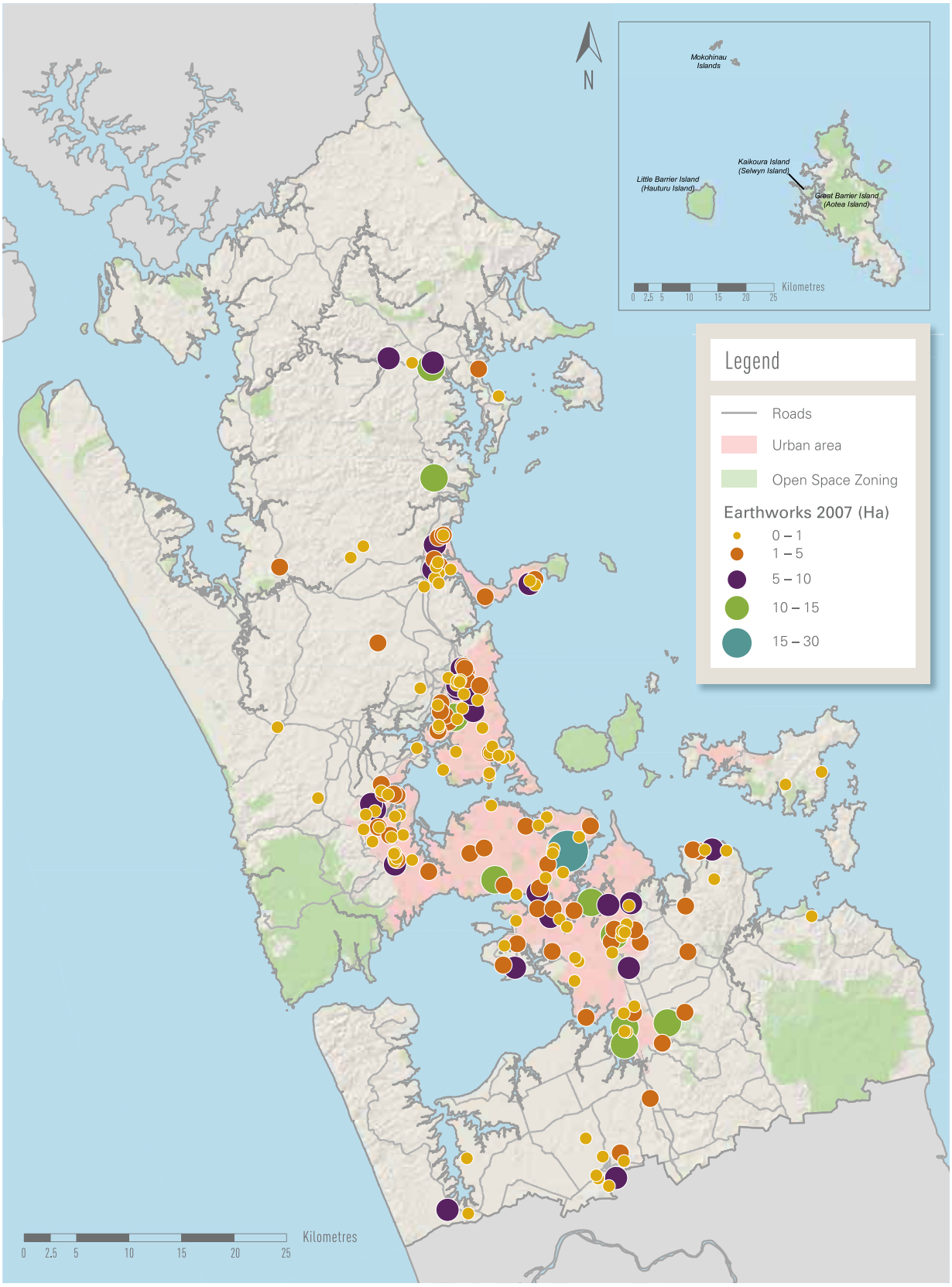

FIGURE 8 Locations of major earthworks activities, February 2007. (Source: ARC).

Pressures: consumption and production

Seabed use

Pressures on the environment do not stop at the coastline. A variety of activities are undertaken within the Coastal Marine Area (CMA) in order to meet the recreational requirements and safety demands of a growing population as well as the resource demands of a growing economy.

Coastal structures

A variety of structures such as boardwalks, breakwaters, jetties, boat ramps, bridges and groynes are found within the CMA (Table 9). Although many of these structures are beneficial they can also:

- → place pressure on the natural values of the coastal environment
- → result in exclusive use that restricts public access to open space
- → adversely impact the natural visual amenity values.

Table 9 summarises the number of current resource consents granted for coastal structures within the Auckland region, as well as the current number of applications. Some of the most heavily developed sections of the coast (in terms of coastal structures) are the Waitemata Harbour, Tamaki Estuary and East Coast Bays. In contrast, Mahurangi Harbour, Kaipara Harbour and the west coast contain relatively few consented coastal structures.

Moorings and marinas

In the Auckland region, 4610 moorings are currently located within specifically designated Mooring Management Areas (MMAs). In addition, there are about 450 unconsented moorings outside the MMAs. These figures include only known moorings and are, therefore, likely to underestimate the actual number.

A 2006 study by the ARC found that demand for moorings within the inner Waitemata Harbour MMAs declined between 1995 and 2006, by approximately 1472. This reduction was attributed to marina berths and other more convenient facilities becoming available. However, along the Rodney coast (including Kawau Island), and at Waiheke Island, Rakino Island and Great Barrier Island, the number of mooring sites increased over the same period. Pressure on the CMA for moorings and marinas is predicted to increase with additional subdivision and development.

Auckland has eight major marinas. These include four in the central Auckland area (Westhaven/Viaduct) and others at Bayswater, Gulf Harbour, Pine Harbour (Beachlands) and Half Moon Bay. Westhaven Marina is reputedly the largest in the southern hemisphere.

Marinas and moorings are sources of disturbance from human activities (e.g. potential input of industrial wastewater and stormwater runoff that can be contaminated by toxic chemicals, particularly oil, organochlorines and various heavy metals). Marinas are commonly sources of heavy metals. Copper, mercury and tin have been used in antifouling paints; chromium, lead and zinc in hull primers and marine paints; cadmium in paint pigments, and zinc is found in sacrificial anodes to reduce corrosion of immersed metal parts.

Dredging, extraction, land reclamation and disposal

Land reclamation and drainage activities are often undertaken to increase the area of useable land or to improve access to the coast. However, land reclamation can have adverse environmental effects such as the loss of coastal habitats and ecosystems, degradation or loss of natural character, changes in sedimentation processes and impacts on historic heritage.

Dredging, which is often required for the development and maintenance of facilities such as marinas and navigational channels, also has the potential to cause or exacerbate coastal erosion, disturb or destroy habitats and smother organisms on the seabed with sediment, and impact on amenity values.

Sand extraction for use by the construction industry and for replenishment of Auckland beaches (such as those at Mission Bay and Point Chevalier) is another activity that occurs on the seabed. Large-scale sand extraction can adversely impact nearby beaches that rely on offshore sand for natural replenishment. (Table 10).

TABLE 9 Type and number of coastal structures consented or under application, December 2008. (Source: ARC).

	Steps	Jetty/wharf/pontoon	Boatshed/dinghy locker	Boardwalk	Breakwater/groyne	Seawall/bank protection	Pipeline cable	Slipway/ramp	Mooring piles	Culvert/outfall	Grid	Bridge	Other	**Totals**
Existing	128	134	37	27	20	383	27	310	9	114	3	81	54	**1,327**
New	22	31	3	24	4	34	24	16	3	41	0	18	44	**264**
Total	**150**	**165**	**40**	**51**	**24**	**417**	**51**	**326**	**12**	**155**	**3**	**99**	**98**	**1,591**

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Pressures: consumption and production

TABLE 10 Current resource consents and applications for disposal, dredging, extraction and land reclamation, 2009. (Source: ARC).

Activity	Current consents	Current applications
Disposal/Deposit/ Replenishment	27	1
Dredging	32	3
Extraction	9	1
Land reclamation	47	9

Aquaculture

Aquaculture has the potential to provide significant economic benefits, but it can also place pressure on the environment as well as commercial and recreational activities and amenity values within the Coastal Marine Area (CMA). Potential environmental effects include modification of the water column and seabed habitats (with associated positive or negative consequences for marine plants and animals), promoting the growth of marine algae, and biosecurity risks.

Other effects include the impact on the seascape and visual amenity values from the marine farming structures and operations, the impact on activities such as recreational boating and fishing from the occupation of the CMA, and the impact of habitat displacement on marine mammals.

In 1998, there were 69 marine farms within the Auckland region that covered about 265 hectares. By 2008 this had increased to 70 farms covering about 341 hectares, principally due to the 76 hectare biomarine oyster farm in the Kaipara Harbour that was approved recently under transitional provisions of the Government's aquaculture law reforms. The ARC currently has 51 applications for marine farms that date back to 2001 or before. Processing of these applications remains on hold until the regional plan provisions for aquaculture are finalised.

This situation reflects a combination of the 1984 moratorium across much of the Hauraki Gulf that was imposed by the Ministry of Fisheries, a national three year moratorium between 2001 and 2004 that was imposed by the Government and complexities of the subsequent aquaculture law reform that came into force in 2005.

Implications of land use, land use change intensification and seabed use

The move towards a dense urban form has some environmental benefits because it facilitates efficient transport solutions and avoids the need to convert more rural land to urban use. This avoids development on productive soil and maintains the soil's ability to produce food. It also reduces pressure on the remaining soil resources, which might otherwise need to be used more intensively, leading to degradation.

However, urban intensification also has some negative environmental consequences as it concentrates other pressures. It can lead to a loss of open space and Significant Natural Areas (SNAs) within the urban area and can adversely affect the quality and amenity values of the urban environment and historic heritage. Large amounts of impervious surfaces can also reduce the water quality and ecological quality of urban streams (see Urban Stream Syndrome Case Study on page 86).

Changes in horticultural land use are likely to have some environmental implications, particularly sediment generation and possible declines in soil quality from continuous cultivation. Large-scale greenhouses that grow crops hydroponically or in special growing media also place a range of pressures on the soil, rural amenity values and water quality (given the potential for nutrient-rich discharges).

As with urban intensification, the implications of rural residential growth are complex. On the negative side, rural residential development can create adverse effects on the environment by changing its character and by requiring people to travel longer distances to employment, education and social activities. Fragmentation of rural land into smaller holdings parcels tends to reduce the economic viability of agricultural activities. In addition, increasing the number of land parcels above aquifers may lead to increased pressure on water resources.

On the positive side, changes in land use wherever rural residential development occurs can reduce the pressures that are commonly associated with agricultural production. For example, reduced amounts of nutrients that are discharged to the land through fertilizers and agricultural sprays, and retirement of land that is susceptible to erosion. It can also mean increased investment in riparian fencing and revegetation, leading to potential improvements in the water quality of rural streams and enhanced amenity values.

Pressures: consumption and production

Water use

Key findings

- Consent holders used 111 million m^3 of water in 2007/08. This is more than the 98 million m^3 used in 2002 but less than the annual volumes used between 2003 and 2005.
- Surface water from reservoirs in the Hunua and Waitakere Ranges provides the majority of water (by volume) used in the Auckland region.
- Applications for groundwater bores for domestic and stock use have increased over recent years. This is likely to reflect ongoing rural subdivision in areas where there is high demand for groundwater.

Introduction

Water is one of the most valuable natural assets and plays a critical role in supporting life and ecosystems. It provides a wide variety of aquatic habitats and important ecosystem services, such as nutrient processing and cycling, climate regulation, and the transportation and dilution of waste.

Water bodies are highly valued in the Auckland region and are used for a variety of recreational activities, including swimming and kayaking. Local iwi have strong historical and spiritual links to many water bodies and streams. The demand for water can place pressure on all these values.

Water is taken from groundwater (aquifers) or from surface water (streams, lakes and dams) to meet the needs of domestic, primary production, commercial and industrial users.

When water is taken out of a stream the flow is reduced which, in turn, may impact the ecology and habitat downstream. The impact of taking groundwater is less obvious but can result in lowered water levels in streams, lakes and wetlands and seawater contamination of the aquifer.

The damming of rivers and the taking of water from them can increase the frequency and duration of low flows, change flow variability, degrade water quality, and reduce instream habitat. There are estimated to be 4,500 dams in the Auckland region; many unauthorised. The cumulative effects of these dams may be substantial, particularly in catchments with many small rivers.

In the Auckland region, the greatest demand is for municipal supply. Watercare Services Ltd, Auckland's largest bulk water provider, supplies about 375,000 m^3 each day. Most of the water comes from supply dams in the Hunua and Waitakere Ranges but some additional water is sourced from outside the Auckland region.

Monitoring water use

The ARC monitors groundwater levels and river flows as part of its long-term baseline programme. Resource consent holders are required to record their water use and submit water use returns to the ARC. Collectively, this data is used to ensure that water use is not causing adverse effects on the environment. If it is, the council can take action to address the problem. Water allocation, use and monitoring data are published annually in the ARC's Water Quantity Statement series.

Major sources of water demand

Indicator 14: Water allocation by sector

During the year ending June 2008, 147 million m^3 of water was allocated by resource consent and approximately 111 million m^3 (76 per cent) was taken by consent holders.

Table 11 shows that, of the water allocated, the major use is municipal supply. Watercare Services Ltd has consents to take up to 88 per cent of the total water allocated within the Auckland region for this purpose, while Franklin District Council takes 2 per cent of total water allocated and Rodney District Council takes 1 per cent.

Irrigation (hothouses, nurseries, pastoral, orchards and market gardening) is the second highest water allocation and use within the Auckland region, followed by industry (for example, piggeries, vegetable washing, poultry farms, industrial use, and cooling/circulation).

It is important to note that water is also taken by users, particularly in rural areas, as a permitted activity. This volume is not included in Table 11.

TABLE 11 Water allocation and use (millions m^3) by sector, 2007-08. (Source: ARC Consents data).

	Municipal	Irrigation	Industry	Community	Other	**Total**
Allocation	109	13	12	7	6	**147**
Use	98	5	5	2	1	**111**

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Pressures: consumption and production

Box 2 Distribution of water demand within the Auckland region

The nature and extent of water demand varies across the Auckland region. Generally, in north Auckland, the principal demands come from horticulture, dairying, golf course irrigation and quarry operations, as well as municipal supply to townships such as Warkworth and Wellsford. However, for the two geothermal aquifers at Waiwera and Parakai, the demands are for swimming pools, accommodation and resort complexes.

In the North Shore-Kaipara River area, the main demands come from horticultural production (particularly around Waimauku, Kumeu, Taupaki, Riverhead and Hobsonville) as well as some relatively large allocations for municipal supply at Helensville, golf course irrigation and industrial purposes.

In the Waitakere and Hunua Ranges, Watercare Services Ltd stores surface water in dams to provide much of Auckland's reticulated municipal water supply. This demand must be balanced against the high ecological, landscape and recreational values provided by water in these areas: the streams of the Waitakere Ranges are amongst the highest quality in the Auckland region.

In urban and peri-urban parts of Auckland, most surface water and groundwater allocations are for industrial purposes or for pastoral, horticultural and recreation ground irrigation, with some minor municipal supply consents.

In south Auckland (the Manukau lowlands, Waiuku, Pukekohe and Bombay) there has been strong growth in horticultural production since the 1980s and there is a high demand for water for irrigation. Over recent years, market gardening has spread into the Karaka area, and there has been a move towards larger scale horticultural (especially glasshouse) production. This has placed additional demand on the water resources of the area, although the increase in rural residential development in the Manukau lowlands is likely to provide a net reduction in water demand where development replaces former orchards.

Indicator 15: Water consumption

Municipal needs dominate water use in the Auckland region. The 2008 average overall daily demand (combined domestic and industrial use and leakage) was 300 litres per person per day.

Domestic use alone in the Auckland region is about 180 litres per person per day. In Hamilton, Palmerston North and Wellington water use is higher at 230, 275 and 248 litres per person per day respectively. Auckland's domestic use is also well below water use in Australian and American cities, and is similar to Europe, which has a longer history of water efficiency measures.

Variations in municipal water consumption within the Auckland region are shown in Table 12. See Figure 8 in Part 2 for information about recent trends in water use.

TABLE 12 Water consumption (litres per person per day) in the Auckland region, 2008. (Source: Three Waters Strategic Plan).

Local authority*	Average personal use	Total use
Rodney District	180	**250**
Papakura District	190	**330**
Auckland City	185	**355**
Manukau City	190	**305**
North Shore City	200	**260**
Waitakere City	165	**233**

* Data available for Franklin District Council

Indicator 16: Trends in water use

Over the last six years, the number of consents to take water has decreased within the Auckland region (Figure 9). This may be partly explained by the move to fewer (but larger volume) irrigators and the new rules for taking water in the Proposed Auckland Regional Plan: Air, Land and Water.

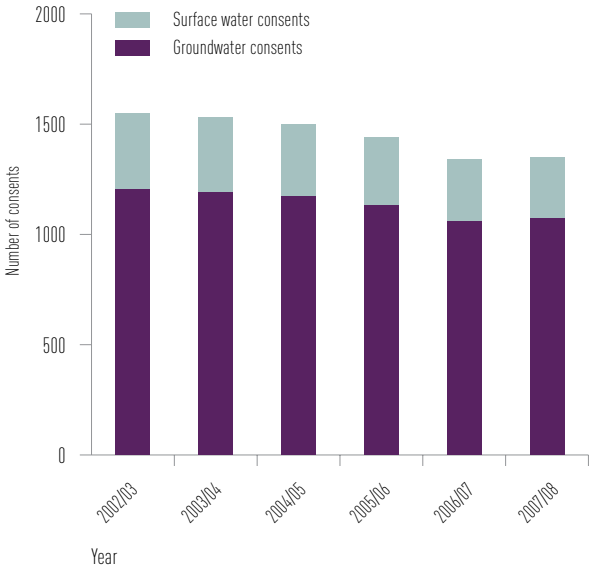

FIGURE 9 Groundwater and surface water take consents, 2002/03 to 2007/08. (Source: ARC).

Pressures: consumption and production

Figure 10 shows that, since 2002/03, water use has ranged from a maximum of 118 million m^3 in 2004/05 to a minimum of 98 million m^3 in 2002/03. The variation largely reflects the rainfall pattern over this period, with a reduction in water demand during the wetter periods. For example, in 2005/06, the Auckland region was, on average, 7 per cent wetter than the previous year; this meant that many consent holders did not approach their maximum water allocations and that total groundwater and surface water use dropped about 12 per cent compared to the previous year.

FIGURE 10 Combined groundwater and surface water allocation and use, 2002/03 to 2007/08. (Source: ARC).

Indicator 17: Applications for new bores

An indirect measure of increasing water demand in the Auckland region is the number of applications to drill new water supply bores. Table 13 shows that there were 132 applications to drill bores in the 2006/07 year. Over the six years recorded, the applications for bores has generally increased each year. The major increase in water demand from these bores was for domestic and stock water supply.

TABLE 13 Number of applications for new bores between 2000/01 and 2006/07. (Source: ARC).

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Domestic and stock	67	84	83	86	102	122	114
Irrigation	16	14	18	12	14	7	10
Industry	3	10	6	9	6	2	8
Total	**86**	**108**	**107**	**107**	**122**	**131**	**132**

Implications of water use

Dams, to a lesser extent weirs, and direct takes from streams cause a variety of environmental implications including reduced downstream flows that in themselves can have a range of potential environmental impacts. These include reductions in:

- the natural flushing characteristics of rivers, which can lead to sediment build up and increased flood risk
- the natural peaks and troughs in water flow and temperature, which can disturb the migratory patterns of aquatic creatures that use changes in the water flow and/or the physical and chemical properties of the water as cues to start their migrations
- the ability to absorb and dilute contaminants from point and non-point sources
- water flow and the wet channel area, which reduces the amount of stream bed available as habitat for invertebrates and for primary production by micro-organisms, leading to changes in the food web that can impact the ecology of the stream.

These potential effects can degrade the aquatic habitats, recreational value, and ecological and biological values of the stream.

Dams also create a barrier for migratory fish and, therefore, impact the ecology of the areas upstream of the dam.

Groundwater takes that lower groundwater levels can lead to saltwater intruding into the aquifer and contamination of the water source, and reductions in surface water flow and wetlands as natural seepages and springs dry up.

Environmental impacts that are experienced as a result of water takes depends on the volume and rate of take, relative to the particular characteristics of the water source.

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Pressures: consumption and production

Energy use

Key findings

- → Transportation currently accounts for about 56 per cent of all energy use in the region, or 101 Petajoules/year (PJ/year). Of this, road transport uses about 57 PJ/year and aviation 38 PJ/year.
- → Non-transport energy use is dominated by electricity (40.4 PJ/year), coal (17.2 PJ/year) and gas (14.8 PJ/year).
- → Approximately 70 per cent of all non-transport energy is used by industry and commerce, while the remaining 30 per cent is used by households.
- → In the year to 30 June 2008, people and businesses in the region collectively spent an estimated $3.6 billion on energy for transportation, plus an additional $2.1 billion on non-transport energy. The total of this expenditure ($5.7 billion) represents about 10 per cent of Gross Regional Product (GRP).
- → If no significant energy efficiency gains were to be made, the energy demand of the region would be expected to increase by about 65 per cent by 2031, to reach nearly 300 PJ/year.

Introduction

The need for energy is so pervasive that its importance can be overlooked. Often, modern society is reminded of the importance of energy only when the energy supply is interrupted.

The availability and affordability of energy shapes the way that resources are used, including the form of cities and the pattern of settlement and production. The way that Auckland has been built, and the way that residents choose to live within it, reflect the recent abundance of energy sources, particularly fossil fuels.

However, like many other resources, there is a limited supply of affordable energy (certainly with current technology) and harnessing energy by burning fossil fuels, damming rivers or erecting wind turbines has an associated environmental cost. The extent to which society conserves energy, and uses it efficiently, is a fundamental measure of environmental sustainability. Conversely, the more energy that is used, the more pressure that is placed on the environment and future generations.

Monitoring our energy use

The data and graphs appearing in this section have been derived from the Auckland Regional Energy-use Database (RED). The RED was developed by the ARC in order to provide detailed data on regional energy consumption, expenditure and associated carbon dioxide emissions. The RED uses volume data that have been obtained from a wide variety of sources. Data quality is considered to be variable, but in many cases, particularly those involving the larger energy quantities, data have been obtained from organisations that are in direct commercial relationships with the end-consumers concerned, so they can be considered accurate and up-to-date. The RED presents consumption and expenditure data by energy type or form (e.g. transport fuels, electricity, gas, LPG, coal and wood) and by major user group (road transport, shipping, trains, aviation, households, commercial and industrial). The RED is unusual in that it records energy-related data by calendar month. This approach was taken so that seasonal variations can be more readily evaluated and any emerging trends can be detected earlier. The most recent issue of the RED includes data for the three-year period from July 2005 to June 2008 and has been used as the information source for this section.

Energy transformation and use

Nearly all of the energy used in the Auckland region comes from somewhere else. The liquid fuels, natural gas, LPG, coal and most electricity are sourced from outside the region's boundaries. There are two large electricity generators in South Auckland (Otahuhu and Southdown), but both of these use natural gas fuel that comes from Taranaki. There is co-generation (generation using waste heat) from the Glenbrook steel mill. A small amount of electricity is generated from local landfill gas and from small hydro plants on water supply dams. The other exception to the region's dependency is the use of wood for domestic fireplaces and wood-burners, much of which is locally sourced.

The region has some potential for renewable electricity generation. This potential includes wind farms, photovoltaic panels, biomass thermal generators, tidal and wave power. At present, only wind and biomass thermal generator technologies have the possibility of sustaining economically viable projects. No renewable electricity generation project is being planned for the region at present.

Pressures: consumption and production

Although the information provided below provides a useful measure of Aucklanders' energy consumption, this cannot be thought of as simply the amount of energy that we use to provide transportation, lighting, cooking, heating and so on. Before reaching us, many forms of energy are transformed from primary energy into more transportable and convenient forms (e.g. geothermal steam is transformed into electricity). Each transformation process results in considerable energy loss (it is estimated that at the national level approximately one third of New Zealand's primary energy is lost, predominantly as waste heat, in transformation processes). Similarly, energy is lost during the transmission of electricity from the point of generation to the point of consumption (as heat from transmission and distribution lines). These losses are not reflected in the following end-use data.

Indicator 18: Current transport energy use

In the year to June 2008 total delivered energy in the region (in all forms) was about 180 PJ. Transportation accounted for about 56 per cent of all energy use in the region, or 101 PJ/year. Of this, road transport used about 57 PJ/year and aviation 38 PJ/year. The balance was mostly used by shipping and a relatively small amount by trains (Figure 11).

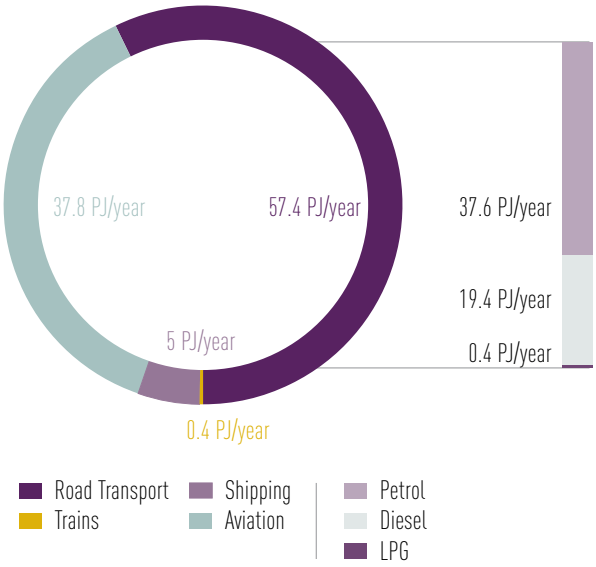

FIGURE 11 Transport energy use by type PJ/year (2008). (Source: ARC).

Indicator 19: Current non-transport energy use

Non-transport energy use in the region in the year to June 2008 was around 79 PJ. It was dominated by electricity (40.4 PJ/year), coal (17.2 PJ/year) and gas (14.8 PJ/year) (Figure 12). The great majority of the coal is used by the New Zealand Steel Ltd. mill at Glenbrook. Wood (Biomass) and LPG are also used by a number of homes for space and water heating. Approximately 70 per cent of all non-transport energy is used by industry and commerce, while the remaining 30 per cent is used by households.

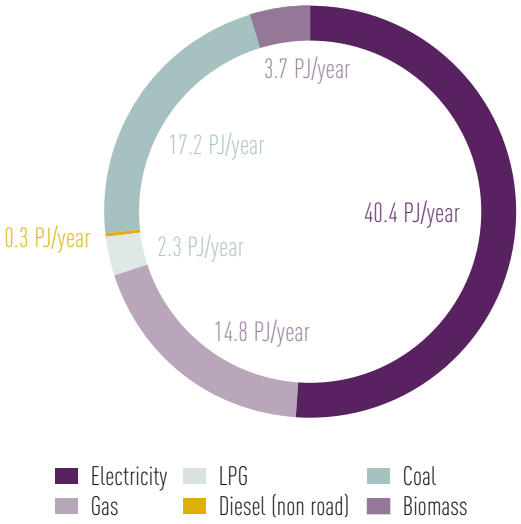

FIGURE 12 Non-transport energy use PJ/year (2008). (Source: ARC).

Indicator 20: Current energy expenditure

In the year to 30 June 2008, the region collectively spent an estimated $3.6 billion on energy for transportation, plus an additional $2.1 billion on non-transport energy (Table 14). The total of this expenditure ($5.7 billion) represents about 10 per cent of Gross Regional Product (GRP).

The breakdown of regional non-transport energy expenditure into the major customer groups is shown in Table 14.

TABLE 14 Non-transport energy sales values and quantities in PJ and $ millions (excluding GST). (Source: ARC).

Year to June 2008	Sale Value ($)	Energy Quantity (P/J)
Industrial	298	33.2
Commercial	808	22.4
Residential	1,017	23.0
Total	**2,123**	**78.6**

3.0

Pressures: consumption and production

Indicator 21: Recent trends in petrol and aviation fuel consumption and prices

Over the three years to June 2008, petrol use has trended slightly upwards at the rate of about 0.4 per cent per year (Figure 13). This increase is significantly below the percentage increases in both population and GRP per person.

Over the same period petrol prices at the pump increased 100 per cent from about $0.90 per litre to about $1.80 per litre. This trend demonstrates that petrol consumption is not very sensitive to price changes – at least in the short term.

The region's second largest use of energy in Auckland is the aviation fuel dispensed at the Auckland International Airport. Usage increase steadily during the eight years to 2004, but it has decreased over the past two years.

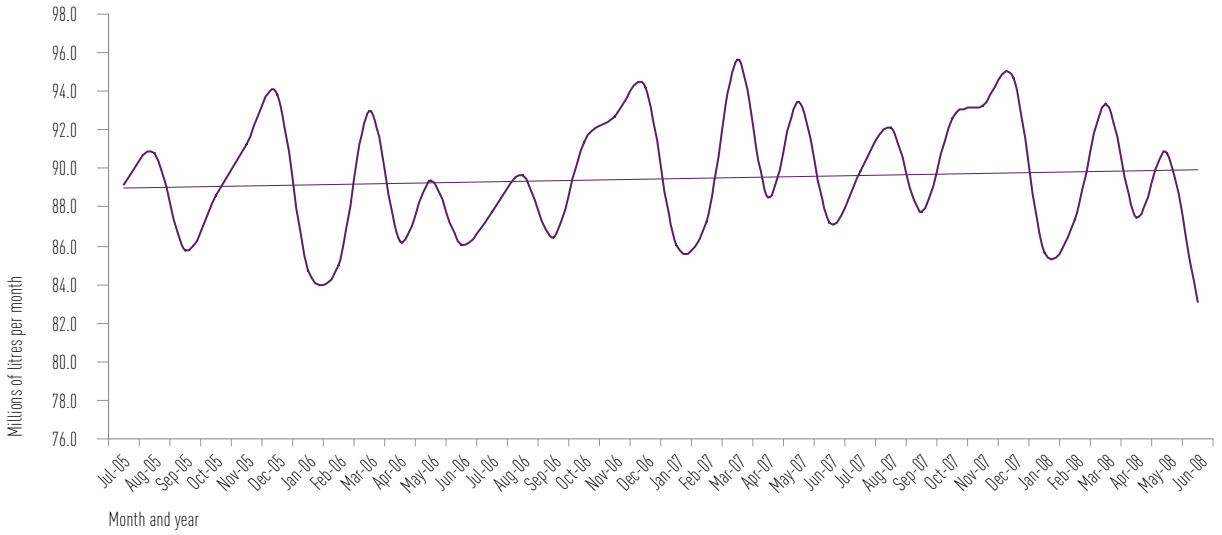

FIGURE 13 Petrol consumption in the Auckland region with trend line between July 2005 and June 2008. (Source: ARC).

Indicator 22: Recent changes in electricity consumption and prices

Total regional electricity consumption has not changed markedly over the past three years. Consumption generally varies from a low of about 750 Gigawatt Hour (GWh) per month over the summer holiday period to a high of about 1,150 GWh per month during winter (Figure 14). The main factors affecting consumption appear to be the summer and winter extremes of temperature. Peak winter demands are driven by household heating requirements and peak summer demands are driven by office building air conditioning demands.

Electricity prices to medium sized residential consumers have increased 60 per cent from 12.7 in 1998 to about 20.8 c/kWh (cents per kilowatt-hour) in 2008. Electricity prices to medium sized commercial and industrial customers have also increased over the past decade, but at a slower rate (20 per cent) than those to residential customers (from around 17 to 20.4 c/kWh). As with petrol consumption, this suggests that overall demand for electricity in the region has not been not particularly sensitive to price increases.

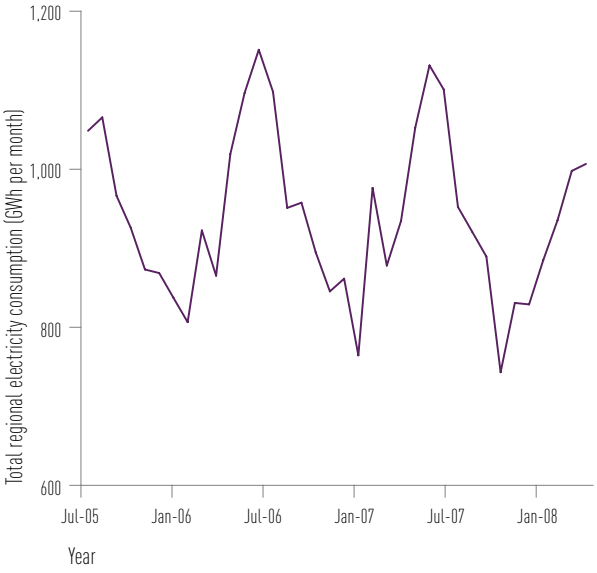

FIGURE 14 Regional electricity consumption (GWh per month) from July 2005 to January 2008. (Source: ARC).

Pressures: consumption and production

Indicator 23: Peak electricity demand

Meeting electricity demand means having enough generation, transmission and distribution capacity to meet the highest (peak) demand. This is because there is no practical way to store electricity in the quantities required.

Transpower Ltd owns and operates New Zealand's high-voltage electricity transmission grid and forecasts peak electricity demand to ensure sufficient capacity is available to meet Auckland's growing needs.

When compared to other regions of New Zealand, the Auckland region has high peak electricity demand, coupled with relatively low local generation. Figure 15 shows the 2009 peak demand forecast for the Auckland region for the next 10 years, indicating that electricity demand is predicted to steadily increase. This will place more pressure on the existing transmission network which will need to be upgraded to meet the demand unless new generation is developed close to Auckland.

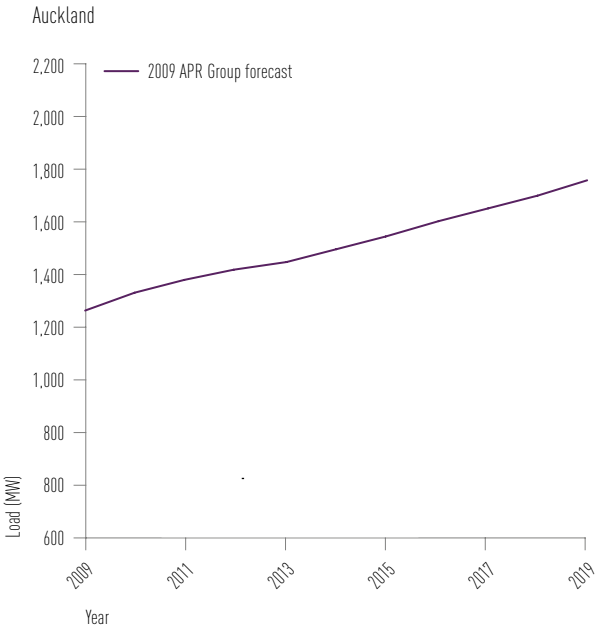

FIGURE 15 Predicted peak electricity demand for the Auckland region 2009 to 2019 (Source: Transpower Ltd).

Implications of energy use

Based on the trends identified above, if no significant energy efficiency gains were to be made, the energy demand of the region would be expected to increase by about 65 per cent by 2031, to reach nearly 300 PJ/year. This large increase seems likely to be moderated to some extent by continuing efficiency gains, lifestyle changes and significant real price increases for energy during the coming decades.

The nature of effects attributable to energy demand is varied. Burning fossil fuels in vehicles, in thermal power stations or as part of industrial processes, results in the release of carbon dioxide into the atmosphere. This has potential consequences for New Zealand's international obligations. It can also result in particulate emissions that have been shown to have negative impacts on human health (see Fine particulates in section 4.5). Other effects that may be felt by other regions due to energy demand in the Auckland region include loss of the natural values of rivers due to hydro development or the loss of landscape quality from wind turbines. Similarly the exploration and development of oil and gas fields have environmental costs and risks that tend to increase with the amount of energy demanded.

It is not just the direct consequences of energy conversion that need to be considered. Major environmental impacts also arise from the infrastructure that is necessary to transport energy to Auckland. Infrastructure such as ports, pipelines, tunnels, fuel storage facilities and transmission lines need to be developed, maintained and periodically upgraded as demand grows. The new electricity transmission line being planned from the central North Island to Otahuhu is an example.

Solid and hazardous wastes

Key findings

- → The annual volume of solid waste sent from Auckland to landfill for disposal has increased by about 320,000 tonnes (about 30 per cent) since 2003/04.
- → Although most of that growth can be attributed to population growth, the amount of solid waste disposal per person increased by 21 per cent over the same five year period, from 0.81 to 0.98 tonnes per year.
- → It is not possible to report recycling data at a regional scale, but data from Auckland councils existing at the time of writing indicates that recycling increased (on a tonnage basis) by 43 per cent in Rodney District and 4.7 per cent in Waitakere City between 2004 and 2008, and increased (on a per person basis) to an impressive 60 per cent in Rodney District and 11 per cent in Waitakere City.
- → Overall, 118,586 tonnes of waste were recycled in the Auckland region (excluding Franklin District) in 2008; this represents 8.6 per cent of the volume of waste going to landfill.

Introduction

Solid waste includes household waste (food and garden wastes), mine and quarry tailings, industrial and commercial waste, and construction and demolition waste.

Typically, solid waste is disposed of in landfills or cleanfills although some industrial, mine and quarry tailings are disposed of onsite. If improperly disposed of, solid waste can pose a risk to human and ecological health, and affect amenity and recreational values.

The amount of solid waste in the Auckland region has increased over time as levels of production and consumption have increased. Waste is a by-product of economic activity and occurs throughout the lifecycle of products, from production through disposal. The Auckland region's economy can be characterised as a 'throughput' economy that takes in significant quantities of raw materials and, in turn, discards them as waste.

However, in recent decades, significant quantities of waste have been removed from the waste stream through recycling, although many potentially useful materials continue to be sent

Pressures: consumption and production

to landfills and cleanfills. For example, it is estimated that (at the national level) food and garden waste, and construction and demolition waste, make up more than 50 per cent of the total landfill waste.

Although recycling can significantly reduce the amount of solid waste, it still requires energy use to transform the recycled materials into useful goods. Recycling has also been hampered by its economic viability, as it is often cheaper to extract raw materials from the ground than to collect and transport recycled materials. Ultimately, re-use is a better option than recycling, as it requires energy only for the delivery of the goods to be re-used.

Indicator 24: Total solid waste to landfills

Table 15 shows the volume of waste sent to landfills in the Auckland region between 1998/99 and 2007/08. Currently, two principal landfills operate within the Auckland region: the Redvale landfill and the Whitford landfill. However, prior to July 2005, the Greenmount landfill also received waste and the closure of this site is the primary reason for the fall in waste sent to Auckland landfills around 2005/06.

Importantly, some of the waste received by landfills in the Auckland region is generated outside the region, while a proportion of the waste generated within the Auckland region is sent outside the Auckland region for disposal. This means that the volume of waste received by Auckland's landfills is not, by itself, a full measure of the pressure generated by solid waste from Auckland households and businesses. Consequently, Table 15 is an estimate of the solid waste sent to landfills that is generated solely by households and businesses in the Auckland region.

These figures include waste sent to the Hampton Downs landfill in north Waikato. Although this landfill is outside the Auckland region, it was intended to replace the Greenmount landfill and serves both the Waikato and Auckland populations. Between 2003/04 and 2007/08, the estimated amount of waste sent to landfills from the Auckland region increased by about 320,000 tonnes (a five year growth rate of 30 per cent). Although much of this can be attributed to population growth, it is important to note that the amount of waste per person has increased from 0.83 tonnes per person in 1998/99 to 0.98 tonnes per person in 2007/08.

TABLE 15 Solid waste sent to landfill, 1998/98 to 2007/08. (Source: ARC).

Year	Waste sent to Auckland region's landfills (tonnes)	Waste from the Auckland region sent to landfills (tonnes)	Waste from the Auckland region sent to landfills (tonnes/ person)
1998/99	992,000	969,331	0.83
1999/00	937,941	911,414	0.77
2000/01	968,096	915,290	0.76
2001/02	909,428	881,221	0.72
2002/03	1,020,892	1,002,121	0.80
2003/04	1,057,015	1,049,776	0.81
2004/05	1,208,238	1,189,720	0.90
2005/06	900,888	1,215,369	0.90
2006/07	977,531	1,440,217	1.05
2007/08	976,432	1,370,044	0.98

Indicator 25: Total recycling by type of waste

Table 16 summarises the volume of solid waste that was recycled by type of waste and by territorial authority between 2004 and 2008 (excluding Franklin District for whom no data was available). The incomplete data mean that it is not possible to report on the Auckland region, as a whole, over this five year period.

Table 16 does not provide comprehensive data, as it shows only the volumes of recycled waste recorded by Auckland councils in existence at the time of writing. Some commercial waste recycling operations are not included. Nevertheless, it is clear that the volumes of recycled domestic waste in the Auckland region have increased over time. The volume varies by council, with Rodney District Council recording the largest growth (60 per cent) and Waitakere City Council the lowest growth (11 per cent). Generally, this variability in growth reflects the different positions of the councils in 2004: e.g. Rodney residents were recycling only 65 kilograms per person per year in 2004 whereas Waitakere residents were recycling 85 kgs. All territorial authorities recorded increases in the weight of recycled material per person over the five year period; this indicates that the growth in tonnage of recycled materials cannot be attributed solely to population growth.

Box 3 Marine litter

Solid waste reaches the marine environment in a number of ways but is often washed down stormwater drains after heavy rain or simply blown into the sea. Typically, plastic bottles, drink caps and plastic bags enter the marine environment in this way. Polystyrene is another type of marine litter and usually comes from construction sites, commercial and industrial sites near streams, or insecure rubbish loads on vehicles. Other types of solid waste (such as used tyres) also enter the marine environment due to deliberate dumping into estuaries or rivers, and as discarded material from vessels.

There is no data available on the volume of solid waste entering the marine environment in the Auckland region, although Chapter 4.6 reports on the volume of marine litter collected from the Waitemata Harbour.

Pressures: consumption and production

TABLE 16 Recycled waste by type and territorial authority (excluding Franklin District), 2004-08.
(Source: Territorial authorities' recycling records).

Year	Waste Type	Volume of Waste Recycled (tonnes)						
		Rodney District	North Shore City	Waitakere City	Auckland City	Manukau City	Papakura District	Franklin District
2004	Plastic	261	*	*	1,683	920	154	*
	Glass	1,792	*	*	11,764	6,220	1,045	*
	Aluminium	12	*	*	85	44	7	*
	Steel	124	*	*	810	441	74	*
	Total Non-paper Recycling	2,189	*	6,903	14,342	7,625	1,281	*
	Paper/cardboard	3,437	*	9,177	23,007	9,317	1,514	*
	Total Recycling	5,626	*	16,080	37,349	16,942	2,795	*
	Total Population	87,200	210,300	189,600	419,300	330,700	45,200	57,900
	Recycling per capita (kg/person)	65	*	85	89	51	62	*
2005	Plastic	352	810	*	1,777	993	168	*
	Glass	2,483	6,114	*	12,822	6,881	1,166	*
	Aluminium	20	117	*	102	55	9	*
	Steel	160	581	*	821	455	77	*
	Total Non-paper Recycling	3,015	7,622	6,758	15,522	8,384	1,420	*
	Paper/cardboard	3,814	13,708	6,281	23,683	10,596	1,593	*
	Total Recycling	6,829	21,329	13,039	39,205	18,980	3,013	*
	Total Population	89,900	213,500	192,300	423,600	338,900	46,000	59,300
	Recycling per capita (kg/person)	76	100	68	93	56	65	*
2006	Plastic	476	1,091	*	1,877	1,019	176	*
	Glass	3,482	6,483	*	14,098	7,446	1,291	*
	Aluminium	30	154	*	125	65	11	*
	Steel	205	604	*	810	439	76	*
	Total Non-paper Recycling	4,193	8,332	8,774	16,910	8,969	1,555	*
	Paper/cardboard	4,587	14,094	7,671	23,864	11,079	1,756	*
	Total Recycling	8,780	22,426	16,445	40,774	20,048	3,311	*
	Total Population	92,400	216,900	195,300	428,300	347,100	46,900	60,900
	Recycling per capita (kg/person)	95	103	84	95	58	71	*
2007	Plastic	547	1,543	*	1,902	1,142	218	*
	Glass	3,978	8,588	*	14,712	8,287	1,591	*
	Aluminium	35	126	*	130	75	14	*
	Steel	214	625	*	774	448	86	*
	Total Non-paper Recycling	4,774	10,883	9,613	17,518	9,952	1,909	*
	Paper/cardboard	4,398	13,708	7,462	23,263	10,636	1,827	*
	Total Recycling	9,172	24,590	17,075	40,781	20,588	3,735	*
	Total Population	94,700	220,200	198,400	433,200	354,800	47,700	62,200
	Recycling per capita (kg/person)	97	112	86	94	58	78	*
2008	Plastic	583	1,281	*	1,901	1,302	225	*
	Glass	3,692	8,167	*	16,090	9,093	1,591	*
	Aluminium	46	111	*	175	103	18	*
	Steel	237	661	*	898	530	92	*
	Total Non-paper Recycling	4,558	10,220	10,513	19,064	11,028	1,925	*
	Paper/cardboard	4,450	14,094	7,412	23,231	10,218	1,873	*
	Total Recycling	9,008	24,314	17,925	42,295	21,246	3,798	*
	Total Population	96,400	223,000	201,300	438,100	361,900	48,300	63,200
	Recycling per capita (kg/person)	93	109	89	97	59	79	*

* No data available

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Pressures: consumption and production

Generally, about half of the total volume of recycled waste in the Auckland region is paper and cardboard. However, this proportion has declined over time, with growth in other types of recycled waste, particularly glass, being recorded.

In 2008, 118,586 tonnes of material were recycled: this represents 8.6 per cent of the volume of waste sent to landfill that year.

Implications of solid waste

The increasing amount of solid waste being generated in the Auckland region (despite the growing rate of recycling) has several environmental implications. At the broadest level, it is symptomatic of the amount of products that are being consumed and discarded.

Solid waste must be disposed of in large, well-designed landfill facilities. Finding suitable sites for such facilities in the Auckland region is difficult, due to the required size of the site and the need to locate it away from sensitive land uses. As the amount of solid waste generation grows, more landfill space is required. These spaces are likely to be found farther and farther away from Auckland, meaning that the solid waste has to be transported greater distances (thereby increasing the environmental impacts associated with transport).

Although disposing of solid waste in landfills removes it from sight, the solid waste remains. When a landfill is filled and closed, it becomes a large contaminated site that requires ongoing management and is limited in terms of future land uses. Even modern well designed landfills, if not properly managed, can result in leachate entering surface water and groundwater. Gases (including the greenhouse gas, methane, associated with the anaerobic breakdown of organic waste) are also produced.

Box 4 Hazardous wastes

Hazardous wastes are those that may damage human health or the environment if they are not properly disposed of. They include household and garden chemicals, paints, solvents, adhesives, petroleum products, batteries and electronic equipment. Liquids often form a high proportion of hazardous wastes and, although the practice is highly undesirable, it is likely that they are often disposed of through the sewerage system. The bulk of the remaining types of hazardous waste are exported offshore for disposal.

Hazardous waste production and disposal is not well understood. Comprehensive data on the total volumes of hazardous waste produced within the Auckland region are unavailable. Collecting such data is also complicated because of the difficulty in classifying wastes as hazardous or non-hazardous.

It is known that the Hazmobile, a free hazardous waste disposal service for Auckland regional residents, collected 242,740 kg of hazardous waste from 8,216 customers at 17 separate collections in the year ending September 2009.

The amount of solid waste going to landfill is only one issue. Solid waste that is improperly disposed of – through illegal dumping, inappropriate storage or, at the minor scale, through littering – is also problematic. It is this type of solid waste that poses the greatest risk to the environment and ecosystems, and has the greatest impact on the scenic values of the Auckland region.

Liquid wastes

Key findings

- → There were 2,479 recorded wet weather stormwater overflow events in 2008, with the majority occurring in combined sewers.
- → Modelling shows that, on a per hectare basis, land used for business activities in the Auckland region generates more suspended sediment, zinc, copper and *Enterococci* bacteria than residential land. However, residential land contributes a larger overall tonnage of suspended sediment into the stormwater networks due to its sheer extent.
- → Modelling of the middle Waitemata Harbour catchment predicts that 126.7 tonnes per km^2 ($t/km^{2)}$ of sediment from the Henderson subcatchment, and 24.4 t/km^2 from the Whau subcatchment, will enter the Waitemata Harbour in 2009.
- → Modelling of the Pahurehure catchment predicts that 34 t/km^2 of sediment from the Papatoetoe/Puhinui subcatchment, and 4.9 t/km^2 of sediment from the Papakura stream, will enter the Pahurehure inlet in the Manukau Harbour in 2009.
- → 133 million m^3 of wastewater is treated in the Auckland region each year. The largest discharges of treated wastewater come from Watercare's Mangere plant (330,000 m^3 per day) and North Shore City's Rosedale plant (54,000 m^3 per day).
- → Liquid wastes from agricultural production continue to degrade streams in rural areas of the Auckland region.

Introduction

The quality of the water within aquatic environments of the Auckland region is subject to a variety of environmental pressures. Some of these arise from the discharge of liquid wastes carrying bacteria, nutrients, sediments, chemicals and other waste products.

The type and extent of these pressures are strongly related to land use and arise in both urban and rural areas.

Pressures: consumption and production

Monitoring liquid wastes

It is not possible to physically monitor stormwater directly, so the volume and contaminant load of stormwater is estimated using models based on land use, area and rainfall. This information tells us where the main stormwater contaminant sources are located and enables us to target our responses accordingly.

Data on wastewater discharges (consented discharge of treated wastes and the incidence of untreated overflows) are collected and reported by the water industry, through the Auckland Water Group.

The impact of liquid waste discharges is measured indirectly through our State of the Environment monitoring programmes. The water and ecological quality of aquatic systems are measured at sites around the Auckland region and can be used to demonstrate impacts related to liquid waste.

Reported pollution events are currently recorded by the ARC's Harbourmaster office (specifically in the marine environment) and, more generally, by the council's Pollution Response Team.

Wastewater and stormwater

'Wastewater' is the sewage and grey water from showers, laundry and industrial waste for treatment and disposal. It poses a public health risk due to the presence of bacteria and pathogens. If it enters a stream, it can cause severe environmental impacts due to its high biochemical oxygen demand (BOD).

'Stormwater' is the water that runs off impervious surfaces such as buildings, roofs, roads and carparks after rainfall.

The urban parts of the Auckland region are served by stormwater and wastewater networks.

Indicator 26: Stormwater and wastewater network overflows

The stormwater network is a collection of pipes, open channels, overland flows and rivers. Stormwater is collected by this network and gravity-fed to the marine environment.

The wastewater network is a collection of pipes and pumping stations that conveys wastewater to treatment plants. In most instances, wastewater is discharged to the marine environment following appropriate treatment. Untreated wastewater may also enter the freshwater and marine environments during accidental overflows.

The stormwater and wastewater networks are critical because they remove unsanitary wastes and ensure that people and property are protected from flooding and other hazards.

The trunk of the wastewater network throughout much of urbanised Auckland is owned and operated by Watercare Services Ltd, a company that is owned by the city and district councils of the Auckland region. Most of the local wastewater networks feed into this trunk network and the wastewater is conveyed to the Mangere Wastewater Treatment Plant (also owned by Watercare Services Ltd).

The local wastewater networks are owned and operated by individual city and district councils or water companies (Metrowater Ltd in Auckland City and Manukau Water Ltd in Manukau City). In Papakura, the privately owned United Networks Ltd manages the Papakura network under contract to the council. The Rosedale Wastewater Treatment Plant and the network that services this area are both owned and operated by North Shore City Council.

Ideally, the stormwater and wastewater networks are completely separate and flows from each are treated appropriately (according to the types of contaminants they contain) before being discharged into the marine environment. However, in the older parts of the Auckland isthmus, the networks are combined.

Combined sewers carry both wastewater (sewage) and stormwater in the same pipe. Although combined sewers flow to the Mangere Wastewater Treatment Plant, they cannot cope with large inflows of stormwater and, during heavy rain, can overflow at designated 'relief overflow' points. These relief overflow points usually channel the overflow into local streams and from there to the coast. When these wet weather overflows occur, some beaches become unsafe for swimming (see Bathing beach water quality on page xx).

Combined sewers represent only about 9 per cent of the total wastewater network. However, contamination of the freshwater and marine environments can also result from the other 91 per cent of the network that is not combined, due to infiltration and exfiltration.

Infiltration occurs when stormwater or groundwater infiltrates the wastewater network through illegal connections or faults in pipes, and can cause wastewater to overflow into streams and the marine environment. Overflows may occur at the designated relief overflow points or in less controlled ways, through gully traps and manholes.

Exfiltration occurs when wastewater leaks from wastewater pipes (not from designated relief overflow points or manholes) and enters the groundwater and/or stormwater network, which then discharges untreated wastewater into streams or directly to the coast.

Dry weather overflows are not related to rainfall and can occur as a result of blockages caused by foreign matter (such as tree roots or silt entering pipes) and mechanical or electrical failure of pumping stations. On average, there were 232 dry weather overflows events each year in the Auckland region between 2004 and 2008.

Quantitative data on the overall incidence and volume of contaminants from overflow events is patchy because not all overflow events are recorded. For the financial year ending 2009, nine wastewater service providers submitted data on the number of wet weather overflow events to the Auckland Water Group (Table 17). The total number of events recorded was 2,479, with the majority occurring in combined sewers.

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Pressures: consumption and production

TABLE 17 Wet weather overflow events, by wastewater service provider, financial year ending 2009. (Source: Auckland Water Group 2009).

Service provider	Type of network	Wet weather overflow events
Auckland City	Combined	2,040
Metrowater	Separate	*
Manukau Water	Separate	4
North Shore City	Separate	9
Waitakere City	Separate	8
Rodney District	Separate	38
United Water	Separate	1
Franklin District	Separate	8
Watercare Services	Separate	52
Watercare Services	Combined	320
Total		**2,479**

* No data submitted

Indicator 27: Contaminant loads in stormwater discharges

In most new subdivisions, the runoff from impervious surfaces has to be treated to manage stormwater quality and quantity through the use of design features such as sand filters, rain gardens, or swale and pond systems. However, most inflows into the stormwater network receive little prior treatment because most established urban areas do not have these design features. This means that most discharges from the stormwater networks find their way into the streams and the marine environment while carrying a considerable contaminant load.

In this report, stormwater discharges are estimated by the quantity of contaminants within stormwater that drains from the residential and business areas within a catchment (business land use includes industrial and commercial land use). Collectively, business and residential land uses are a sub-section of urban land uses.

On a per hectare basis, business land use releases more suspended sediment, zinc, copper and *Enterococci* bacteria into the stormwater networks than residential land use (Table 18).

TABLE 18 Modelled yields of stormwater contaminants from two different types of land use. (Source: ARC).

Land use	Total suspended sediment (kg per hectare per year)	Total zinc (kg per hectare per year)	Total copper (kg per hectare per year)	*Enterococci* (number per hectare per year)
Business	642	6.56	0.28	1.06×10^{12}
Residential	595	0.68	0.08	2.96×10^{9}

These modelled yields are used when calculating the total loads for each type of land use shown in Table 19.

Pressures: consumption and production

However, residential land contributes a larger overall tonnage of suspended sediment to the stormwater networks due to the sheer extent of residential land across the Auckland region (Table 18 and 19).

The contaminant loads within stormwater runoff have not been measured in real time but have been estimated, using models, for two main subcatchments: the middle Waitemata Harbour and Pahurehure in the south-east Manukau Harbour (Figure 16).

TABLE 19 Modelled yields of stormwater contaminants from differing types of land use in the seven local authorities. (Source: ARC).

*Local Authority	Land use	Area (hectares)	Total suspended sediment	Total zinc	Total copper	*Enterococci*
			Total load (tonnes yr^{-1})	Total load (tonnes yr^{-1})	Total load (tonnes yr^{-1})	Total load (tonnes yr^{-1})
Auckland City	Business	2,224	1,428	15	0.6	2.36×10^{15}
	Residential	8,160	4,855	6	0.6	2.42×10^{13}
North Shore City	Business	7,88	506	5	0.2	8.34×10^{14}
	Residential	5,849	3,480	4	0.5	1.73×10^{13}
Manukau City	Business	2,470	1,586	16	0.7	2.62×10^{15}
	Residential	7,184	4,274	5	0.6	2.13×10^{13}
Waitakere City	Business	575	369	4	0.2	6.09×10^{14}
	Residential	5,652	3,363	4	0.4	1.67×10^{13}
Rodney District	Business	380	244	2	0.1	4.02×10^{14}
	Residential	3,507	2,087	2	0.3	1.04×10^{13}
Papakura District	Business	738	474	5	0.2	7.82×10^{14}
	Residential	1,376	819	1	0.1	4.07×10^{12}
Franklin District	Business	616	395	4	0.2	6.52×10^{14}
	Residential	1,475	878	1	0.1	4.37×10^{12}

* Local authorities existing at the time of writing.

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Pressures: consumption and production

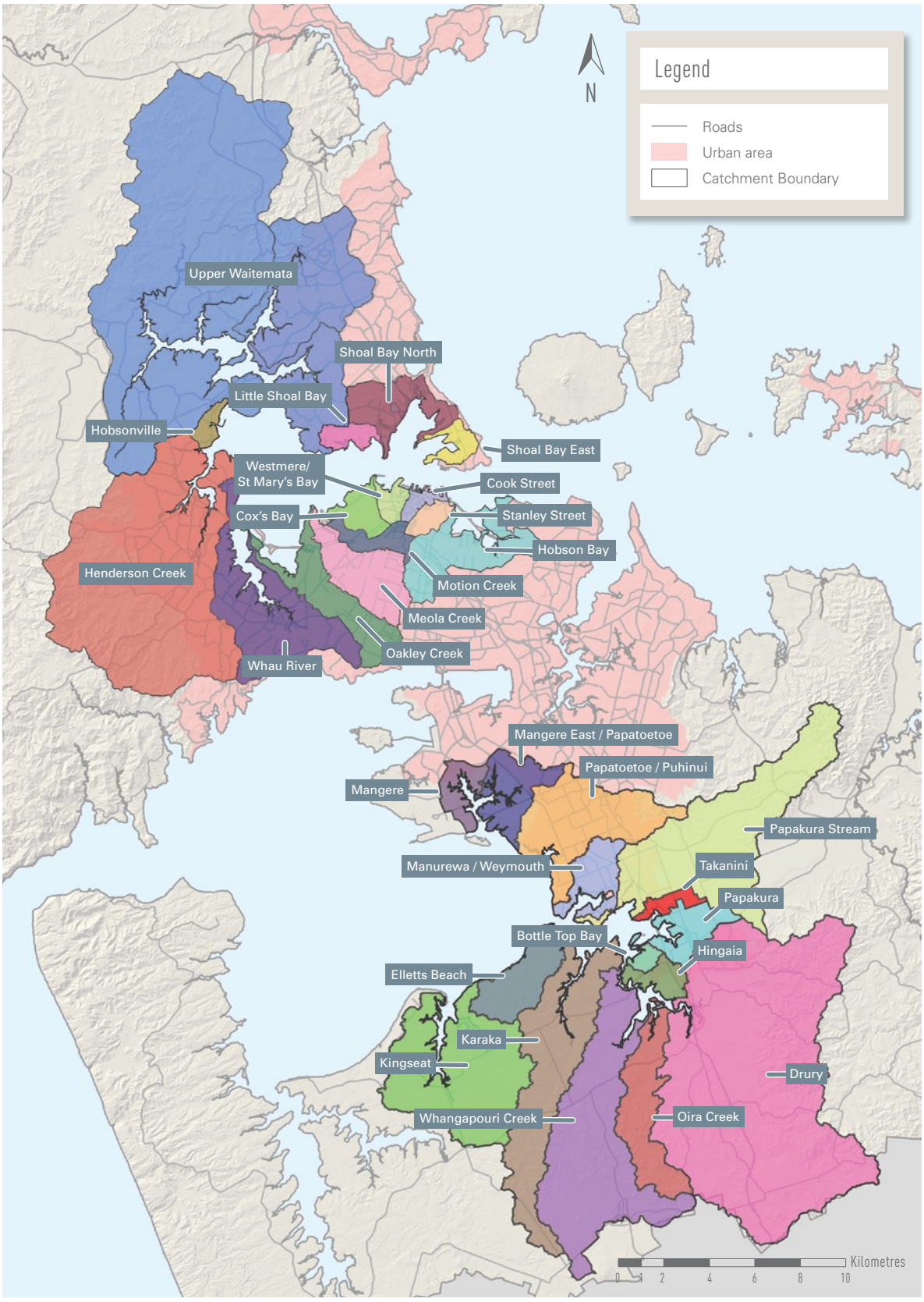

FIGURE 16 Location and extent of the middle Waitemata Harbour subcatchments and Pahurehure subcatchments in the south-east Manukau Harbour. (Source: ARC).

Pressures: consumption and production

The modelling suggests that during the 2009 calendar year, substantial quantities of sediment (126.7 and 27.4 t/km^2) will enter the Waitemata Harbour from the Henderson and Whau subcatchments respectively (Table 20). For information on the estimated sediment yields in some other catchments in the Auckland region, see Sediment in Chapter 4.2.

These two subcatchments are predicted to contribute the highest loads of zinc and copper in comparison to all the other subcatchments within the Waitemata Harbour catchment area (Table 20).

The levels of contaminant loads from each subcatchment reflect the types of land use, e.g. the Whau subcatchment has greater industrial and commercial land use.

TABLE 20 Predicted contaminant loads (t/km^2) from each subcatchment within the middle Waitemata Harbour for the 2009 calendar year. (Source: ARC).

Subcatchment	Predicted loads (t/km^2)		
	Suspended sediment	Total zinc	Total copper
	2009	2009	2009
Hobson Bay	12.399	0.020	0.003
Stanley Street	3.162	0.008	0.001
Cook Street	1.359	0.005	0.001
Westmere/St Marys Bay	2.890	0.011	0.001
Cox's Bay	2.841	0.006	0.001
Motions Creek	3.582	0.012	0.001
Meola Creek	5.953	0.011	0.001
Oakley Creek	11.609	0.030	0.003
Whau River	27.466	0.052	0.006
Henderson Creek	126.736	0.074	0.009
Hobsonville	3.236	0.004	0.001
Upper Waitemata			
Little Shoal Bay	3.606	0.005	0.001
Shoal Bay, North	12.227	0.021	0.003
Shoal Bay, East	3.186	0.006	0.001

Predominantly urban Mixed urban/rural Not available

3.0

Pressures: consumption and production

For the Pahurehure subcatchments, large quantities of sediments (47 and 34 tonnes per km^2) are predicted to discharge from the Papakura Stream and the Papatoetoe/Puhinui subcatchments respectively (Table 21). The highest amounts of zinc are predicted to come from the Karaka and Kingseat subcatchments (0.049 and approximately 0.054 tonnes per km^2 respectively). The highest amount of copper is predicted to come from the Kingseat subcatchment (0.011 tonnes per km^2).

Potentially, these elevated loads result from the Papakura Stream subcatchment being highly urbanised whereas the Papatoetoe/Puhinui subcatchment is dominated by industrial and commercial land uses. The Kingseat and Karaka subcatchments are predominantly used for agriculture (see Rural land use change on page 44).

TABLE 21 Predicted contaminant loads (t/km^2) from each subcatchment within the Pahurehure subcatchment of the south-east Manukau Harbour for the 2009 calendar year. (Source: ARC).

Subcatchment	Predicted loads (t/km^2)		
	Suspended sediment	Total zinc	Total copper
	2009	2009	2009
Kingseat	15.759	0.054	0.011
Elletts Beach	11.090	0.038	0.008
Karaka	14.054	0.049	0.010
Whangapouri Creek	4.372	0.006	0.001
Oira Creek	6.027	0.021	0.004
Drury	9.584	0.014	0.001
Hingaia	2.050	0.001	0.000
Papakura	4.989	0.011	0.001
Takanini	1.260	0.003	0.000
Papakura Stream	47.152	0.013	0.002
Manurewa/Weymouth	10.053	0.007	0.001
Papatoetoe/Puhinui	34.037	0.036	0.005
Mangere East/Papatoetoe	16.747	0.008	0.001
Mangere	1.062	0.001	0.000
Bottle Top Bay	0.395	0.001	0.000

Predominantly urban Mixed urban/rural Predominantly rural

Pressures: consumption and production

Indicator 28: Wastewater discharges

Around 133 million m^3 of wastewater are treated annually in the Auckland region: 104 million m^3 (78 per cent) are treated by Watercare Services Ltd at the Mangere Wastewater Treatment Plant and another 21 million m^3 (16 per cent) are treated at the Rosedale Treatment Plant on the North Shore. The remainder is treated at smaller plants throughout the Auckland region such as those at Drury, Beachlands-Maraetai, Waiheke Island and Warkworth.

The average daily flow of wastewater into treatment plants in the Auckland region is about 290 litres per person per day. This includes stormwater from combined sewers and groundwater infiltration into pipes.

The Mangere Wastewater Treatment Plant discharges 330,000 m^3/day of treated effluent. The quality of the effluent has improved dramatically due to improvements to the treatment process, and the decommissioning of the treatment ponds at Mangere in 2002. These improvements have led to reductions in:

- → nitrogen (from 9 tonnes/day in 1999 to 0.8 tonnes/day in 2008)
- → total phosphorus (from 2.2 tonnes/day in 1999 to 1.6 tonnes/day in 2008)
- → the median number of faecal coliform bacteria (from 18,000/ml in 1999 to 719/ml in 2008).

The improvements in effluent quality are reflected in the coastal water quality monitoring programme undertaken in the Manukau Harbour (see Indicator 1 in Chapter 4.4 page 185).

The North Shore plant discharges 54,000 m^3/day of treated effluent. The quality of this effluent has also improved in recent years due to a major upgrade of the facility: in particular, the UV treatment of wastewater that was introduced in 2004 has dramatically reduced the amount of microbial contaminants.

A new outfall that will discharge treated effluent 2.8km off the Mairangi Bay coastline is currently under construction. This will replace the existing 45 year old outfall 600m off Kennedy Park.

Rural discharges

In some rural parts of the Auckland region, the rivers are subject to a range of environmental pressures from liquid wastes resulting from agricultural production. The greatest contributors to water degradation are:

- → nutrient-rich point source discharges from dairy farming operations and intensive farming (such as piggeries, poultry farms and glasshouse-based horticulture)
- → sediment-laden discharges from cultivated land (market gardening)
- → diffuse discharges of nutrients and sediment associated with livestock farming (particularly discharges associated with stock effluent, fertiliser application and livestock in rivers),
- → contaminants associated with the leaching of herbicides and pesticides through soil.

Box 5 Dairy shed wastes and other farm discharges

Dairy farms use large volumes of water for washing down dairy sheds, machinery and yards after milking to clear away effluent. This untreated wastewater (known as wash water) has a high Biochemical Oxygen Demand (BOD) and elevated levels of nitrogen and phosphorus. It also contains microbial contaminants and suspended solids.

Many dairy farms also generate large volumes of dairy sludge (the accumulated organic solids from dairy oxidation ponds, barrier ditches and storage ponds). Dairy sludge needs to be disposed of as part of normal dairy operations but, like wash water, contains high levels of nutrients that can have significant adverse impacts on freshwater.

Other sources of farm discharges that arise from dairy and livestock operations include feedlots/hard stand areas, silage pits, offal holes and wintering barns.

Indicator 29: Fertilisers

Fertiliser applications to agricultural land within the Auckland region have shown both positive and negative trends between 2002 and 2007 (Table 22).

On the negative side, application rates of nitrogen-containing fertilisers are estimated to have increased by about 3 kg/hectare for urea and 5 kg/hectare for all other nitrogen fertilisers. There has also been a substantial increase in the number of hectares sprayed with effluent.

On the positive side, the application rates for ammonium phosphate, other phosphatic fertilisers, diammonium phosphate (DAP) and lime decreased over the same period by 1, 3, 4 and 23 kg/hectare respectively. In line with national trends, there has also been a substantial decline in the application rate of potassic fertilisers.

3.0

Pressures: consumption and production

TABLE 22 Annual fertiliser use (kg/hectare) in the Auckland region in 2002 and 2007. (Source: Statistics New Zealand: Agricultural Production Survey, 2002 and 2007).

	Urea	Diammonium phosphate	Ammonium sulphate	Lime	All other nitrogen containing fertilisers	All other phosphatic fertilisers	All potassic fertilisers	Hectares sprayed with effluent
2002	29	16	5	281	36	138	56	5,291
2007	32	12	4	258	41	135	24	7,633
Change 2002-07	3	-4	-1	-23	5	-3	-32	2,342
% change 2002-07	8.7	-22.9	-21.3	-8.0	14.0	-2.2	-57.5	44.3

Marine discharges

In addition to the contaminants discharged from rural and urban land use activities, some contaminants such as oil and fuel are discharged directly to the marine environment, mainly from shipping activities.

Indicator 30: Marine pollution

The number of marine pollution events is shown in Table 23. The large increase in volume in 2008 was due to four commercial oil spills in the port area. These released a total of 3,100 litres of hydrocarbons, ranging from thick heavy fuel oil to light diesel, into the Waitemata Harbour.

TABLE 23 Number of recorded oil spill events in marine waters immediately surrounding the Auckland region, and volumes discharged, 2005-08. (Source: ARC).

	2005	2006	2007	2008
Number of events	4	8	9	22
Estimated volume	451	1,671	1,195	3,616

Implications of liquid waste

Point source discharges

When stormwater is flushed into the marine environment, contaminants in the stormwater can cause adverse effects on marine life in many different ways. For example, suspended sediment reduces the amount of light transmitted through the water, clogs fish gills, affects filter-feeding shellfish, smothers organisms on the seabed and changes habitats. When sediment starts to fill up estuaries and harbours, it affects their ecological, recreational and amenity values.

Sediment in freshwater has a similar environmental impact. High levels of suspended sediment can be lethal to fish and invertebrates but these levels are rare in the Auckland region. Instead, the effects from lower concentrations are more prevalent, particularly the decreased levels of light that reduce photosynthesis and primary production (plant and algal growth). This can have wide-reaching consequences for the food chain in freshwater environments. Suspended sediment also reduces the visual range of sighted organisms and affects the foraging ability of fish predators. Migrating fish may be discouraged from entering streams that are made turbid by suspended sediment. This is particularly important because 70 per cent of New Zealand's freshwater fish species migrate to and from the sea to complete their lifecycles.

Heavy metals have wide-ranging environmental effects and have been associated with interfering in the development and function of reproductive, endocrine, immune and nervous systems in animals – including humans. Heavy metals can affect the food chain by reducing the number and diversity of organisms in aquatic environments. Heavy metals are not broken down (or are broken down so slowly that they are, effectively, permanent) so they accumulate in organisms. Some can biomagnify in food chains, meaning that carnivores at the top of the food chain, such as birds and mammals (including humans), can absorb heavy metals by eating contaminated food, especially shellfish and fish. Mercury, cadmium and lead pose the most widespread threat for human health.

Overflows of the stormwater network (particularly combined sewers) and many rural discharges result in organic pollution. As this organic material decomposes, it can use up the dissolved oxygen in the water at a greater rate than it can be replenished, causing oxygen depletion. This has severe consequences for aquatic organisms. Organic wastes from humans and animals can also contain bacteria and viruses that can cause disease. When overflows that contain this type of microbial contamination discharge at the coast they can make beaches temporarily unsuitable for swimming.

Pressures: consumption and production

Non-point source discharges

A number of compounds and elements may, at times, limit primary productivity in freshwater systems but it is only high levels of nitrogen and phosphorus compounds that lead to nuisance growths of algae and plants.

Nitrogen and phosphorus are essential nutrients for all living organisms and in the majority of lakes and rivers, phosphorus is normally the limiting nutrient for plants and algae. Consequently, an increase in phosphorus often results in an increase in primary productivity. However, nitrogen can be the limiting nutrient in some freshwaters and where this occurs, increases in nitrogen can lead to increases in primary productivity. As a result, elevated levels of these two nutrients (known as eutrophication) lead to more frequent nuisance growths of algae and plants.

In addition, under nitrogen limiting conditions, some cyanobacteria (blue-green algae) can obtain nitrogen directly from the atmosphere and continue to grow. Under these conditions, cyanobacteria can occur at very high levels because they out-compete other types of algae. This can cause problems because some cyanobacteria can produce chemicals that are toxic to mammals.

Air pollution

Key findings

- → The urban area represents only 10 per cent of the total land in the Auckland region but contributes most of the total regional emissions for each air pollutant.
- → Transport is responsible for 47 per cent of all PM_{10} particulate emissions, 83 per cent of NO_x, 85 per cent of CO, 52 per cent of Volatile Organic Compounds (VOCs), 65 per cent of SO_2 and 48 per cent of CO_2. Motor vehicles are responsible for the vast majority of transport-related emissions.
- → Home heating is the second largest source of PM_{10} particulates and CO as the result of burning wood and coal. Solid fuel is burnt in 29 per cent of Auckland households.
- → Industrial sources are the second biggest source of other contaminants discharged into the air.

Introduction

A vast number of daily activities, including many that are taken for granted such as driving cars and heating homes, release contaminants that place pressure on the environment and, in particular, the air quality.

Air pollutants can contain a range of chemicals and fine particulates from various origins. Many of these substances, especially when produced in sufficient quantities or concentrations, are potentially harmful to human health and the quality of life, as well as to plants, animals and their ecosystems. There is also an impact on amenity values when the air quality deteriorates: brown haze or smog becomes a regular and persistent reminder of air pollution.

The most significant pressures on air quality within the Auckland region result from the burning of fuels (such as diesel, petrol, wood, gas and oil), home heating appliances and industrial processes.

A variety of other sources, including rubbish and garden waste incineration, decomposing landfill waste, quarries and other mineral extraction activities, industrial and household chemicals, and biogenic (natural) sources such as pollens, bush fires, volcanoes and sea salt also contribute to poor air quality.

Sources of air pollution

The ARC currently maintains the Auckland Air Emissions Inventory. It was first developed in 1993 and was updated in 1998 and 2004.

The inventory estimates the emissions to air in the Auckland region with an emphasis on key ambient air pollutants including fine particulates (PM_{10}), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), sulphur dioxide (SO_2) and carbon dioxide (CO_2). See Chapter 4.1 for a description of these pollutants.

The inventory considers emissions from four major sectors: transport, domestic, industry and biogenic.

Due to progressive improvements in the methodology used to prepare the inventory, data from earlier years is not comparable with the current data so trend analysis is not possible.

Indicator 31: Emissions by sector

In terms of the pollutants measured by the inventory, transport is the single greatest contributor to emissions (Table 24). In 2004 it was responsible for 47 per cent of all PM_{10} particulate emissions, 83 per cent of NO_x, 85 per cent of CO, 52 per cent of VOCs, 65 per cent of SO_2 and 48 per cent of CO_2.

Industry is the second largest source of emissions for each pollutant type (except PM_{10} particulates and CO, where domestic wood burning is a major source of emissions).

3.0

Pressures: consumption and production

TABLE 24 Emissions by source kilometres per year (kt/yr), 2004. (Source: ARC).

Category/source	CO	NO	SO_2	PM_{10}	VOC	CO_2
Domestic						
Coal combustion	0.91	0.01	0.10	0.33	0.16	27.80
Lawn mowing	3.05	0.02	0.00	0.01	0.63	4.60
Natural gas and LPG use	0.03	0.09	0.00	0.02	0.01	136.80
Outdoor burning	0.55	0.04	0.01	0.10	0.20	22.20
Wood	18.02	0.11	0.04	1.86	5.15	310.90
Sub-total	**22.56**	**0.27**	**0.14**	**2.33**	**6.15**	**502.30**
Industry						
Solvent use**	0.00	0.00	0.00	0.00	4.40	0.00
Dry cleaning	0.00	0.00	0.00	0.00	0.16	0.00
Gas leaks	0.00	0.00	0.00	0.00	0.69	0.20
Consented industry	3.44	4.51	1.25	0.78	3.94	3,959.20
Service stations	0.00	0.00	0.00	0.00	2.68	0.00
Surface coatings and thinners	0.00	0.00	0.00	0.00	4.84	0.00
Commercial gas combustion	0.04	0.10	0.07	0.03	0.00	146.90
Sub-total	**3.48**	**4.61**	**1.32**	**0.81**	**16.71**	**4,106.30**
Transport*						
Aviation	2.52	0.87	0.06	0.07	0.61	191.50
Bitumen and road laying	0.00	0.00	0.00	0.00	0.13	0.00
Rail	0.20	0.64	0.07	0.04	0.19	31.60
Motor vehicles	134.22	24.72	1.09	2.45	30.78	3,929.80
Off road vehicles	5.77	0.82	0.03	0.02	0.65	45.10
Pleasure craft	2.28	0.19	0.02	0.01	0.63	26.20
Ships at berth	0.04	0.24	0.20	0.03	0.02	15.40
Ships at sea	0.14	1.63	1.25	0.16	0.04	79.50
Sub-total	**145.17**	**29.12**	**2.71**	**2.78**	**33.03**	**4,319.10**
Biogenic*		0.95			8.28	
All sources	**171.2**	**35.0**	**4.2**	**5.9**	**64.2**	**8,927.7**

* These estimates do not include secondary particulates, natural sources of particulates, or road dust.

** Solvent use creates aerosols which are a suspension of liquid droplets in air.

Pressures: consumption and production

The density of emissions varies across the Auckland region. The urban area covers only 10 per cent of the total land in the Auckland region but contributes most of the total regional emissions for each pollutant:

- → 83 per cent of PM_{10} particulates
- → 82 per cent of NO_x
- → 91 per cent of CO
- → 82 per cent of VOC
- → 50 per cent of SO_2
- → 78 per cent of CO_2.

Indicator 32: Motor vehicle fuel sales

Transport (including ships and locomotives) places the greatest pressure on the environment in terms of discharges of contaminants to the air. Table 24 shows that motor vehicles in the Auckland region contribute the most emissions, particularly:

- → CO (78 per cent of all emissions)
- → NO_x (71 per cent of all emissions)
- → VOCs (48 per cent of all emissions)
- → PM_{10} particulates (42 per cent of all emissions).

Figure 17 shows where the greatest motor vehicle emissions are discharged regionally.

This pressure is reflected in the level of fuel sales as most, though not all, of these sales are transport-related. Fuel sales have increased substantially over the last 15 to 20 years.

Between 1990 and 2008, the volume of petrol sold increased by about 140 per cent while the volume of diesel increased by about 280 per cent. The most significant increase occurred in the early/mid 1990s, when the average increase in petrol sales reached 4 per cent each year and diesel sales reached 14 per cent each year. This coincided with a period of very high population growth in the Auckland region, particularly during 1995 and 1996. However, over recent years there has been some levelling-off in total fuel sales and even a decline in the total fuel sales per person (coinciding with a period of very high fuel prices). (Table 25).

TABLE 25 Annual fuel sales for the Auckland region (millions of litres), 1996-2007. (Source: Auckland City Council).

Year	Petrol	Diesel	Petrol (litres/person)	Diesel (litres/person)
1996-97	913	366	819	329
1997-98	927	394	809	344
1998-99	952	396	815	339
1999-2000	975	418	824	353
2000-01	969	414	808	345
2001-02	1005	421	826	346
2002-03	1045	459	833	366
2003-04	1065	493	822	380
2004-05	1079	516	815	389
2005-06	1064	517	790	384
2006-07	1080	523	788	382
2007-08	1078	523	773	375

Sales for non-transport purposes (such as mowers, chainsaws, generators and so on) are included.

Indicator 33: Use of coal and wood for home heating

Approximately 29 per cent of Auckland households burn solid fuels (wood and coal) for home heating. This places major pressure on air quality, particularly in terms of CO, SO_2, and PM_{10} particulates and especially during the winter months of June, July and August. Coal produces a higher level of SO_2 and PM_{10} particulate emissions (per kilogram of fuel) than wood or natural gas.

The emission of contaminants from wood depends partly on the dryness of the wood. Wet wood produces more than double the emissions of dry wood.

While the use of domestic wood burners can be economic, renewable and enjoyable, their efficiency varies significantly. Wood burners that are poorly constructed or not well operated and maintained produce excessive amounts of smoke that wastes energy and produces high levels of pollutants.

Pressures: consumption and production

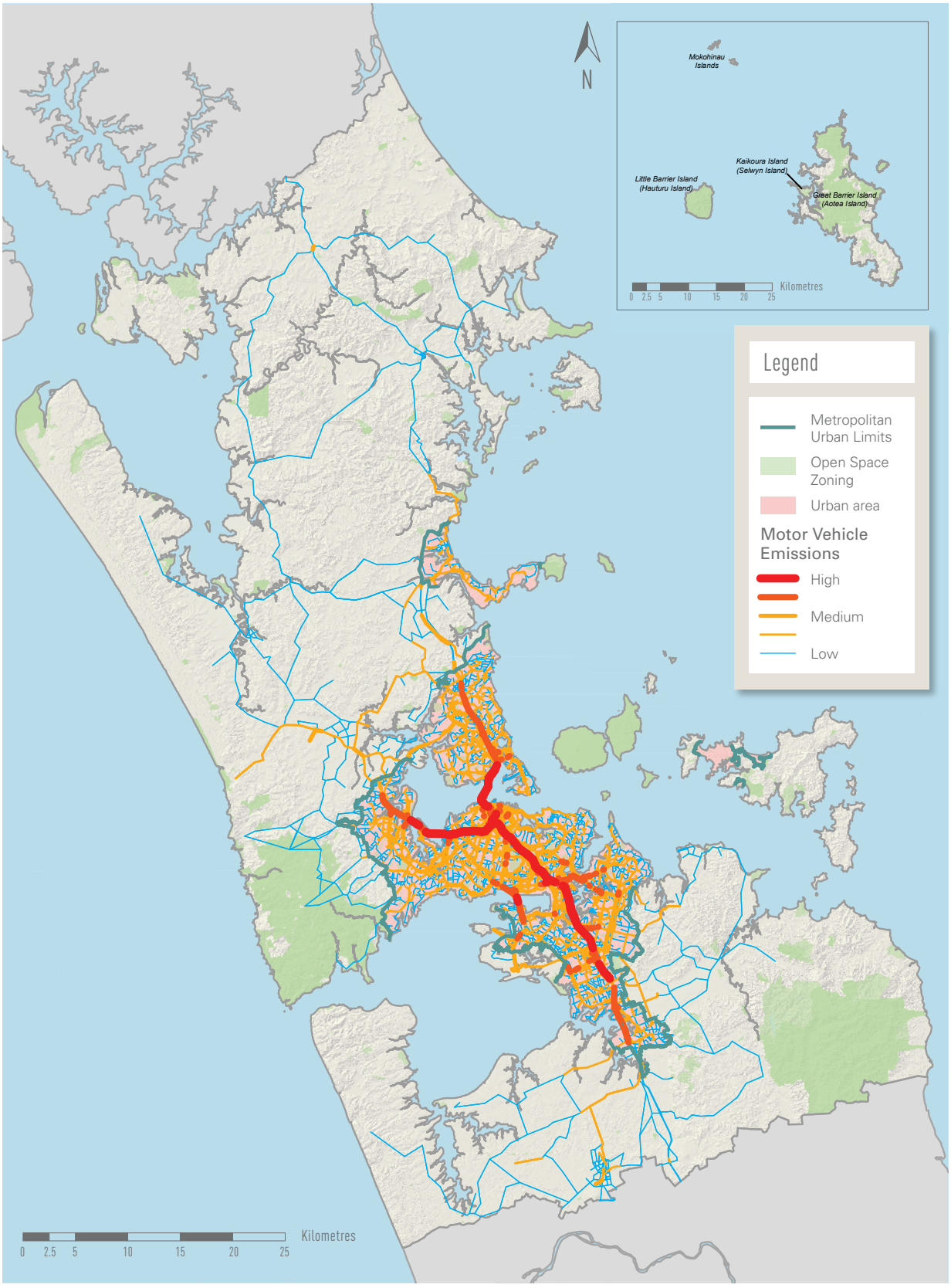

FIGURE 17 Motor vehicle emissions in the Auckland region, 2006. (Source: ARC).

Pressures: consumption and production

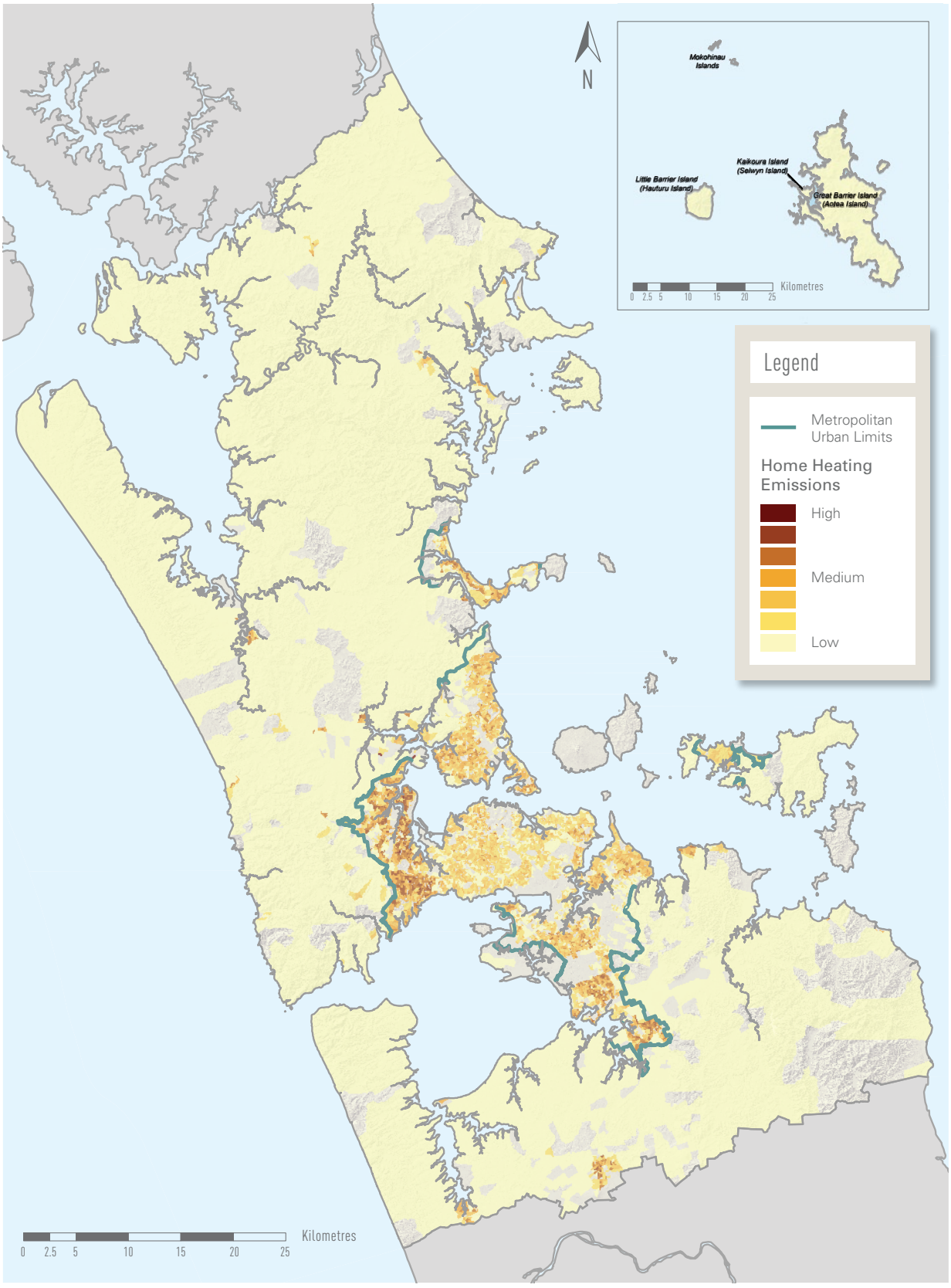

FIGURE 18 Home heating (analysis by meshblock method), 2006. (Source: ARC).

Pressures: consumption and production

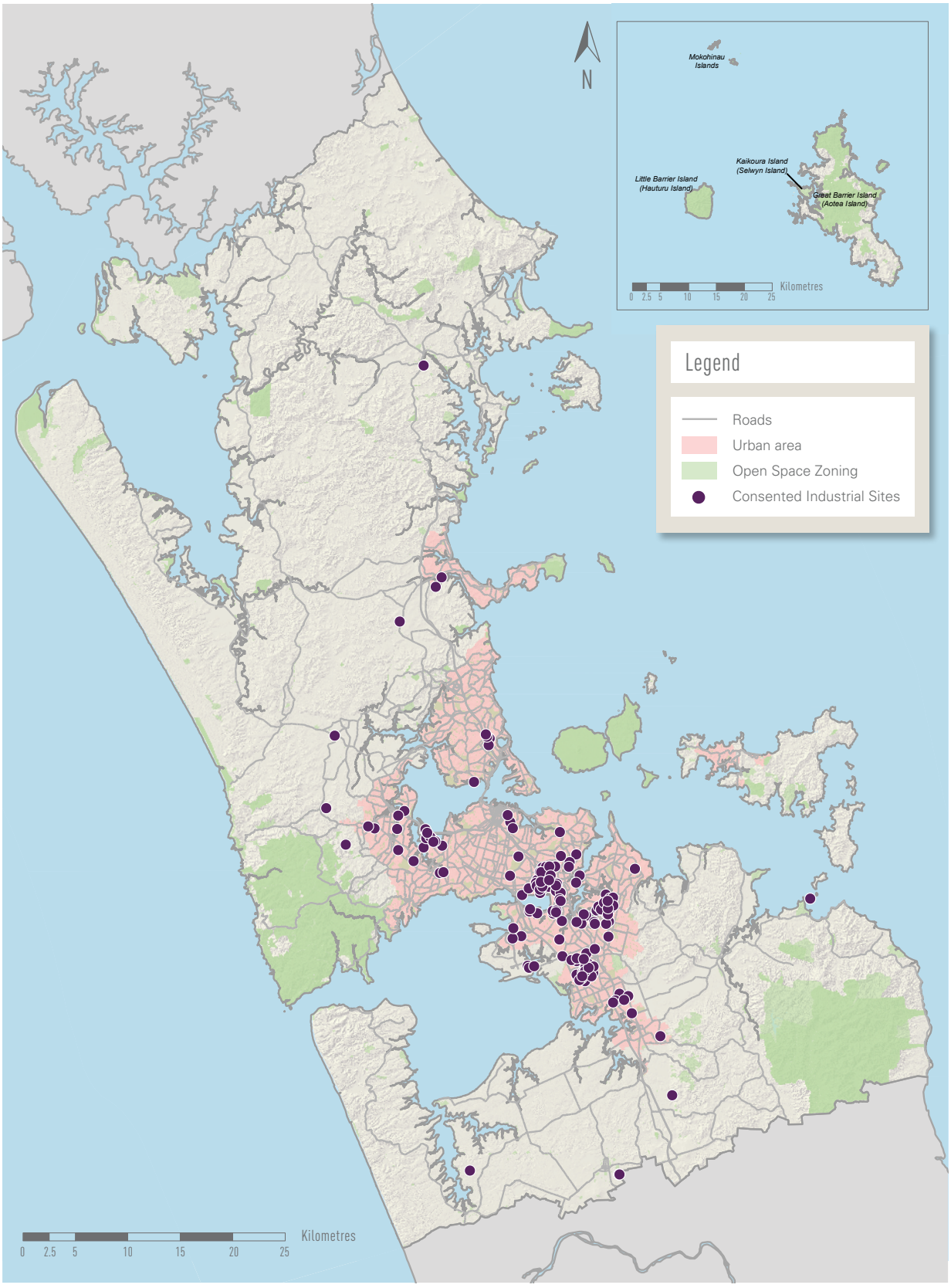

FIGURE 19 Location of consented industrial sites that emit PM_{10}, 2006. (Source: ARC).

Pressures: consumption and production

Generally, the oldest and least efficient forms of home heating (particularly open fires) are found in the older parts of the city (Figure 18). Surveys indicate that the use of coal and wood for home heating is declining. In the last five years or so, this decline has been set against dramatic increases in the sale of electric heating and ventilation systems such as heat pumps.

Indicator 34: Industrial sources

Pressure on the air quality from industrial sources is associated with a wide variety of industrial activities, each with different emission profiles. Examples include iron and steel production (mainly CO_2 and PM_{10} particulates), food and beverage production (mainly PM_{10} particulates, NO_2, CO_2 and VOCs), quarries (mainly PM_{10} particulates), textile manufacturers (mainly VOCs) and service stations (mainly VOCs).

The New Zealand Steel Mill at Glenbrook is the largest emitter of NO_x, SO_2, CO, CO_2, as well as PM_{10} particulates in the Auckland region. Electricity generation is another large source of industrial emissions of NO_x and CO_2 and the proposed new power station in Kaukapakapa will add to those emissions. However, industry is not the main source overall of those contaminants in Auckland.

In terms of the distribution of emissions across the Auckland region, Figure 19 shows that the majority of industrial PM_{10} particulate emission sources are within the urban area, particularly within the industrial suburbs of Penrose, Mt Wellington, Otahuhu and Wiri.

Implications of air pollution

The use of diesel fuel is expected to increase in the future, particularly in commercial vehicles. This could have an impact on human health (see Fine particulates in Chapter 4.1). For every kilometre travelled, diesel vehicles produce disproportionately more NO_x and PM_{10} particulates (around 73 per cent of PM_{10} particulate emissions from motor vehicles come from diesel exhaust alone), although petrol vehicles produce more CO. (See Implications for air quality in Chapter 4.1 for more information).

Transport

Key findings

- → Nationally, vehicle ownership increased from 641 vehicles per 1000 people in 2001 to 698 vehicles per 1000 people in 2007. The Auckland region is likely to have experienced the same or a similar trend.
- → Congestion in Auckland shows considerable variability. Travel times in the evening peak have declined for the past three years, however it is too early to tell if this is a long-term trend.
- → Between 2004 and 2008, the amount of Vehicle Kilometres Travelled (VKT) in the Auckland region is estimated to have increased by about one billion (nine per cent).
- → Nationally, there was steady growth in the engine size of vehicles between 2001 and 2007. However, this rate of growth declined for both New Zealand-new and used imports in 2006 and 2007.

Introduction

One requirement of a prosperous economy is that goods and people can move efficiently between locations. Social expectations also mean that people want to be able to travel safely and quickly from place to place.

However, the desire for mobility and the transport systems that are built to deliver that mobility create pressures on the environment. These are related to both the development of transport infrastructure (such as motorway construction) and the subsequent use of that infrastructure (increased vehicle emissions).

As mobility has increased over recent years, the associated pressures on the environment have increased accordingly.

Monitoring transport

The ARC regularly collects and commissions information on transport trends in the Auckland region. It uses this information to help develop, implement and monitor the Regional Land Transport Strategy.

Travel times and distances

Indicator 35: Traffic congestion

Over the past few decades the road transport network in the Auckland region has struggled to keep pace with the rapid growth in population and increased vehicle numbers.

Traffic congestion contributes to the adverse environmental effects generated by the transport system. Traffic congestion occurs mainly during the morning and evening peak travel periods but some areas experience congestion throughout the day. Traffic congestion not only wastes time for motorists and passengers but also leads to increased fuel consumption and vehicle emissions owing to increased idling, acceleration and braking.

Over the last five years a survey has been undertaken to research the average minutes of delay per kilometre on samples of Auckland's strategic road network at various times of the day. (Table 26).

The results show considerable variability since monitoring began. However, the results for 2009 are positive overall for motorways, with reductions in the inter-peak, evening peak and average delays. For other highways and regional arterial roads, the results show that after reductions in delay times in March 2008, these had increased again by March 2009. The delay times recorded in March 2009 on the state highways were, overall, still better than those recorded in 2007 apart from the morning peak period.

Pressures: consumption and production

TABLE 26 Average delay (minutes per kilometre) during one week in March, 2004-09. (Source: Beca).

Year	Road category											
	Motorway				State highway				Regional arterial			
	Morning peak	Inter-peak	Evening peak	Average day	Morning peak	Inter-peak	Evening peak	Average day	Morning peak	Inter-peak	Evening peak	Average day
2004	0.67	0.12	0.55	0.36	0.66	0.36	0.49	0.51	1.17	0.10	0.98	0.87
2005	0.82	0.11	0.56	0.51	0.63	0.29	0.95	0.64	1.07	0.46	0.93	0.84
2006	0.73	0.10	0.57	0.48	0.40	0.30	0.80	0.51	1.08	0.43	0.93	0.83
2007	0.79	0.13	0.67	0.55	0.91	0.35	1.05	0.79	1.27	0.41	0.94	0.89
2008	0.79	0.15	0.59	0.53	0.35	0.19	0.60	0.39	1.14	0.47	0.97	0.88
2009	0.85	0.13	0.45	0.49	0.98	0.32	0.79	0.71	1.25	0.55	1.01	0.95

Morning peak is between 0730 and 0930. Inter-peak is between 1000 and 1200. Evening peak is between 1600 and 1800.

Some of the recent improvements in the levels of traffic congestion reflect a tapering off of growth in the VKT in the Auckland region, significant road transport infrastructure investment and increasing use of public transport.

Some recent and important improvements to the road network capacity have been the opening of the State Highway 20 Mt Roskill and State Highway 1 Alpurt B2 extensions in 2009, the completion of the Northern Busway, Greenhithe deviation and Esmonde Road interchange in 2008, and the completion of the Central Motorway Junction in 2007.

Ongoing projects include the Manukau motorway link between State Highways 1 and 20 on the western ring route, ramp signalling and automated traffic management systems on the motorways, and the Central Connector project that will provide permanent bus priority measures between Newmarket and the Auckland CBD. These are expected to improve traffic flows.

Indicator 36: Vehicle Kilometres Travelled (VKT)

A common indicator of road transport pressure is an estimate of the total VKT. However, this does not take into account the amount of traffic congestion experienced or improvements in fuel quality or efficiency, so it must be considered in conjunction with other indicators of transport pressure.

Between 2001 and 2008, the total VKT in the Auckland region is estimated to have increased by about two billion kilometres, about 20 per cent (Table 27). In the past five years (since 2004) the VKT increased by about one billion kilometres (9 per cent).

TABLE 27 Vehicle Kilometres Travelled (VKT) in the Auckland region, 2001-08. (Source: New Zealand Transport Agency).

Year	Total vehicle distances travelled (millions km)	Average vehicle distances travelled per person (km)
2000-01	10,098	8460
2001-02	10,340	8497
2002-03	10,797	8611
2003-04	11,077	8582
2004-05	11,401	8659
2005-06	11,734	8776
2006-07	11,853	8727
2007-08	12,047	8734

The VKT has also been increasing on a per person basis by about 0.5 per cent each year, on average. This indicates that people within the Auckland region are travelling further. However, in common with the data on traffic congestion and vehicle ownership, this trend has shown some tapering off in recent years.

Pressures: consumption and production

Vehicle numbers and types

Indicator 37: Motor vehicle ownership

In the Auckland region (as for all of New Zealand) road transport is the largest sector of the transport system. The heavy reliance on road transport is a reflection of, and a contributing factor to, land use and settlement patterns in the region. These are relatively low in density and dispersed by world standards.

People in the Auckland region, like all New Zealanders, also have very high rates of vehicle ownership (Table 28). New Zealand has one of the highest rate of vehicle ownership internationally, with almost 700 cars per 1000 people.

TABLE 28 National light fleet vehicle ownership, 2001-07. (Source: Ministry of Transport).

Year	Light vehicles (at year end Dec 31st)	Light vehicle ownership per 1000 people
2001	2,486,230	641
2002	2,557,144	649
2003	2,658,215	663
2004	2,757,280	679
2005	2,849,825	695
2006	2,897,832	692
2007	2,951,878	698

Vehicle ownership rates throughout the country rose dramatically during the late 1990s. This coincided with a period of significant reductions in the real purchase price of new and used vehicles: this was associated primarily with the removal of vehicle import tariffs and restrictions on parallel importing.

Strong growth in private vehicle ownership has continued, with the number of light vehicles per person increasing by around 9 per cent between 2001 and 2007. This growth reflects a number of factors including the high value of the New Zealand dollar, high employment and a buoyant economy. However, ownership rates levelled off in 2006 and 2007, possibly in response to increasing oil prices.

Indicator 38: Fleet composition

Although improvements in vehicle efficiency have been made over the last decade in relation to fuel consumption, this has been largely offset by people choosing progressively larger vehicles, the growing population, and people travelling longer distances.

In 1960, a typical family car had a 1.5 litre engine. By 2000, the average engine size was just over 2.0 litres and currently it is near to 2.3 litres. Figure 20 shows the light fleet average engine size in New Zealand (tracked monthly) between 2001 and 2007.

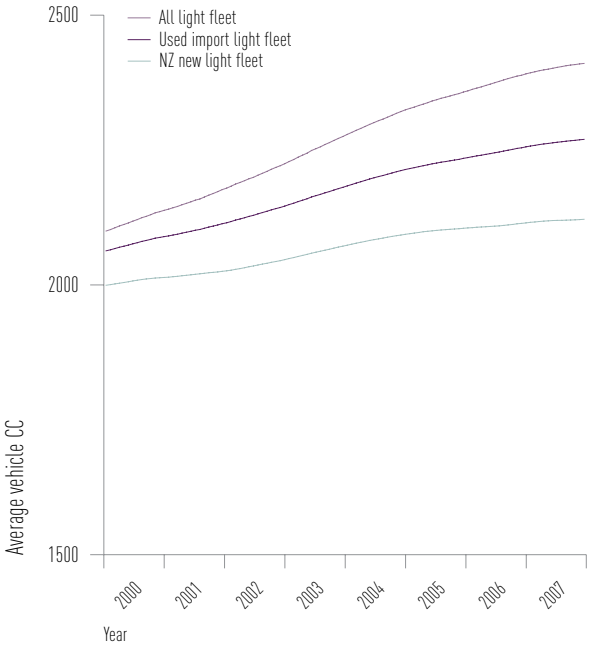

FIGURE 20 Light fleet average engine size in New Zealand 2000-07. (Source: Ministry of Transport).

Interestingly, the New Zealand-new component of the national vehicle fleet has a significantly larger engine capacity than the used imported component, due mainly to new Australian-made vehicles that are imported into the country.

The age of the vehicle fleet also has an impact on the fuel efficiency and the amount of pollutants generated by road transport. In 2007 the average age of the New Zealand light fleet was 12.0 years, compared with 11.6 years in 2000. Older vehicles are more likely to use fuel inefficiently and to emit pollutants that contribute to poor air quality. A poorly maintained vehicle can be a high polluter irrespective of age.

Pressures: consumption and production

Box 6 Fuel prices

The tapering off in vehicle ownership rates and VKT during 2006 and 2007 coincided with a period of very steep climbs in the global price of oil, which translated into marked increases in the prices of petrol and diesel at the pump in New Zealand.

This suggests that there is a negative correlation between the price of fuel, vehicle travel per person and the fuel economy of vehicles entering the fleet. Fuel prices are predicted to continue to increase in the long-term. A recent study undertaken on behalf of the NZTA concluded that sustained high prices for transport fossil fuels are likely to motivate a gradual – but continual – shift in travel and land use patterns, characterised by increasing demand for alternative transport modes as well as denser and more diverse land use patterns.

Public transport

Since 1994 there has been a significant increase in the use of public transport in the Auckland region. The total number of passenger boardings increased from 33.3 million to 54.7 million (about 64 per cent) between 1994 and 2008. Between June 2008 and June 2009, this increased by 7.7 per cent to 58.6 million trips (Figure 21).

Rail has shown the greatest increase (albeit from a low base) over the medium term. Train patronage over the last five years grew 97 per cent to 7.6 million passenger trips per year, in the year to June 2009.

Indicator 38: Public transport trips by mode

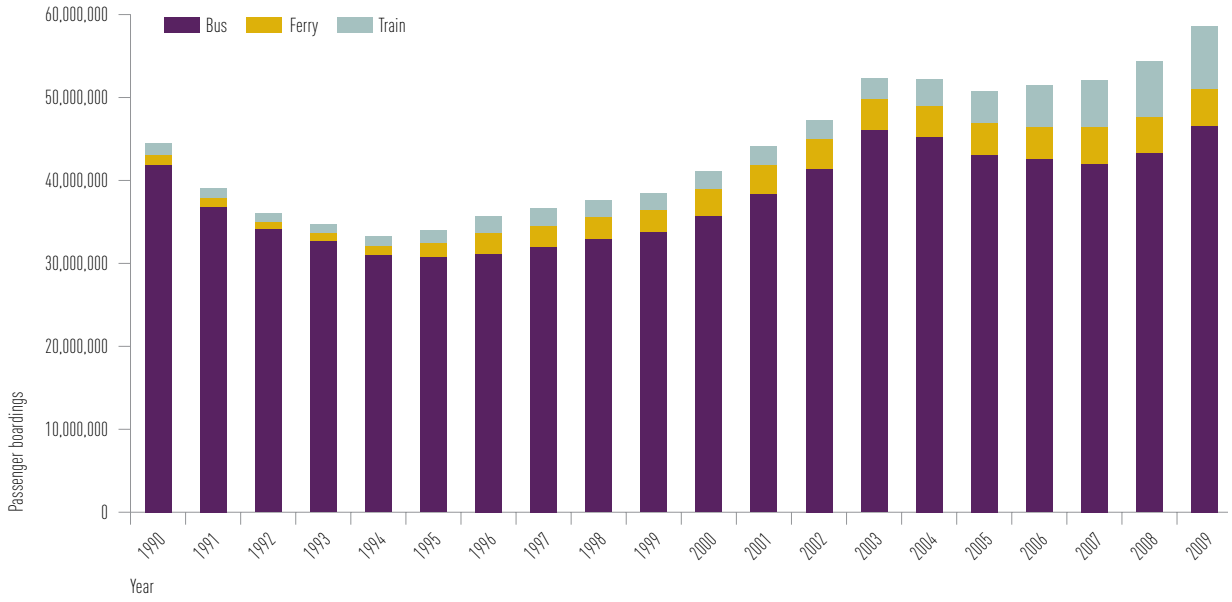

FIGURE 21 Annual public transport boardings in the Auckland region, 1990-2009. (Source: Auckland Regional Transport Authority).

Walking or cycling

Walking is one of the easiest and cleanest forms of transport. Most people can cover about 2km in less than half an hour. Cycling too is an energy efficient form of transport and allows greater distances to be covered.

Indicator 39: Cycling and walking rates

Monitoring of cycling rates in Auckland is co-ordinated by Auckland Regional Transport Authority (ARTA) on behalf of the local councils and NZTA and is carried out in March of each year. More than 10,000 cyclist movements passing through 83 monitoring sites were counted in March 2009 during the morning and evening peaks. The number of people cycling during this period appears to have stabilised after 30 years of continual decline. Increases were particularly apparent in Waitakere and North Shore cities following the extension of the North Western Cycle Way and Takapuna and Devonport cycle lanes (Figure 22).

Pressures: consumption and production

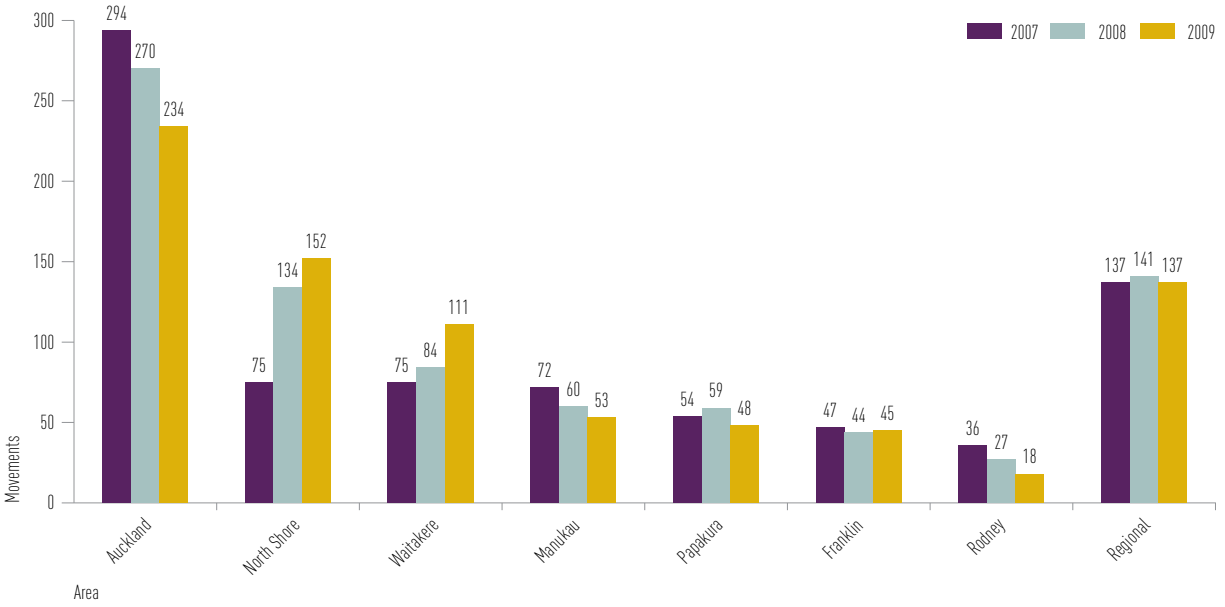

FIGURE 22 Average number of cyclist movements by territorial authority between 2007 to 2009. (Source: Auckland Regional Transport Authority).

In 2006, 24,000 Auckland residents said they walked to work on Census Day, representing 4.5 per cent of those who worked that day. While the percentage of walkers has remained static over recent years, there has been a large increase in the actual number of people – an increase of 28 per cent between the 2001 and 2006 census.

Implications of transport

An extensive and efficient transport network is critical to Auckand's social, cultural and economic well-being. At the same time, all forms of motorised transport (road, rail, shipping and air) are associated with adverse effects on communities and the natural and built environment. In particular:

- → the transport sector is a contributor to greenhouse gas emissions and is the major contributor to air pollution.
- → the construction and operation of transport equipment and infrastructure requires inputs of resources including land, fossil fuels and other energy resources, aggregates, metal ores and other minerals.
- → noise and vibration generated from transport activities can be detrimental to the quality of life of some residents.
- → the contaminants generated from transport activities, including vehicle emissions, used oil and the by-products of tyres and brakes are a major cause of water quality degradation in freshwater and marine environments.
- → the construction and operation of transport infrastructure has the potential to adversely impact natural habitats, discharge sediment and can cause the loss or fragmentation of public open spaces, items or areas of historic heritage, and natural landscapes.

Future population growth in the Auckland region is expected to create significant additional demand on the existing transport networks. Although the use of public transport is increasing, so is private vehicle use. Despite the projected increases in the use of public transport, emissions from the transport sector and the amount of stormwater contaminants from the transport system are both projected to grow.

ARC's responses

Strategies and processes

Chapter 4.6 discusses the ARC's current responses to the specific impacts of pressures though specific rules and programmes that are mostly undertaken as part of its functions under the Resource Management Act (RMA).

On a broader scale, however, the ARC uses a range of strategies and policies to address the various pressures discussed in Part 3, either individually or collectively. These strategies take a 'whole of council' and sometimes a 'whole of regional community' approach that is not limited to the ARC's regulatory functions under the RMA. These broader scale responses are discussed below.

Auckland Regional Growth Strategy (ARGS)

The ARGS is prepared by the Auckland Regional Growth Forum which consists of representatives from the ARC and each of the Auckland councils in existence at the time of writing. Established in 1996, its main role is to produce and oversee the implementation of the ARGS.

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Pressures: consumption and production

The ARGS contains a vision for the continued prosperity of people and the sustainability of the environment in the Auckland region. It aims to address a range of environmental pressures. It also sets out and prioritises desired outcomes and principles, in terms of all the natural resources (such as the water and air quality), environmental values (such as rural and urban amenity values) and social matters (such as housing choice, employment opportunities, and safe and healthy communities).

The key part of the ARGS is the Growth Concept: a high-level spatial plan of how future urban development might be best accommodated to promote the various outcomes and principles identified (Figure 23). In other words, it sets out a vision of where, and what type of, future development should occur.

One principal intent of the Growth Concept is that growth will be managed by promoting quality and compact urban environments (urban intensification) rather than continued low density sprawl. Other intents are that:

- most growth will occur within the existing metropolitan area (intensification) with development outside the defined Metropolitan Urban Limits only when environmental, accessibility and community principles can be met.
- intensification will be focused around town centres and major transport routes (corridors) to create higher density, mixed use communities with a variety of housing, jobs, services, recreational and other activities.
- there will be much less emphasis on infill throughout suburban areas.
- specific new areas outside the suburbs are earmarked for growth.
- future urban areas are located outside the Metropolitan Urban Limits but avoid the most sensitive environments in the Auckland region.
- rural and coastal towns are expected to roughly double in size through natural growth, and those located on the rail corridor should accommodate the greatest growth outside the MUL.

The Local Government (Auckland) Amendment Act Order (2004) requires all local and regional authorities in the Auckland region (that is, city and district councils and the ARC) to change their district plans (and the ARPS in the case of the ARC) to give effect to the Growth Concept. Therefore, the Auckland Regional Policy Statement (ARPS) sets out detailed policies that establish the MUL, and various planning policies to direct development in a way that gives effect to the wider Growth Concept. District plans of city and district councils must give effect to the ARPS.

Any effective response to the environmental pressures identified above must include (but not be limited to) controls to influence the form and shape of urban growth – the physical development within the Auckland region. In this respect, the ARGS is a critical factor in our broad response strategy to current and future environmental challenges in the Auckland region.

The findings from Indicator 4 and Indicator 5 are consistent with the findings of a review of the ARGS that are shown in Box 7.

Box 7 Evaluation of the Auckland Regional Growth Strategy (ARGS)

In 2007, an evaluation of the ARGS was carried out for the 2001 to 2006 period. The evaluation found that a good start had been made towards implementing the ARGS, particularly in terms of the detailed planning required through the sector agreements (detailed agreements negotiated between the ARC and the territorial authorities in each of the four sectors in the Auckland region).

There are also signs of real change, particularly in the type of residential development. For example, nearly half of the housing built since 2000 has been terraces, town houses or apartments. There has also been significant investment in infrastructure consistent with the outcomes sought in the ARGS.

However, the evaluation found that not all of the development trends reflected the intent of the ARGS. For example:

- growth rates are higher outside than within the MUL. There has been strong pressure for development outside the MUL, including proposals for whole new settlements. 14 per cent of residential development was in rural and coastal areas outside the MUL,
- 'greenfield' areas identified for development by the ARGS were developed quickly. 40 per cent of new residential development occurred on vacant land,
- a significant portion (33 per cent) of residential development occurred within existing residential areas as general infill,
- although 35 per cent of the growth occurred within growth centres (areas targeted for high density development), most was within the CBD.
- there has been limited action in terms of planning for growth of identified growth centres and corridors.

As a consequence, there has been very little comprehensive redevelopment in identified growth centres and corridors. This means that, although there appears to be increasing demand for higher density living, it is not necessarily translating into development in the areas earmarked for intensification by the ARGS due to their infrastructure servicing advantages. Where redevelopment has occurred, it tends to be small-scale rather than comprehensive.

The evaluation also noted that some key infrastructure projects needed to support urban intensification were lagging. Some community resistance to changing the existing urban form was also apparent, due to unfortunate examples of poor urban design and non-weathertight (leaky) housing.

Pressures: consumption and production

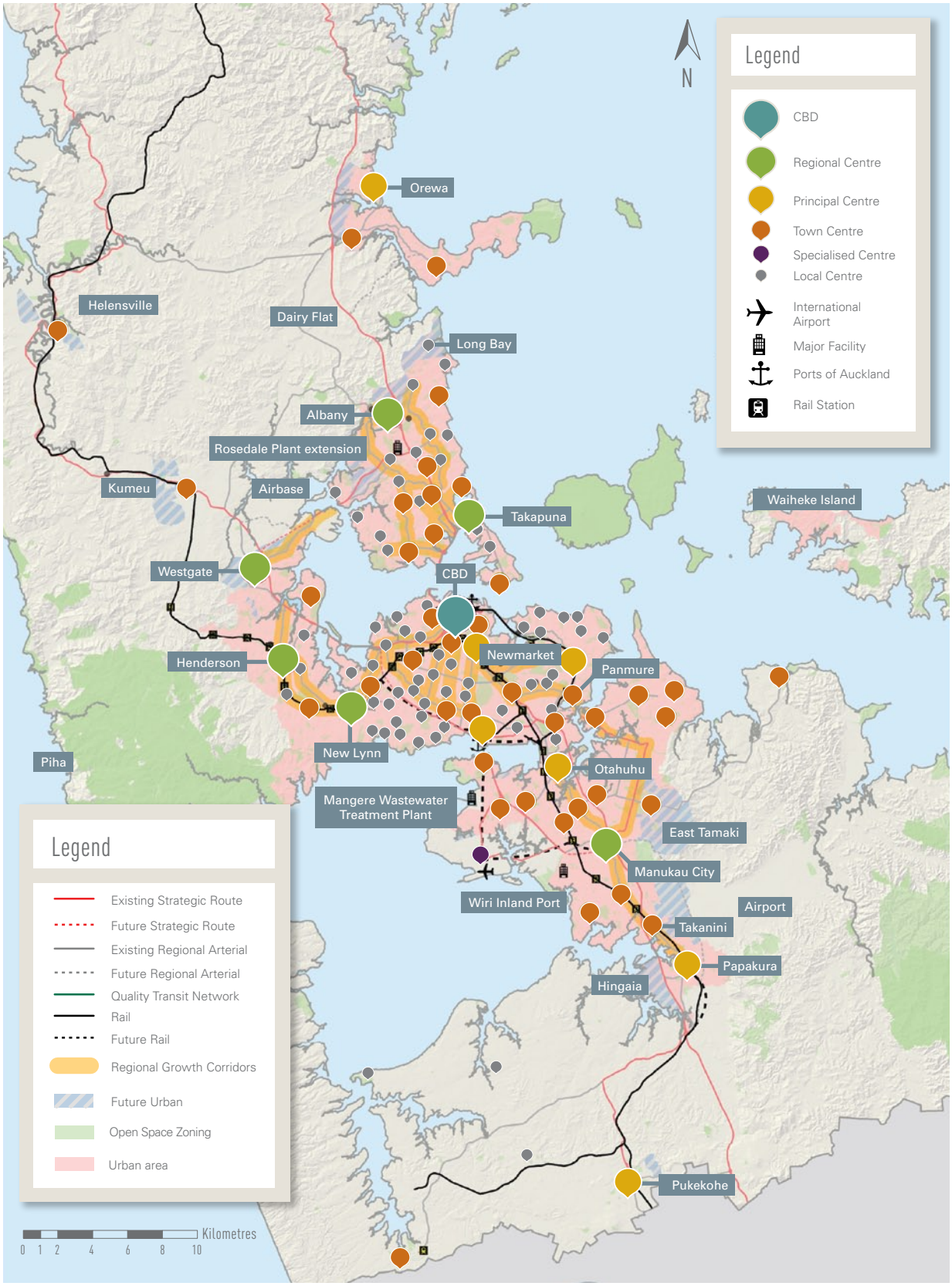

FIGURE 23 Auckland Regional Growth Strategy – Growth Concept, 1999. (Source: ARC).

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Pressures: consumption and production

The Three Waters Strategic Plan

Watercare Services Ltd is the regional bulk water and wastewater service provider owned by the city and district councils of the Auckland region. In 2004 it was asked to facilitate the development of a regional Three Waters Strategic Plan to meet future challenges associated with wastewater, water supply services and stormwater networks in a more integrated and efficient way. The process was driven by recognition of high levels of projected future population growth, increasing legal and public expectations about the quality of service and the environmental responsibilities of the sector.

The intent of the Three Waters strategy is to take a long-term (100 year) view of Auckland water and wastewater needs and then develop responses that are consistent with the vision agreed in 2005. That vision focuses on sustainability and "A region where water services fully meet our needs and expectations and contribute to a safe and healthy environment where people enjoy living, working and playing."

Therefore, the Three Waters Strategic Plan sets out a range of responses that include demand management and new capital works. The plan takes a longer-term view than that of the individual 20 year asset management plans of the various service providers in the Auckland region. It also takes a strategic view of the responses to the environmental challenges associated with the water industry. The plan promotes solutions that could not be achieved solely by existing regulatory responses (e.g. the RMA) while, at the same time, positions the water industry to be able to deliver the higher environmental standards that future regulations are likely to demand.

Key proposals set out in the Three Waters Strategic Plan are to:

- place a strong emphasis on water demand management in order to delay (by up to 20 years) the need to provide a new water source, with an estimated deferred expenditure of $300 million and consequent deferred environmental costs.
- reduce the gross per person demand for water by 15 per cent (of the 2004 levels) by 2025. This will be achieved by measures such as leakage reductions, appropriate pricing, pressure management, water conservation and promotion of water-efficient appliances. An additional 10 per cent of total demand will be met by using treated wastewater for industrial purposes and rainwater for non-potable household purposes over the same period (to be confirmed by cost benefit analysis).
- plan for higher regulatory standards in relation to drinking water and wide-ranging changes to the way that water supply systems are managed from source to tap.
- secure long-term access to the Waikato River as the main water source for Auckland but continue to investigate a new northern water source, increased use of central Auckland aquifers, and the use of rain tanks and treated wastewater as possible alternative future water sources.
- provide a new central interceptor to augment trunk wastewater sewer capacity as a matter of urgency. This will reduce wet weather wastewater overflows that already occur (see Indicator 26) and avoid the occurrence of almost daily dry weather overflows, possibly as early as 2035. The new central interceptor will achieve more than a 70 per cent reduction in untreated wastewater discharges from Watercare's trunk sewer network.
- ensure continued focus on maintaining and enhancing water quality of the Manukau Harbour by optimising and improving treatment provided by the Mangere Wastewater Treatment Plant. Provision will be made to divert flows from parts of the contributing catchment to an alternative facility to ensure that the nitrogen capacity of the harbour is not exceeded.
- secure access to a second regional wastewater facility at Rosedale for use when the Mangere Wastewater Treatment Plant reaches capacity.
- manage stormwater locally, in accordance with levels of service agreed with the community for flood, stream and contaminant management and, in addition, to develop regionally consistent policies, infrastructure design and implementation standards for a range of issues that affect the delivery of both stormwater and wastewater services.

Implementation of the Three Waters Strategic Plan depends on each party (councils, Metrowater, Manukau Water and United Water) developing their own specific implementation plans with targets for performance measurement. As the Three Waters Strategic Plan was finalised only recently, implementation plans have yet to be developed.

Auckland regional waste programmes

Nationally, responsibilities in respect of waste have recently been reviewed and reformed by the Waste Minimisation Act (2008). Under that Act, the ARC has no specific functions for waste minimisation as the territorial authorities have primary responsibility.

Although the ARC does not have a specific regional waste strategy, waste minimisation is certainly a key factor of its broader sustainability policies. In addition, we have waste programmes that are aimed at addressing key regional risks and opportunities.

Hazardous Waste Programme

The Hazardous Waste Programme focuses largely on public education but also provides Auckland residents with a way to safely dispose of hazardous household and agricultural wastes, and provides information to businesses about cleaner production and waste disposal. This is done through the provision of:

- the urban-based HazMobile Programme. This provides 14 to 18 collection events in the Auckland region each year where people can bring along hazardous waste for collection free of charge.
- the rural-based AgChem Collection Programme. This is a free, twice yearly service that involves the collection of old or unwanted agricultural chemicals from rural properties whose residents have registered with the ARC.
- transfer station cleanouts of household hazardous waste and agrichemicals at the Warkworth and Silverdale transfer stations; and agrichemicals clean-outs at the Waitakere transfer station.

Pressures: consumption and production

The Hazardous Waste Programme also focuses on reducing the amount of hazardous waste generated in the Auckland region through product stewardship initiatives so that increasing amounts of waste can be diverted in future years. The ARC is currently working to establish product stewardship for household waste oil and have trialled E-waste (electronic waste) collection.

RENEW waste exchange

The Resource Exchange Network for Eliminating Waste (RENEW waste exchange) is a regionwide information exchange designed to help businesses find markets for industrial by-products, surplus material and waste. The programme has been operating in Auckland since 1991.

The exchange now operates as a website (currently managed by the ARC) that matches one party's waste to another's needs. Businesses can list surplus materials and waste on the website free of charge and other businesses, schools, charities or individuals can register to search the website for material that may be of value to them. Materials are generally exchanged at low or no cost (although the terms of any exchange are left to the parties involved).

The exchange aims to conserve energy, resources and landfill space and create better understanding about alternative uses and reuse of materials.

WasteWise Schools

Together with the councils in the region in existence at the time of writing, the ARC has designed and funded delivery of the WasteWise Schools programme since 2008. At the beginning of the 2009 school year, 34 schools in the Auckland region had signed up to the programme.

The WasteWise Schools programme aims to assist schools to reduce their waste and, therefore, their ecological footprint (see Case study: Ecological footprint of the Auckland region, Chapeter 3.0 page 90). Schools sign up to a seven-point programme of action to be completed within two years with the assistance of a facilitator that the ARC provides.

The actions revolve around teaching waste reduction, undertaking annual waste audits, developing student action plans to divert waste from landfill; and implementing plans, policies and procedures to reduce reuse or recycle waste throughout the school. The programme aims to teach students waste reduction practices they can use at home and in everyday life.

Transport planning and public transport delivery

The ARC is responsible for setting the strategic direction for all transport development within the Auckland region and for funding public transport initiatives (with the NZTA). The ARC does this by producing, in conjunction with the other currently existing councils in the Auckland region and interest groups, a Regional Land Transport Strategy (RLTS) and by allocating funding through its Long Term Council Community Plan (LTCCP).

Delivery of public transport services and oversight of territorial authority and NZTA programmes is the responsibility of the Auckland Regional Transport Authority (ARTA), a council-controlled organisation owned and funded by the ARC. ARTA is required to implement the RLTS.

The 2005 RLTS has a number of economic, social and environmental objectives but, importantly, is designed to support and reflect the Auckland Regional Growth Strategy. It calls for a substantial increase in spending on public transport, the completion of key elements of the strategic road network and places new emphasis on travel demand management, in particular walking and cycling.

The RLTS is implemented through the Auckland Transport Plan (ATP) and the Regional Land Transport Programme, both prepared by ARTA. ARTA's planning reflects the direction of the 2005 RLTS, with significant increases in the extent and quality of public transport services across the Auckland region in recent years.

Substantial capital investment has been committed to building and enhancing public transport infrastructure, and developing a fully integrated multi-modal public transport system designed to reduce dependency on private motor vehicles. Important capital investments include:

- → a major upgrade of the Auckland rail network to increase capacity, extend reach and improve reliability. This includes current high-profile projects such as the double tracking of the western line and station development as well as less visible signalling improvements. Ontrack's Project Dart is contributing $600 million towards the track upgrade components of the programme while ARTA is paying for the station upgrades and redevelopment.
- → electrification of the Auckland metropolitan rail network, planned for completion by 2013. In 2007 the Government agreed to fund Ontrack to provide the installation of the overhead wiring as well as the necessary track and signalling upgrades. This is in addition to Project Dart (outlined above) although Project Dart went ahead in anticipation of electrification.
- → the purchase of electric trains for passenger transport and the development of stabling and maintenance facilities for the electric fleet. The establishment and operation of the electric services was to be funded by a new regional fuel levy but in March 2009 the Government announced that this would be funded by the Crown.
- → completion of the Northern Busway, with buses connecting to Britomart station. The $210 million cost of the busway 'spine' was provided by Land Transport New Zealand and the ARC contributed $50 million for the busway stations (through the former agency Infrastructure Auckland) with North Shore City Council providing $35 million.
- → work to develop an integrated fares system to make it easier for people to transfer between bus, train and ferry services and hence encourage use of public transport.

All of these projects have gained funding support because of their alignment with the RLTS. The ARC has also taken a strong advocacy position in favour of enhancing the public transport system and has made substantial funding contributions, through ARTA, to many public transport projects. The ATP 2008/09 records a total contribution to public transport across the Auckland region from all parties (central, regional and local agencies) of almost a quarter of a billion dollars. Of that, the ARC committed $180 million to ARTA for operating and capital programmes (up from 35.7 million in 2001/02).

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Pressures: consumption and production

The RLTS is currently out for consultation and is expected to be completed by April 2010. This version will look 30 years ahead (rather than ten years, as with the current RLTS). This provides an opportunity to consider the fundamental long-term transport challenges faced by Auckland, including the prospect of rising energy costs, transport modal shifts and possible fuel substitution.

The Resource Management Act, Auckland Regional Policy Statement and regional plans

The Resource Management Act (RMA) 1991 gives the ARC both the mandate and the regulatory powers to manage the environment in the Auckland region. Under the RMA, the ARC has a number of mandatory functions related broadly to water, soil, air, and the coast. The ARC can also direct land use where there are regionally significant issues at stake.

In order to fulfil these functions, the ARC prepares the Auckland Regional Policy Statement (ARPS) and Auckland Regional Plan: Coastal and may also prepare other regional plans, as necessary.

Auckland Regional Policy Statement

The ARPS provides an overview of the resource management issues of the Auckland region, and looks at the policies and methods to achieve integrated management of the natural and physical resources throughout the region. In this context, integrated management means ensuring that all the ARC's various policies and methods are mutually supportive and work together to achieve an agreed set of objectives for the environment, and that relevant policies of other currently existing Auckland councils also contribute to the regionally-defined objectives.

It fulfils this by setting out, in one document, the objectives, policies and methods relating to those issues for which it has a responsibility under the RMA (such as management of water, air, soil and the coast) and for other regionally significant issues such as urban growth and historic heritage.

These objectives, policies and methods are then implemented through more specific regional and district plans and are considered when making decisions on resource consent applications.

The ARPS also seeks to integrate management of resources through policies and methods that implement the ARGS (see The Auckland Regional Growth Strategy).

The current ARPS was prepared in 1999 and a review is underway. This State of the Auckland Environment Report 2009 is a contribution to evaluating the effectiveness of the existing ARPS.

Regional plans

We have prepared four regional plans that contain detailed objectives, policies, rules (and other methods) that control how the natural resources of the Auckland region can be used. The plans also describe the actions that we will take to ensure that these objectives are achieved. These plans are the:

- → Auckland Regional Plan: Coastal
- → Auckland Regional Plan: Farm Dairy Discharges
- → Auckland Regional Plan: Sediment Control
- → Proposed Auckland Regional Plan: Air, Land and Water.

These plans, and how they work, are discussed in more detail elsewhere in this report.

Advocacy

To ensure that district and regional plans implement the ARPS, the ARC maintains a 'watching brief' over structure plans, district plans and plan changes and notified resource consent applications. It reviews these documents to assess their consistency with the ARPS and related ARC policies, makes formal submissions through the statutory process and, where necessary, appeals matters to the Environment Court (and higher courts if necessary). The ARC places particular emphasis on:

- → environmentally sensitive transformation of rural land to urban use. By taking an interest in the nature, scale, density and design of urban development we seek to ensure that urban development of 'greenfield' (former rural) areas within the Metropolitan Urban Limits takes account of regional policies and priorities such as water quality, coastal values, historic heritage, ecological values and landscapes.
- → limiting subdivision and development outside the MUL. This aims to protect the life-supporting capacity of rural soils and the ability of those soils to meet the needs of future generations, as well as other rural and coastal values and environmental conditions such as the landscape, rural and natural character, and water quality and quantity.

One Plan

Decisions that influence the sustainable development of the region (including major investment decisions) are made by the ARC, other Auckland councils and their subsidiaries, central government agencies and a range of other public agencies.

One Plan is a joint initiative by all the above and led by the ARC, to improve and better integrate regional decision-making and respond to a community call to turn the many strategies and plans in the region into action.

As its name suggests, One Plan is a single plan of action that sets out the agreed priorities for projects and programmes that relate to the development of the physical and social infrastructure in the Auckland region.

The first version of One Plan contains seven programmes that were agreed after assessment against various criteria, including consistency with the Auckland Sustainability Framework. These programmes include improving public transport, completing the road network, Digital Auckland, Destination Auckland, CBD and Waterfront, Building Communities, and Growth through Skills.

Although components of these programmes all existed before One Plan, their inclusion in ensures delivery that is consistent with regional aspirations for sustainable development.

In the longer term, subsequent versions of One Plan will ensure that better decisions are made regarding future projects and programmes to be developed and implemented in the Auckland region. In particular, it will ensure that decisions are guided by the Auckland Sustainability Framework's vision of sustainability.

Pressures: consumption and production

Hauraki Gulf Marine Park and Forum

The ARC is also a member of, and the administering authority for, the Hauraki Gulf Forum that was established under the Hauraki Gulf Marine Park (HGMP) Act (2000). This is a collection of local authorities whose districts or regions fall, in part or in whole, within the catchment of the Hauraki Gulf, as well as representatives of tangata whenua, Te Puni Kōkiri, the Department of Conservation and the Ministry of Fisheries.

The forum works to promote the purpose the HGMP Act and the management objectives that this sets for the Hauraki Gulf. The HGMP Act and the creation of the Hauraki Gulf Forum recognises that the environmental, social and recreational values of the Hauraki Gulf are dependent on the management of its wider catchment. It is a response to the problem of local and central government administrative boundaries not coinciding with the boundaries of a resource of national significance and the potential, therefore, for fragmented management that would be detrimental to the Hauraki Gulf and its environment.

The forum is charged with integrating management and, where appropriate, promoting the conservation and sustainable management of the natural, historic and physical resources of the Hauraki Gulf. It does this by agreeing the strategic issues for the Hauraki Gulf, sharing information, co-ordinating action and publishing a State of the Environment Report for the Hauraki Gulf.

The forum has few functions and powers beyond those that the constituent parties have under other legislation. The value of the forum is that it encourages parties to exercise those functions in a collaborative manner, and reinforces the importance of the Hauraki Gulf and its many values.

Waitakere Ranges Heritage Area

The Waitakere Ranges Heritage Area Act (WRHAA) (2008) established the Waitakere Ranges Heritage Area. This covers about 27,000 hectares and includes the ARC-managed Waitakere Ranges Regional Park.

The Act recognises the national, regional and local significance of the Waitakere Ranges Heritage Area and promotes the protection and enhancement of its heritage features. The Act also influences policy-making and regulations that the ARC (and other affected local authorities) develop under the RMA.

When the ARC prepares or changes the ARPS or any regional plan, we must implement the purpose of the Act and its objectives. Similarly, the ARC must have a particular regard for the Act and its objectives when we consider resource consent applications for activities within the Waitakere Ranges Heritage Area. District and city councils have corresponding obligations in respect of district plans and land use consents.

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Case Study: Urban Stream Syndrome

Roading, roofs, playgrounds and car parks are examples of the hard surfaces that human development brings. These hard – or impervious – surfaces prevent rainfall from soaking into the ground. This has a knock-on effect on rivers in the catchment where temperatures rise, flows change and pollution and sediment increase – all affecting river water quality and ecology. This has become known internationally as 'urban stream syndrome'.

The creation of impervious surfaces has the obvious effect of changing the terrestrial ecosystems they replace, but equally as insidious are the less obvious effects on rivers of temperature, pollution and sedimentation.

In typical residential areas, impervious surfaces make up about 40 per cent of the land area and in commercial or light industrial areas this can increase to as much 80 per cent. Yet just 10 per cent impervious surfaces can cause urban stream syndrome.

In forested catchments, only a small proportion of the water in a stream comes from rainfall landing directly in it. Rain falling on catchments is intercepted by plants, and much of the remainder infiltrates into the soil and then into groundwater. This groundwater often resurfaces as freshwater springs and seepages, and provides water recharge to streams at times of low rainfall.

In a catchment with lots of impervious surfaces, rain cannot be absorbed by plants or soak into the ground and most of it will flow immediately into the nearest river. This causes highly unnatural flow patterns. Following a storm, the flow in a river with a highly impervious catchment will increase more rapidly and peak up to 3 times higher than in a natural river. In contrast, at times of low rainfall, rivers with an impervious catchment typically have lower flows, and can even dry up completely, because of the absence of groundwater recharge.

Whilst an impervious surface does not cause chemical pollution in itself, the urban and industrial activities that occur on it produce a wide range of heavy metals, hydrocarbons and other organic pollutants, which are washed into rivers after rain events. Several studies have shown that this polluted stormwater has toxic affects upon aquatic organisms.

Increases in impervious surfaces also lead to the warming of river water from two sources. Firstly, impervious surfaces absorb heat from the sun and transfer it to the rainfall that enters the rivers. Secondly, urban development is often accompanied by a loss of riparian vegetation and subsequent loss of shade along the stream. In addition, this loss of vegetation takes away a valuable source of organic matter, which acts as an important food source for aquatic organisms.

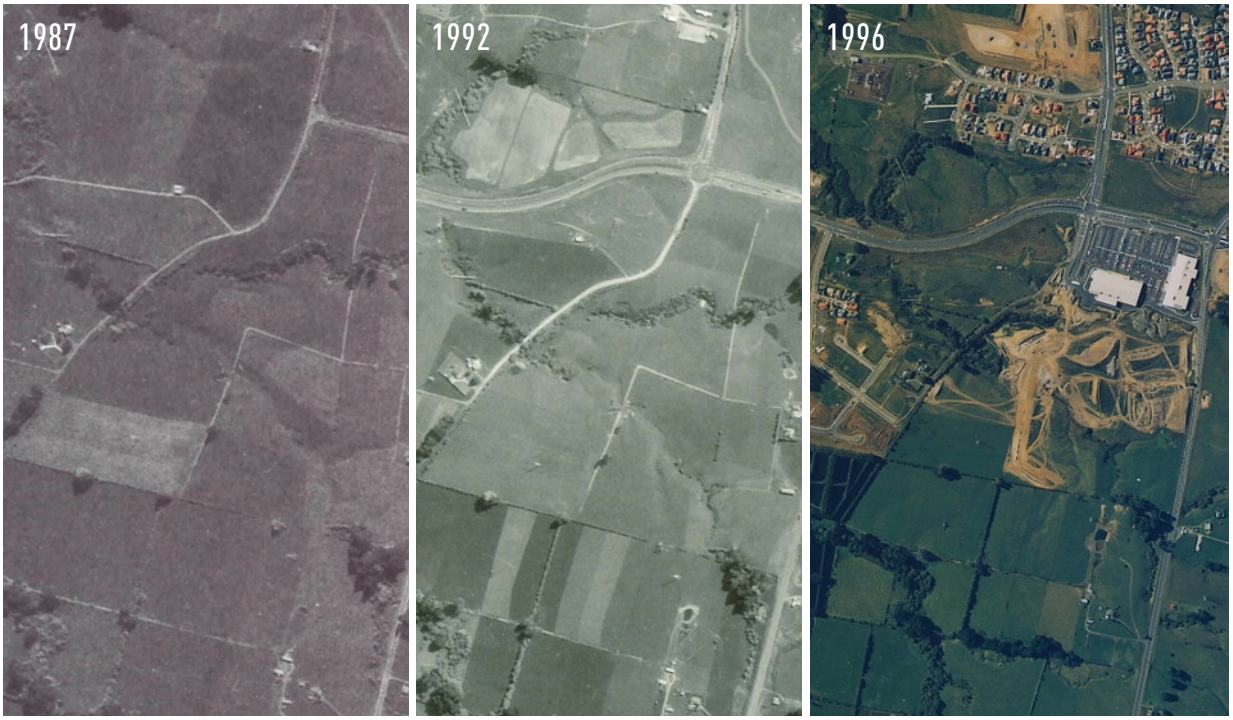

FIGURE 1 Botany Town Centre development, 1987 – 2006. (Source: ARC).

Pressures: consumption and production

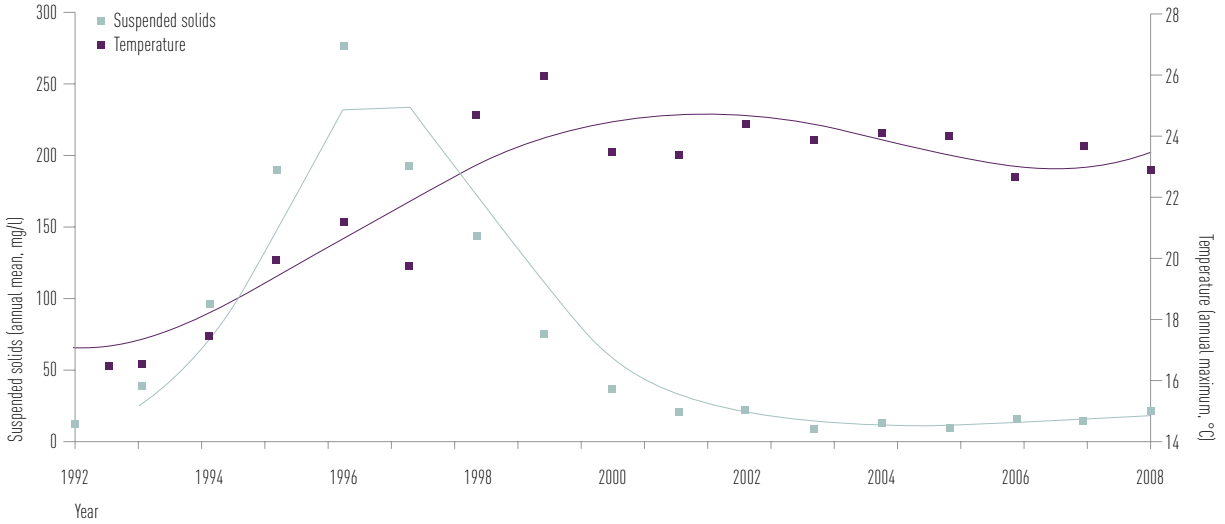

FIGURE 2 Pakuranga Creek from 1987 to 2006 showing the progressive urban development of the catchment. 2008. (Source: ARC).

Indicator 6 describes the increase in impervious surfaces within the region's MULs, and an example of this can be clearly seen in the photo sequence below of the Botany Town Centre development. To assess the effects of this development on the nearby freshwater systems, we monitored water quality in the Pakuranga Creek between 1992 and 2008.

The sediment in the river water increased greatly during the early stages of the development as a result of large scale earthworks, but dropped markedly as the development progressed and as large areas of land with potential to cause sediment were sealed under impervious surfaces. In contrast, the temperature of the river increased during the course of the development, resulting in temperatures that are frequently above 20°C, a threshold above which fatal effects can be observed in invertebrate and fish populations.

3.0

Pressures: consumption and production

Case Study: Historical sedimentation accumulation rates

Soil disturbance occurs through natural erosion processes and through human-induced land use activities. When soil is lost, naturally or otherwise, the productive capacity of land is reduced and sediment may be generated. This sediment enters rivers and streams and is transported to the marine environment.

Sediment has two effects on the freshwater environment. Firstly, sediment suspended in the water column increases turbidity and reduces light penetration which in turn decreases photosynthesis and reduces the visual ability of sighted organisms. Secondly, sedimentation alters the physical composition of the river bed. In the Auckland region, as most rivers are in 'soft' geological formations, the impacts of sedimentation are potentially less than those of suspended sediment.

The marine environment is the final destination for sediment generated on land and transported by freshwater. Increased inputs of sediments can decrease water clarity and reduce productivity. Sediment deposits can smother organisms and clog the feeding structures of animals like shellfish, and they can change a once sandy habitat to a muddy one. Sedimentation and infilling of estuaries is a natural process, but the rate of the process is increased by human land use activities.

Looking back in time

The ARC recently commissioned a study of sediment accumulation rates (SAR) in Auckland's east coast estuaries. By examining the sequence and composition of sediment deposits in sediment cores (or samples) and using radioisotope dating, it was able to look at the effects of human activities on sedimentation rates through time.

Results show that before European settlement and large-scale deforestation, SAR were typically less than 1mm yr-1. From about 100 years ago sedimentation rates rapidly increased. Catchment deforestation, conversion to pasture and horticulture, and rapid urban development caused the SAR

Photo: Drury Creek infilled with sediment, 2008. (Source: ARC).

Photo: Sediment layers – by using cores and radioisotope dating to look at changes in sediment through time, we can determine sediment accumulation rates and relate these to human activities. (Source: ARC).

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to increase by as much as an order of magnitude during this period, accelerating estuary infilling. Tidal creeks have in-filled the quickest, averaging 20mm yr-1 over the last 50 years. In the main body of estuaries, sedimentation has built extensive intertidal flats providing a habitat in which mangroves can thrive. In the last 50 years, intertidal flats have become shallower by approximately 0.5m, which is significant as the average high-tide water depth in many Auckland estuaries is less than one metre.

For some estuaries, cores indicate that sedimentation rates continued to increase until 20–40 years ago (~1960–1980 AD) and since that time have not increased further or have slightly reduced. These apparent plateaus may relate to reductions in catchment sediment loads and/or estuary storage capacity. At other sites, SAR has continued to increase. There is no compelling evidence that sedimentation is slowing down in Auckland estuaries and it is likely that sediment infilling of Auckland estuaries will continue at several mm yr-1, at least double the natural rate.

Finding the source

The ARC and NIWA developed a novel technique to track the source of sediments deposited in the marine environment. The technique compares the specific fingerprints in catchment sediments (compound specific isotopes) to sediments in the marine environment. A study using this technique was carried out in the Mahurangi Harbour where land-derived sediment entering the harbour is depositing on the harbour floor and remains suspended in the water affecting the harbour's ecology.

Most of the sediment entering the harbour comes from pastoral land use (10-30 per cent). However pine forest contributed higher than expected loads. Although it makes up only 8 per cent of the catchment use, it contributed 14 per cent of recent sediment to the overall harbour and contributed the majority of sediment deposited on the river delta. The bulk of the harbour's annual sediment load is delivered by a few storms. The risk of erosion is greatest during these more intense rainfall events. Proportions of sediment contributed by different sources differs between estuaries.

Photo: Waiwera Estuary. Sediment generated on land has flowed down freshwater systems and been deposited in this estuary and in the wider marine environment. Note how mangroves thrive in these conditions. (Source: ARC).

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Case Study: The ecological footprint of the Auckland region

An ecological footprint is the area of productive land needed to produce the resources a population consumes and assimilate the waste it creates. It is made up of the land used for the production of meat, crops, wool, milk and so on; the marine area used to produce seafood; the forest area used to produce wood, pulp and fuel wood; the land used for urban areas, transport networks, industry, housing and so on, and the area of land required to absorb carbon dioxide emissions from energy consumption.

In 2003/04, the ecological footprint of the Auckland region was 2 million local hectares (lha) or 24.9 per cent of New Zealand's total footprint[1]. It is the largest ecological footprint of any region in New Zealand; not surprising since the region has the largest population. In 1997/98 the regional footprint was 304,000 lha smaller, but at that stage there were 157,200 less people.

Each person in Auckland has an ecological footprint of 1.52 lha – about one and a half rugby fields. Auckland's per capita footprint is the second lowest of all the New Zealand regions; partly due to Auckland's high population density, which leads to land use efficiencies in transportation, infrastructure and retail space. In addition, much of the food consumed within the region comes from the Waikato and Bay of Plenty regions.

The ecological footprint of the Auckland region takes into account the amount of land used within the region, in other regions of New Zealand and overseas to produce goods and services used in the Auckland region. Only about 20 per cent of the regional footprint is from land in the region; land from other New Zealand regions makes up 45.5 per cent and the remaining 34.5 per cent is made up of land overseas. Therefore the Auckland region exceeds its useful land area by 2.97 times and is ecologically dependant on land from other regions and overseas.

In terms of land use, agricultural land within and outside the Auckland region makes up 71 per cent of the regional footprint. Energy land makes up 16.6 per cent (higher than the national average of 12 per cent due to Auckland's heavy energy use which is mainly transport-related). Forest land makes up 6.6 per cent, housing land 2 per cent, recreational land 1.6 per cent, commercial and industrial land 1.1 per cent, and transport and utility networks 0.4 per cent.

The ecological footprint of our purchases

Part of the region's ecological footprint is based on an analysis of the goods and services consumed by households, of which food is by far the largest contributor (0.58 lha per capita or 38.0 per cent) see Figure 1.

Food products include fruit and vegetables, meat products and a high proportion of manufactured foodstuffs. The land that makes up the food component of the footprint is used for horticulture (within and outside the Auckland region), sheep, beef and dairy farming (mostly outside the Auckland region) and energy, commercial and industrial land associated with the transportation and processing of food.

Households in the region also purchase large quantities of goods and services that are produced abroad, such as computers, cars and household items. Many of these are manufactured, high value-added goods that require large amounts of energy to produce. This contributes to the high ecological footprint of imported goods and services (0.25 lha per person or 16.7 per cent of the regional footprint).

Purchases of services such as construction, retail, business, accommodation, health and education contribute around 0.72 lha per person (30.7 per cent) of the regional footprint. Their footprint is often hard to calculate as many service providers appear to have small land use requirements. However, when calculating the footprint of these services, we need to consider both direct and indirect land use requirements. For example an accountant's land use may appear to be the small office they work from, but indirectly it is higher because the computers, paper, equipment, furniture and other services they may purchase all require considerable land inputs for their production.

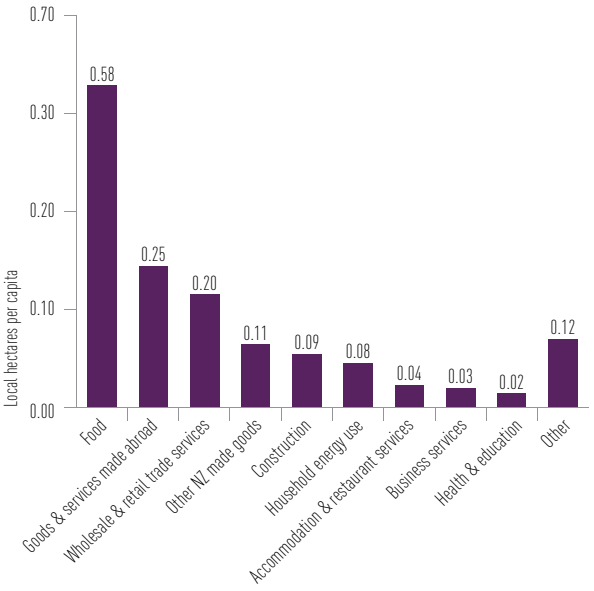

FIGURE 1 Ecological footprint of the Auckland region by goods and services purchased, 2003/05. (Source: Market Economics Ltd.).

[1] In order to account for differences in biological productivity among the nations of the world, ecological footprints are typically measured in global hectares (gha). One gha is defined as a hectare with the world-average ability to produce resources and absorb wastes. 'Equivalence factors' are used to convert to actual land areas or, local hectares (lha), to gha but equivalence factors do not exist at a regional level in New Zealand so lha are used instead.

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Auckland's ecological balance of trade

Auckland produces goods and services for its own consumption and also for export. Auckland also imports goods and services. Interestingly, Auckland is one of the few regions in New Zealand that has a 'net ecological deficit'; with exports of embodied land (170,000 lha) considerably less than imports (2.71 million lha). This ecological balance of trade reflects the large role of the region in the wider New Zealand economy. The manufacturing and service industries have a strong ecological dependence on other New Zealand regions for their supply of raw materials such as timber, milk and horticultural produce. To a lesser extent, other regions in New Zealand, and other nations, depend on the ecological capacity of the Auckland region for service sector exports.

How to reduce your ecological footprint

People are becoming increasingly aware of the need to reduce their environmental impact. Each person's purchasing choices directly and indirectly involve the consumption of natural resources and the generation of waste. The table below shows how small changes can make a difference.

Waste minimisation	Energy conservation
→ Avoid excess packaging → Avoiding buying items you don't need → Use your own shopping bags → Compost your own food scraps	→ Make sure your home is well insulated → Switch off appliances at the wall to reduce standby power loss → Purchase high efficiency Energy Star rated appliances → Switch off all incandescent light bulbs or LED
Transport	**Diet**
→ Carpool, walk, cycle or take public transport → Drive a fuel efficient car → Regularly inflate your tyres	→ Try vegetarian meals

FIGURE 2 Actions to reduce your ecological foot print. (Source:)

For more information on the ecological footprint of the Auckland region, see Ecological Footprints of New Zealand and its regions, 2003-04. Smith, N.J. and McDonald, G.W. (2008). New Zealand Centre of Ecological Economics, Palmerston North.

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