3.0

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.

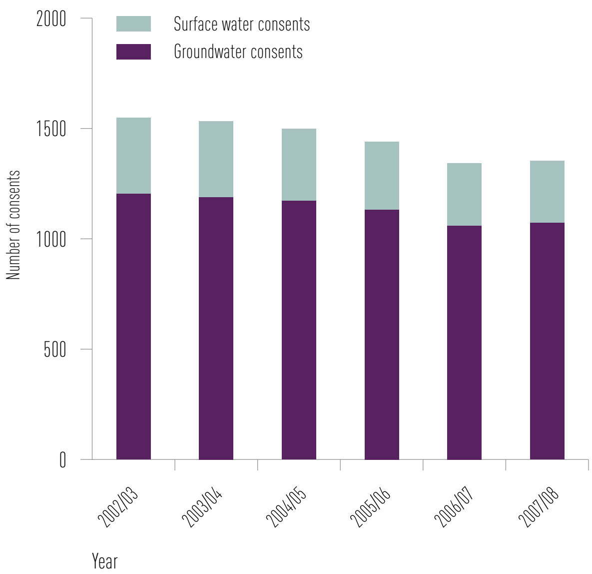

FIGURE 9 Groundwater and surface water take consents, 2002/03 to 2007/08. (Source: ARC).

Pressures: consumption and production

Figure 10 shows that, since 2002/03, water use has ranged from a maximum of 118 million m³ in 2004/05 to a minimum of 98 million m³ 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.

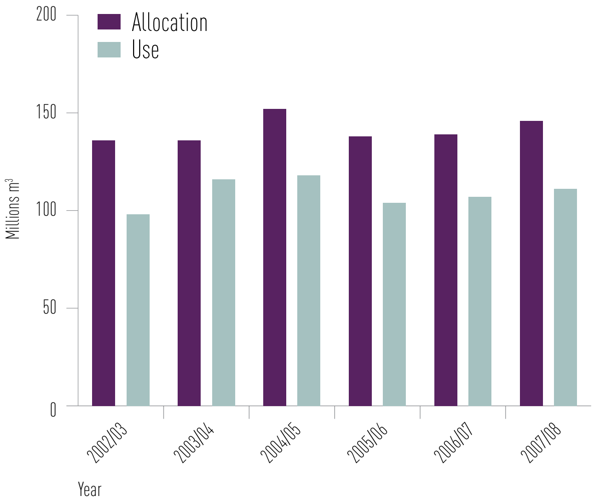

FIGURE 10 Combined groundwater and surface water allocation and use, 2002/03 to 2007/08. (Source: ARC).

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.

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).

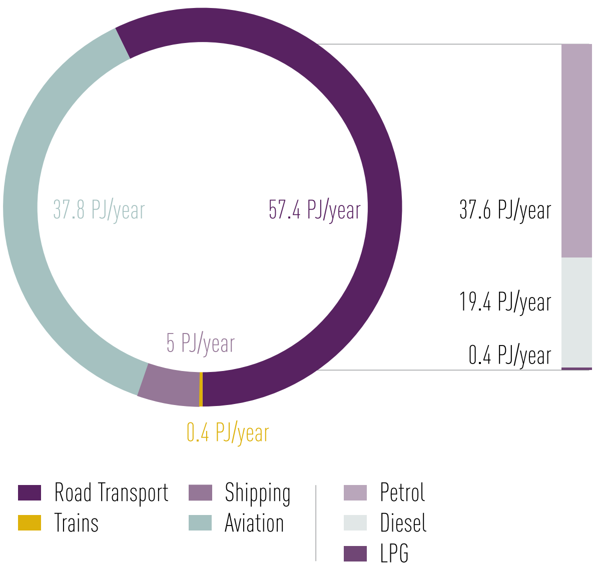

FIGURE 11 Transport energy use by type PJ/year (2008). (Source: ARC).

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.

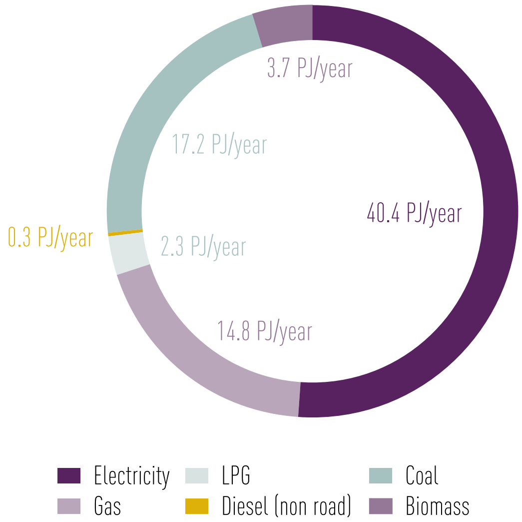

FIGURE 12 Non-transport energy use PJ/year (2008). (Source: ARC).

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.

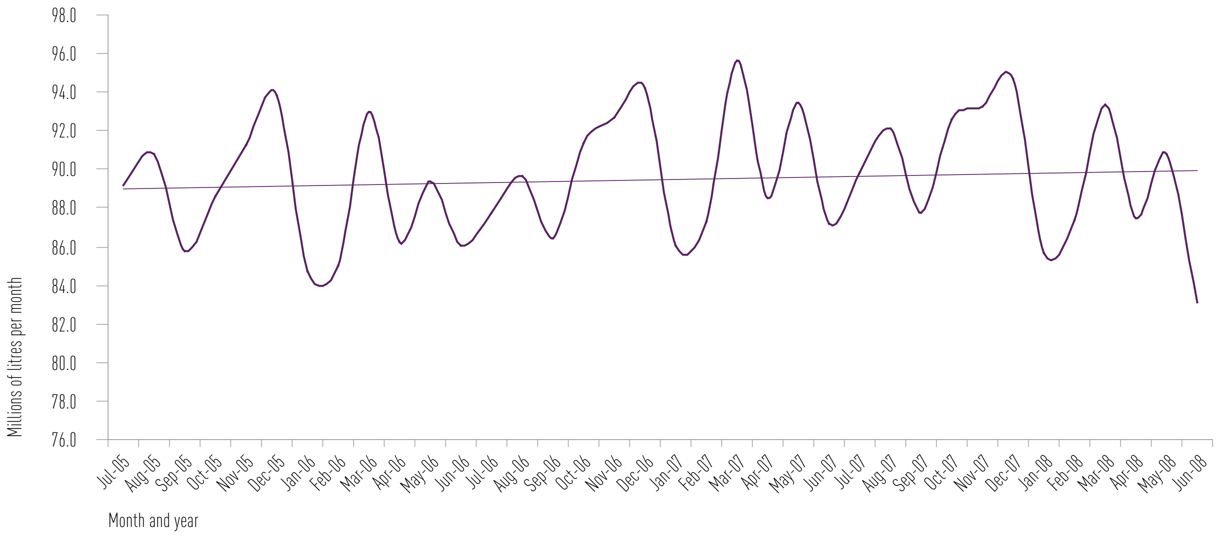

FIGURE 13 Petrol consumption in the Auckland region with trend line between July 2005 and June 2008. (Source: ARC).

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.

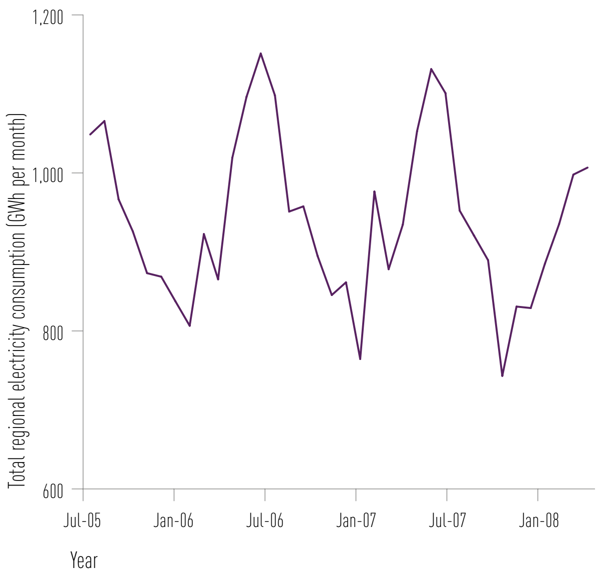

FIGURE 14 Regional electricity consumption (GWh per month) from July 2005 to January 2008. (Source: ARC).

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.

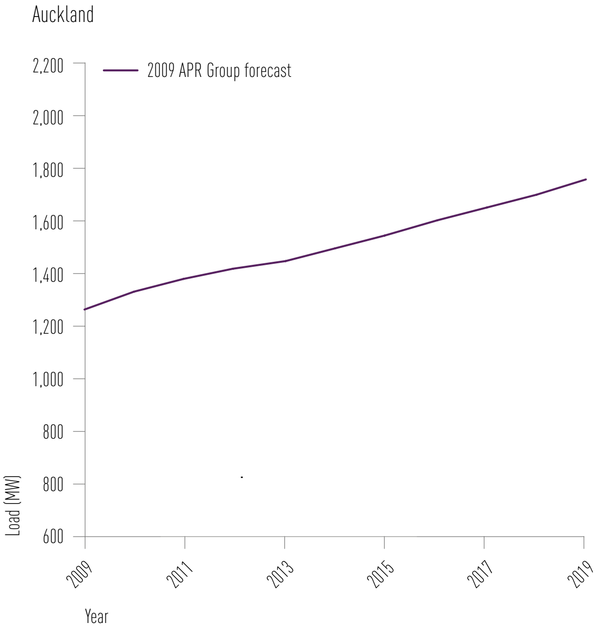

FIGURE 15 Predicted peak electricity demand for the Auckland region 2009 to 2019 (Source: Transpower Ltd).

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

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.

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.

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

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.

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.

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.

Pressures: consumption and production

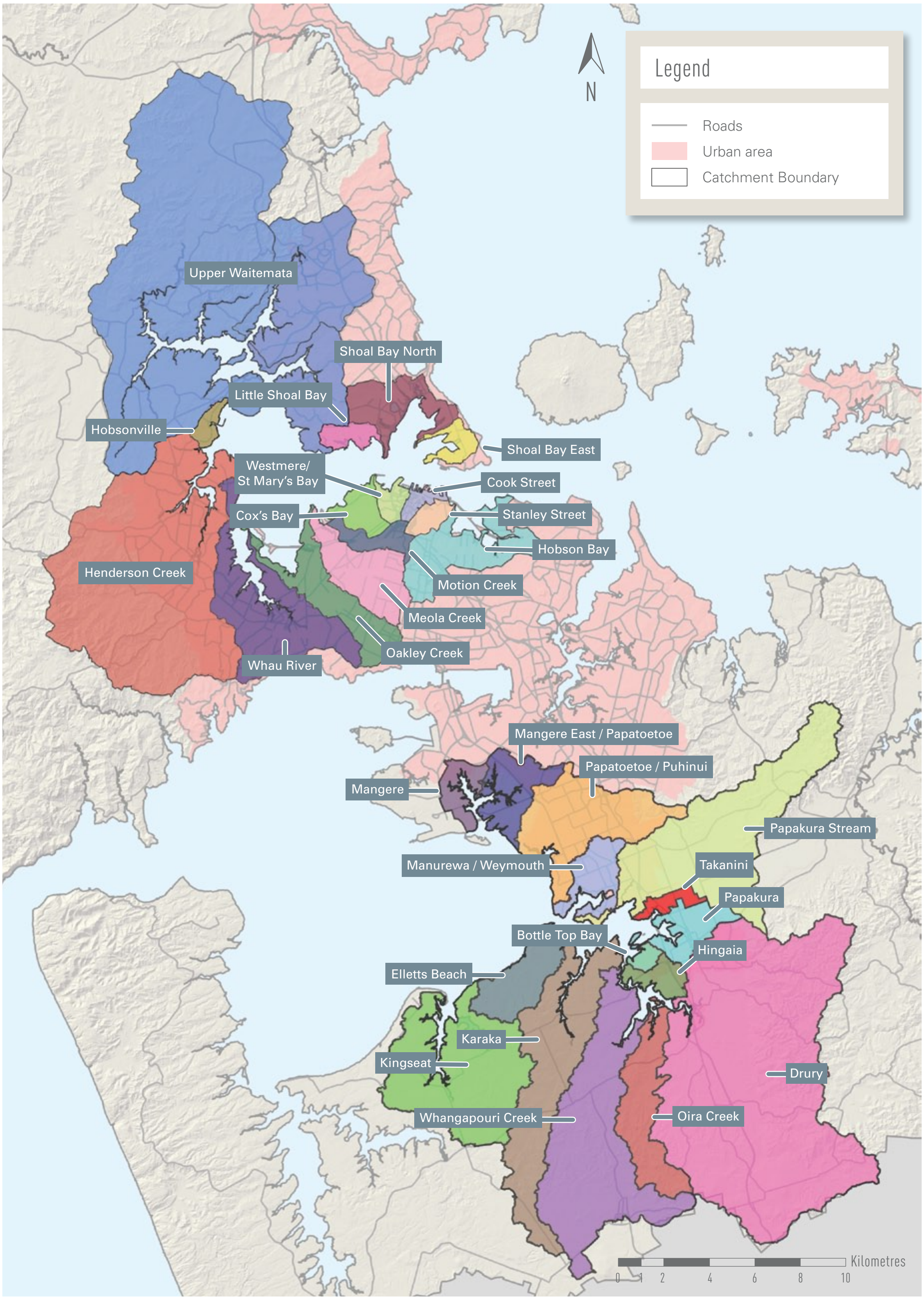

FIGURE 16 Location and extent of the middle Waitemata Harbour subcatchments and Pahurehure subcatchments in the south-east Manukau Harbour. (Source: ARC).

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

Pressures: consumption and production

For the Pahurehure subcatchments, large quantities of sediments (47 and 34 tonnes per km²) 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 km² respectively). The highest amount of copper is predicted to come from the Kingseat subcatchment (0.011 tonnes per km²).

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/km²) from each subcatchment within the Pahurehure subcatchment of the south-east Manukau Harbour for the 2009 calendar year. (Source: ARC).

Subcatchment	Predicted loads (t/km²)		
	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.

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 Componds (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).

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

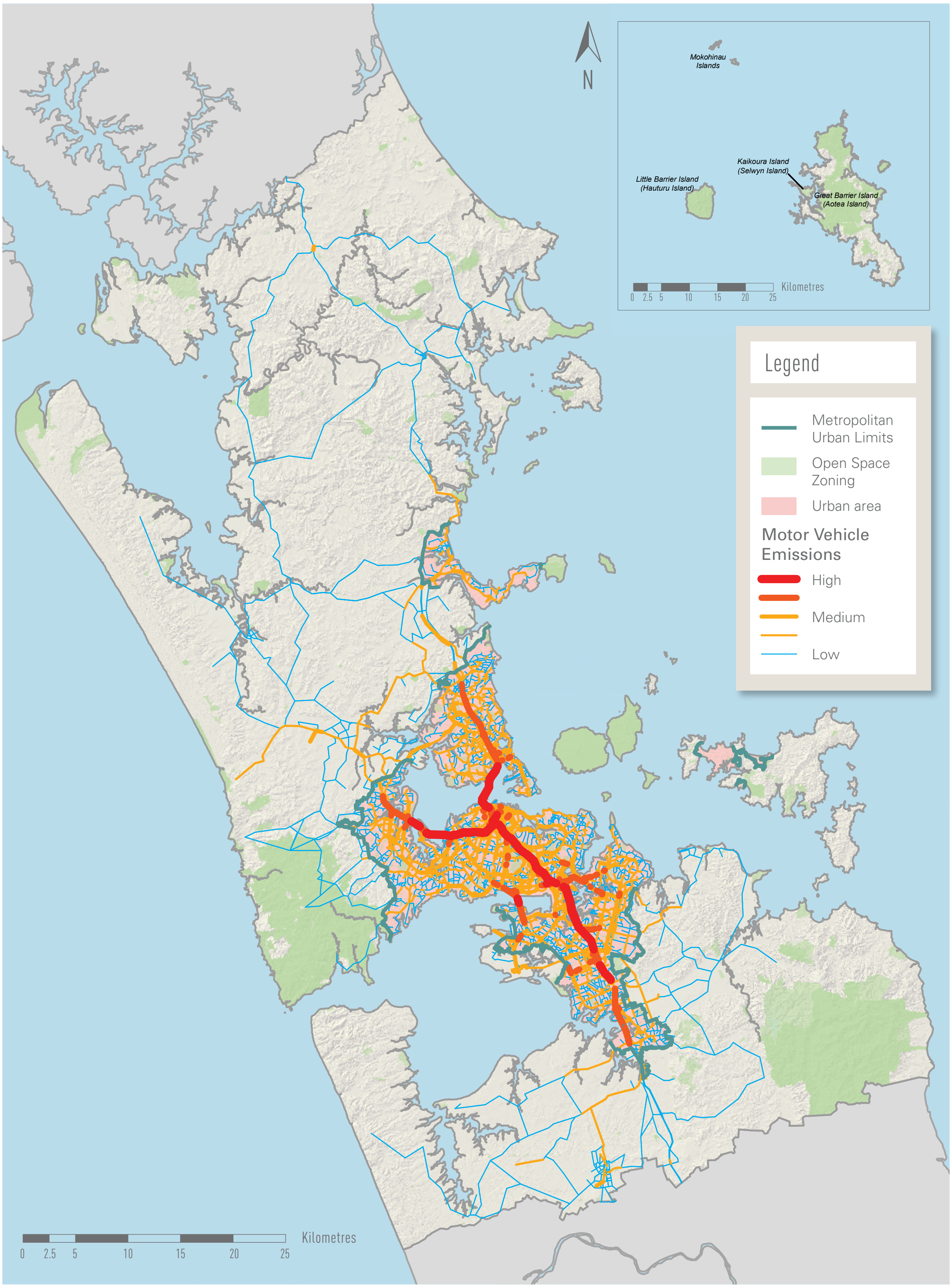

FIGURE 17 Motor vehicle emissions in the Auckland region, 2006. (Source: ARC).

Pressures: consumption and production

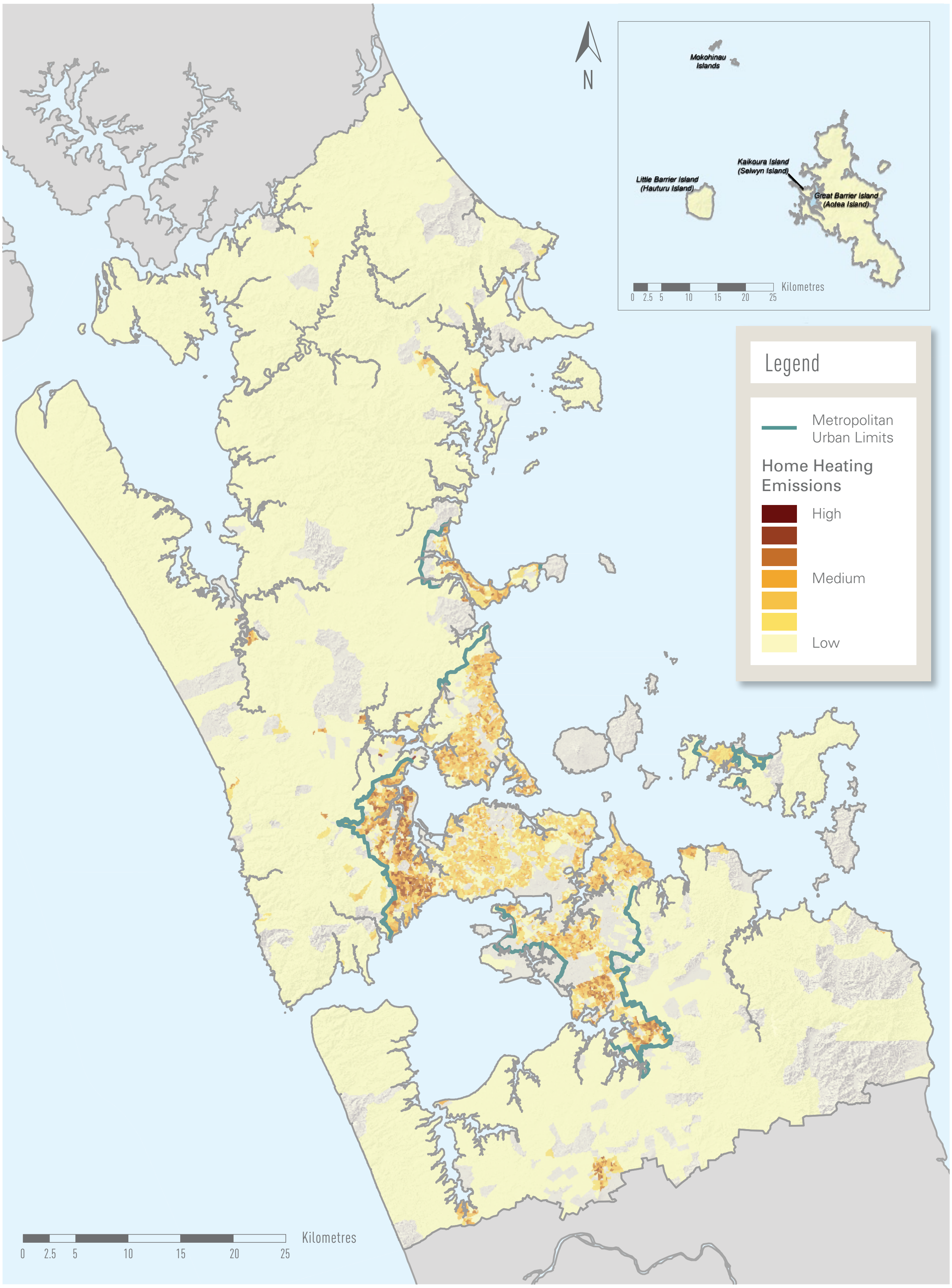

FIGURE 18 Home heating (analysis by meshblock method), 2006. (Source: ARC).

Pressures: consumption and production

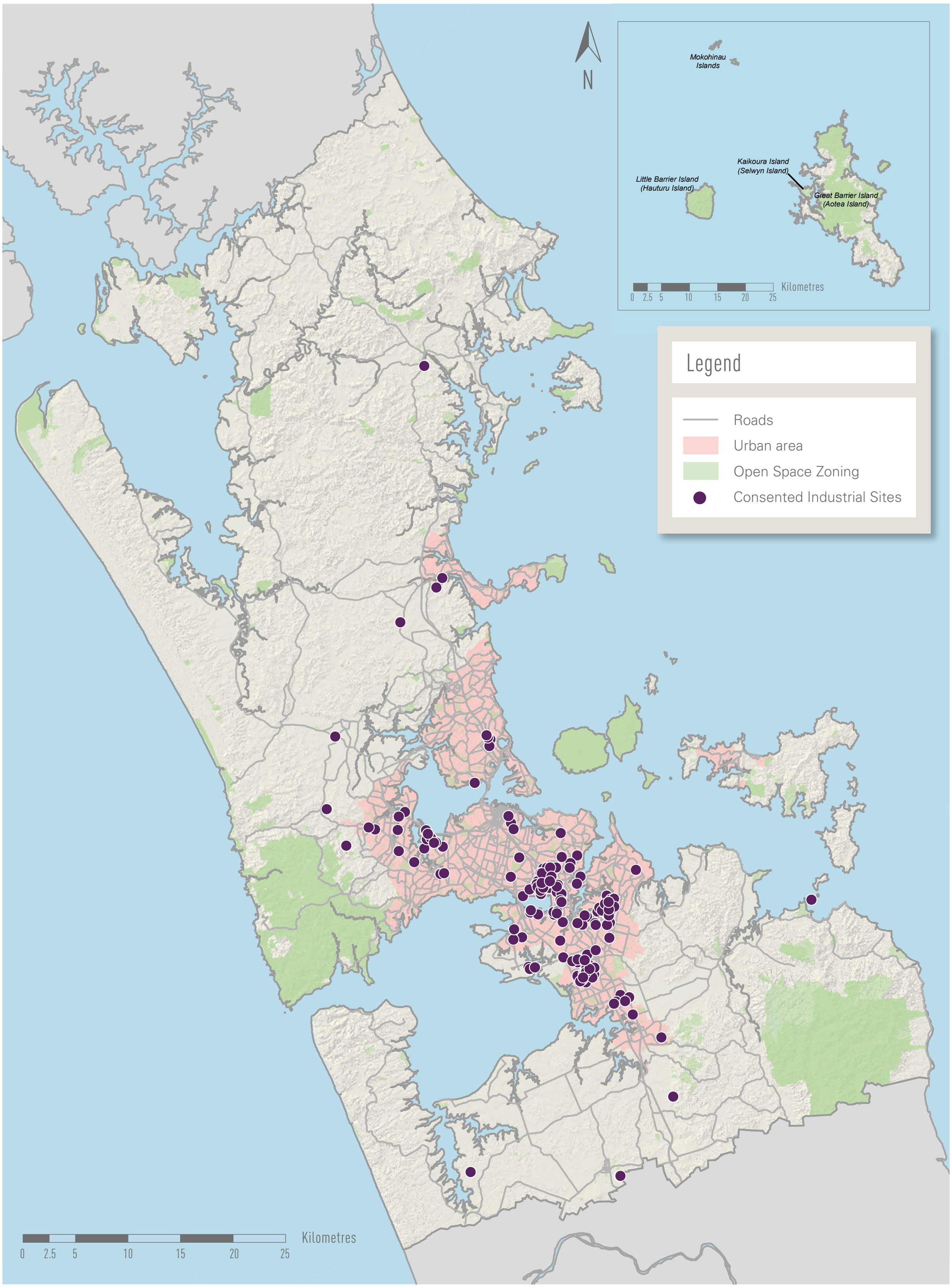

FIGURE 19 Location of consented industrial sites that emit PM_{10}, 2006. (Source: ARC).

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.

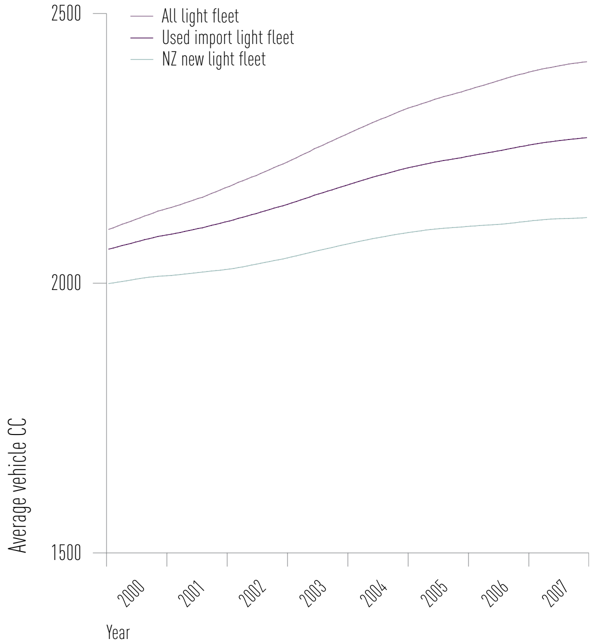

FIGURE 20 Light fleet average engine size in New Zealand 2000-07. (Source: Ministry of Transport).

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.

3.0

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

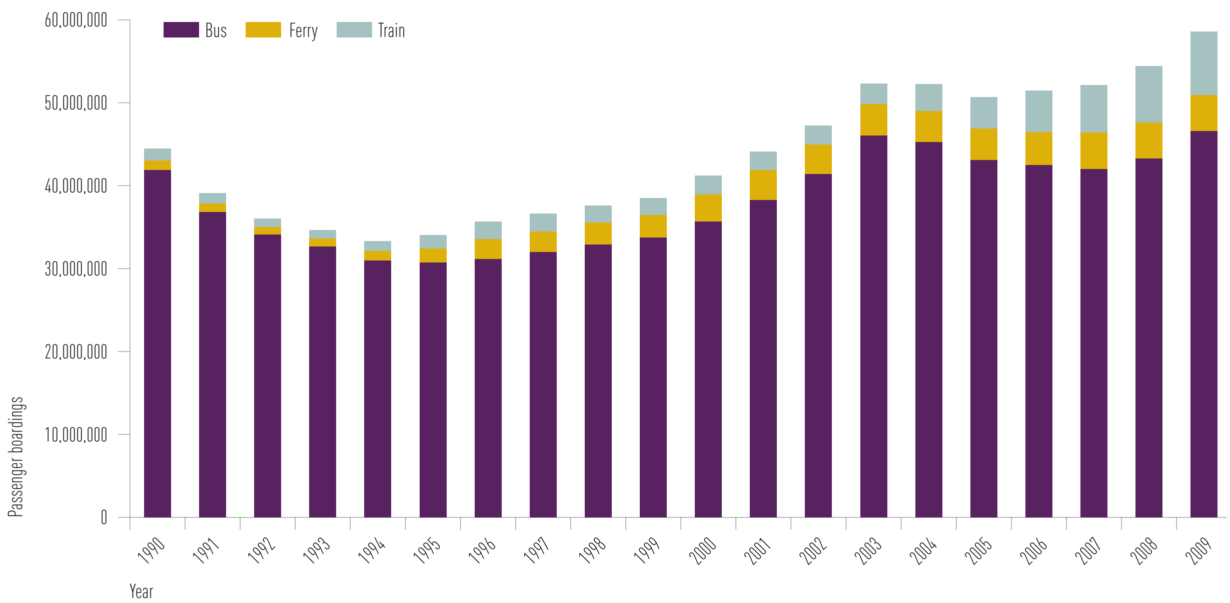

FIGURE 21 Annual public transport boardings in the Auckland region, 1990-2009. (Source: Auckland Regional Transport Authority).

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

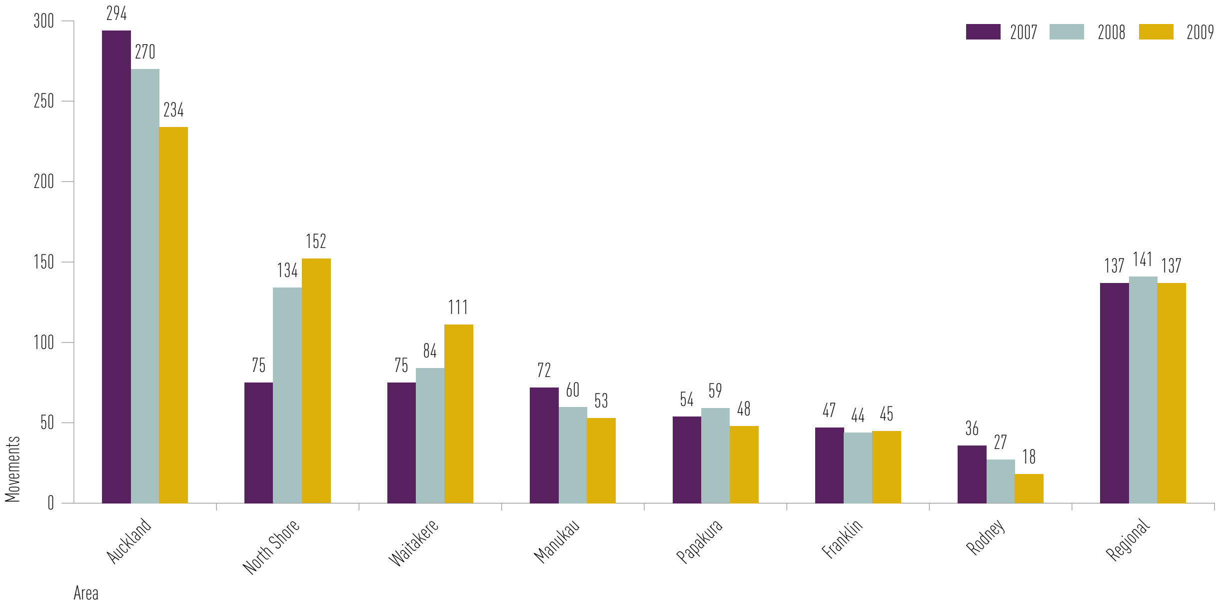

FIGURE 22 Average number of cyclist movements by territorial authority between 2007 to 2009. (Source: Auckland Regional Transport Authority).

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.

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

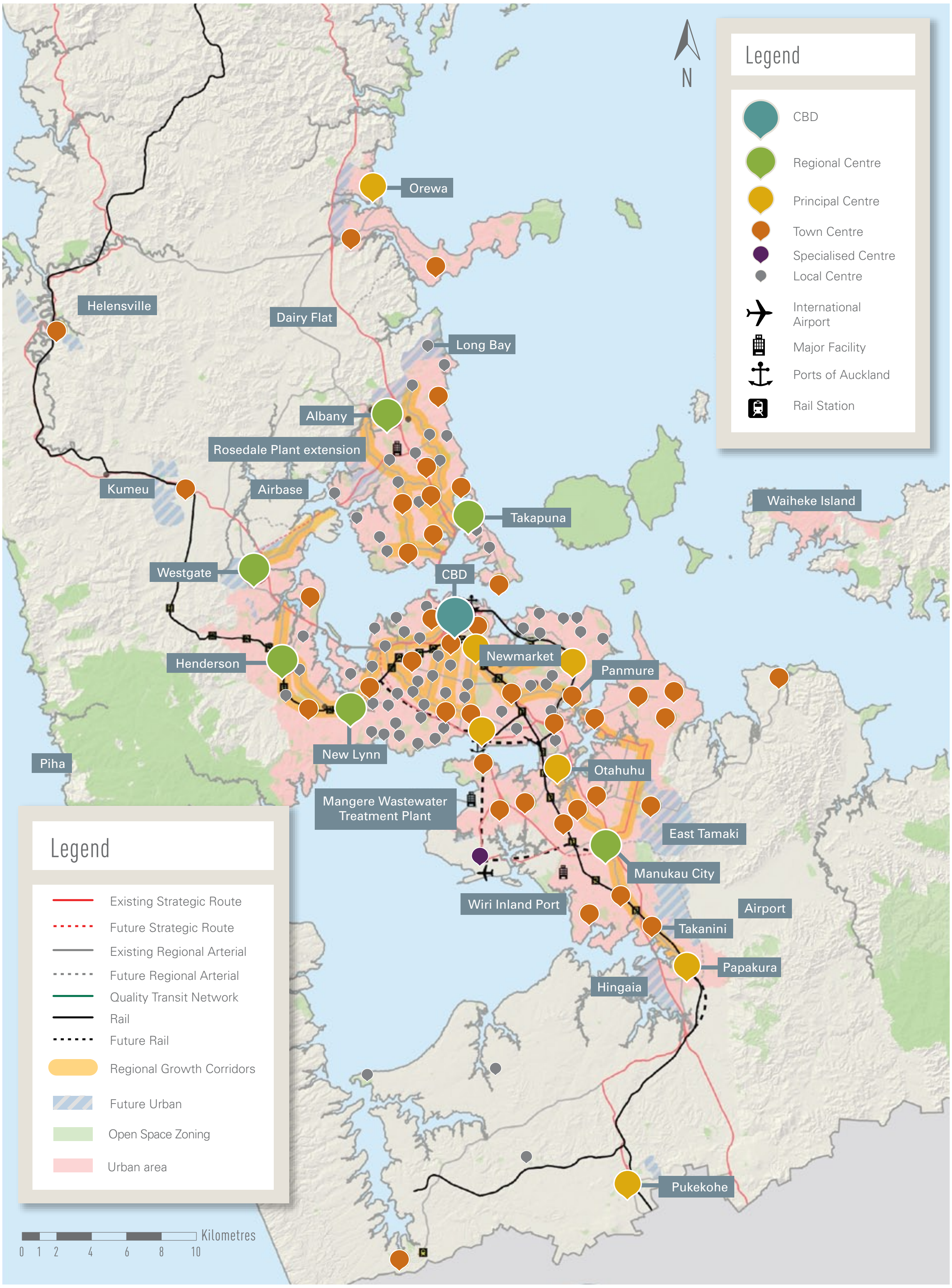

FIGURE 23 Auckland Regional Growth Strategy – Growth Concept, 1999. (Source: ARC).

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).

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.

Pressures: consumption and production

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.

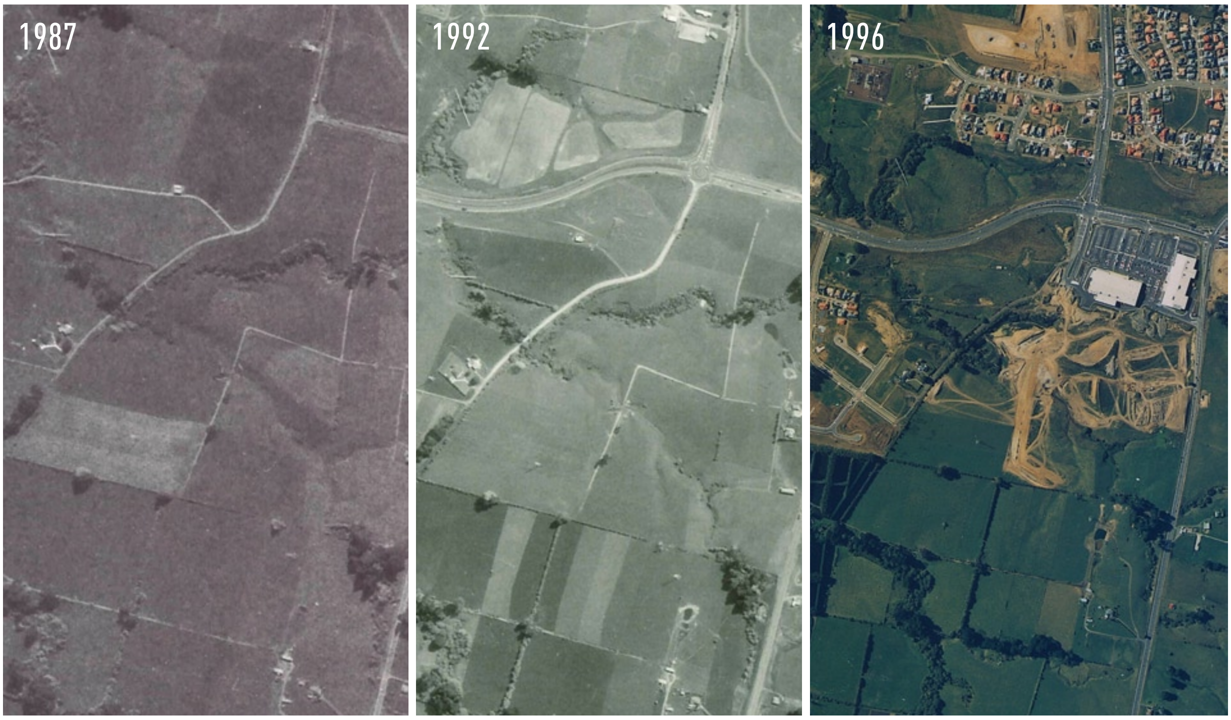

FIGURE 1 Botany Town Centre development, 1987 – 2006. (Source: ARC).

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.

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).

Pressures: consumption and production

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).

Pressures: consumption and production

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.

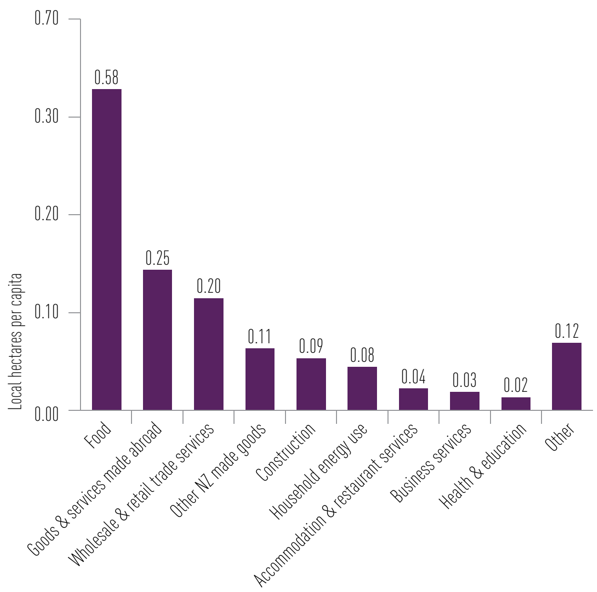

FIGURE 1 Ecological footprint of the Auckland region by goods and services purchased, 2003/05. (Source: Market Economics Ltd.).

[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.

Pressures: consumption and production

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.

Pressures: consumption and production

References and further reading

Auckland Regional Council, 2002. *Auckland water resource quantity statement 2002*. Auckland Regional Council Technical Publication 171.

Auckland Regional Council, 2006. *Auckland air emissions inventory 2004*. Auckland Regional Council Fact Sheet, reference AQ06-01.

Auckland Regional Council, 2007. *Home heating survey*. Unpublished findings prepared by Auckland Regional Council.

Auckland Regional Council, 2007. *State of the Environment monitoring: Auckland water quantity statement June 2005 – May 2006*. Auckland Regional Council Technical Publication 323.

Auckland Regional Council, 2007. *Growing smarter: The Auckland Region in the 21st Century. An evaluation of the Auckland Regional Growth Strategy 1999*. A technical report for the Auckland Regional Growth Forum. Auckland: Auckland Regional Council.

Auckland Regional Council, 2008. *Auckland Regional Land Transport Strategy: Report on progress 2007/08*.

Auckland Regional Council, 2008. *Capacity for growth study 2008 – interim report*. Auckland Regional Council Technical Publication No. 369.

Auckland Regional Council, 2008. *Regional parks visits report 2007/08*. A report prepared by Data Capture Basics Ltd. for the Auckland Regional Council.

Auckland Regional Council, 2008. *State of the environment monitoring: Auckland water quality statement 2006/07*. Auckland Regional Council. Technical Report 2008/011.

Auckland Regional Council, 2008. *The Auckland Regional Council hazardous waste programme report: December 2007 to December 2008*.

Auckland Water Group, 2008. *2006/07 Auckland water industry: annual performance review*. Auckland Water Group.

Beca, 2009. *Auckland travel time surveys performance monitoring report*. A report prepared for the Auckland Regional Council.

Buckett, N.R., 2007. *National impacts of the widespread adoption of heat pumps in New Zealand*. Building Research Association of New Zealand Ltd. Study report No. 169. Judgeford, New Zealand.

Donovan, S., Genter, J., Petrenas, B., Mumby, C. et al., 2008. *Managing transport challenges when oil prices rise*. A report prepared for the New Zealand Transport Agency. NZ Transport Agency Research Report 357. Wellington.

Donovan, S., Petrenas, B., et al., 2008. *Transport fuels and other energy forms – price forecasts to 2060*. Prepared for the Auckland Regional Council. Regional Land Transport Strategy Working Report No.05.

Hartill, B., Bian, R., Armiger, H., Vaughan, M., Rush, N., 2007. *Recreational marine harvest estimates of snapper, kahawai, kingfish in QMA 1 in 2004-05*. New Zealand Fisheries Assessment report 2007/26.

Kuschel, G. and Macmillan, A., 2009. *Environmental sustainability and public health policies.* A report prepared for the Auckland Regional Council. 2010 RLTS WP20.

Land Transport New Zealand, 2008. *2008/09 National land transport programme: northern region summaries*. Land Transport New Zealand, Wellington.

Livestock Improvement Corporation (LIC) Limited, 2009. *New Zealand dairy statistics: regional dairy statistics 2002-2008*. Livestock Improvement Corporation Limited, Hamilton.

Ministry of Economic Development, 2006. *New Zealand's energy outlook to 2030*. Ministry of Economic Development, Wellington.

Ministry of Transport, 2009. *The New Zealand vehicle fleet: fleet statistics 2008*. Available online at http://www.transport.govt.nz/research/NewZealandVehicleFleetStatistics/

New Zealand Transport Agency, 2009. *Network condition trends 2007-08*. NZ Transport Agency, publication reference 04 February 2009. Available from http://www.smartmovez.org.nz

Smith, N., and McDonald, G., 2008. *Ecological footprints of New Zealand and its regions, 2003-04.* New Zealand Centre for Ecological Economics, Research Monograph Series No. 14. Palmerston North.

Waite, D., Davies, P., Williamson, J., 2008. *Rural economies in the Auckland region – examining the transformation potential.* A report prepared by Ascari Partners for the Auckland Regional Council.