Chapter 2 — The City's Resources

CONTENTS

This Chapter is presented as follows:

2.1 INTRODUCTION

2.1.1 Purpose of Chapter

One of the key themes of the Resource Management Act is the integration of the environmental decision-making process. Integrated management in the decision-making process requires that Manukau City Council has an understanding of the natural and physical resources within the City, irrespective of whether they are under its direct statutory control.

This Chapter addresses the following matters:

- what are the current resources within the City?;
- what is their current quality state and what are the key human activities that impact on these resources?;
- what trends can be discerned?; and
- what are the resource management issues?

2.1.2 Statutory Context

The purpose of the Resource Management Act 1991 is to promote the sustainable management of natural and physical resources. Natural and physical resources are defined as "*including land, water, air, soil, minerals and energy, all forms of plants and animals, (whether native to New Zealand or introduced) and all structures*".

It should be noted that the primary responsibility for achieving integrated management of the natural and physical resources of the region lies with the Auckland Regional Council. The ARC is directly responsible for the control of discharges of contaminants into or onto land, air or water, and such matters as the maintenance and enhancement of water quality, soil conservation etc.

Nevertheless, territorial authorities such as Manukau City have a significant role at the local level as they are required to establish objectives, policies and methods to achieve "*integrated management of the effects of the use, development or protection of land and associated natural and physical resources of the district*" (S31 Resource Management Act 1991).

It is also evident that the development of District Plan objectives and policies and/or the consideration of resource consents for particular activities cannot be undertaken without consideration of the impacts those activities will have on other resources which may be under the jurisdiction of other regulatory agencies, in particular the Auckland Regional Council.

2.1.3 Information Base

It is important to note that this Chapter describes the state of natural and physical resources in the City so far as is possible given the current extent of monitoring those resources. The amount of information available on each of the natural and physical resources and consequent depth of analysis is variable.

For example, there is a great deal of information available in respect of some of the natural resources but very little meaningful information in respect of "structures". Additionally, some of the divisions of resources are somewhat artificial, as "soils" and "minerals" and arguably some of the other separately defined resources, are integral to any discussion of the "land" resource which is, of course, the real focus of the District Plan. The "land" resource section should therefore be read as an overview discussion and does not

analyse the state of the resource and subsequent issues to the degree of detail that is evident with the other resources.

It is these gaps in information that should be the focus for future monitoring (see Monitoring Statement in Chapter 1 and Monitoring Procedures Section of each Chapter). Clearly, the policy analysis which resulted in this Plan has been constrained by this information shortfall. A full State of the Environment Report will be required following Plan notification and in particular systematic environmental trend monitoring needs to be further developed for Manukau City.

2.2 LAND/WHENUA

2.2.1 State of Resource

Land is also more than a simple physical commodity. It is a source of identity for many people, and in Maori law the people are the land — they are the descendants of Papatuanuku (the earth mother). The earth passes through women. The word 'whenua' means both 'land' and 'placenta'. The right to a place was by descent from the people of that land, the tangata whenua.

The land resource in this section is dealt with both as a "surface" on which to undertake activities and in terms of its intrinsic landscape/landform value in human terms. This section should be read in conjunction with the other sections of the chapter but especially "soils" and "minerals".

In terms of landform, landscape, and land use, the land resource within the district can be generally divided into two main areas. These are:

(a) The low lying land west of the Point View Drive to Redoubt Road ridge and bordering the waters of the Manukau Harbour, the Tamaki Estuary and the Hauraki Gulf, referred to as the "urban area"; and

(b) The undulating hill country and river valleys east of the Point View Drive ridge to the Firth of Thames, and the area in the west of the City comprising rural areas in Puhinui and parts of Mangere, and land designated for the Auckland International Airport referred to as the "rural area" below.

2.2.1.1 The Urban Area

The urban area comprises approximately one-third of the total area of the City. Most of the land is low-lying and has a gentle to moderate slope.

Distinctive geographic features of the urban area are the volcanic cones and the coastline.

Many of the volcanic cones have been quarried for basalt and scoria, but the following are important landscape features: Mangere Mountain, Pigeon Mountain, Te Puke o Tara [AM123], McLaughlins Mountain.

A distinguishing natural feature of the coastline is its diversity, ranging from pohutukawa-lined cliffs around Musick Point to the tidal flats of the Mangere Inlet. The coastline is highly valued for its scenic, recreational and cultural values. However, only a small area of the coastline within the urban area is in the form of beaches suitable for a wide range of recreation activities.

Land within the urban area has three characteristics which have made it, and will continue to make it, particularly suitable for urban development. These are:

(a) The landform is low-lying with a gentle slope and is capable of being serviced relatively easily for urban development.

(b) The land is strategically located within the narrow corridor between Auckland the rest of New Zealand to the south. All the major land transportation systems and utilities pass through this corridor.

(c) There are no major natural hazards that severely restrict or prevent urban development.

The isthmus, northern and western sectors of the Auckland Region do not have these three characteristics to the same degree. As long as there is sustainable economic growth within the New Zealand and Auckland economies, Manukau City will continue to attract urban development due to these advantages.

One of the major benefits of the three characteristics specified above is that the district has, in the past, been able to provide a significant quantity of affordable housing. Consequently, the largest land use (approximately 7,000 ha) within the urban area is residential. Residential development has mainly been in the form of single, one-storey, detached houses on sites of about 600m² although in recent years there has been demand for more intensive forms of residential development.

Other important activities are industry and commerce (2000 ha).

The general pattern of urban development is low density when measured in terms of floor area per hectare. A major factor contributing to the low density of development is the extensive areas of public open space throughout the City in the form of reserves, schools, golf courses and similar uses.

The most intensely developed area in the district is the Manukau City Centre.

2.2.1.2 The Rural Area

The rural area of the district east of the Point View to Redoubt Road ridge contains an area of about 350km². Distinctive features of the landform are the ridge and valley topography and the extensive coastline which borders the Hauraki Gulf and the Firth of Thames. The rural area in the west of the City is much smaller and generally flat to undulating and includes Puketutu Island.

The major land uses in the rural part of the district are agriculture and forestry. In the valleys, and in the western area, horticulture has been established. On the hills and ridges, pastoral farming and forestry are the dominant land uses.

Most of the land adjoining the Hauraki Gulf coastline from Howick to Beachlands / Maraetai is elevated, north-facing, is reasonably close to the urban area and has landscape character which is attractive for those seeking a rural lifestyle.

Beachlands and Maraetai are the two major settlements of the area. Originally established as holiday settlements, both are developing as 'dormitory' suburbs of the urban area. The recent establishment of a reticulated sewerage system will encourage further residential development. Smaller rural and coastal settlements exist at Whitford, Clevedon, Orere Point and Kawakawa Bay.

Generally, the rural landscape of Manukau City embodies a diverse range of characters and quality. These range from areas of largely pristine coastline and native forest which are of the highest quality and vulnerability, to substantially modified areas which border the existing urban edge of the City.

2.2.2 Trends

On average about 100 ha of the "urban area" (as defined above) has been urbanised each year in recent years. Average residential lot size has reduced over the last decade as the intensity of development has increased in accord with market preferences. This intensification has occurred mostly through infill housing and medium density housing developments in greenfield areas (such as Botany Downs in East Tamaki). Nevertheless, the intensity of development within the urban area is, on average, low when compared with that within Auckland City.[AM123]

The Growth Concept in the Auckland Regional Growth Strategy and the Regional Land Transport Strategy contain a policy direction towards more intensive, quality urban development. These Strategies indicate where future growth should occur: growth within the existing urban areas will be directed as a priority within and around town centres that are well served by public transport, while new greenfield residential development will take place principally in Flat Bush.[AM123]

In the business sector market dynamics has led to a breaking down of the traditional distinction between retailing and industry but an increased degree of centralisation in business activity. There are also increasing demands to provide and protect public open space and heritage resources in the urban areas to provide a more livable and diverse environment.

In the rural area there has been a general trend towards more intensive forms of rural activity. There is an increasing demand for dwellings erected for rural-residential or "countryside living" purposes particularly at or near the urban edge and in coastal locations. Horticulture and forestry have resulted in significant landscape modification in the form of shelterbelts and exotic pine plantations. This has resulted in a perceived reduction in the diversity of landscape types.

The rural area is increasingly seen as a recreational resource by urban dwellers and this in turn can lead to tension between urban and rural residents as increasing demands for public access to rural and coastal amenities conflict with the business of farming. Increasingly, recreational facilities such as hotels and golf courses are seeking to establish in the rural area.

2.2.3 Resource Management Issues: LAND

(a) Manukau City's low density urban form has high environmental and financial costs

The land within the City which has characteristics that make it suitable for urban development is a scarce resource. While constraints on the spatial expansion of urban Manukau are arguably not as great as elsewhere in the Auckland Region, it is widely accepted that the City has reached or is approaching a number of servicing and environmental thresholds. These thresholds mean that urbanisation cannot occur anywhere outside the current metropolitan limits (as defined in the Auckland Regional Council Policy Statement) without compromising major resource and environmental values; coming up against major physical constraints to development, and/or triggering major expansions or duplications of infrastructure items.

The disadvantages of low density development in Manukau include:

- large investments in roads and utilities which increase per property served;
- growing demand for services spread over an increasing area;
- conflicts with the desire and need for improved public passenger transport;
- access to key service points become difficult;

- very high daily private vehicle use with resulting congestion, noise, pollution, community severance and stress;

- high proportions of households living beyond comfortable walking distance to shops, community facilities and schools; and

- the trend to centralisation in business activity has resulted in less energy efficiency.

In summary, low density development raises energy, social, environmental and financial costs. Any future restraint on personal vehicle use brought about by oil supply, cost or attempts to lessen pollution or global warming would place Manukau City in a vulnerable position unless it can adapt.

(b) Significant landscape and heritage features within the City can be threatened by urbanisation

In the past urban development has resulted in the destruction of natural landforms and heritage features at the bulk earthworks stage. Many of these areas have cultural significance particularly to tangata whenua.

The coastal environment is particularly sensitive in this regard but the volcanic features which make parts of Manukau unique have also been badly affected in the past. While some landscape and heritage features have been incorporated in the public open space network in the past, once land has been subdivided and developed the opportunity to provide for additional areas of public open space is limited. Consequently, there is a need to identify public open space for landscape and heritage protection well in advance of the urban development process.

(c) Recreational and lifestyle uses often foreclose or otherwise compromise other land use options such as livestock farming.

The rural area is a resource that is becoming increasingly appreciated by urban dwellers for its landscape and recreational qualities. This is manifested in the establishment of properties for "countryside living" and recreation facilities such as "destination" hotel resorts, country clubs and horse riding establishments. It also brings a demand for the provision of public access to and protection of significant recreational resources like the coast and native bush.

Seen from the primary producer's perspective, the rural land resource is an economic asset which must be utilised in a business-like manner. Urban pressures increase land values and consequently the rating burden while demands for public access and heritage protection are seen as an unwelcome interference in private property rights and the primary producer's business. There is a need to recognise that rural Manukau is a significant part of the Region's rural economy producing fresh produce and milk for the urban area and containing large areas of livestock, farming and forestry.

(d) The rural landscape has unique and diverse qualities worthy of protection

More intensive farming practices and the impact of horticulture and forestry have significantly modified many rural landscapes. While it is argued by landscape professionals that the establishment of tall shelter belts, for example, results in the loss of the sense of being within a plain or basin, others like the sense of order imparted by regular rows of trees

lining rural roads. Pine plantations with their consistent colour, texture and form also evoke a mixed response although the harvesting phase is clearly visually unattractive and potentially environmentally damaging (e.g. sediment discharge).

There is more unanimity, however, in terms of the intrusion of major urban related structures e.g. high tension power lines in the rural landscape. The number and insensitive siting of imposing rural residences and their road access as well as the increasing proliferation of large business signs is also often seen to detract from the rural landscape.

2.3 WATER/WAI

2.3.1 State of Resource

2.3.1.1 The Importance of Water

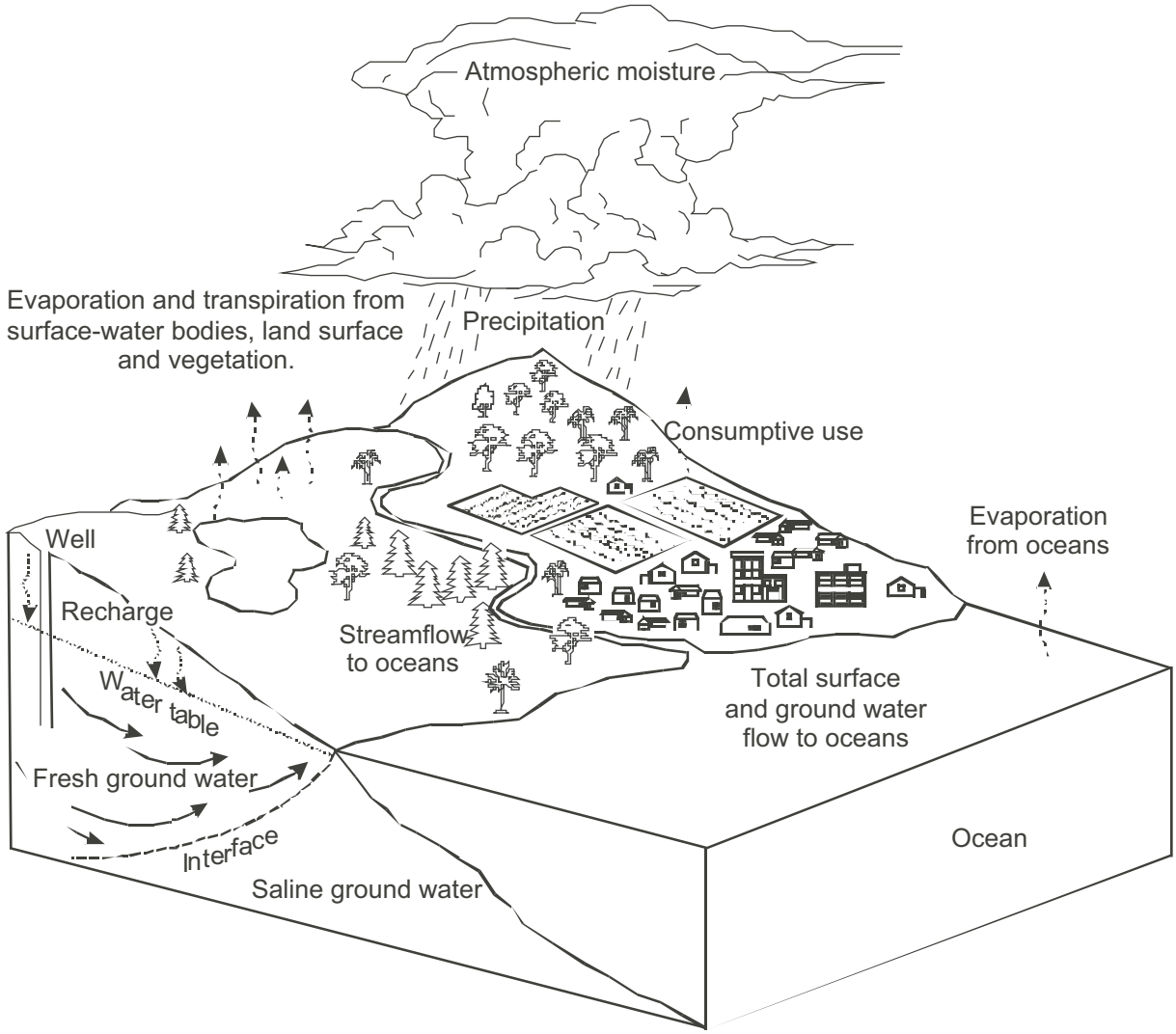
Water (Wai), like land, plays an important role in Maori life and provides physical and spiritual sustenance. Water is viewed as life-giving and is used in various rituals and customs. Just as there is a physical water cycle moving through the landscape — from rain to stream, river and ground water and down to the sea — there is a spiritual cycle. Water at its most spiritually pure falls as rain. The physical quality of the waterways, including the sea, is essential to Maori spiritual wellbeing.

Water is a crucial element necessary to maintain all life forms, hence there is a need to maintain its quality at a level which is consistent with safeguarding its life supporting capacity. Failure to take appropriate action can lead to environmental damage and endanger the health of the population if they come into contact with or use contaminated water.

A brief explanation of the water cycle (see Figure 2.1) shows how the natural circulation of water can be contaminated by both nature and human activities. Water precipitates from the sky as rainfall, hail or snow, and falls on the ground. Some is absorbed by the ground and then may flow underground to reach streams or be stored in porous soils and aquifers.

Water which directly runs off the surface or passes underground, may absorb or carry pollutants such as chemical sprays, animal faeces, spillages, debris from roads etc. Water may then pass through the aquifer and enter streams or the sea at some remote point. Direct runoff may enter streams either immediately or through a piped drainage system if the area is urbanised.

As water passes through either stream or aquifer, pollutants are spread throughout the system where they may damage the immediate environment or harm water users. Water may pass into lakes or the sea where during the process of evaporation water rises as vapour to the sky to eventually form clouds which result in precipitation, thereby completing the water cycle. The process of evaporation will leave behind the water-borne pollutants which result in degradation of the receiving waters. The natural water cycle process may collect and spread pollutants throughout the environment hence there is a need to develop policies to control the release of pollutants into the environment.



Source: Council or Environmental Quality. Environmental Trends, (Washington, DC CFQ, 1989). P 21

FIGURE 2.1 THE WATER CYCLE

2.3.1.2 Quality

A considerable amount of water quality monitoring is undertaken around the region by the Auckland Regional Council. This includes monitoring at some sites within Manukau City and around its coastline. Five types of monitoring are undertaken:

(a) long term baseline data collection for streams

(b) target catchment surveys

(c) baseline data collection for the saline environment

(d) bathing beach water quality surveys

(e) groundwater quality

In addition to these programmes, Manukau City Council undertakes one-off studies of water quality, for example, on Whitford landfill leachate, Otara Lake, and water quality at rural coastal settlements.

Results of recent water quality work in Manukau can be summarised as follows.

(a) Long Term Baseline Data for Streams

Water quality in many streams in Manukau City is poor. Urban streams in particular are often severely degraded by multiple discharges. In common with most Auckland streams, Manukau stream catchments are often relatively small and have low flows in summer. These less than average flows, reduce the assimilative capacity of the water body.

A further factor is that both soils derived from weathered Waitemata Group rocks, which are present in the Pakuranga/Howick and Whitford through to Alfriston areas, and the soils derived from sedimentary rocks in the western part of the city, are readily erodible, which results in runoff and some fine material always being present in waters. Natural in-stream values may also have been severely compromised by removal of adjoining vegetation, piping or channelisation, although these practices are now being employed more selectively than in the past.

Streams in Manukau City which have been shown to be "degraded" and unsuitable for many uses on a majority of occasions, (according to the New Zealand Water Quality Index[1]), include the Otara Creek (monitored both at East Tamaki Road and at Hills Road, lower down the catchment), Pakuranga Creek tributaries at Guys Road, Greenmount Drive, Botany Road and Bells Road, and the Lower Papakura Stream. The Puhinui Stream may also be degraded, but monitoring results do not yet demonstrate this conclusively.

In general, sites with the greatest extent of urbanisation show greatest compromise of water quality, and water quality tends to decline over time as catchments are developed. However, poor water quality can and does also occur in rural areas as a result of dairy shed discharges, intensive grazing practices, removal of riparian vegetation, and the practice of allowing stock access to stream banks and beds.

The Otara (East Tamaki Road) monitoring site, for example, shows a strong influence from rural wastes. Suspended sediment and faecal coliform levels are two major contributors to water quality degradation across all sites.

(b) Target Catchment Surveys

In Manukau, the Tamaki catchment has been intensively studied since 1986. It is one of the most "at risk" water systems in the region due to the high degree of urbanisation/ industrialisation of the catchment, limited flushing of the estuary, and the presence of several main arterial roads.

Monitoring shows the water quality of many of the fresh water streams in the catchment to be generally poor in relation to other streams in the Auckland region, as detailed above. (Nevertheless the worst monitoring results in the catchment were in fact on the isthmus or Auckland City side). This is because of the relatively intensive level of development and small dilution capacity of the streams. For the estuary itself, upper estuary sites show poorer water quality than lower sites, due to polluted fresh water inputs and less effective tidal flushing.

1. Smith, D G (1989) Water Quality Indexes for Use in New Zealand's Rivers and Streams, DSIR Water Quality Centre, Publication 12.

Monitoring of shellfish quality and sediment quality has also been undertaken to try to identify trends and detect pollution sources more specifically. Oysters positioned upstream absorbed high levels of trace elements, especially copper (predominantly road runoff eg from brake linings and radiators, but also from industrial and agricultural sources) and zinc. The same pattern occurred for synthetic organic contaminants. Dieldrin, a pesticide, was of concern, as were DDT and PCB. Levels of tin, lead, copper and zinc were high in sediment at some sites.

(c) Baseline Data for the Saline Environment

This monitoring programme covers the Manukau Harbour and includes water quality, shellfish, benthic ecology and sediment quality. The north eastern Manukau Harbour has degraded water quality. Northeastern sites in the harbour show elevated biochemical oxygen demand and enterococci levels[1] and phosphorus, nitrogen and faecal coliform concentrations are relatively high with levels showing a gradient down the harbour towards the Manukau Heads. These levels are primarily a result of effluent from the Manukau Wastewater Treatment Plant.

Southern sites are better oxygenated and less contaminated, but inorganic nitrogen and enterococci levels can sometimes be elevated for reasons other than oxidation pond discharge. For example, stormwater discharges from the airport and from industrial development impact upon the Pukaki Creek monitoring site.

(d) Bathing Beach Water Quality

Water quality at 11 bathing beaches in Manukau is sampled each summer as part of a regional sampling programme. Beaches sampled are:

- Weymouth
- Bucklands Beach North
- Bucklands Beach South
- Howick Beach
- Sunkist Bay
- Shelly Bay
- Omana West
- Te Pene
- Maraetai
- Waiomanu
- Umupuia Beach

Enterococci results in 1993–94 were generally very good with only occasional incidents where single sample maximum levels were exceeded. These were of short duration and likely to be a result of stormwater discharges containing faecal inputs of either human or animal origin.

1. Enterococci levels are now used as the preferred health related indicator of water quality

(e) Groundwater Quality

Groundwater quality at priority sites is also monitored by the Auckland Regional Council. There are four main aquifers across the city at varying depths (see following discussion of water quantity). Volcanic aquifers are close to the surface and are therefore susceptible to pollution. Some initial work has been undertaken for the Greenmount volcanic aquifer, which underlies parts of the East Tamaki industrial area, and this aquifer does appear to be degraded. The volcanic aquifer in the Papatoetoe/ Wiri area is also susceptible to pollution. Water from the sedimentary Pleistocene aquifer sometimes has an elevated iron content (for example, in the Clevedon Valley). The Waitemata Group sandstone/mudstone aquifer below this is the main aquifer in Manukau City. Water from this aquifer sometimes has an elevated boron content, which may increase with bore depth and proximity to geological faults.

2.3.1.3 Quantity

The majority of the City's population and industry obtains its water supply from the regional bulk water supply system, via municipal supply lines. The largest proportion of regional water requirements comes from storage dams in the Hunua Ranges. However, residents in the rural areas of the City, including coastal settlements not serviced by the bulk supply system, obtain water from sources such as tank water, groundwater and watercourses.

The main uses of groundwater in quantitative terms are for horticulture and industry, the former usually because of limited summer flows in streams and the latter for cost reasons, as using groundwater may be cheaper than paying bulk water charges.

As noted above, there are four main aquifers in the city. Volcanic aquifers are nearest the surface. They can yield moderate quantities of water but they are present only in localised areas, which limits their overall utility. In flatter western parts of the City there is a recent sedimentary (Pleistocene age) sand/silt/gravel aquifer in reasonable thicknesses. Below this again is the main aquifer in Manukau, the Waitemata Group sandstone/mudstone aquifer, which has moderate water-producing capability and generally yields very good quality water. The deepest Jurassic age greywacke aquifer underlies the western part of the city at great depths and outcrops at the surface in some of the eastern parts of the City. It is generally a poor, but sometimes moderate, water producer.

Groundwater resources in the Clevedon Valley and thermal groundwater resources at Whitford have management plans controlling allocation. There are no current restrictions on the taking of groundwater in Manukau for quantity reasons. Although there are only a limited number of industrial users the groundwater resource in the Wiri area from the Waitemata Group rock aquifer (below the volcanic aquifer) is now fully allocated. The volcanic aquifer under McLaughlins Mountain which formerly supplied Papatoetoe, is now used only as an emergency water supply.

Surface water was formerly restricted in the Papakura Stream catchment, but this is no longer the case as demand has decreased. Stream flows are monitored for a number of rivers and streams in Manukau apart from the Taitaia and Papakura Streams. These include the Wairoa River, the Aroaro Stream in the Ness Valley, the Orere River, Turanga/Mangemangeroa tributaries and the Puhinui Stream.

2.3.2 Trends

To make any meaningful statements about trends in water quality or quantity, long term monitoring programmes with considerable inputs of resources are required. These resources are not always available and only a selection of sites are monitored. A further problem is the high number of variables affecting water quality, which makes it difficult to make definitive statements.

Despite some particular improvements, for example through reductions in sewage pump station overflows, water quality in urban streams monitored in the city has not improved over time and in some cases has declined, as catchments are progressively developed for urban purposes.

On the other hand, water quality in the Tamaki estuary, which is already degraded, does not appear to be getting worse over time, although trace elements and synthetic organic contaminants are long lasting and can have long term biological effects. Nor does water quality in the Manukau Harbour appear to be declining over time. In fact there were significant improvements in faecal coliform concentrations at northern sites in 1990 and 1991, mirroring changes in effluent concentrations at the Manukau Wastewater Treatment Plant.

It is even more difficult to make meaningful statements about trends in water quantity, although the water shortage of 1994 highlights the need to monitor water supplies across the board. Land use changes need to be monitored in terms of their effects on the quantity of water in streams and aquifers as there are some areas where supplies are approaching full allocation, as noted above.

2.3.3 Resource Management Issues: WATER

2.3.3.1 Management Responsibilities

While the Auckland Regional Council is responsible for any resource consents with respect to water, Council has responsibility to consider land uses which impact on water quality. The issues relevant to council's role with respect to water quality and quantity are identified in points 2.3.3.2(a) to (j) and 2.3.3.3(k) to (m) below.

2.3.3.2 Quality — Introduction

In Resource Management terms there is an interaction between water quantity and water quality issues. Water conservation and efficient use will become increasingly important in the future with greater demands on water resources.

Stormwater contamination is a significant issue which must be addressed if water quality in the City is to be maintained, and where possible enhanced, in the future. Safeguarding the life-supporting capacity of water is a fundamental element of the purpose of the Resource Management Act. Contaminants derive from land development processes, industrial activities, transportation and residential activities, and in rural areas from overland run-off.

(a) Land Development Processes Contribute Significantly to a Lowering of Water Quality through Stormwater Contamination

The effect on water quality from land development processes includes increases in the amount of contaminants and sediments carried by stormwater as a result of vegetation clearance, earthworks, the provision of or upgrading of utility services, streamworks, and the modification and construction of roads.

Manukau City has specific engineering functions in the area of land development control and undertakes comprehensive catchment planning for greenfields areas, resulting in the granting of comprehensive discharge consents. As a result of increasing awareness of stormwater contamination issues, various source control measures and treatment devices are now being developed to minimise contaminants entering stormwater from land development. In addition, the Regional Plan Sediment Control places controls on earthworks areas greater than 1 ha, or greater than 0.5 ha, but within 50 m of a permanent watercourse.[AM123]

In order to avoid development of the most highly valued and sensitive catchments and coastal environments, the Growth Concept of the Auckland Growth Strategy promotes development in already urbanised catchments. However, intensification will bring pressure on existing stormwater infrastructure, particularly where stormwater issues have not been adequately addressed in the past. The Council has a rolling 10-year programme to revise Comprehensive Catchment Management Plans across the city, with priority given to growth centres, and promotes designs which minimise stormwater run-off, provide on-site treatment and/or allow the re-use of rain-water. In the Flat Bush area, a comprehensive approach to stormwater management has been adopted to ensure that future development does not compromise water quality downstream, in the Otara Lake and in the coastal area. Approximately 48% of the area has been identified for non-urban use, existing natural streams are protected from development and enhanced as ecological corridors, and significant areas of existing native bush are retained.[AM123]

(b) Business Practices Contribute Significantly to a Lowering of Water Quality

The main causes of stormwater contamination from business activities are poor yard practices, accidental spills and lack of awareness of pollution consequences, eg of illegal stormwater connections or inappropriate storage of products. Substances spilled include petroleum products, heavy metals and synthetic organic contaminants. Targeted advice and education is one solution which addresses site management practices. The Auckland Regional Council is investigating options to address this matter.

Manukau City Council will also have a role in promoting production and site management methods which minimise or prevent accidental discharges, and in controlling the location of and landscaping and fencing requirements for industrial and trade activities in relation to adjacent water bodies.

(c) Transportation Sources Contribute Significantly to a Lowering of Water Quality

Heavy metals such as lead, zinc, copper, chromium and hydrocarbons (sump oil) are the most common contaminants in urban stormwater. The main source of these is transport-related activities, including exhaust emissions deposited or stripped by rainfall and run-off contributing contaminants from brake linings, radiators, tyres, etc. Predictably, the most significant effects occur in poorly flushed coastal waters adjacent to the most densely urbanised part of the region, eg for Manukau City in the Tamaki Estuary and Manukau Harbour.

There is a need to control and treat the run-off from major roads, especially new roads and motorways. Retrofitting of stormwater treatment devices may also be possible for priority transport routes, where available land makes this practical. Environmental impact reporting on roading proposals needs to specifically address the issue of stormwater contaminants.

(d) Residential Activities Contribute to a Lowering of Water Quality

Increases in hard surfaces as residential areas are developed or intensified result in greater stormwater runoff to watercourses and more contaminants entering watercourses. A proportion of these are likely to be car-related contaminants, which have been discussed above. However, the main sources of stormwater contamination from existing residential areas are household and garden chemicals disposed of to stormwater drains or to ground and illegal connections of stormwater to sewage systems, leading to emergency overflows. Pets and birds generally also contribute faecal matter and decaying plant material contributes nutrients. Similar comments apply as for (c). Planning policies for the development of new residential areas and the intensification of growth centres promote a compact urban form and a comprehensive

approach to stormwater management in order to minimise the impact of new residential development. In the case of the intensification of selected growth centres, catchment management will be reviewed to assess whether retrofitting of stormwater quality measures is necessary to achieve water quality improvements.[AM123]

(e) Sewage Pump Station Overflows and Sewage Discharges Contribute to a Lowering of Water Quality

Most raw sewage discharges are derived from sewage pump station overflows, resulting from excessive inputs to the reticulation system during wet weather, and power failures. Water quality impacts are localised but can be significant depending on location of the pump station. There has been an ongoing programme to upgrade sewage pump stations in Manukau City's area within the last few years to provide greater peak flow capacity and storage, and screening to trap solids if overflows do occur.

The largest treated sewage discharge in the region is the outfall from the Manukau Wastewater Treatment Plant into the Manukau Harbour. Recent upgrading of the plant has led to improvements in water quality and reduced impacts on receiving waters. However, in 2001 the plant's "deemed coastal permit" under the Resource Management Act will expire and further consents will need to be in place. There is ongoing technical evaluation of discharges and public involvement in future disposal options. During the plan period the new Beachlands/Maraetai sewage plant will be discharging treated sewage to land irrigation and an associated wetland and thence to the Te Puru Stream. Monitoring of water quality impacts will be necessary.

(f) Rural Run-off Contributes to a Lowering of Water Quality

Overland run-off from rural areas can contain high-strength organic wastes such as faeces and urine from grazing stock as well as herbicides, pesticides and fertilisers. Pollution can also result from vegetation clearance (especially riparian), earthworks and stock access to riparian margins and waterways. As noted above, poor stream water quality can and does occur in rural areas. In catchments with a mix of rural and urban uses, rural inputs, even where treated by oxidation ponds or spray irrigation systems, may constitute a significant proportion of overall wastes discharged to water.

(g) The Operation of Landfills and Quarries Contributes to a Lowering of Water Quality

There are several old landfill refuse disposal sites in Manukau City which are now closed. Sites such as these were constructed prior to the introduction of modern methods to provide adequate leachate and stormwater collection and disposal, and some have not been monitored for potential adverse effects.

The Greenmount landfill in the Tamaki catchment is being filled currently and is the only landfill in the Auckland region where hazardous wastes are accepted. Greenmount landfill has a low permeability liner and a leachate collection system, but despite this there is some evidence that leachate is reaching groundwater below the site. There are proposals to upgrade the collection system.

Some monitoring is undertaken on the Whitford landfill leachate, which indicates that the only major impact is on nitrate levels in the stream below the landfill. While the existing landfill is not lined, new areas will be lined. An extensive programme of leachate treatment and disposal is now in place. There are several private trade waste disposal facilities in Manukau including at least one with unlined pits.

Extraction of minerals can result in discharges of contaminants such as sediments to surface and groundwater. Discharge consents are required through the Auckland

Regional Council, and details of methods to prevent contamination of water are required by Manukau City in quarry management plans. However, there is little systematic monitoring of the water quality effects of the twenty quarries in the city.

(h) Foreshore Works and Boat-Related Activities Contribute to a Lowering of Water Quality

Reclamations and foreshore works carried out within Manukau City are much more limited than in the past. Discharges of sewage and oily bilge water from boats and spills of petrol/diesel from refuelling are still a concern, as are run-off from boat building and maintenance activity and antifoulants from boat hulls which enter waterways over a period of time. Studies are currently being undertaken in the Tamaki estuary. To date, levels of bacteria in both surface and subsurface samples near high concentrations of boats have not shown results above bathing water standards.

(i) There is a Need to Take More Account of Tangata Whenua Perspectives

The tangata whenua of Manukau City, the Tainui people, have a particular perspective on water as a taonga. As a principle, they wish to see all wastes derived from land returned to the land. This includes sewage discharges and other urban and rural discharges and run-off. For purification purposes, discharges need to be discharged to land to find their own way to the natural water ways.

(j) Riparian Vegetation Removal and Natural Stream Modification Disrupts the Natural Water Cycle

Vegetation on natural stream banks filters out sediments and contaminants from diffuse surface runoff before it enters streams where it can damage the immediate aquatic environment and downstream ecosystems. The canopy effect of overhanging vegetation also preserves the intrinsic ecological balance of those ecosystems. Natural stream modification (e.g. recontouring, piping) also adversely affects the access of biota by disturbing or destroying the natural stream environment.

2.3.3.3 Quantity — Introduction

In resource management terms water quantity issues are less significant for the City than water quality issues, although water conservation will become increasingly important in the future as resources become fully allocated.

(k) Demand Exceeds the Availability of Water Resources in Some Areas

There are some parts of the city where surface or groundwater supplies are fully allocated or are approaching this situation. These include the surface water in the Taitaia catchment, in the Clevedon Ward the Whitford Thermal Resource and groundwater in the Wiri area. While availability issues do not yet appear to be a significant constraint on land use, they could become so in the future.

(l) Water is Used Inefficiently

Conservation, both of bulk water and other water supplies, is becoming a significant issue for the Auckland region and for Manukau. More efficient water use can reduce potential conflicts between competing users and the potential for adverse environmental effects, for example through the construction of new storage dams.

(m) Land Use Changes and Practices can Adversely Affect Water Flow

Land use changes and practices can reduce the quantity of water contributing to streams, lakes and aquifers. Urbanisation, afforestation and major drainage works are examples of land use which may have serious effects on water quantity and the water cycle. Urbanisation can result in higher peak flow and lower low flow. Similar effects result from major drainage works. Afforestation could give stream flow regimes with lower peak flows and lower average and low flows. These changes can adversely affect the ecological balance of the stream and the receiving environment as a result of increased erosion potential and the destruction of low flow habitats.

2.4 AIR

2.4.1 State of Resource

It is not yet possible to accurately describe existing air quality in Manukau City, as no ambient air quality monitoring is undertaken. Some limited monitoring is, however, undertaken on the industrial discharges, as part of applications for and conditions imposed on air discharge permits.

The ARC plans to locate a sampling station in Manukau. The station is likely to measure ambient levels of total suspended particulates and lead. Results from this and any subsequent monitoring stations set up within the City should help to confirm whether Manukau's air quality is, as would be expected, similar to that of the Auckland region as a whole, and establish any differences.

In the meantime, some monitoring results for the Auckland region are available. Historical air quality monitoring data shows that, in general, Auckland has relatively clean air. Auckland's maritime environment and winds usually ensure good ventilation and rapid dispersal of pollutants. However, in winter the atmosphere is more stable, pollutants disperse more slowly and air pollution levels can increase.

At any time of the year, specific sources of air pollution and local climatic and topographical features can give rise to localised air pollution. For example, when nitrogen oxides and non-methane hydrocarbons (also known as volatile organic compounds) combine with high sunlight and low wind conditions in summer in Auckland, photochemical smog can occur.

There are a number of air quality monitoring stations in the Auckland region. These sites collectively measure ambient levels of the following pollutants:

SUBSTANCE	SOURCES	EFFECTS
Total suspended particulates	Vehicles, industry & domestic activities such as backyard burning	Adverse effects on respiratory system
Lead	Primarily vehicles, sometimes industry	Neurophysiological, especially in children
Sulphur dioxide	Vehicles and industry	respiratory, combines with particulates. May cause acid rain
Nitrogen oxides (nitric oxide and nitrogen oxide)	Primarily vehicles and industry, also domestic (combustion processes)	Respiratory irritant, produces nausea and headaches. Precursor to photochemical smog
Non-methane hydrocarbons	Vehicles and industry	Precursor to photochemical smog
Smoke	Vehicles, industry, rural and domestic	Respiratory, effects on visibility
Carbon monoxide	Primarily vehicles, but also industry and domestic combustion	Reduces haemoglobin in humanblood

Global air quality issues such as greenhouse gases and ozone depletion are dealt with at a national level. The Government is involved in international agreements to maintain or reduce greenhouse gases and phase out ozone depleting substances.

2.4.2 Trends

For total suspended particulates, concentrations are higher in winter than in summer, but in general levels are decreasing gradually over time. This may be partly as a result of decreases in particulate lead, but it also tends to indicate that air quality generally in the Auckland region is improving.

Lead levels fell significantly in the Auckland region after July 1986 when lead levels in leaded petrol were halved, and there was a further more gradual reduction in lead levels in air after the introduction of lead-free petrol in 1987.

Sulphur dioxide levels in the Auckland region are low and stable. Sulphur dioxide levels are less of an issue now than in the past because there has been a decline in the use of high sulphur fuels, such as coal, in the region.

Trends for nitrogen oxides and non-methane hydrocarbons are difficult to establish because of data problems, although there are higher concentrations of nitrogen oxides in the winter months. The latter is also true for smoke for which levels are generally stable over time. Trends are also difficult to establish for carbon monoxide, for which monitoring has not been continuous.

2.4.3 Resource Management Issues: AIR

2.4.3.1 Air Quality Management

Under the Resource Management Act 1991, the Auckland Regional Council has responsibility for the management of air quality. In 1992, however, the ARC transferred certain powers concerning discharges to air to Manukau City Council. These include processing air discharge permits for industrial and trade activities that have a medium to small scale impact on air quality and associated compliance and impact monitoring. Manukau City Council also enforces the provisions of the Auckland Regional Plan relating to the discharge of contaminants to air in Manukau City, and responds to all complaints concerning discharges to air. Complaints relating to industrial and trade activities that have a large scale impact on air quality are referred to the Auckland Regional Council.

(a) Vehicle Emissions are the most Significant Source of Air Pollution in Manukau City

The most significant issue for air quality in Manukau City is undoubtedly vehicle emissions, especially given the high level of private car usage in the City resulting from its low density form. Possibly over half of the total volume of emissions to air in the region are from vehicles, although there is no recent emissions inventory to prove this. Vehicles produce all of the pollutants monitored in the Auckland region and they also produce carbon dioxide, a significant greenhouse gas.

As yet there are no controls on vehicle emissions in the Auckland region or elsewhere in New Zealand, although voluntary emission testing is in place in Canterbury. It may be appropriate for Manukau City to lobby central government to introduce vehicle emission standards.

(b) Industrial and Trade Emissions are an Important Source of Air Pollution

Collectively, industry is the second most important source of emissions to air. Industrial emissions are controlled through air discharge permits under the Resource Management Act. The control of discharges to air is a function of the Auckland Regional Council although the Auckland Regional Council has delegated some of their powers to territorial authorities. [AM89]

While each air discharge permit application is assessed and conditions set, often including monitoring requirements to ensure there will be no significant adverse effect on the environment, cumulative effects are not addressed. Nor are there prescribed emission limits for particular contaminants; emission limits are determined on a case-by-case basis.

In addition, while the Ministry for the Environment has published ambient air quality guidelines, the proposed levels are far higher than existing levels of pollutants in the region. A second set of standards at a lower level may be defined by the ARC to ensure protection of existing air quality where this is already better than national guidelines, but again these secondary levels have not yet been set. This makes it difficult to administer an "*air quality management approach*" for industrial and trade emissions. The current approach can best be described as requiring the adoption of the best practicable option to minimise discharges.

Issues of adequate separation distances between air-polluting industrial and trade premises and adjacent sensitive land uses also arise at the local level.

(c) Open Burning causes Large Numbers of Air Quality Complaints

Open burning is the largest single cause of air quality complaints to Manukau City Council. This includes burning of trees and scrub on new subdivisions, burning of waste at landfill sites, disposal of domestic waste (backyard burning), and disposal of waste in industrial areas. Local nuisance effects are produced and emissions from open burning can be detrimental to property and to health, because many of the particulates generated are in the inhalable size range.

(d) Large Amounts of Dust are Generated During Land Development and Quarrying

Dust generation can be a problem in land development areas, and during quarrying activity in summer. While for quarries this may be addressed through conditions on air discharge permits, it is also a management issue. Recently Manukau City has introduced a negotiated "Environmental Management Plan" procedure for areas of land undergoing development where dust generation, smoke, etc may be a problem.

(e) Domestic Heating Emissions Cause Some Air Pollution

Pollutants from domestic fireplaces and solid fuel burning appliances are similar to those from open burning. In the absence of an emissions inventory, it is difficult to establish how significant this issue is at the City level. It may also be that control at source through a regional or national standard is a more effective way of addressing this issue than regulation of emissions at a district level.

(f) Spray Drift Results in Nuisance Complaints and May Cause Health Problems

Chemical spray drift, resulting in health and nuisance effects, is another issue about which little is known for Manukau City. Remedies may lie in public education through

codes of practice, or in maintaining buffer distances between particular land uses, if problems can be clearly demonstrated.

(g) Odour from Sewage Disposal is a Nuisance

Although some improvements are imminent with current upgrading, odour associated with the operation of the Mangere Wastewater Treatment Plant has been an on ongoing problem for residents in some areas of Mangere. It is important to ensure that new sewage treatment plants such as that serving Beachlands and Maraetai are located at a sufficient distance from residential uses.

(h) Discharge of Ozone Depleting Substances and Greenhouse Gases are a Significant Long Term Adverse Environmental Effect

While local authorities have no direct role in implementing the Ozone Layer Protection Act 1990, nor in reducing discharges of greenhouse gases *per se*, these issues will be significant for the City's air quality and climate in the long term. There is clear potential for reducing carbon dioxide emissions from the transport and industrial sectors in the City, and there may be a public education role for Manukau City in preventing discharges of ozone depleting substances, and on methods of storage and disposal of substances such as chlorofluorocarbons.

(i) Management of Air Resources Needs Local Input

While control of discharges of contaminants to air is primarily a regional responsibility, it is important that the City adopts a pro-active stance with regard to the need for appropriate ambient air quality standards, and the need for an adequate air quality and climate monitoring network within the region, and particularly within South Auckland.

2.5 SOIL

2.5.1 State of Resource

Soil resources are important to Manukau's economy and especially to agriculture and horticulture in the City. The City is fortunate in possessing a higher proportion of moderate to high value soils than New Zealand as a whole.

The New Zealand Land Resource Inventory provides an overall land use capability assessment for those parts of New Zealand outside of built-up areas and sets out eight Land Use Capability classes ranging from I to VIII in decreasing order of versatility. According to this inventory nearly 37% of Manukau's surveyed land (that is, land outside of built-up areas) is of Classes I-III, compared to only 15% for New Zealand as a whole. When Class IV land is included this proportion rises to 48.7%, compared to 25% for New Zealand as a whole.

PROPORTION OF MANUKAU'S SURVEYED LAND	LUC CLASS	DESCRIPTION
1.3%	Class 1	The best land, flat, free draining, well structured fertile soils suited to sustained intensive horticulture with minimal inputs.
21.3%	Class II	Slight limitations to intensive arable use e.g. Slope and erosion.
14.3%	Class III	Moderate limitations to arable use. Commonly alluvial flats with a wetness limitation.

PROPORTION OF MANUKAU'S SURVEYED LAND	LUC CLASS	DESCRIPTION
11.8%	Class IV	Typically rolling hill country, too steep and too erodible for regular cultivation but suited to intensive pastoral farming, such as dairy farming.
45.0%	Class VI	Mainly strongly rolling to moderately steep hill country. Typically semi-intensive pastoral use, such as sheep and beef farming.
6.1%	Class VII	Steep hill country and semi-consolidated sands, typically with a severe erosion limitation. Limited sustainable productive potential. Typically conservation areas.
0.13%	Class VIII	Steep coastal cliffs and foredunes. Protection areas.

Source: New Zealand Land Resource Inventory Database

Class I, the highest quality land within Manukau, is located in small areas around Ihumatao Road near the airport, around the Manukau Wastewater Treatment Plant, immediately south of Pukaki Crater and on the Waiouru Peninsula. However most of the best soils within Manukau are of Class II,with slight limitations, either of erosion susceptibility, poor drainage or high water table or most commonly, rooting zone limitations such as soils of only moderate depth or which require nutrients. Those limitations can easily be overcome.

Class II land is located around the airport and west of Papatoetoe, through the East Tamaki corridor, in parts of the Whitford area, around Beachlands and in the Orere River Valley, and in a large swathe around Manurewa and through the Clevedon Valley. Wetness is the most common limitation of the Clevedon Valley soils and those in the North Road area. Along with Class I land, these areas of Class II land are the City's "horticultural quality" soils.

Class III land is located around Class II land in Manukau but suffers from more limitations, most commonly susceptibility to erosion, but also wetness. Class IV land is usually located in the foothills of steeper country and is generally used for intensive pastoral farming. Here, the main limitation is a tendency to erode.

The majority of Manukau's land is classified as Class VI, which is strongly rolling to moderately steep land well suited to grazing and forestry. The dominant limitation of this land in Manukau is susceptibility to erosion (discussed in more detail below). Class VI land is found through the majority of the eastern part of the city, excepting the river flats and coastal areas mentioned above. Class VII land is located in the "foothills" of the Hunua Ranges. Much of it is included within the Auckland Regional Council's "Water Supply Area" designation. The very small areas of Class VIII land within Manukau are located in the coastal areas around and south of Orere Point.

Even though susceptibility to erosion is the main limitation on land use in Manukau, erosion risk is negligible for nearly half of the surveyed area of the City, and slight for most of the remainder (predominantly Class VI land). There are only small areas of "moderate" erosion potential. The majority of this is on the Class VII and VIII land, although there is an area of Class VI land of moderate erosion potential (for sheet erosion)stretching south from Ormiston and Sandstone Roads. There are no areas within the City with severe or extreme erosion potential.

Types of erosion which occur in the City, for example when vegetation is cleared, tend to be soil slip (sliding, flowing movements of soil and subsoil exposing a slip surface), sheet erosion (bare ground loses a thin layer of soil by water runoff), and debris avalanche (rapid flows or slides on steep slopes that result in long narrow scars).

The soils information within the New Zealand Land Resource Inventory is derived from a DSIR Soil Bureau survey of Manukau City soils undertaken in 1979. The survey produced detailed information about soils across the City, excluding the built-up areas, looking at profile (vertical variability in colour and texture),

structural stability (under cultivation), drainage, flood risk, permeability, continuity (the average size of map units in each soil class) complexity and variability.

From these factors, overall ratings for suitability for various agricultural uses were derived including a rating for food production. Of the over 49,000ha of soils surveyed in the City 7% were of high actual value for food production, 9.2% of high potential value, 31.6% of moderate value and 52.2% of low value.

No overall surveying of the quality of soils within the built-up areas of the City has been undertaken although small areas have been investigated. It is known, however, that many of the soils of the areas such as Mangere now covered by urban development were of high value for food production. Some larger sites within the residential areas of Mangere are still used for glasshouse fruit and vegetable production.

Soils of high value for agricultural production are Class I, II and III according to the Land Resource Inventory, soils of moderate value for agricultural production are Class IV and soils of low value for agricultural production are Classes VI and above.

Soil quality and slope are also strongly correlated. 22.4% of Manukau's surveyed soils are on slopes of less than 3° and a further 20.6% on slopes of between 3 and 12°. 7.7% of slopes are between 12 and 18°. Slopes of more than 18° tend to be of lower value for food production and be Class VI land or above.

Higher quality soils on flat or easy rolling and on rolling land may be of sedimentary, volcanic or organic origin. Soils derived from volcanic parent material (basalt, scoria, tuff and ash) made up 13.8% of the DSIR survey and are located around the City's 19 volcanoes in Mangere, the Papatoetoe area, Wiri and East Tamaki.

Soils of organic origin (peats i.e. completely decomposed dead plant material) made up 2.8% of the DSIR survey. Those areas of peat around Takanini are now part of Papakura District, although there are still some areas of peat land within Manukau City's boundaries, in the Clevedon Valley (Parish Line Road, Clevedon-Takanini Road etc).

Soils of sedimentary origin (the remaining 82.3% of the survey) range from those based on estuarine sediments, to alluvium, to sandstone/siltstone soils and large areas of greywacke-derived soils in the eastern part of the City.

2.5.2 Trends

Soil-forming processes occur over thousands of years and therefore soil is essentially a non-renewable resource. While resources are relatively finite and locationally fixed, soil degradation can occur through a variety of natural processes and can be accelerated by land management practices. Once soil is lost or compromised, the soil resource is unavailable or suitable only for a smaller range of uses.

Unfortunately, almost no monitoring of soil health or soil erosion is undertaken in the Auckland region, as to date most attention had focused on urban earthworks control. A rural soil conservation programme is only now being set up by the Auckland Regional Council and a regional database on soil degradation is being established. The Auckland Regional Council aims to develop a monitoring programme for soil. Although issues are becoming clearer (see below) it is not yet possible to state what monitoring will be done within Manukau City and where. As monitoring is expensive, costs will be a limiting factor.

Information may however be available on individual sites in the City where soil testing has been undertaken for particular reasons. Examples of biophysical indicators of soil health which it is possible to test for include: spray residues, earthworms, bulk density, air permeability, water permeability, microbial biomass carbon, total carbon and acidity/alkalinity (pH).

2.5.3 Resource Management Issues: SOILS

(a) High Quality Soils have been lost to Urban Development

Peripheral expansion of the Auckland metropolitan area has over time led to a significant loss of high quality soil, in a region where such soils form a higher proportion of the area than the national average. The Regional Council estimates that a quarter of the original area of Class I and II soils in the region have been urbanised.

It is difficult to provide a similar figure for Manukau City, but there is no doubt that post-war expansion of the City on flat easily developable land resulted in the building over of significant areas of good quality soils, particularly in Mangere, Otara and Manurewa. Current peripheral expansion south of Howick is continuing this process. The East Tamaki corridor, which for some years now has been earmarked for Future Urban Development, consists largely of Class II land. It should be noted that this area is within the metropolitan limits and has been accepted by the Proposed Auckland Regional Policy Statement as an appropriate location for new urban development in the light of all other factors, such as historical commitments to urbanise this area, major infrastructure investments, and the need to avoid urbanisation of the Whitford-Beachlands coastline.

Outside of the metropolitan limits, some high quality soils may be lost in the future around the International Airport, for example, if the second runway is built. The Regional Policy Statement recognises South Mangere-Puhinui as a Special Development Area, and provides for the existing and future operation of the Airport and the Mangere Wastewater Treatment Plant as strategic regional utilities, which would mean the acceptance at a regional level of a loss of high quality soils resulting from such growth.

However, for the most part the metropolitan limits and the regional strategy of selective intensification within existing urban areas will set a limit on urban expansion and therefore the loss of high quality soils for this reason, for the foreseeable future.

(b) Uses Not Dependent on the Soil Resource are establishing in the Rural Area and may foreclose or compromise options for activities that are dependant on the Soil Resource

The Auckland Regional Policy Statement considers that subdivision and development of high quality soils in rural areas for activities which are not dependent on the soil resource or on high quality soils (such as rural-residential or lifestyle blocks, and other miscellaneous urban fringe uses) is inappropriate and that these activities should be directed onto poorer quality land. The rationale for this view appears to be that providing for rural-residential or other urban type uses or even part-time farming where this confers residential rights lowers productivity and takes land out of production through structures, roads and a more intense subdivision and development pattern. [AM89]

Under the Resource Management Act, the protection of land having a high actual or potential value for the production of food is no longer a matter of "national importance". Nevertheless, Section 7 of the Resource Management Act does state that particular regard should be had to the efficient use and development of natural and physical resources, and any finite characteristics of those resources, which implies that soil resources should not be used wastefully.

(c) Parts of Manukau are susceptible to soil erosion

As already noted, susceptibility to erosion is the main limitation on land use capability in Manukau. Erosion is a natural process which can be accelerated by inappropriate land

management activities such as clearance of protective vegetation from susceptible land. While the degree of erosion susceptibility in Manukau is for the most part slight, quite large areas are susceptible and actual erosion does occur, reducing the productive value of the land.

More monitoring is needed on this issue for Manukau, to establish the extent of the problem. However, comparing maps of erosion potential in Manukau with maps of vegetation cover (native or exotic forest, or scrubland) indicates that three areas of slight erosion susceptibility where cover has already been lessened, and therefore where the possibility of erosion could be greatest if further clearance occurred. These areas are:

- the Mangemangeroa and Whitford areas and through the Brookby Hills, where dominant pasture is combined with some gorse, mixed native scrub, and cutover podocarp-hardwood forest; and

- parts of the area to the northeast of Ness Valley Road, and north of Kawakawa-Orere Point Road, where dominant pasture is mixed with cutover podocarp-hardwood forest, mixed native scrub, and some manuka and kanuka.

(d) Soil Structure can be damaged by Repeated Cultivation and Stock Trampling

Soil structure is critical to drainage and fertility. Soil structure can deteriorate through frequent saturation, surface crusting, sub-surface pan formation or general structural disintegration. Repeated cultivation or stock trampling can accelerate these processes.

Soil compaction does not seem to be a major issue in Manukau, with the exception of two areas. On the broad flat-to-gently undulating plain beside the Wairoa River and extending into the North Road area, soils have low permeability and suffer from severe wetness in winter. Soil structures are weak to moderate and would be destroyed by more than occasional cultivation. Some of the Class VI land in the Brookby Hills, while not likely to be cultivated, can also suffer from structural deterioration.

(e) Loss of Soil Fertility, Chemical Contamination and Topsoil Removal Adversely Affect the Soil Resource

Loss of soil fertility refers to nutrient loss by soil erosion or runoff, leaching, or harvesting of plant or animal products. Chemical contamination of soil can result from inappropriate application of herbicides, pesticides and other chemicals, or from accidental or deliberate waste disposal to land. Topsoil removal may occur in association with land development and urban earthworks.

Little is known about the first two issues for Manukau, although it can be surmised that levels of fertiliser application may change where land is used for rural-residential purposes. However, monitoring of both these issues is needed to make any definite statements. Monitoring of chemical contamination of soil through waste disposal would be of particular interest. The significance of topsoil removal during urban earthworks is debatable; the scale of this issue or its effects may not be great enough to justify intervention.

2.6 MINERALS

2.6.1 State of Resource

This section of this chapter deals only with minerals as a resource and not with the detail of mineral extraction and its effects, which is addressed in a later chapter of the Plan.

Manukau City's chief mineral resources are aggregates. In the western part of the City, volcanic aggregates occur at and around 19 volcanoes. These are Puketutu, Mount Mangere, Mangere Lagoon, Waitomokia, Pukeiti, Otuataua and Maungataketake in the Mangere area; Pukaki, Crater Hill and Kohuora in the Papatoetoe area; Matakarua, Manurewa, and Ash Hill in Wiri; Pukekiwiriki, Styaks Swamp, Green Hill, Otara Hill, and Hampton Park in East Tamaki; and Pigeon Mountain in Pakuranga. Products of these volcanoes include lava flows, scoria cones, ash and lapilli mantles[1] and tuff[2]. The aggregate resource around some of these volcanoes, where extraction has occurred over a long period of time, has been substantially reduced.

Sedimentary aggregates (greywacke and argillite) are found over a large portion of the eastern part of the city, from the Maraetai coast to the south of Brookby, and from east of Clevedon to the far eastern boundary of the City. Argillite is most common as a surface material, and this may be underlain by brown greywacke, with higher quality blue greywacke normally only occurring at depth. Greywacke is exposed only at the eastern end of the district east and south of Kawakawa Bay.

There is a small limestone deposit at Whitford, and a clay deposit at Brookby. Coal is present at considerable depths at Ardmore just outside Manukau City boundaries, but this is a very thin deposit, and therefore not likely to be workable.

Aggregates are used in the roading and construction industries, with the largest portion of Manukau's production being used for roading purposes (this can be of lesser quality than rock for building aggregate) followed by a lesser quantity for building aggregate, and the remainder for fill for various purposes including harbour work, reclamation and filling. Clay extracted at Brookby is used for the production of bricks and tiles.

Over the last 15 years production levels of aggregates in Manukau have fluctuated, from a low of just over 1 million tonnes in 1979, to highs of over 3.5 million tonnes in 1984 and 1986. However, since 1986, production has shown a generally downward trend. (See Figure 2.2).

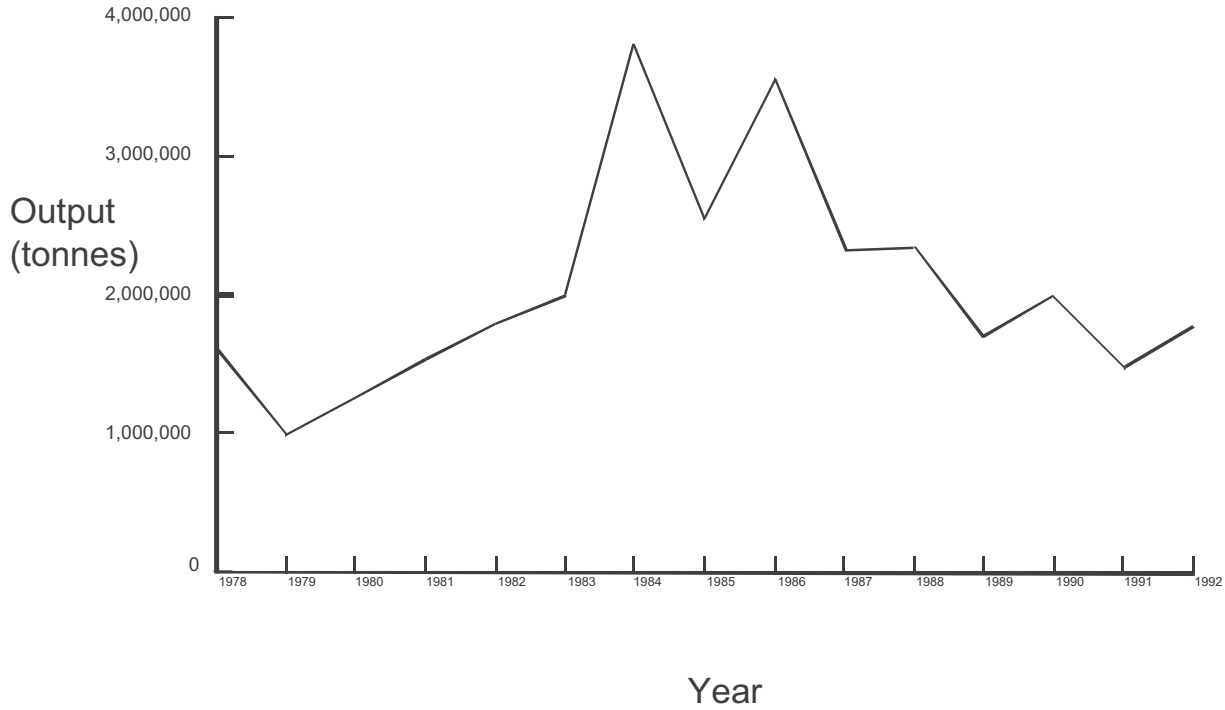
Manukau's share of the Auckland (including Northland) region's production of aggregates has also fluctuated, from over one third in the mid 1980s to about 28% in 1992. Average "consumption" of aggregates was 5.7 tonnes per person per annum in the Auckland region over the 1986 to 1991 period. On this basis Manukau City is still a net exporter of aggregates. Within the City the largest production area for aggregates in the 1988–1992 period was East Tamaki, followed by Wiri and then Mangere. 20 quarries operated during this period, although not all quarries were open all of the time.

In terms of total volume of material extracted over this five year period the largest four quarries were Puketutu Island, East Tamaki Quarry (west of Harris Road and north of Crooks Road), Roscommon Quarry and Greenmount Quarry. Other large quarries are Whitford Quarry, Ellets (Maungataketake), Stevenson's East Tamaki (between Smales and East Tamaki Road), Wiri Mountain, Wiri Station Quarry (north of Wiri Station Road) and Puhinui Scoria. Medium-to-small-sized quarries are predominantly those producing sedimentary rather than volcanic materials, and tend to be located in the eastern part of the City.

1. Ash and lapilli mantles are unconsolidated beds of dark grey to black sand to pebble sized fragments.+
2. Tuff consists of beds of light grey to grey mud and sand-sized ejected fragments of sandstone, mudstone and alluvium, together with some basaltic or basanitic fragments. Tuff may be very soft, compacted or cemented.

Production figures from existing quarries are readily available, but it is more difficult to establish the overall extent of the mineral resource in Manukau, as information on total reserves is very patchy, and definition of a mineral resource can only occur through the process of exploration. However, volcanic resources are limited in areal extent (and in depth) and it is unlikely that further resources will be found, although remaining reserves may be more clearly defined. There appears to be relatively limited potential for extensions to existing quarries, although as volcanic aggregates become scarcer, reworking of areas from which material has already been extracted could become viable.

The situation with sedimentary resources is rather different. Large areas of the City may be underlain with greywacke, indicating substantial deposits. There are also a number of quarries which were worked in the past where reserves could still exist. However, there are significant problems associated with extracting some of these minerals, including the cost and practical problems associated with removing overburden, and higher transport costs associated with moving minerals from the eastern part of the city.



Sources: Annual returns of Production from Quarries; Ministry of Energy; and NZ Annual Mining Reviews: Ministry of Commerce

FIGURE 2.2 TOTAL OUTPUT OF AGGREGATES FOR MANUKAU CITY (EXCLUDING CLAY)

2.6.2 Trends

Minerals are not renewable and the sustainable management of them as natural and physical resources which is required by Section 5 of the Resource Management Act 1991 does not include sustaining the potential of minerals to meet the foreseeable needs of future generations. The remaining life of existing quarries is dependent on the rate of extraction and returns realised for the resource, and production levels for individual quarries and even for Manukau City as a whole fluctuate significantly over time.

Although the recent decline in production from the City's quarries may be partly related to a drop in demand since the boom years of the mid-1980s, when large quantities were extracted, there are strong

indications that a number of the quarries, in Manukau City, in particular some of the volcanic quarries are moving towards being worked out within the foreseeable future. These quarries make up about 90% of Manukau's total aggregate production.

The mineral industry itself has predicted that within ten years many of the reserves currently being mined in these areas will be exhausted. Production figures and other information indicate that several quarries may even be exhausted within five years. Larger reserves do remain in some of the individual quarries.

Production from the City's sedimentary quarries constitutes less than 10% of the City's total aggregate output. Although production has fluctuated over time, it has declined recently. It seems likely that given the extent of sedimentary resources, production could increase to make up some of the shortfall likely to occur as volcanic resources are worked out. However, quantities extracted are unlikely to be enough to make up the difference, and in the longer term the City may not be able to supply even its own requirements for aggregates, resulting in a need to import from other districts.

2.6.3 Resource Management Issues: MINERALS

(a) Mineral Resources can be rendered inaccessible by Other Activities

Mineral resources are limited to particular locations. They are significant to Manukau City's economy and to that of the Auckland region as a whole. In view of a declining supply of mineral resources in the region, and high costs of transportation from elsewhere, it is important to ensure that remaining reserves at existing quarries are able to be utilised, subject to minimisation of adverse environmental effects.

Basalt resources in the East Tamaki area have been made inaccessible in the past, for a variety of reasons including the fact that some resources were not perceived to be economic to extract, and the existence of high water tables. For the last decade quarrying has been provided for as a permitted use in a large part of the industrial area west of Harris Road. The value of volcanic aggregates has risen and will rise further with increasing scarcity, so that resources are less likely to be made inaccessible in the future.

(b) Extraction of Mineral Resources can be in conflict with the protection of Natural and Cultural Heritage

A number of the scoria cones in the City were originally significant landforms, and because of the settlement which historically occurred in close proximity to these cones, were also significant archaeological sites. Many of these cones have now been modified to the point that they no longer retain their original values.

The City has no identified potential for hydropower, geothermal resources are at much too low temperatures to have any potential for energy development, and wind speeds are at best very marginal for wind farm development. (Wind speeds at Auckland Airport average only 7 metres per second at 50m above ground level, whereas there are many open exposed sites in other parts of New Zealand with much greater average wind speeds).

Given that the City has so few energy resources, this section concentrates on the City's use of the energy which is for the most part imported from other parts of New Zealand and from overseas.

At the national level, it is clear that the use of oil, gas and electricity has increased at a much greater rate than population increase in the last few decades. Per capita final energy consumption has doubled since 1960. Oil is primarily used by the transport sector, gas in electricity generation and in industry, and electricity by industrial and domestic users.

As well as increased use of energy, there are also indications that New Zealanders are using energy less efficiently over time, for example in terms of energy required per unit of GDP. In 1970 it took 0.48 tonnes of oil equivalent to produce $US1000 of GDP, whereas in 1988 this energy requirement had increased to 0.63 tonnes of oil equivalent. This reflects higher energy intensiveness of our industrial base and our transport system.

It is much more difficult to estimate energy use at the Manukau City level, although regional figures are available for electricity usage, and for petrol and diesel sales, because of the existence of a regional fuel tax. These figures are referred to in the Issues section below.

2.7 ENERGY

2.7.1 State of Resource

There are no oil, gas, or coal resources within Manukau City, although major oil and LPG terminals are located at Wiri, and Kapuni and Maui gas pipelines run through the city. Electricity is generated from time-to-time at the Otahuhu Power Station which has a 85MW operating capacity.

Nor is there particular potential for the generation of energy within the City from renewable sources, with the possible exception of solar technologies for heating buildings, production of biofuels from forest residues or fuelwood plantations, the production of biogas from wastes, or the use of landfill gas. Some landfill gas is currently used for electricity generation at Greenmount landfill.

The City has no identified potential for hydropower, geothermal resources are at much too low temperatures to have any potential for energy development, and wind speeds are at best very marginal for wind farm development. (Wind speeds at Auckland Airport average only 7 metres per second at 50m above ground level, whereas there are many open exposed sites in other parts of New Zealand with much greater average wind speeds).

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2.7.2 Trends

Some information on trends in energy usage in Manukau City has already been given in the section above. To summarise, the City appears to be using more energy over time. It is clear that petrol usage is increasing, that the City has high and increasing numbers of private vehicles and that numbers of trips per

person (therefore overall mobility, at least for the majority of the population) is increasing. Energy may also be being used less efficiently over time, although it is very difficult to demonstrate this for the City.

A large proportion of the City's usage of energy is of non-renewable fossil fuels which will eventually be depleted. For example, the Maui gas field will run out within the first decades of the 21st century. Given the consequences of vehicle and combustion emissions in terms of the City's air quality, contributions to the greenhouse effect (the transport sector contributes about 45% of NZ's total carbon dioxide emissions) and contaminated run off from roads impacting detrimentally on water quality within the City, it can be said that the use of energy within Manukau City is unsustainable. In addition, few attempts are yet being made to use energy more efficiently, decrease overall use of fossil fuels, or to encourage renewable energy sources.

Moving towards a more sustainable pattern of energy use entails considering that environmental costs are high enough, congestion or parking problems are bad enough, or that petrol is scarce or too expensive, in order that a commitment is made to change lifestyles or current patterns of car usage. This does not seem likely in the near future, and even when New Zealand's indigenous fossil fuel reserves become significantly depleted, they are likely to be replaced with imported fossil fuels. It may be that pollution, and the need to reduce CO_2 emissions to meet global obligations, will place an earlier constraint on the use of fossil fuels than will resource depletion.

2.7.3 Resource Management Issues: ENERGY

(a) Energy is not being used Efficiently in the Business and Residential Sectors

It is very difficult to assess how efficiently energy is used across sectors within the City, for example within industry. As noted above, there are indications that New Zealanders are using energy less efficiently over time. One exception to this trend could be in the area of domestic use of energy. Insulation has been compulsory for residential buildings since 1978/79, and insulation requirements under the Building Act have recently been increased. On the other hand it appears that Auckland households use much more energy than households in the South Island, relative to climatic conditions.

While the greatest users of energy are land transport and major industry, the best immediate prospects for energy efficiency improvements may actually be in other industrial and commercial sectors and in the domestic sector.

Given that Manukau City's population constitutes approximately 40% of the total population within Mercury Energy's area of supply, for the year ended March 1993, Manukau's electricity consumption would have been of the order of 1,553,625,000 kWh. Of this total, about 30% would have been sold to domestic consumers.

On a pro rata basis from regional figures (which probably understates the significance of manufacturing in Manukau), 39% of sales would have been to commercial users i.e. wholesale and retail, transport, storage and communications, business and financial services, and community, social and personal services; 17% to manufacturing and 0.7% to agriculture, hunting, forestry and fishing, and mining and quarrying. Electricity usage is increasing nationally and also within the City.

A recent study[1] indicates that the most attractive options in commerce and industry could save around 10% of business energy use on average. For commercial buildings, measures could include greater efficiency in lighting, and more careful maintenance and tuning of heating, ventilation and air conditioning systems. Energy audits at factory level can identify energy efficiency potential for industry. Measures could include high

1. Report to the Officials Committee on Energy Policy (1993): Promoting the Market for Energy Efficiency.

efficiency, appropriately sized motors, boiler efficiency and heat recovery, cogeneration, and process changes. Resource recycling, for example of energy-intensive products such as aluminium and steel, has potential for saving energy.

Opportunities exist for relatively simple measures related to water heating, lighting, space heating and refrigerators and could save about 15% of domestic energy use. Passive solar design of new houses offers potential. Such buildings maximise the use of solar gain through features such as more glass facing the sun, and the use of thermal storage materials such as concrete, brick and water. Replanning buildings in this way can save up to 70% of space heating costs in Auckland[1].

Much greater energy efficiency is also possible in construction of houses and production of building materials, for example by maximising the use of timber floors, cladding and window frames, and concrete tile roofing; rather than iron roofs and aluminium window frames. Clay products such as bricks, while thermally efficient, require more energy to produce[2].

(b) The Rate of Use of Fossil Fuels in Manukau City is Increasing

Regional petrol sales have increased each year since the collection of figures began in the 1985/86 year, and in (1992/93 were over 778 million litres of petrol. Diesel sales are more stable and in the same year were over 201 million litres for the region. As Manukau City had 23.9% of the Auckland's region's population in 1991 and 21.4% of the region's motor vehicles, it is reasonable to assume that over 20% of petrol sold within the region would be bought within Manukau City i.e the City's usage could be more than 165 million litres of petrol per year.

Apart from direct measures of fossil fuel there are a number of indirect measures, such as those related to transport usage. For the Auckland region as a whole, population has increased 23.2% in the two decades from 1973–92 whereas vehicle numbers increased 62.0% in the same period, and numbers of vehicle trips went up 64.1%. Greater private vehicle availability and, more recently, cheaper cars and petrol have obviously led to increased vehicle usage. Numbers of trips per person are increasing as are total distances travelled, and therefore it is not surprising that the results are increased fuel use and increased traffic volumes.

The deregulation of the freight transport industry has resulted in a major shift of freight transport mode from rail to road.

While the City has slightly fewer motor vehicles per capita than the region as a whole, car ownership rates are still high. At the 1991 census, only 11.8% of Manukau's households had no car, whereas 41.4% had one car, 31.9% had two cars and 12.2% of households had three or more cars. There were however variations by ward, from highs of 23.3% with no car in Otara, and 18.0% in Mangere, to lows of 3.7% in Clevedon, 5.3% in Pakuranga and 5.9% in Howick. In these latter three wards over 58% of households two or more cars.

Use of public transport shows a pattern which is the inverse of these car ownership rates. In other words, public transport usage is lowest in the more affluent suburbs,and highest in the less affluent suburbs with lower car ownership. This would suggest that people tend only to use public transport when they have no choice.

Overall, public transport usage in Manukau declined in the period 1986–1991 with only 13.7% of full-time work journeys made by public transport in 1986 and only 6.6% in 1991.

1. Donn and Van Der Werff (1990): Design Guidelines: Passive Solar in New Zealand.
2. Honey & Buchanan (1992): Environmental Impacts of the New Zealand Building Industry.

In general, public transport is more fuel efficient than use of private cars even at low occupancies, but as noted above patronage has been declining in Manukau. Reasons for low patronage include greater travel time and walking distance to destinations, under-provision of services arising from poor patronage, and a frequent mismatch between services provided and the needs of travellers.The Council's strategy document "Passenger Transport for Manukau in the 1990's" addresses some of these problems with for example:

- increased levels of bus service
- reorientation of services to connect the City's residential communities with major employment centres in Wiri and East Tamaki
- services which are easier to use because of regular frequencies and good infrastructure

The promotion of "low energy" modes of transport such as walking and cycling which have historically been given low priority, must also be considered both in the planning of greenfields areas and in relation to existing built-up areas.

One of the difficulties in attempting to reduce the use of private cars is that of the interrelationship between transport and urban form. Population densities across Manukau City are low, although variable. Research on the relationship between per capita transport fuel use and land use patterns across a number of cities in the world suggests that it is much more difficult and costly to make public transport viable at population densities of less than 30 persons/ha. This is because insufficient people live near the transit routes to justify a satisfactory service. Densities in Manukau reach this level only in restricted areas and for the most part are much lower.

Issues of how, and to what extent, densities can be increased along major transport routes, and whether and to what extent mixed use development should be promoted (for example at key transport nodes) offer major challenges for Manukau's future urban form. These issues are not purely transport or energy-driven; they are also interrelated with region-wide strategic issues such as the lifestyles we adopt in terms of residential densities and what should be the ultimate extent of the metropolitan area.

(c) There are few Renewable Energy Sources currently identified in Manukau City

As already noted, there is little obvious potential for the generation of energy within the City from renewable sources. Nevertheless, it is important for the City to encourage investigation and use of appropriate technologies where they do exist or could be more economic, in order to move towards a greater degree of sustainability in energy use.

Solar space heating either directly or through photovoltaics (storage cells) is probably the cheapest renewable energy technology with application in Manukau, although the extent of power able to be produced is uncertain, and probably small. Digesting waste to produce biogas, or using landfill gas to generate electricity would again produce a limited amount of power. Biofuels from forest residues or fuelwood plantations could be more expensive and would require further investigation, but offer greater future energy potential.

(d) The Use and Distribution of Energy has some Adverse Environmental Effects

Environmental effects of the use of energy have already been mentioned above in relation to air and water quality. In addition, the transport sector produces nearly half of New Zealand's energy-related CO_2 emissions, and the industrial sector also makes significant contributions through combustion processes. These emissions contribute to global warming and potential climatic changes. The Government is now a party to the

Framework Convention on Climate Change, which aims to stabilise CO_2 emissions at 1990 levels by the year 2000.

Apart from these effects, construction of energy-related infrastructure including transmission systems (such as pipelines, cables and high tension power lines and pylons, in Manukau's case), can have adverse environmental effects including land use disruption and visual impacts.[AM123]

2.8 PLANTS, ANIMALS AND ECOSYSTEMS

2.8.1 State of Resource

Manukau City's natural resources include its plants (trees, shrubs, ferns, orchids, grasses, sedges, rushes and herbs), animals (birds, insects, frogs, lizards, bats etc) and their habitats (terrestrial, freshwater and marine) which together make up ecosystems (biological communities of interacting organisms and their physical environment).

As settlement proceeded in the City, many of these natural resources and ecosystems were extensively modified and depleted, so that conservation of the remaining plants, animals and ecosystems now assumes greater importance in order to ensure that representative examples of the City's original natural heritage (which includes a high level of species endemic to New Zealand) are protected. It is estimated that about 10% of Manukau City as a whole now remains in native forest and scrub cover.

The City lies in three ecological districts, Hunua, Manukau and Tamaki, on the basis of broadly similar topography, geology, soils and vegetation (see Figure 2.3).

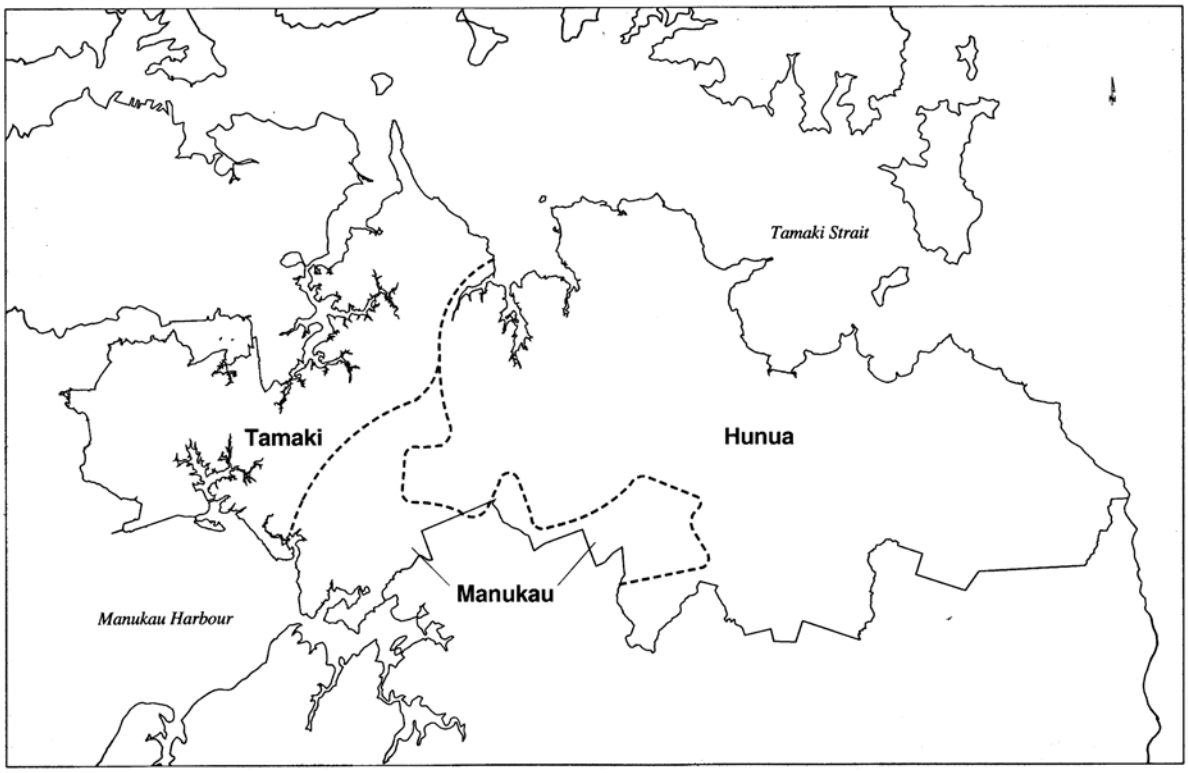

FIGURE 2.3 ECOLOGICAL AREAS

(a) Hunua Ecological District

The Hunua Ecological District includes most of the eastern part of the City and also extends outside the City through the Hunua Ranges, southwards to Mangatawhiri and Mangatangi. Originally the Hunua district was heavily forested down to the water's edge, although some areas of open country were found in the Wairoa valley, along the Orere coastal strip, and in the valley mouths of the Waikopua and Mangemangeroa creeks.

During the 19th century and early 20th century there was logging for selected timber species, particularly kauri, and in places extensive clear felling. Some areas were also logged later on, for example for the construction of the Hunua dams.

Today about 40% the Hunua Ecological District remains in indigenous vegetation, of which 17.3% is in forest and 22.5% in scrubland (areas of woody plants and ferns generally less than 6 metres tall); 0.1% of the district is in fresh water wetland.

The Hunua Ranges contain over 20,000ha of continuous native forest, although it should be noted that only the northern fringe of the Ranges is within Manukau City. The Ranges are described in the Department of Conservation's "Draft Conservation Management Strategy for Auckland 1993–2003", as a key area for conservation because of their indigenous forest habitats, which are of outstanding value for wildlife and conservation. A number of nationally and regionally threatened species have been recorded. Three quarters of the forest of the Hunua Ranges is Tawa-Podocarp, while kauri, hard beech, tanekaha and taraire forest species are found on the ridge tops and drier lower land.

Birds of the Hunuas include a small community of the endangered kokako, one of the few remaining mainland bellbird populations, kaka and a North Island brown kiwi population, as well as many more common species. Animals of the Hunua Ranges include the threatened Hochstetter's frog, the green gecko, and a variety of native land snails. Both rare short-tailed bats and long-tailed bats (New Zealand's only native land mammals) have been sighted in the Hunuas.

Outside of the Hunua Ranges, the Hunua Ecological District is characterised by a remnant forest landscape and an extensive coastline. Most of the remnants of forests left are under 10ha, although a few substantial blocks remain. The two most significant of these within Manukau City are the large stand of native forest (about 500 ha) in the Clevedon Maraetai Hills, and the Mataitai State Forest. Although both forests were logged over the last 100 years, the former shows advanced regeneration with many seedling species, and the latter is now in good condition. Both forests include the nationally rare kauri-hard beech association.

Other significant vegetation within the Hunua Ecological District includes the Otau Forest and associated wetlands (Harrisons Flax Swamp, which is of moderate to high value for wildlife, and Sharpes Raupo, of moderate value for wildlife); and a forest remnant on Munros Road which is the only known remnant of forest outside the Hunua Ranges which has not been selectively milled.

Much of the coastline of the Hunua Ecological District (Manukau's Hauraki Gulf coastline) is of high ecological value. The Wairoa River and Estuary, including Umupuia (south of Whakakaiwhara Peninsula) and Kauri Bay, contains the largest area of mangroves and intertidal salt marshes in the Hunua Ecological District. Some of the saline vegetation communities are still in their natural state, and as a whole they are considered to be one of the five best saline wetland systems in the Auckland Region. Notable vegetation includes the two best coastal mangrove forests in the Ecological District and a coastal glasswort herbfield.

Wildlife values of the Wairoa River and Estuary are high, due in part to extensive areas of mudflats of high productivity which act as feeding grounds. New Zealand Dotterel (a threatened species) have been observed to breed both at Duders Beach and at Kauri Bay. There are high tide roosting sites used by waders (knots, godwits, and South Island pied oystercatchers are the most common birds), and mangrove/saltmarsh habitat used by branded rail and fernbird (both also threatened).

The Mangemangeroa/Turanga/Waikopua Creeks and Estuary as a whole (also known as the Motukaraka Estuary) is a site of Special Wildlife Interest of moderate to high value for wildlife. There is good wader habitat with over 1000ha of sand and shell mudflats. Godwits, and South Island oystercatchers are common migrant visitors and banded rail breed behind the mangrove areas of the Mangemangeroa Creek. New Zealand Dotterel also breed on the shellbanks between the Waikopua and Turanga Creek mouths. Banded dotterel and Caspian tern, which are also classified as threatened, have been recorded here.

There is high vegetation diversity within this estuary, with reasonably unmodified saline vegetation and remnant coastal forest sites. Of particular note are the islands of the Turanga Creek, with tree daisy dominated shrublands, flax and cabbage associations and young coastal forest.

(b) Manukau Ecological District

The second ecological district within Manukau City's area is the Manukau Ecological District, which also includes much of Franklin District and the southern part of Manukau City including the Clevedon valley and the Manurewa area.

In pre-European times vegetation north of Papakura was a combination of scrubland around Papatoetoe (fern and kanuka) which was later cleared, and swamp here and around Takanini, which was drained during the 19th century. On the Papakura flats, and around Alfriston and Ardmore, there are likely to have originally been stands of kauri forest, but these had largely disappeared before the arrival of the Europeans, possibly due to the effects of volcanic eruptions.

Because of extensive clearance of forest and scrubland and draining of swamps, the Manukau Ecological District today retains only 0.6% its area in forest cover and 1.2% in scrubland i.e. 1.8% in total in indigenous vegetation. The District is largely modified with much urban settlement and pastoral farming.

In contrast to the Hunua Ecological District, no work has yet been undertaken to identify the best representative examples of ecosystems under the Protected Natural Area Programme. However, it is clear that the only significant area of the natural landscape remaining in the District is the Manukau Harbour itself.

The Manukau Harbour has very extensive mudflats (there are 145km² of intertidal flats) with vegetated tidal land (mangroves, saltmarsh and eelgrass flats) covering about 5% of this. Two regionally significant habitats within Manukau City are the Puhinui Creek area, a wildlife refuge of particular importance for banded rails, fernbirds and marshcrakes (a large area of salt marsh to the north of the Creek mouth is also significant); and the Manukau Harbour foreshore from Mangere Bridge to Ambury Park, which is an important roosting and feeding area for seabirds and wading birds. Eleven species are known to breed in the west of this area including whitefaced heron, banded rail, banded dotterel and pied stilts.

The vast expanse of intertidal areas in the Manukau Harbour which can be used for feeding means that overall it is one of the most important wintering grounds in New Zealand for wading birds, including migratory species. Up to 50,000 birds at one time may use the harbour, making it a Site of Special Wildlife Interest of outstanding value, of national and possibly international significance.

Evidence suggests that the Manukau Harbour may be a major gathering place of migrant bird species in the Auckland region prior to departure to the Northern Hemisphere. Although feeding areas and food availability are not a limiting factor over the harbour as a whole, roosting areas often reach capacity. Principal roosting areas include shellbanks, small grassed islands and pasture adjacent to intertidal feeding areas. Within Manukau City the principal high tide roosts are the Manukau Harbour foreshore around Ambury Park, as mentioned above; the Mangere Wastewater Treatment Plant ponds, which attract waterfowl, and the Wiroa Island artificial roost, which attracts birds away from the airport approaches.

The large intertidal area of the Manukau Harbour results in an abundance of edible shellfish such as cockles. The Harbour also supports abundant finfish populations, with mudflats and mangroves providing food sources and shelter for species such as flounder, snapper, mullet, kahawai and trevally.

(c) Tamaki Ecological District

The third ecological district within Manukau City's area is the Tamaki Ecological District. This covers much of the built up area of Manukau City, as well as the Tamaki estuary and includes the Auckland Isthmus and North Shore. Again, little work has been undertaken on ecosystems in Manukau's portion of the Tamaki Ecological District or on its original ecology and subsequent modification.

It appears that the original forest was the characteristic northern North Island lowland type with abundant taraire and puriri. There was clearance and landform modification even during pre-European times, and today the ecological district is occupied by New Zealand's largest urban centre. Only 1.1% of the district remains in forest and 5.2% in scrub cover. It is believed that there have been up to 60 local plant extinctions in this Ecological District.

The most significant remaining habitat within Manukau City's portion of the Tamaki Ecological District is the Tamaki Estuary, which as a major wetland habitat is of moderate to high value for wildlife. The mangrove areas of the upper estuary and its tributaries are significant, as are the tidal flats which act as feeding areas for a variety of birds. The saltmarsh and associated habitats at the Tahuna-Torea spit is of regional significance, although within Auckland City rather than Manukau City's jurisdiction.

Although only very minor remnants remain of the original vegetation of the Tamaki Ecological District, it should be remembered that today's urban landscapes are shaped by significant tree and shrub planting which has been undertaken over time on City reserves, along streets and on private properties. These urban trees are a resource for the City. Trees or groups of trees may form significant habitats for urban wildlife. Perhaps most significantly in terms of sustainable management of our environment, trees have a positive effect on the atmosphere by recycling moisture, giving off oxygen and absorbing carbon dioxide.

Little work has yet been undertaken on the function of urban vegetation as a carbon dioxide "sink" although it is clear that fast growing species take up more CO_2 than slow-growing varieties and mature trees (the latter do however store CO_2). While plantings would probably need to be substantially increased to come anywhere close to off setting locally generated CO_2 emissions, urban trees and indeed trees right across the City must be seen as making some contribution to greenhouse gas reduction.

2.8.2 Trends

The preceding section has broadly estimated the extent of loss of vegetation cover in the three ecological districts making up Manukau City since pre-European times. It is much more difficult to establish the rate of such loss. It is clear that losses were greatest during the 19th and early 20th century as land was settled, and forests converted to pastoral land. Losses have however continued, albeit at a slower rate in recent

decades. Some clearance of forest has occurred from time to time in rural parts of the City, although such instances appear to have reduced since the introduction in 1987 of native bush protection in the District Plan, along with eligibility for rates relief.

Manukau City's rapid growth as an urban area imposes special pressures on the natural environment. While vegetation cover on the urban fringe has in many cases already been substantially modified through farming activity, the process of land development for urban purposes can result in further clearance. As the regional strategy of urban containment and selective intensification shifts the balance from peripheral growth to a higher degree of infill development, further pressures will be placed on urban trees on larger residential sites,and retention and enhancement of urban vegetation will become a significant issue.

Few freshwater wetlands remain in the City as virtually all of the original swamp areas have already been drained.

A more significant trend in recent years has been the modification of coastal habitats through harbour works and marina development, and more gradually as a result of pollution. While direct modifications are limited to particular locations and limited by demand (for example for boating facilities) deterioration of habitat quality through pollution can be widespread. This is especially obvious in estuarine areas near concentrations of industry and population, although rural activities can also have significant water quality effects which lead to long term changes in estuarine vegetation, fish populations etc.

Areas already mentioned in the water section of this chapter as having degraded water quality or being susceptible to water quality degradation (the Tamaki Estuary, the north-eastern Manukau Harbour, and the Pukaki and Puhinui Creek environs) all have notable ecological value. Where tidal flushing is not complete, contaminants from diffuse runoff and stormwater outfalls accumulate readily. Although shellfish surveys are already undertaken by the Auckland Regional Council, more systematic long-term ecological monitoring is needed to obtain a full picture of impacts of pollution on fish and bird populations.

2.8.3 Resource Management Issues: PLANTS, ANIMALS, ECOSYSTEMS

(a) There is Significant Loss and Deterioration of Particular Indigenous Habitat Types in Manukau City

The habitat types most at risk within Manukau City are native forest, scrubland habitats, wetlands and coastal habitats, particularly those within estuaries. Although clearance appears to have reduced in recent years there are still isolated examples, not just in connection with farming activity but in relation to public works, quarrying activity and rural-residential uses.

Total habitat loss is not always the issue; modification of habitats may be a threat through land management practices such as earthworks, which may result in siltation of watercourses and estuaries, diffuse runoff from fertilisers and pesticides, and allowing stock to graze within saltmarsh or unfenced bush areas, trampling the ground tier of vegetation.

As habitats in their natural state are reduced in number and size, to habitat "islands" it becomes increasingly difficult to maintain viable areas for particular plant and animal species to ensure regeneration, migration, colonisation, genetic exchange or breeding. This is one of the reasons why urban areas are often severely depleted of wildlife.

As a result of habitat loss, 56 animal and 105 plant species are threatened in the Auckland region. A substantial number of these are represented within Manukau City. Some could become endangered and eventually extinct in the region if habitat loss continues.

(b) Habitat Quality is Being Threatened By Introduced Plant and Animal Species

Possums are currently causing significant damage within the forests of the Hunua Ranges, in some areas wild goats threaten bush, and invasive weed species threaten the quality of other areas of bush. Weed invasion often results from proximity to urban development and greater opportunity for uncontrolled public access, as well as from domestic pets and stock spreading weed seeds.

2.9 STRUCTURES

2.9.1 State of the Resource

The structures of the city include all buildings, roads, utilities and facilities constructed by people and fixed to the land. These structures have all been built to serve some human need. The form of these structures determines the way in which people and communities interact with the natural environment.

The most common structure in the City is the dwelling which provides for the basic human need of shelter. In January 1995 there were 72,243 dwellings in the City.

Business premises including factories, warehouses, shops and offices amount to 3.2 million m^2 of floorspace in the City.

In the commercial sector the most significant structures and facilities are in the major town centres. There is considerable investment in these centres and in the infrastructure that serves them.[AM123]

A variety of public and private utilities and facilities service these structures and allow activities to be undertaken in a safe and convenient manner. In 1994 major items of infrastructure in the City consisted of:

- 1060 kilometres of roads;
- 140 bridges;
- 13km of rail tracks (North Island Main Trunk Railway) and 9 railway stations (Otahuhu, Mangere, Middlemore, Papatoetoe, Puhinui, Wiri, Homai, Manurewa, Te Mahia)
- the Wiri Oil Services Terminal (including Wiri-Airport Pipeline)
- 1270 kilometres of sewer pipes;
- 2 major sanitary landfills;
- 70 sewage pumping stations;
- 1600 kilometres of water pipes;
- the Auckland International Airport;
- the Mangere Wastewater Treatment Plant;
- the Otahuhu Power Station; and
- extensive telecommunications and energy transmission networks. [AM123]

Some of these facilities are of international, national and regional importance (e.g. Auckland International Airport) and others are of regional importance (e.g. Mangere Wastewater Treatment Plant). Nearly all of the major items of infrastructure within the City have been built since the end of World War II. Consequently, while they have been built to a high standard only some of these utility and facility services now have sufficient spare capacity to cater for future urban development of a scale that has occurred and is expected to continue, within the Auckland Region. However, problems such as sewer pump station overflows and stormwater quality need addressing in terms of the sustainable management of the water resource. Rail transport has been underfunded and neglected for decades and significant investment will be required to develop a rail network with a significant role in Auckland's future passenger transport network.[AM123]

There is a need to manage the effects of existing and future infrastructure (including regionally significant infrastructure) on growth and similarly the effects of urban growth on the ability to provide, operate, maintain and upgrade that infrastructure.[AM123]

In 1994 there were a large number of structures within the City with known cultural heritage significance. This figure includes not only European structures (primarily dwellings) but also the huge range of settlements, gardens and fortifications of tangata whenua. Many structures with cultural heritage significance have been destroyed in the past, significantly depleting the resource.

The presence of rail and road infrastructure has played a major role in the way Manukau developed in the past. The history and identity of many areas of the city has been strongly influenced by transport infrastructure. For example, the construction of the Great South Road in 1863 and the railway line in 1875 prompted the development of Papatoetoe, Hunters Corner and Manurewa in the late 19th century. Similarly, the rapid development of roading infrastructure, fuelled by an ever-increasing demand from private motor vehicles, promoted low density suburban development in the city from the 1950's, and large retail centres provided ample space for parking.[AM123]

2.9.2 Trends[AM123]

(a) The city's housing stock is growing rapidly. In the period 1996-2001 an average of 1700 dwellings were constructed each year, compared with an average of 1200 dwellings constructed each year in the first half of the 1990's.

(b) The establishment of new business structures over the last 5 years has primarily been directed to the Manukau Central and East Tamaki industrial areas and to those shopping centres that are close to developing residential areas.

(c) The expansive growth within Manukau City means significant infrastructural thresholds which will trigger the need for major new facilities (e.g. in relation to a proposed second runway at Auckland International Airport). Urban growth and intensification and greater public awareness of environmental issues is increasing the demand for higher quality infrastructure (e.g. enhanced treatment of stormwater before discharge to receiving waters).

(d) Increasingly, the public are becoming aware of the heritage value of some structures. This is especially apparent in areas which are subject to rapid urbanisation as a result of the trend identified in (a) above.

(e) Roading and public transport infrastructure on a regional scale are being upgraded in order to support the urban form promoted by the Growth Concept and according to the directions set in the Growth Strategy and the Regional Land Transport Strategy.

(f) Today the dominant retail environments comprise traditional strip centres and enclosed shopping malls, and the vehicle oriented large format stores and centres. Along with further development of the town centres there has been continued pressure and

demand for business and commercial, including larger format retail, development along corridors and other out of centre locations.

2.9.3 Resource Management Issues: Structures

(a) Urban redevelopment occurring outside of Town Centres and Intensive Corridors in an ad hoc manner can result in the loss of urban amenities.

Commercial development within new localities or by means of the expansion of existing Town Centres may improve access to goods and services and better enable people and communities to meet their social and economic needs. However, significant changes in the pattern of distribution of commercial development can result in particular adverse effects, or require consideration of the relationships with other aspects of the "Growth Concept", including the following:

- The relationship to higher density residential areas;
- The efficiency of the use of existing physical resources, including public transport;
- The extent and rate at which impacts on other centres (particularly High Density Centres) could reduce their amenity, and adversely impact on their social and economic functions;
- Whether adversely affected town centres have outlived their function.

Development outside of Town Centres and Intensive Corridors may also result in:

- Increased traffic congestion and underutilisation of public transport systems
- Damage to natural and cultural heritage
- Increases in stormwater run-off to Auckland's sensitive receiving environments.[AM123]

(b) Many Structures with Cultural Heritage Significance have been Destroyed in the Past

A number of structures (including pre-European structures) within the City have cultural heritage significance. This part of the resource has additional cultural, historical and architectural values which make it a rare commodity in a young and rapidly developing city. Some of these structures are very well maintained in close to their original condition, but a large number have been destroyed or modified in the past.

(c) There is Potential for Major Items of Infrastructure to be Inefficiently Used

The information presented above suggests that there is considerable investment in the existing infrastructure of the City by both public and private sectors. The sustainable management of the use, development and protection of this resource involves having particular regard to its efficient use and development in the context of this plan. Sustainable management must recognise, however, the efficiency is a relative concept and that the longevity of some infrastructural items sets in place activities and patterns of behaviour that can have inter-generational consequences where the built environment lags behind economic and cultural change. However, the intensity of use of the land resource may have a direct effect on the efficient use of infrastructure.

(d) The siting and design of structures can cause adverse effects on amenity values and influences the liveability of the City

The quality of pedestrian space, streets, parking spaces and public open spaces is affected by the nature and design of the built environment. This affects the visual appearance of the streetscape, rural and urban landscapes together with the use and enjoyment of public open space. It also affects personal, pedestrian and vehicular safety. Amenity values such as the enjoyment of sunlight and daylight are also affected by the location and design of buildings. The siting and design of social and physical infrastructure also affects how liveable neighbourhoods are e.g. people's accessibility to each other and to other places such as workplaces.

(e) The City's infrastructure is a physical resource which can be adversely affected by adjoining activities.

The City's infrastructure is a physical resource. Its provision must be co-ordinated with adjoining land use activities, in order to minimise potential adverse effects on it from these other activities. For example, the access arrangements and traffic generation of adjacent land use activities can adversely affect the safety and capacity of the primary road network.

(f) Infrastructure is sometimes provided in a way that fails to promote the sustainable management of natural and physical resources and may result in an inability to meet the future needs and expectations of the community.

A failure to provide infrastructure to the appropriate level, standard or design can result in adverse effects on the environment and the health, safety and well-being of the community. The provision of infrastructure, such as the transportation and utility services networks, also greatly affects the ability to develop land to its planned potential in an energy-efficient and sustainable manner. Inefficiencies and the waste of resources may also result where infrastructure is provided at a scale greater than is necessary.

(g) There will be a need for major new facilities or the upgrading of existing facilities as existing infrastructure reaches capacity.

There are various infrastructural facilities and network utility services in Manukau City which are likely to require upgrading, extensions or replacement during the planning period covered by this District Plan. Examples are the Auckland International Airport where the proposed second runway may be required, the National Grid where significant additional capacity is required, the possible expansion and upgrading of electricity generating facilities such as Otahuhu A and Otahuhu B and the need to upgrade stormwater quality measures and stormwater reticulation to cope with increased flows potentially resulting from urban intensification. Similarly, sanitary sewerage and water supply networks may require upgrading in High Density Centres. Rail transport infrastructure will be upgraded and expanded as Manukau City Centre will be connected to the North Island Main Trunk Line and two future Rapid Transport Corridors (East Tamaki and Auckland Airport corridors) may be developed. Unless such expanded or new infrastructural facilities can be provided for, there could be adverse effects on the environment and on the health, safety, social and economic well-being of the community.