MELBOURNE – THE PLACE
AND THE PEOPLE

Metropolitan Melbourne has been shaped by the natural landscape. Aboriginal family groups have occupied this region for around 40,000 years, adapting to periods of extreme climatic conditions and the isolation of Tasmania from the mainland by rising seas. The initial choice of location by European settlers was largely determined by the presence of freshwater in the Yarra River, with a natural rocky weir preventing the intrusion of saltwater upstream.

During early settlement, the landscape was rapidly modified, most notably the removal of features including Batman’s Hill located near Spencer Street, the draining of swamps and the clearing of vegetation for both resource use and establishing both agricultural and pastoral land. The natural basalt weir on the Yarra was removed during construction and repairs on Queens Bridge and tidal influences now extend further upstream to Dights Falls in Clifton Hill.\(^2\)

Large scale changes continue to occur with residential development in established urban areas and expansion outwards along major growth corridors. Some natural values have been diminished by these changes, and some flora and fauna species are now lost from this region. Others are more resilient to change.

Part B of this discussion paper provides information about the investigation area and its residents. It outlines the natural environment of the investigation area in terms of the geology and geomorphology, hydrology, biodiversity and climate of the investigation area. It also describes the Indigenous and non-Indigenous history and heritage of the investigation area and discusses Melbourne’s population today and what it will be like in the future.
CHAPTER 2 provides information about the geology and geomorphology, hydrology, biodiversity and climate of the investigation area.

2.1 Geology and geomorphology of the investigation area

This section provides a geological and geomorphological history for metropolitan Melbourne and describes important geological sites. Geology encompasses the origin, distribution, physical structure and formation of rocks on the earth. Geomorphology is the study of landforms such as mountains, plains, coastlines and rivers, and the processes that shape them. These may be influenced by land-use practices such as the building of dams, jetties, bridges or other structures.

Across much of metropolitan Melbourne the surface expression of the geological past is obscured by urbanisation. However, in some places such as along streams, railway and road cuttings, coastal cliffs, and in areas of high elevation to the north and east of Melbourne, outcropping rocks still reveal its long geological history.

Melbourne's natural geomorphological processes have been extensively altered. The Yarra River and Moonee Ponds Creek are reshaped, and many waterways have been utilised as drains, and at times, open sewers. Coastal changes such as artificial harbours, groynes and piers affect the seasonal movement of coastal sediments and the natural shape of popular beaches. Many beaches are now artificially renourished because of these alterations to natural processes. New landforms have been created, such as Herring Island located in the Yarra River near Burnley, and other areas have been reclaimed from the sea.

2.1.1 GEOLOGICAL HISTORY OF THE MELBOURNE REGION

The geology of metropolitan Melbourne ranges in age from around 480 million years ago (Ma) in the Palaeozoic era to the last few thousand years. A geological timeline including eras, periods and epochs of geological time is shown in table 2.1. Rocks in this region were formed during two main geological eras and comprise: Palaeozoic era sedimentary and granitic rocks, and Cainozoic era sedimentary and volcanic rocks. Major events in the Earth's history are also described in table 2.1.

The oldest Palaeozoic age (251 to 542 Ma) rocks in the investigation area, and indeed those of south-eastern Australia, are described in terms of a series of geological zones based on changing rock types or character. A geological map of the investigation area showing these zones is in figure 2.1.

These structural zones have experienced a complex history of major mountain building events, burial, erosion, faulting (deformed by breaking) and folding. Two of these zones occur in the investigation area: a small region of the Bendigo Zone in the west and the Melbourne Zone in the east. The Bendigo Zone — folded and faulted Ordovician age deep-sea sediments — occurs west of a major rock break-line exposed at the surface near Heathcote and extending from Sunbury to Werribee in the investigation area.22 These rocks are mostly buried beneath younger volcanic and sedimentary rocks across much of western part of the investigation area. Ordovician through to Devonian age sandstones and mudstones of the Melbourne Zone, once buried to great depths then folded and faulted, returned once again to the Earth's surface across the central and eastern parts of the investigation area.
<table>
<thead>
<tr>
<th>ERA</th>
<th>SUB-ERA OR PERIOD</th>
<th>EPOCH</th>
<th>MAJOR EVENTS IN EARTH’S HISTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cainozoic</td>
<td>Quaternary 0-1.8 Ma</td>
<td>Holocene</td>
<td>Extinction of most Australian megafauna by ~25,000 years ago. Humans arrive in Australia by 40,000 years ago</td>
</tr>
<tr>
<td></td>
<td>Tertiary 1.8-65 Ma</td>
<td>Pleistocene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neogene</td>
<td>Pliocene</td>
<td>First upright walking hominids ~4 Ma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene</td>
<td>Diversification of mammals and birds</td>
</tr>
<tr>
<td></td>
<td>Paleogene</td>
<td>Oligocene</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eocene</td>
<td>Australia completes separation from Antarctica</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paleocene</td>
<td></td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Cretaceous 65-141 Ma</td>
<td>Late</td>
<td>Mass extinction of 75% life at 65 Ma Australia separates from New Zealand at ~80 Ma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early</td>
<td>Eastern Highlands uplifted ~90 Ma Otway and Gippsland basins formed across the southern margin rift between Australia and Antarctica</td>
</tr>
<tr>
<td></td>
<td>Jurassic 141-205 Ma</td>
<td>Late</td>
<td>Break-up of Gondwana commenced initial separation of Australia and Antarctica commences at ~140 Ma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early</td>
<td>First appearance of birds</td>
</tr>
<tr>
<td></td>
<td>Triassic 205-251 Ma</td>
<td>Late</td>
<td>First appearance of dinosaurs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early</td>
<td></td>
</tr>
<tr>
<td>Palaeozoic</td>
<td>Permian 251-298 Ma</td>
<td>Late</td>
<td>Mass extinction of &gt;80% of all life forms at the end of this era</td>
</tr>
<tr>
<td></td>
<td>Carboniferous 298-352 Ma</td>
<td>Late</td>
<td>First insects develop ~300 Ma</td>
</tr>
<tr>
<td></td>
<td>Devonian 352-410 Ma</td>
<td>Late</td>
<td>First land animals ~400 Ma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silurian 410-434 Ma</td>
<td>Late</td>
<td>First land plants</td>
</tr>
<tr>
<td></td>
<td>Ordovician 434-490 Ma</td>
<td>Early</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cambrian 490-542 Ma</td>
<td></td>
<td>First abundant life on Earth</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>Ediacaran 542-600 Ma</td>
<td></td>
<td>Oldest known multi-cellular organisms ~600 Ma</td>
</tr>
<tr>
<td></td>
<td>Archaean 2500-4560 Ma</td>
<td></td>
<td>Oldest life known at about 3,500 Ma</td>
</tr>
<tr>
<td></td>
<td>Hadean &gt;4560 Ma</td>
<td></td>
<td>Origin of the earth</td>
</tr>
</tbody>
</table>
Figure 2.1
Geology of the investigation area
In the Late Devonian age granites from great depths in the Earth’s crust were forced up into both the Melbourne and Bendigo Zone rocks. In some places this lava erupted at the surface as volcanic rocks. These rock types are generally resistant to weathering and form more elevated topography such as the nearby ranges. Examples are at Bulla, Woodlands, Morang, Kinglake, Lysterfield and prominent nearby areas such as Mount Dandenong, You Yangs and the Macedon Ranges. Granitic landscapes are common across central and eastern Victoria and include some of our most scenic regions, such as Mount Buffalo and Wilsons Promontory.

During the Permian period glaciers scoured the land surface across large areas of central Victoria. Permian glacial sediments which were deposited as the glaciers melted are found to the west of Melton and throughout the Bacchus Marsh area. The best of these sites are at Darley and Bacchus Marsh, located just outside of the investigation area. These rocks are historically important as they provide evidence that today’s continents were once joined together in a single land mass – Gondwana – and that they separated through continental drift and tectonic processes.

By the end of the Permian period the glaciers had melted and there was a great extinction of life (95 per cent of marine species and 70 per cent of terrestrial vertebrates died out). The next era of Earth history, the Mesozoic, marked the beginning of a new range of plants and animals, including the rise of the dinosaurs. Triassic and Jurassic age rocks are rare in the investigation area. These rocks are historically important as they provide evidence that today’s continents were once joined together in a single land mass – Gondwana – and that they separated through continental drift and tectonic processes.

Cainozoic era (up to 65 Ma) rocks are extensive in the investigation area and comprise two main types: volcanic lavas and terrestrial or shallow marine sediments. The volcanic rocks have been traditionally divided into two age groups: Older and Newer Volcanics, and several regions or sub-provinces (for example, Werribee Plains, Melbourne, Tullamarine-Maribyrnong River valley flows). Although the distinction between the two events is somewhat arbitrary, with lava eruptions occurring intermittently for an extended period of time, the division has been retained based largely on geographic locations. Older Volcanics range in age from the Palaeocene to early Miocene with a peak in activity around 22 Ma. These rocks occur at the Pentland Hills near Bacchus Marsh (80–50 Ma), Mornington Peninsula-Cape Schanck and Phillip Island (48–42 Ma), Chirnside Park, Greensborough and Tullamarine (22–20 Ma). Other minor occurrences are extremely weathered and difficult to accurately date (e.g. Royal Park railway cuttings).

Pliocene-Pleistocene age Newer Volcanics extend from Melbourne to Mount Gambier in South Australia. The eruption of these lavas has formed a predominantly flat plain punctuated by the weathered domes of extinct volcanoes. In geological terms, this province is still active – eruptions have occurred as recently as the last 10,000 years at Lake Gnotuk near Camperdown and 4,300 years at Mount Gambier. Several excellent examples of volcanic eruption points and flows are found in the investigation area including Mount Cottrell (2.2 Ma), Mount Kororoit (2.5–2.2 Ma), Bald Hill at Kalkallo, Williamstown lava flow (2.5 Ma) and the ‘Organ Pipes’ in the valley of Jacksons Creek (2.5–2.8 Ma) at Sydenham. Cuttings for the eastern freeway near Fairfield reveal the internal flow and cooling structures of the Burnley Basalt – one of the youngest flows in the region dated at about 0.8 Ma – that flowed down an early Darebin Creek and along the ancestral Yarra River valley.

Cainozoic marine and non-marine sedimentary rocks are exposed at many localities across the investigation area. They are broadly grouped into the Palaeocene-Lower Miocene age non-marine sandstones, claystones and coals of the Yaloak and Werribee Formations, and are overlain by Miocene marine carbonate Torquay Group and Pliocene sandstones of the Brighton Group. Equivalent rocks in the Westernport area include the Sherwood Marl and Baxter Formation respectively. Examination of subsurface boreholes west of Melbourne indicates that the Werribee Formation may be up to 200 metres thick with brown coal seams up to 40 metres thick in some areas (e.g. Maddingley seam at Bacchus Marsh). Miocene-Pliocene fossil-rich rocks (Black Rock Sandstone and Red Bluff Sands) form scenic coastal outcrops between
Beaumaris and Sandringham. This area also provides a useful series of teaching sites for coastal geomorphology. Royal Park railway cuttings along the operating Upfield railway line expose Brighton Group sediments overlying Silurian age basement rocks, and highly weathered Miocene Older Volcanics.

A veneer of Quaternary age sediments followed the pattern of Tertiary sedimentation. Deposits comprise thin shallow marine, beach, dune and alluvial deposits. In many areas these sediments are derived from erosion of the material from underlying rocks and stream-supplied mud. This is particularly the case in the Bunyip and Yarra rivers deltas and the western margin of Port Phillip Bay where the sediments were stabilised by fringing mangroves and marshes.

Sea level fluctuations and climate changes during the Quaternary period, especially increasing aridity in the Pleistocene epoch, had a major impact on Victoria, and particularly coastal areas such as Port Phillip Bay and Western Port. In places evidence of relict landscape features such as higher sea levels and coastal shorelines remain intact (e.g. in the Altona, Skeleton Creek, Point Cook and Williamstown areas). Sand ridges and dunes south-east of Melbourne formed parallel to the coast during that time. These ridges acted as a barrier to the sea allowing streams to form lagoons or swamplands such as Carrum Carrum Swamp, which extended from Mordialloc to Frankston. Swamps also formed at the mouth of Kororoit, Cherry and Skeleton Creeks near Altona. The Patterson River near Carrum was modified in the late 1800s to facilitate drainage of the Swamp. Edithvale-Seaford Wetlands are one of the few remaining area of these swamps. One of the largest wetlands in Victoria, Koo-wee-rup Swamp north of Western Port, suffered a similar fate – drainage to provide access to land for the expanding agricultural needs of Melbourne.

At Cranbourne, Langwarrin and areas south of Lang Lang, wind blown sands accumulated in thin sheets during the Quaternary. These fine siliceous Cranbourne Sands form an undulating topography. Cranbourne Sands probably blocked flow of Cannibal Creek, the Bunyip and Lang Lang rivers leading to the formation of Koo-wee-rup Swamp at least 10,000 years ago, before a rise of sea level inundated much of Western Port. The sands were probably blown from dry plains formed where higher sea levels now occupy Port Phillip Bay.

Box 2.1
Geological influences on the development of Melbourne

The diverse geology of Melbourne provided a range of materials for the development of the city and influenced the manner in which the region was settled. The history of Melbourne is presented in chapter 3, but a brief look at some of the important historical connections to the rocks of the region is provided here.

Rocks of the Palaeozoic era, often referred to as basement rocks or bedrock, were exposed to weathering at various times during subsequent eras. Clay formed by weathering those rocks is an important source of brick and pipe clay in this region. Some of the first industries established in Melbourne utilised these earth resources, with more than 40 brickworks and potteries established in Brunswick by the 1860s.
2.1.2 GEOMORPHOLOGY OF THE MELBOURNE REGION

Victoria has a diversity of landscapes formed by variations in geomorphological processes across variable topography, geological history and rock lithology or composition. In addition, climate and sea level changes have also played a role in forming the land surface we see today. Victorian geomorphology has been described in terms of regions and smaller units of differing character on a regional or local scale. This section describes geomorphological landforms and processes within the Metropolitan Melbourne Investigation area.

Geomorphological regions

A statewide geomorphological framework has been developed by the Geomorphological Reference Group (GRG) and the Department of Primary Industries (DPI), building upon work started in the 1960s by the Soil Conservation Authority. Under this classification, the investigation area encompasses the six regions described below and shown in figure 2.2.

Eastern Uplands

The Eastern Uplands form the Victorian section of the Great Dividing Range encompassing the drainage divide; that is, the area separating streams flowing inland to the Murray River from those flowing south to the coast. In eastern Victoria the uplands are a prominent and rugged mountain region, but much of the western part is at lower elevations. There are also areas of low relief comprising elevated plateaus (Kinglake surface at 275 metres elevation, Bogong High Plains at 1500-1600 metres elevation) as well as highly dissected valleys along the northern and southern slopes. The Yarra River flows southwest from the Eastern Uplands to Port Phillip Bay. The elevated topography of the northern and eastern regions of the investigation area is part of the Eastern Uplands (figure 2.2).

Western Uplands

The Western Uplands extend from Kilmore Gap north of Melbourne westwards towards the Victorian-South Australian border, as a low-relief drainage divide with an average elevation of about 300 metres. A small area of the Western Uplands occurs in the northern and western part of the investigation area from Toolern Vale, north of Melton, to Riddells Creek. The Maribyrnong, Werribee, Lysterfield and Moorabool Rivers flow southeast from these uplands. Rock type and structure strongly controls landform in the Western Uplands. The southern margin has been burred by the extensive lava flows of the Volcanic Plains in many places. Volcanic eruption centres within the Western Uplands have produced valley-filling lava flows and lava plateau which may have developed waterfalls, such as Trentham Falls and Lal Lal Falls.
Figure 2.2
Geomorphological units in the investigation area
Southern Uplands
The Southern Uplands are deeply dissected fault bound blocks. Notable areas include the Otway Ranges, Bellarine Peninsula, Mornington Peninsula, Strzelecki Ranges and Wilsons Promontory. A small area of the Southern Uplands is represented in the investigation area towards the northern end of the Mornington Peninsula (Moorooduc Plains) and northeast of Western Port (western Strzelecki Ranges). The low relief Moorooduc Plains are mainly comprised of Neogene sediments while other areas of Southern Uplands are formed on Lower Cretaceous Otway and Strzelecki groups sedimentary rocks and exhibit higher relief and moderate elevations (Otway and Strzelecki Ranges, Barrabool Hills). Both the Bellarine and southern Mornington Peninsula comprising the headlands on either side of Port Phillip Bay are more geologically varied than the other areas of Southern Uplands and consist of Older Volcanics, Neogene age marine sands, Palaeozoic sediments and granitic rocks.

Western Plains
The Western Plains are a low-lying undulating plain formed on some of the youngest volcanic and sedimentary rocks of Victoria. They comprise the majority of the western portion of the investigation area extending from an area near the Plenty River to the west (and eventually to South Australia). They are bound by Western Uplands to the north, and to the south by the coastline and Southern Uplands (Otway Ranges).

Much of the area is grassland, punctuated in places by volcanic eruption centres. Mount Elephant volcano near Denimium in southwestern Victoria is a striking example rising some 240 metres above the surrounding plain to an elevation of 393 metres. West of Melbourne, the Werrindee Plain has about a dozen volcanic eruption centres including Mount Cottrell — a large shield volcano south of Rockbank (205 metres elevation). North of Melbourne, the volcanic plains are composed of numerous lava flows extending along the ancestral Darebin, Merri and Maribyrnong stream beds. Many of these streams have excavated new channels along the margin of the valley-filled lava flows. One of the best examples is along Jacksons Creek near Sydenham where columns of lava known as the “Organ Pipes” have been exposed. A prominent scoria cone and crater at Mount Fraser (424 metres elevation) near Beveridge, north of Melbourne, can be readily observed from the Hume Freeway.

Low-lying sedimentary regions occur such as the Werrindee River delta-like alluvial plain. This area is fringed by shallow coastal deposits supporting saltmarsh and mangroves.

Eastern Plains
The Eastern Plains lie east of Port Phillip Bay and between the Eastern and Southern Upland regions. They are mostly low relief surficial Quaternary to Recent sediments derived from erosion of the Eastern Uplands. The Eastern Plains range from undulating rises to almost level plains. The youngest sediments are the flood plains, swamps and morasses associated with the present-day rivers and streams. In Western Port and Port Phillip Bay (between Frankston and Mornington), swamps and lagunal deposits were drained after European settlement. Recent wind blown deposits include the calcareous and siliceous dunes of the Cranbourne Sand.

Coast
The coastline of the investigation area includes low coastal areas, active cliffs, basaltic headlands, coastal barriers forming lagoons and swamps and sandy beaches. Modified or engineered coastal environments are also present at the Yarra River mouth and the confluence with the Maribyrnong River, as well as the Bunyip River mouth in Western Port.

The northern margin of Western Port and the north western Port Phillip Bay, from Point Cook Coastal Park to Kororoit Creek, are low coastal areas fringed by mangroves and saltmarsh. These areas are strongly influenced by tidal changes. Active cliffs are present along the margin of the Brighton Coastal Plain exposing Brighton Group sediments. Shore platforms formed by resistant Black Rock Sandstone protect these cliffs from undercutting, and the main erosion in this area is caused by run-off and seepage after heavy rain rather than coastal retreat by wave action. These cliffs also provide input of sandy material to the beach; however, landscaping and engineering works such as re-surfacing have altered these natural geomorphological processes. The natural seasonal movement of sandy beach deposits along this coastline caused by seasonal changes in wave incidence have been disrupted by groynes and sea walls leading to the capture of sediments, erosion of beaches, and shallowing of some harbours. Restricted sand movement and reduced input of new beach material from the erosion of coastal cliffs has

A few Palaeozoic outcrops occur within the Western Plains. These inliers are predominantly granitic rocks that were islands rising above the Pliocene sea and surrounded by lava flows. The You Yangs form prominent granite hills above the Werrindee Plains. The area encompassing Woodlands Historic Park and Greenvale Reservoir are also low granitic hills rising above the Western Plains landscape.
had a significant impact on many beaches, particularly in eastern Port Phillip Bay. Human engineering intervention is often required to restore sandy deposits. Offshore sands are periodically extracted and pumped onshore to renourish beaches that have been eroded.

2.1.3 SITES OF GEOLOGICAL AND GEOMORPHOLOGICAL SIGNIFICANCE

Geological features and sites help us understand the geological history of the earth. A site of geological significance has special scientific or educational value and forms the basis for geological education, research or reference. Specific geological sites may be significant examples of natural features, landforms or landscape, type localities for rock units, fossils, minerals, or important illustrations of the operation of natural processes. The size and nature of geological sites varies widely, but consist of two main groupings:

- natural exposures such as in rivers, steep cliffs or mountains and along coastlines
- those exposed by human excavation in road or railway cuttings and by mining works in quarries.

A total of 153 sites of geological significance* have been identified on public land in the investigation area. Thirteen sites are of high significance (international, national or state). Sites of international significance are rare or global type localities and are typically well known as reference sites for geologists. Nationally significant sites show features that are rare in Australia or are important by virtue of their scale or state of preservation. Sites of state significance are important in defining the geology and geomorphology of Victoria. Sites of high geological or geomorphological significance located on public land in the investigation area are listed in appendix 2. More detailed descriptions of sites of significance are provided in Sites of geological and geomorphological significance on public land* available at www.veac.vic.gov.au.

Seventy-three sites of regional significance are found on public land in the investigation area. These sites include landforms or geological features representative of the Melbourne region and include several examples of the alluvial terraces along creeks or streams. The remaining sixty-seven sites are of local significance.

2.2 Hydrology: rivers, creeks, groundwater, wetlands and coasts

The hydrological system of the investigation area is made up of surface water (rivers and streams), ground water, wetlands and coasts. Each is described below.

2.2.1 RIVERS AND STREAMS

A catchment is an area of land, bound by hills or mountains from which runoff water flows into rivers, streams, bays, wetlands and the coast, eventually entering the sea. Five catchments lie either wholly or partly within the investigation area. These are, from west to east, the Werribee, Maribyrnong, Yarra, Dandenong and Western Port catchments.

Almost 9,000 kilometres of rivers and streams (natural and man-made) flow through the investigation area to eventually reach Port Phillip Bay and Western Port. Major watercourses in the investigation area are shown below in table 2.2. Figure 2.3 shows the catchments and major waterways within the investigation area.

Table 2.2

<table>
<thead>
<tr>
<th>CATCHMENT</th>
<th>RIVER/ STREAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Werribee</td>
<td>Werribee River, Kororoit Creek, Skeleton Creek</td>
</tr>
<tr>
<td>Maribyrnong</td>
<td>Maribyrnong River, Deep Creek, Emu Creek, Jacksens Creek</td>
</tr>
<tr>
<td>Yarra</td>
<td>Yarra River, Plenty River, Darebin Creek, Diamond Creek, Merri Creek, Moonee Ponds Creek</td>
</tr>
<tr>
<td>Dandenong</td>
<td>Dandenong Creek, Eumemmerring Creek,</td>
</tr>
<tr>
<td>Western Port</td>
<td>Bunyip River, Cardinia Creek,</td>
</tr>
</tbody>
</table>

The largest river within the investigation area is the Yarra River which, having formed in the higher country to the east, runs westward some 240 kilometres, passing through the city and across the Yarra delta. The upper reaches of the Yarra River between Warburton and Warrandyte wind through a series of scenic floodplains and gorges. This stretch of the Yarra River, which extends beyond the investigation area, has been protected under legislation as a Victorian Heritage River due to its high environmental and social values. Downstream, the Yarra River is an iconic part of the city of Melbourne. The reliable

* Significance ratings are assigned by the Geological Society of Australia (Victoria Division) Heritage sub-committee. Assessment criteria include the rarity, representation and replication of features as well as site accessibility and management conditions.
freshwater from the river was a key reason for the establishment of Melbourne. Over the years, the river has been altered in many ways by the straightening of several sections and the carving of new channels.

The catchment of the Yarra River is the largest of the region at some 4,000 square kilometres. The upper Yarra catchment provides the majority of Melbourne’s drinking water.\(^{40}\)

Other major rivers of the region include the Maribyrnong River, one of the few large rivers developed on the volcanic plains north and west of Melbourne, and the Werribee River, which forms a broad, delta-like alluvial plain edged with spectacular cliffs and coastal salt marshes. Many watercourses provide the basis for natural linkages of public land across the investigation area (e.g. Merri Creek trail, Dandenong Valley Parklands, Plenty River Parklands).

### Figure 2.3
Major catchments and waterways in the investigation area

River and stream condition

The condition of waterways is measured by the Index of Stream Condition (ISC).\(^{41}\) It integrates the condition of river hydrology, water quality, streamside zone (vegetation), physical form (bed and bank condition and instream habitat) and aquatic life. The index measures the change from natural conditions and indicates the capacity of the waterway to support a diverse biological community. In essence, it is a measure of change from natural or ideal conditions for all Victorian streams at a common point in time. This allows different types of streams to be compared across Victoria.

River and streams in the hilly, forested areas in the north-east of the investigation area are generally in better condition than those further downstream in more urbanised areas. None of the rivers and streams within the investigation area is in excellent condition, with only a small percentage in good condition. Most rivers and streams are in poor condition, largely due to land use changes such as urbanisation, vegetation removal, drainage and flood control works, stock access, increased storm water runoff and invasion by weeds. The lower reaches of some rivers such as the Yarra and Mordialloc Creek are so heavily modified that they contain almost no natural streamside vegetation.\(^{17}\)
Water quality

Water quality is naturally variable and can be affected by a range of factors. Water quality within the investigation area is generally higher in the forested upper catchments on Melbourne’s fringe and lower in urbanised areas closer to the city. The decline in water quality is due to factors such as increased run-off rates, loss of riparian and in-stream vegetation, litter, invasion by introduced plants and animals, pollution and reduced water flows. The following brief description of water quality in Melbourne’s catchments is drawn from the Port Phillip and Westernport regional river health strategy.42

The Werribee catchment is located in a relatively low rainfall area, with low water flow a major issue for its streams. The condition of rivers and streams in the Werribee catchment is variable, with higher water quality in the upper catchment that decreases progressively downstream. Water quality in streams such as the Skeleton and Kororoit Creeks is generally low.

Water quality in the rivers and streams of the upper Maribyrnong catchment is generally good. However, urban and industrial development in the lower section of the Maribyrnong catchment has led to low water quality in many of its watercourses.

The construction of numerous major water storages and the use of water for agriculture have significantly altered flows in the Yarra River and other tributaries since European settlement. Water quality in the upper Yarra catchment today is generally high, whereas rivers and streams downstream tend to have poor water quality due to changes in land use.

Modifications to rivers and streams for flood protection (for example, concrete lining and channel straightening) have been extensive within the Dandenong catchment. Water quality is generally fair to poor throughout, although some watercourses in the upper catchment still maintain relatively good water quality (for example, Dandenong Creek). While storm water runoff continues to degrade parts of the catchment, there has been a significant improvement in water quality over the last 30 years with the extension of the sewerage system to areas under development and a reduction in industrial discharges to rivers and streams.

Water quality is generally good in the upper Western Port catchment but declines downstream of the Princes Highway. For example, water quality in the middle and upper reaches of the Bunyip River is good but becomes poor to very poor in the lower reaches of the river.

The investigation area contains a number of major reservoirs including Yan Yean, Sugarloaf, Silvan, Cardinia and Greenvale reservoirs. These collect, store and provide water for domestic, industrial and agricultural uses across Melbourne.

2.2.2 GROUNDWATER

Groundwater refers to the reserve of water found below the earth’s surface in pores and crevices of rocks and soil. The quality of groundwater across the investigation area is generally fresh to brackish. It is used for irrigation, commercial, stock and domestic purposes.

Three groundwater basins underlie the investigation area: the Port Phillip basin in the west and inner south-east, Highlands basin to the north and east and Western Port basin to the south-east.

The Port Phillip basin underlies and surrounds Port Phillip Bay. The groundwater resource is relatively small and some areas are saline.43 Groundwater extraction in the south-eastern suburbs of Melbourne is largely for watering gardens (especially during periods of water restrictions) and golf courses and for market garden irrigation. West of Melbourne, groundwater is extracted for use in market gardens, and for some industrial use in the western suburbs of Melbourne.43 Some aquifers in western Melbourne are polluted due to past discharges of liquid industrial waste, leaks and seepage.44

The Highlands basin covers approximately one third of Victoria, with only a small portion occurring in the investigation area. Much of the groundwater within the basin is fresh water. Within the investigation area, groundwater is generally extracted for stock and domestic use and market garden irrigation.43

The Western Port basin is a relatively small basin.43 Much of the groundwater within the basin is fresh water. Groundwater is generally extracted for market gardening and irrigation.43

Groundwater within the investigation area may be impacted by overuse, poor recharge due to lack of rain, and pollution. The recent drought has increased the demand for groundwater in the investigation area, while reducing natural groundwater recharge from rainfall.45
2.2.3 WETLANDS

Prior to European settlement, Melbourne contained extensive wetlands. A description of the widespread wetland systems historically present in metropolitan Melbourne is provided in section 2.3.

Many wetlands across the region were drained and converted to new uses, mostly agriculture. These freshwater habitats are now one of the most depleted and altered environments across the region. Changes to water extraction, river manipulation and the extended dry period are having ongoing and significant impacts on wetland environments.

Victoria has lost more than one third of its wetland area, largely due to drainage, filling and other modification.46 This loss of wetlands is reflected within the investigation area. Since European settlement, deep freshwater marshes (such as Koo-wee-rup) have been almost completely depleted, with less than one per cent remaining, and less than ten percent of shallow freshwater marshes (such as Carrum Carrum Swamp) remain. Public land within the investigation area has retained a much higher proportion of original wetlands than private land.

New wetland environments such as reservoirs, storm water treatment ponds and sewerage treatment plants have also been created within the investigation area, and now account for almost three-quarters of wetlands within metropolitan Melbourne.

Major wetlands in the investigation area today include the Edithvale-Seaford Wetlands (the remains of Carrum Carrum Swamp) and Cheetham Wetlands (which were created through the activities of a former saltworks). One of the least known areas is the northern Western Port coastline. This area is the remnant of one of the great swamp landscapes: Koo-wee-rup and Tobin Yallock swamps.4 Across the area, channels have been excavated to drain the swamps but in places, natural drainage lines are still present.

2.2.4 COASTS

The coastline is an important resource for Melburnians and all Victorians with our beaches providing important environmental, scenic and recreation values.

The coastline of the investigation area stretches approximately 186 kilometres from Port Phillip Bay in the west and south, from Werribee to Frankston; and Western Port to the south-east, from Warneet to Lang Lang. Almost the entire coastal foreshore within the investigation area (94 per cent) is Crown land. About two-thirds of metropolitan Melbourne's coastline is in parks and reserves such as Point Cook Coastal Park-Cheetham Wetlands, Altona Coastal Park, Truganina Coastal Park and numerous coastal and foreshore reserves.

Coasts within the investigation area range from rocky pebble beaches to steep sea cliffs and shallow mangrove-lined mudflats. A description of the geomorphology of metropolitan Melbourne's coasts is provided in section 2.1.2.

The coast contains a range of vegetation communities, including coastal alkaline scrub, coastal dune scrub, coastal saltmarsh and coast banksia woodland. Melbourne's richly diverse intertidal and coastal environment is home to a number of endemic species but also provides important habitat and breeding sites for migratory birds from places such as Japan and China.

Metropolitan Melbourne's beaches and foreshore areas are popular recreation sites. A variety of facilities have been installed such as piers, beach boxes, boat sheds, dressing pavilions, band stands, sailing club rooms and surf lifesaving clubs. Many of these facilities have local and state heritage values, and are evidence of a long and close association with the beach. Most beaches and foreshores provide opportunities for activities such as walking and cycling and group gatherings such as picnics and barbecues. Piers such as St Kilda Pier provide opportunities for other recreation activities such as fishing.

Melbourne's coastal environment is subject to pressures such as increasing urbanisation and recreational use, introduced plants and animals and coastal erosion and sedimentation. The emergence of the "sea change" lifestyle has brought more people to the coast as permanent residents, exacerbating some of these pressures.17 Coastal environments are also susceptible to the predicted impacts of climate change such as rising sea levels (see chapter 7 for more detail). For example, coastal saltmarsh communities along parts of the western coast of Melbourne grow in muddy intertidal zones that are inundated daily with seawater. Rises in sea levels due to climate change may lead to the permanent inundation of some saltmarsh communities.47
2.3 Biodiversity

Biodiversity refers to the variety of all forms of life, including plants, animals and micro-organisms, their genes and the terrestrial, marine and freshwater ecosystems of which they are a part.46

2.3.1 PRE-SETTLEMENT FLORA AND FAUNA OF METROPOLITAN MELBOURNE

The land around Port Phillip Bay historically supported a diverse natural environment, with forests, woodlands, heathlands, wetlands and grasslands all common. The source of the material for this section is The Encyclopaedia of Melbourne.48

The margins of Port Phillip Bay contained coastal tussock grassland on the sand dunes and coastal scrub in higher, better drained areas. Wetlands were also relatively common along the coast. For example, an extensive lignum swamp system occurred around present day Altona and south-west to Point Cook. West Melbourne and areas adjacent to the southern bank of the Yarra River contained extensive wetlands, as did Prahran, Caulfield and Bulleen. The largest swamps were the Koo-wee-rup Swamp in the south-east, which extended over 40,000 hectares, and Carrum Carrum Swamp, which covered more than 4,000 hectares from Mordialloc Creek to near Frankston. The coast and wetlands supported a great diversity of mammals, birds, reptiles, amphibians and fish.

The area west and north-west of the present city centre contained extensive grassland plains with a wide variety of grasses and herbs. A number of major waterways (e.g. Werribee River and Kororoit Creek) fringed by riparian vegetation passed through the plains. There were also areas of woodland dominated by various species of eucalypt Eucalyptus spp. and she-oak Allocasuarina spp.

The area south and south-east of the Yarra River (to the edge of Western Port) contained heath and heathy woodland on rolling hills, with patches of dense tea-tree Leptospermum spp. Open forest containing large areas of grassland occurred further south-east, from Springvale and Dandenong to the foothills of the Dandenong Ranges and south-east to Western Port. Smaller areas of grassland occurred near Box Hill and Ringwood, generally within river valleys and alluvial flats. These areas supported large groups of eastern grey kangaroo Macropus giganteus and emu Dromaius novaehollandiae, and a wide range of bird life.

The northern side of the Yarra River contained both wet and dry forests. These stretched into the Dividing Range foothills, and the foothills and uplands of the Dandenong Ranges. The forest understory supported small mammals, black wallaby Wallabia bicolor and koala Phascolarctos cinereus (more open forest) and various bird and bat species.

The following sections provide an overview of the biodiversity values of metropolitan Melbourne today.

2.3.2 BIOREGIONS

‘Bioregions’ are broad geographical regions that share common physical and biological features, such as climate, soils and plant and animal communities. Bioregions reflect underlying environmental features and as such, are used as a broad framework for conservation planning and management.49

Australia is divided into 85 regions and into further sub-regions, based on major geomorphic features.50 These are referred to as the IBRA (Interim Biogeographical Regionalisation for Australia) bioregions. The investigation area is largely located within IBRA’s Victorian Volcanic Plain bioregion (different in area to the Victorian bioregion of the same name) and South East Coastal Plain bioregion with smaller areas of the Victorian Midlands and South Eastern Highlands bioregions also present.

In Victoria, the landscape is divided into 28 bioregions, which correspond closely with the IBRA subregions. As shown in figure 2.4, the investigation area contains parts of six bioregions, namely the Gippsland Plain, Highlands-Southern Fall and Victorian Volcanic Plain bioregions with smaller patches of Otway Plain, Central Victorian Uplands and Highlands-Northern Fall bioregions. A brief description of each bioregion is provided below.

The Gippsland Plain bioregion extends east across to Lakes Entrance and from Foster in the south to Moe in the north. It is characterised by flat to gently undulating, low-lying coastal and alluvial plains. Common vegetation communities include heathy woodland, swamp scrub, plains grassy woodland, grassland and wetland (floodplains and swamps) and lowland forest (higher areas). Approximately 16 per cent of the bioregion occurs in the south-eastern part of the investigation area.
The Highlands-Southern Fall bioregion forms the southern part of the Great Dividing Range and extends from Melbourne to near Omeo. It contains uplands and high plateaus, with alluvial flats along the valleys. The vegetation is dominated by dry and damp forest on the slopes, with wet forest in the valleys. Cool temperate rainforest occurs in protected gullies. Approximately 12 per cent of the bioregion occurs in the north-eastern part of the investigation area.

The Victorian Volcanic Plain bioregion extends west to the South Australian border, south to Colac and north to Broadford. The landscape contains peaks from long-extinct volcanoes, stony rises created by old lava flows, and many large, shallow lakes. Characteristic vegetation communities on the plains include grassy woodland and grassland, with stony knoll shrubland on stone rises. Volcanic outcrops generally support woodland communities. Approximately eight per cent of the bioregion occurs in the western part of the investigation area.

The Otway Plain bioregion extends east of Princetown to the Bellarine Peninsula. It consists of coastal plains and dunes, foothills with river valleys and lowland swamps. The vegetation includes lowland forest, heathy and grassy woodland and plains grassy woodland. Approximately six per cent of the bioregion occurs in the western part of the investigation area.

The Central Victorian Uplands bioregion extends from the Grampians and Ararat in the west to Porepunkah in the east; and from the You Yangs and Lara in the south to Lurg in the north. It contains rugged to gently undulating terrain, with the vegetation being mainly dry forests. Approximately one per cent of the bioregion occurs in the western part of the investigation area.

Less than one per cent (approximately 280 hectares) of the Highlands-Northern Fall bioregion occurs along the northern boundary of the investigation area.
2.3.3 ECOLOGICAL VEGETATION CLASSES

The diversity and complexity of vegetation communities requires a framework that can be used to simplify and identify common features. In Victoria, native vegetation is classified into Ecological Vegetation Classes (EVCs). Approximately 300 EVCs are recognised in Victoria with 85 EVCs recognised within the investigation area. Many of these EVCs also occur outside of the investigation area and within adjoining bioregions.

Most vegetation within the investigation area can be defined within 19 EVCs covering the coastal scrubs, heathland and heathy and grassy woodlands in the south-east; the woodlands and wet and dry forests of the north-east; and the grasslands and woodlands in the north and west.*

Native vegetation extent

The modelled pre-European and current extent of EVCs within the investigation area is shown in figures 2.5 and 2.6. These use the most recent Department of Sustainability and Environment (DSE) 2004-2005 data and mapping of native vegetation extent. DSE’s simplified native vegetation groups (groups containing similar EVCs) are used to allow for a simpler representation of the data. A list of all EVCs recorded within the investigation area and their current extent is published at www.veac.vic.gov.au.

Approximately 145,620 hectares (or 26 per cent) of land in the investigation area contains native vegetation. This figure is higher than previously thought, largely due to recent improvements in detection of native vegetation from satellite data (particularly grasslands), rather than any increase in the actual extent of native vegetation. Despite the extensive loss of vegetation within the investigation area, significant areas of native vegetation still remain, particularly on the outer fringes of Melbourne.

Approximately 66 per cent (or approximately 95,980 hectares) of native vegetation within the investigation area boundary is located on private land. The remaining 34 per cent (or 49,640 hectares) is located on public land. Approximately 20 per cent (28,700 hectares) is managed for conservation within the protected areas system. The remaining native vegetation on public land occurs on land managed primarily for other purposes such as water supply catchments, road and rail reserves and water frontages.

All bioregions, except the Victorian Volcanic Plain bioregion, have been more heavily cleared in the investigation area than in the remainder of the state** (figure 2.7). The Victorian Volcanic Plain bioregion has been heavily cleared both within the investigation area and the state. The portions of the Otway Plain, Gippsland Plain and Victorian Volcanic Plain bioregions within the investigation area have been extensively cleared, with less than 20 per cent of their original vegetation remaining.

This vegetation loss has not been a random process. These areas are suitable for agricultural activities and were developed relatively rapidly following European settlement. Grasslands within the Victorian Volcanic Plain bioregion were heavily targeted for early pastoral settlement (probably because of their suitability for grazing without the need for extensive clearing of woody vegetation), and fertile soils around Werribee in the Otway Plain bioregion were developed for market gardens, poultry farms and orchards in the early 1900s.*

The Highlands–Southern Fall bioregion still retains a high proportion of native vegetation cover within the investigation area. The bioregion is characterised by areas with steep terrain or low fertility areas generally considered unsuitable for agriculture.

* The most common EVCs in the investigation area are EVC 16 Lowland Forest, EVC 18 Riparian Forest, EVC 20 Heathy Dry Forest, EVC 22 Grassy Dry Forest, EVC 23 Herb-rich Foothill Forest, EVC 29 Damp Forest, EVC 30 Wet Forest, EVC 45 Shubby Foothill Forest, EVC 47 Valley Grassy Forest, EVC 48 Healthy Woodland, EVC 53 Swamp Scrub, EVC 55 Plains Grassy Woodland, EVC 61 Box Ironbark Forest, EVC 126 Sampy Riparian Complex, EVC 128 Grassy Forest, EVC 132 Plains Grassland, EVC 164 Creekline Herb-rich Woodland, EVC 175 Grassy Woodland, and EVC 793 Damp Heathy Woodland.

** The Highlands-Northern Fall bioregion was excluded from the analysis as it only represents a very small proportion of the investigation area (0.02 per cent).
Figure 2.5
Pre-1750 native vegetation in the Metropolitan Melbourne investigation area
Source: Department of Sustainability and Environment (2005)
Figure 2.6
Existing native vegetation in the Metropolitan Melbourne investigation area
Source: Department of Sustainability and Environment (2005)
Native vegetation quality

While EVC mapping describes the extent and composition of vegetation within the investigation area, it does not provide information on the quality of the vegetation. DSE has mapped vegetation quality at a landscape scale within Victoria based on assessment of the biophysical components of the site (site condition), the size of the patch and its proximity to other patches of remnant vegetation (landscape context). DSE has modelled vegetation quality across Victoria, with categories ranging from ‘poor’ to ‘good’ quality. Areas of poor quality, for example, may have remnant overstorey trees remaining but the understorey components are often absent or degraded due to clearing and/or invasion by weeds. Conversely, areas considered good quality, have most or all components of the vegetation community remaining intact.

Vegetation quality within metropolitan Melbourne is highly variable (see figure 2.8). It is generally higher in the north-eastern and eastern parts of Melbourne around Gembrook, Christmas Hills and Warrandyte. Medium quality vegetation generally occurs in the western part of Melbourne around Rockbank, Tarneit, Mount Cottrell and Wyndham Vale while large areas of poor quality vegetation occur in the north and north-west around Sunbury and Craigieburn.
Figure 2.8
Vegetation quality within the Metropolitan Melbourne Investigation area
Source: Department of Sustainability and Environment (2005)
Bioregional conservation status of native vegetation

Conservation status is the extent to which ecosystems or species remain in their natural state in relation to their pre-European distribution. A classification system of bioregional conservation status which assesses EVCs as either presumed extinct, endangered, vulnerable, depleted, rare or least concern has been developed by DSE. Threatened EVCs include those listed as either endangered or vulnerable. The bioregional conservation status takes into account how commonly the EVC originally occurred within the bioregion, the current level of depletion and the level of degradation of condition typical of remaining stands or remnants.

As shown in figure 2.9, the western and northern parts of the investigation area contain large areas of threatened native vegetation. Native vegetation in the north-eastern part of the investigation area is generally not considered threatened.

The extent of threatened vegetation within the investigation area also varies by bioregion and land tenure. For example, the Gippsland Plain and Victorian Volcanic Plain bioregions have a higher proportion of threatened native vegetation communities than other bioregions. This is not surprising given their history of early settlement and subsequent land clearance for agriculture.

Threatened vegetation communities predominately occur on private land within the investigation area and are generally poorly represented in the protected areas system. Less than 15 per cent of threatened vegetation communities are protected in metropolitan Melbourne.

2.3.4 NATIVE FLORA AND FAUNA

Flora

A total of 1,753 vascular native plant species has been recorded within the investigation area since 1990. This is approximately 40 per cent of all vascular plant species recorded in Victoria although the area of the investigation area only represents approximately 2.5 per cent of the area of Victoria. The investigation area also contains 640 bryophyte (mosses and liverworts), lichen and fungi species. A list of flora recorded within the investigation area is published at www.veac.vic.gov.au.

The high plant diversity of the investigation area is largely due to its location at the junction of three major geological formations: fertile clay soils of the basalt plain to the west and north-west; the hillier country of generally poor, strongly weathered soils to the north and east; and the sandy plains to the south-east of the city. This high recorded diversity is also likely to be due to the intensive plant and animal survey effort undertaken within the metropolitan area.

It is noted that small organisms such as fungi have been poorly surveyed and as a result the number of species recorded is thought to be significantly lower than the number of species present.

Fauna

Native fauna species have responded to the urbanisation of Melbourne in a variety of ways. Many are now restricted to relatively small and often-fragmented patches of habitat while other species survive only in larger parks. Conversely, populations of some native species have remained constant, have adapted to change, or even thrived. While built environments (roads, buildings, paved areas) are often considered unsuitable for fauna, other highly modified environments may, in fact, remain suitable. For example, common brushtail possums Trichosurus vulpecula often live in native remnants in Melbourne but also forage in the surrounding residential landscape.
Box 2.2
The grey-headed flying-fox - an urban adaptor

The grey-headed flying-fox *Pteropus poliocephalus*, the largest member of the fruit bat family, is endemic along the south-eastern coast of Australia including south-west Victoria. It had been an occasional visitor to the Melbourne area since 1884, but it wasn’t until 1986 that it settled in the Royal Botanic Gardens Melbourne. The population was subsequently relocated to Yarra Bend Park in 2003 as it was causing serious damage to significant vegetation at the gardens.

Urban areas appear to be becoming increasingly important to the grey-headed flying-fox with flying-fox camps within or near Melbourne, Sydney, Brisbane and Darwin. The movement to Melbourne is probably due to a combination of natural habitat removal, local climate change (Melbourne is now warmer and more humid) and an increased and year-round availability of food resources (for example, 120 plant species native to Queensland and NSW and favoured by the grey-headed flying-fox have been planted in parks and along Melbourne’s streets). Melbourne also provides protection from shooting, and street lighting may provide easier night-time navigation.

Source: Yarra Bend Park flying-fox campsite: review of the scientific research.54

A total of 495 native vertebrate fauna and 72 native invertebrate species have been recorded within the investigation area. Perhaps surprisingly, given the level of habitat modification, metropolitan Melbourne has a diverse vertebrate fauna with approximately 70 per cent of species currently known in Victoria recorded within the investigation area. A list of fauna recorded within the investigation area is published at www.veac.vic.gov.au.

The investigation area contains 319 species of birds, approximately two-thirds of all fauna species recorded in the investigation area. Mobile species such as birds are well suited to urban areas as they can more easily move between fragmented habitat patches. Species such as rainbow lorikeet *Trichoglossus haematodus* and Australian magpie *Gymnorhina tibicen* are common in a variety of habitats across Melbourne while others, such as eastern yellow robin *Eopsaltria australis*, white-browed scrubwren *Sericornis frontalis* and superb fairy-wren *Malurus cyaneus*, prefer more intact habitat.

Forty-seven terrestrial and semi-aquatic mammal species have been recorded within the investigation area, largely bats and other arboreal mammal species such as possums and gliders. This may be because urbanised areas such as Melbourne often lack suitable habitat for ground-dwelling mammals.56 The common brushtail possum *Trichosurus vulpecula* and common ringtail possum *Pseudocheirus peregrinus* are the two most widespread arboreal native mammal species within inner Melbourne. They have adapted to inner Melbourne for several reasons including an unspecialised diet, their use of man-made structures for shelter and their ability to move across cleared ground and via the tree canopy.56 Other arboreal mammal species such as yellow-bellied glider *Petaurus australis*, feathertail glider *Acrobates pygmaeus* and eastern pygmy possum *Cercartetus nanus*, have more specialised diets and are largely restricted to natural areas in outer metropolitan Melbourne. Seven marine mammal species such as dolphins and seals have also been recorded.

Forty-one reptile species have been recorded within the investigation area. These include 29 lizard species with all major groups (geckos, skinks, dragons, goannas and legless lizards) represented. Eight snake species have also been recorded, with common species including eastern brown snake *Pseudeonaja textilis*, tiger snake *Notechis scutatus* and common copperhead *Austrelaps superbis*. 
Nineteen amphibian species have also been recorded within the investigation area (out of a total of 33 species within Victoria). Species such as the southern brown tree frog *Litoria ewingii* and eastern banjo frog *Limnodynastes dumerilii* are common within Melbourne and can often be heard calling from suburban gardens.

Sixty-two species of fish have been recorded within the investigation area. These include freshwater fish such as eels, lampreys, galaxiids, gudgeons, river blackfish *Gadopsis marmoratus*, pigmy perch, smelt and tupong *Pseudaphritis urvillii*.

Seventy-two terrestrial and freshwater invertebrate species have been recorded within the investigation area. These include 59 terrestrial and freshwater insect species (mostly butterfly species) and 13 crustacean species (such as yabbies and crayfish). Many species of invertebrates are yet to be described.

**Threatened species and communities**

The investigation area contains a large proportion of Victoria’s threatened flora and fauna species with 178 plant species, 106 vertebrate fauna and eight invertebrate fauna species listed as threatened in Australia and Victoria.\(^57,58\)

Habitat for some species such as the grassland earless dragon *Tympanocryptis pinquircola* and various orchid species occurs almost exclusively within the investigation area. Box 2.3 on the following page provides some background on one of these species, the Eltham copper butterfly *Paralucia pyrodiscus lucida*.
Box 2.3
Eltham copper butterfly

The threatened endemic Eltham copper butterfly is a small butterfly that survives in a highly urbanised environment. The butterfly prefers woodland habitat with an understorey containing the shrub sweet bursaria *Bursaria spinosa* (on which the larvae feed) and a ground layer of native grasses, mosses and leaf litter. It is considered endangered in Victoria and is listed under the Flora and Fauna Guarantee Act 1988.

The Eltham copper butterfly was discovered in 1938 in Eltham. It was thought to be extinct in the 1950s, but a population was rediscovered at Eltham in 1986. Since then, the Eltham copper butterfly has decreased in abundance and numbers due to destruction and fragmentation of its habitat through urbanisation, competition for food with introduced wildlife (for example, brown hares and rabbits eat sweet bursaria plants), and altered fire regimes (which can cause understorey vegetation to grow excessively, reducing the area available for flight paths). The main populations currently occur in small patches of bushland surrounded by suburban development (for example, the Eltham Copper Butterfly Reserve, owned by Trust for Nature).

Government agencies, local councils, ‘Friends of the Eltham Copper Butterfly’ and volunteers have monitored butterfly populations nearly every year since 1988. They have also improved habitat on private land in the Eltham area by planting host plants to help the dispersal of butterflies between reserves, and have protected the butterfly’s habitat in a series of reserves where development is strictly controlled.
Many vegetation communities within the investigation area are threatened, with several listed for protection under the Flora and Fauna Guarantee Act 1988. This Act is the key piece of Victorian legislation for the conservation of threatened communities and management of potentially threatening processes. These communities are listed in table 2.3.

**Table 2.3**
Communities within the Metropolitan Melbourne Investigation area listed under the Flora and Fauna Guarantee Act 1988

<table>
<thead>
<tr>
<th>COMMUNITY NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cool Temperate Rainforest</td>
<td>This community is dominated by a dense canopy of non-eucalypt tree species over an understorey of climbers, broad-leafed shrubs, ferns and soft-leafed herbs. Key sites within the investigation area include gullies in the southern section of Kinglake National Park and in the Yarra State Forest.</td>
</tr>
<tr>
<td>Rocky Chenopod Open-scrub</td>
<td>This community has an open canopy of eucalypts over a sparse, shrubby understorey dominated by wattles and chenopods. Key sites within the investigation area include above the Plenty River at Janefiel, Bundoora and Jacksons Creek between Sunbury and Diggers Rest.</td>
</tr>
<tr>
<td>Western (Basalt) Plains Grassland</td>
<td>This community is predominantly open, treeless grassland dominated by tussock grasses, with herbs occurring in the inter-tussock spaces. Key sites within the investigation area include the Craigieburn Grassland Reserve, Merri Creek Grasslands, Derrimut Grassland Reserve and Laverton North Grassland Reserve.</td>
</tr>
</tbody>
</table>

### 2.3.5 WETLANDS, RIVERS AND STREAMS

Wetlands within the investigation area provide habitat for a range of flora and fauna (including migratory birds from Asia) and act as a drought refuge. Some of Melbourne’s larger wetlands such as Edithvale-Seaford Wetlands and wetlands within the Western Treatment Plant at Werribee are considered priority sites for bird conservation within Australia (see box 2.4). The coastal wetlands of Port Phillip Bay and Western Port provide over-wintering and breeding habitat for migratory species such as sharp-tailed sandpiper, red-necked stint and bar-tailed godwit, and are internationally and nationally recognised as important bird habitat.

Three of Victoria’s 11 Ramsar sites are located within the investigation area, and are predominantly on public land. The Edithvale-Seaford Wetlands are three freshwater wetlands recognised for their high waterbird diversity and numbers and for supporting threatened species. They are located in the southern part of the City of Kingston and the northern part of the City of Frankston. The wetlands are mostly on land owned by Melbourne Water, although parts of the Seaforad Wetland are owned by the City of Frankston.

Approximately 7,735 hectares (or 30 per cent) of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site lies within the investigation area (the remainder is located on the Bellarine Peninsula). This Ramsar site contains the Point Cook Coastal Park and Cheetham Wetlands in the Cities of Wyndham and Hobson Bay and the Western Treatment Plant in the City of Wyndham. It is recognised for its high waterbird diversity and numbers.

The Western Port Ramsar site is located in Western Port in Melbourne’s south-east. The northern coast of the site lies within the investigation area and contains extensive, narrow areas of saltmarsh and mangroves. The Western Port Ramsar site is recognised for its unusually wide variety of habitat types and for its high waterbird numbers.
The Western Treatment Plant, Werribee
Melbourne Water’s Western Treatment Plant treats 52 per cent of Melbourne’s sewage and is located about 35 kilometres south-west of Melbourne, and occupies approximately 11,000 hectares on the western side of Port Phillip Bay. The eastern half of the plant is within the investigation area. The Western Treatment Plant is the largest area of public authority owned land within the investigation area, and parts contain significant biodiversity values.

The Western Treatment Plant supports regular numbers of the critically endangered orange-bellied parrot Neophema chrysogaster (including important wintering habitat), and large numbers of international migratory waders. The plant regularly provides habitat for more than 20,000 waterfowl, and has more than one per cent of the population of several species of waders and ducks.

Above: Migratory waders at the Western Treatment Plant

The investigation area contains about 6,400 kilometres of natural rivers and streams, including major waterways such as the Yarra, Maribyrnong and Werribee Rivers. These and smaller waterways provide important habitat for a range of riparian, semi-aquatic and aquatic flora and fauna, and also act as wildlife corridors.

2.3.6 INTRODUCED SPECIES
The environment within the investigation area has been highly modified with a large number of introduced flora and fauna species. Forty-five introduced animal species have been recorded. Common introduced fauna species include birds such as the common blackbird, common myna Acridotheres tristis, common starling Sturnus vulgaris, spotted turtle-dove Streptopelia chinensis and house sparrow Passer domesticus, and mammals such as the European rabbit Oryctolagus cuniculus and red fox Vulpes vulpes.

More than 1,100 introduced plant species (about a third of all plant species recorded in the investigation area) have been recorded within the investigation area. This includes some species which are commonly found in Melbourne’s gardens, but which have escaped into more natural areas. Common introduced species include African boxthorn Lycium ferocissimum, ragwort Senecio jacobaea, gorse Ulex europaeus and bridal creeper Asparagus asparagoides, grassy weeds such as Chilean needle grass Nassella neesiana and serrated tussock Nassella trichotoma, riparian weeds such as blackberry Rubus sp., willows Salix sp. and phalaris Phalaris aquatica, and salvinia and alligator weed Alternanthera philoxeroides in waterways and aquatic systems.

A number of these introduced species can invade more natural areas, leading to a decline in biodiversity values. The impacts of invasive species are discussed further in section 8.1.
2.4 Climate

Meteorological measurements have been collected in Melbourne since 1854. These long-term records are important tools used to understand climate averages and ranges, particularly when daily and yearly weather patterns are so highly variable. A description of Melbourne’s climate and the impacts of climate change are presented below.

2.4.1 Melbourne’s ‘Normal’ Climate

International conventions draw upon the 30 year period from 1961 to 1990 to define normal or current climatic averages or typical conditions. Under these conventions Melbourne’s climate is described as temperate with distinctly dry and warm summers using the Köppen classification scheme. During this 30 year period, the region had average maximum summer temperature of around 22 to 24ºC near the coast and in the ranges to the east, and 25 to 27ºC in Melbourne and inland. Winter average maximum temperatures were mostly around 12 to 14ºC with frosts occurring inland, but rarely near the coast and inner urban areas.

Rainfall was highly variable. The average annual rainfall for the Melbourne city gauge was 639 millimetres (mm), but was less than 600mm in Werribee and Laverton west of Melbourne and more than 1300mm north and east at Toolangi and the Dandenong Ranges. Generally, rainfall was greatest in winter and spring. Despite a wet and grey weather reputation, Melbourne averaged 98 rainy days a year between 1961 to 1990 when at least 1mm of rain fell (Station: Melbourne regional office). In comparison, Brisbane averaged 93 rainy days (Station: Brisbane regional office) and Sydney averaged 101 rainy days over the same period (Station: Sydney: Observatory Hill).

2.4.2 Melbourne’s Changing Climate

Temperatures and rainfall for Melbourne have been atypical for the last decade, even when the natural variability of the climate is taken into account. Since 2001 Melbourne experienced five of the twenty driest years in over 150 years of records (below 472mm in the city gauge), and annual mean temperatures are rising. Climatric modelling suggests that this period is probably not only a ‘normal’ – albeit longer – drought cycle, but also reflects climate change.

Climate change has significant implications for Australia’s environment, economy and society through its effects on the availability and distribution of water, higher average temperatures and increases in the occurrence of droughts, fires and floods. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme. The IPCC Fourth Assessment Report, released in 2007, concluded that “warming of the climate system is unequivocal” and “most of the observed increase in global average temperatures since the mid-20th century is very likely [greater than 90 per cent probability] due to the observed increase in anthropogenic greenhouse gas concentrations.”

The levels of the three main greenhouse gases (carbon dioxide, methane and nitrous oxide) have grown significantly since 1750. In the past, forest absorption, atmospheric and oceanic processes buffered the earth against short-term natural spikes in greenhouse gases (e.g., from volcanic eruptions). Our increasing use of fossil fuels and land clearing has produced an unprecedented and sustained increase in greenhouse gas emissions, while also undermining the natural absorption processes of the environment.

Carbon dioxide is the most significant of the anthropogenic (human produced) greenhouse gases. Present day global carbon dioxide concentrations were recently measured as 386 parts per million (ppm). For the 10,000 years before 1750, atmospheric carbon dioxide levels were within the range 280± 20ppm. Furthermore, the normal or natural range of carbon dioxide during at least the last 800,000 years has been determined by climate scientists as 170 to about 300ppm. There has been a strong correlation between carbon dioxide and temperature over the last 420,000 years. A rapid rise of carbon dioxide levels beyond long term natural variations commenced at the start of the 1800s. But it is not just the increase of the post-industrial greenhouse gas concentrations that is unusual; it is also the rate at which this has occurred. From 1750 to 2005, carbon dioxide increased from 280-379ppm (35 per cent), methane increased from 715-1774ppb (148 per cent) and nitrous oxide from 270-319ppb (18 per cent). At no stage in the recent geological record has such a rapid and sustained change occurred. Relatively slow atmospheric reaction times and feedback loops will result in climate change continuing in response to greenhouse gases we are emitting today until at least 2030. There are potentially other long-term changes yet to be fully realised that may be more severe and irreversible from the perspective of human timescales.
Globally, warming is accelerating. The average rate of increase over the past 50 years is twice that of the 50 previous years. Combined global land and marine surface temperature records from 1850 to 2008 show thirteen of the fourteen warmest years occurred in the fourteen years from 1995 to 2008. Analyses of over 400 proxy climate records (from trees, corals, ice cores and historical information) show 1998 to be the warmest year of the last 1000 years and the 20th century the warmest century.

Global average temperatures have increased by 0.74°C from 1906 to 2005. Over a significant length of time, such changes in climate are what induce ice ages and warm interglacial periods. These changes are a driver for biological change — evolution or adaptation, migration and extinction — even though they may seem inconsequential in relation to Melbourne’s variable daily temperatures.

Mean annual temperatures across Australia also reflect this warming trend. The period 2000-2009 was Australia’s warmest decade since high-quality data records became available in 1910 and there has been a progression of hotter mean temperatures for each decade since 1940.

Climate change projections forecast warming across south-eastern Australia and also a strong increase in frequency of hot days and warm nights. In broad terms, CSIRO modelling for south-eastern Australia projects:

- increases in temperature and sea level, extreme events such as storms, floods and fires
- uncertainty in rainfall (because of extreme events), rainfall patterns/distribution, soil moisture, soil erosion, changed hydrological processes

**Temperature increases**

From 1950 to 2005 mean annual maximum temperatures increased by 0.71°C (0.13°C per decade) in Victoria and by 0.81°C (0.14°C per decade) in Melbourne. Over the same period annual minimum temperatures increased by 0.44°C (0.08°C per decade) in Victoria but in Melbourne the increase was far greater at 1.79°C (0.32°C per decade).

Projections by CSIRO suggest the future climate of the Port Phillip and Western Port region, including metropolitan Melbourne, will be hotter and drier than it is today. By 2030, average annual temperatures are projected to be around 0.8°C warmer than 1990 averages. By 2070, a further increase in temperature of 1.3°C is projected, even under a lower emissions growth scenario. Under a higher greenhouse gas emissions growth scenario, these increases double to 2.6°C and Melbourne’s temperatures would resemble present day Echuca, while annual rainfall would be similar to present day Seymour. At the same time, the annual frequency of hot days above 35 degrees will increase from an average of 9 to 11 by 2030. Under higher emissions scenarios this may rise to 26 days above 35 degrees by 2070. Melbourne recorded 15 days above 35 degrees maximum temperature in 2009.

**Increased incidence of extreme weather events**

Extreme weather events, such as storms, floods and heatwaves are likely to increase as climate change continues. Heat waves, such as the one experienced in southern Australia during January and February 2009, can be expected to increase in frequency. The effects of this event on metropolitan Melbourne included loss of power supply to some areas and shutting down of many businesses or services due to high power demand, and delays to or cancellations of trains and trams due to infrastructure or equipment failure.

The significance of this prolonged heatwave has been somewhat overshadowed by the devastating bushfires that followed on 7 February (Black Saturday): the hottest day ever recorded in Melbourne with a maximum of 46.4 degrees. This eclipsed the previous record of 45.6 degrees for 13 January 1939, and exceeded the hottest February record by 3.2 degrees (set in 1983). Three of Melbourne’s hottest five days were recorded during this heatwave period. Although similar in duration to the 1939 heatwave, the 2009 episode was accompanied by sweltering overnight minimum temperatures. Melbourne’s six consecutive nights above 20 degrees equalled records set during 1908.

Climate change is already having an effect on human health and there are concerns that the quality of life for Melburnians will be further impacted in the future. Victoria’s Chief Health Officer reported 374 additional deaths across the state, including 248 people aged 75 years or over, during the record-breaking three consecutive days over 43 degrees in Melbourne.

Heat-related mortality rates in Australian cities are expected to increase substantially by 2050, taking into account demographic changes, with heat-related mortality for Melbourne likely to at least double from current averages.
Reduced rainfall

Melbourne has a highly variable annual rainfall but has generally enjoyed a long-term reliable average (figure 2.10).66 The long-term average annual rainfall over the last 150 years recorded in the Melbourne city gauge is 647mm, with a range of 967mm (1916) and 332mm (1967).66 Annual rainfall has not exceeded the long-term annual average since 1996, and despite some good rainfall in 2010, it is unlikely that this year will see a return to wetter conditions.

Between 1998 and 2007 the average rainfall across this region was 14 per cent below the long-term average. Average inflows to Melbourne’s major dams (Thomson, Upper Yarra, O’Shannassy and Maroondah) from 1997 to 2007 were between 30-40 per cent below average (figure 2.11).64,86

Melbourne has experienced a number of periods with dry conditions or drought generally associated with El Niño Pacific Ocean climatic conditions. In overall terms the current dry period is similar in some ways to the period during World War II, but there are very important differences in seasonal patterns. In particular autumn changes are outside natural variability as well as there being generally drier conditions.87 Melbourne may have had a step-change in its annual rainfall and stream flows related to climate change.88 The last 13 years since 1997 constitute the longest period of below average annual rainfall recorded.66 Perth, at a similar latitude to Melbourne, experienced step changes reducing average annual rainfall on at least two occasions: for the period 1911 to 1974 there are statistically significant reductions over the period 1975 to 1996 and 1997 to 2005.

Figure 2.10
Annual rainfall recorded in central Melbourne from 1856 to 200966

- Rainfall (mm)
- Median

<table>
<thead>
<tr>
<th>Year</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860</td>
<td>1000</td>
</tr>
<tr>
<td>1880</td>
<td>800</td>
</tr>
<tr>
<td>1900</td>
<td>600</td>
</tr>
<tr>
<td>1920</td>
<td>400</td>
</tr>
<tr>
<td>1940</td>
<td>200</td>
</tr>
<tr>
<td>1960</td>
<td>0</td>
</tr>
<tr>
<td>1980</td>
<td>200</td>
</tr>
<tr>
<td>2000</td>
<td>400</td>
</tr>
</tbody>
</table>
Increasing temperatures alter wind patterns (atmospheric circulation) and humidity. A key atmospheric circulation is the exchange of air from the tropics to mid-latitudes. A predicted change in this pattern will produce more erratic rainfall events. In south-eastern Australia, average annual rainfall, and the number of rainy days are expected to decrease, however the intensity of rainfall events or heavy rain storms is likely to increase. Combined with increasing air temperatures, there will generally be less surface water and soil moisture.

Changing rainfall patterns, particularly increased time between rainfall events and high intensity storm events, is likely to have negative effects on the natural environment, water quality, and both sewerage and drainage infrastructure. Melbourne Water has identified some of the risks to infrastructure as:

- flash flooding or damage to sewers and drains, particularly in coastal environments (see section below), due to high rainfall events
- pipe failure and collapse due to dry soil conditions
- longer travel times and high concentrations of sewerage due to reduced flow
- decreased surface water and run-off leading to reduced water quality.

River health is also impacted by reductions in rainfall, with declining river flows potentially causing significant changes in stream conditions and threatening many aquatic or semi-aquatic species.

In Melbourne's catchments, a decrease in inflow of 7-64 per cent from previous long term averages by 2055 is modelled for medium emissions growth scenarios. At the same time increasing population and temperatures are likely to increase future water demands.

Water conservation and demand management solutions have been implemented in recognition of current falling storage levels. In response to these programs and public campaigns, and despite high temperatures and drought, Melbourne's per capita domestic water consumption has decreased by 34 per cent in 2006/07 compared to averages of the 1990s; industry has also reduced consumption by around 38 per cent.
Above: Storms at Ricketts Point Beaumaris have eroded coastal dunes and foreshore areas.

Sea level rise

Global sea level rise is caused by ice sheet melting, particularly land-based glacial ice in Antarctica and Greenland, and the thermal expansion of the ocean. This process has occurred naturally throughout the Earth’s history and is linked to glacial and interglacial cycles. While there is some uncertainty about the amount of sea level rise under various future carbon emission scenarios, sea levels are currently rising and will continue to rise during the 21st century and beyond.  

Climate change is already having significant impacts on coastal environments. Around Australia the sea level rose by about 1.2mm per year during the 20th century. From 1961-2003, the rate was 1.8mm per year and from 1993-2003 it increased to 3mm per year. This rate of increase is an order of magnitude faster than the average rate of rise over the previous several thousand years. The IPCC indicated that, relative to 1990 levels, sea levels will rise between 0.18-0.59 metres by 2090-2099 plus an additional ice sheet melt contribution of 0.1-0.2 metres. However, sea level rise may be much greater than these values and recent observations suggest that we are tracking along the upper bounds of earlier IPCC 2001 projections. The 2008 Victorian Coastal Strategy established a policy of planning for sea level rise of not less than 0.8 metres by 2100. Recent Commonwealth Government coastal planning using a risk based approach has applied 1.1 metres sea level rise as a plausible worst case scenario for this century.

Climate change effects on the Victorian coastline include an increased frequency and severity of storm events leading to greater coastal inundation and erosion. The combined effects of sea level rise, the impact of tides, storm surges, wave processes and local conditions such as topography, elevation and geology will determine the areas of greatest damage.
CHAPTER 3 describes the Indigenous and non-Indigenous history of the investigation area and discusses how people lived and continue to live in what is now metropolitan Melbourne.

Material from this section was largely drawn from reports commissioned by VEAC for this investigation. These reports are available at www.veac.vic.gov.au

3.1 Early Indigenous history

People have observed the changing landscape of Melbourne for up to 40,000 years. Aboriginal inhabitants have adapted over generations to a dramatically changed environment as the climate shifted from warm and wet to cool and dry. By the height of the Last Glacial Maximum 18,000 years ago, Melbourne was cold, dry and largely treeless. The average temperature in winter would rarely have exceeded 10°C. The temperature was on average 5-10°C cooler than today. Rainfall was lower by 30 to 50 per cent and the land was locked in a drought with no foreseeable end. Snow would have fallen on Mount Macedon, and gale-force winds howled across the land. The shallow lakes which had once covered large areas of Victoria were dry and the forests of warmer, wetter years had retracted and disappeared along with the megafauna they once supported. But not everywhere was inhospitable. Small damp pockets of forest survived amidst the tracts of steppe-like grasslands and herbfields.

The vast frozen poles had locked up the world’s water, dropping sea levels 65 metres below the current coastline and connecting Tasmania to Victoria across the Bassian Plain. It seems likely that the Aboriginal people inhabited and utilised the Bassian Plain, along with the grassy basin of what was to become Port Phillip Bay (see figure 3.1) but any evidence of their presence has long been reclaimed by the sea. A smattering of humans left traces across this landscape in shell middens, quarries and fish traps; their scatterings of artefacts, scarred trees and earth mounds testament to thousands of generations of continuous land use.

Figure 3.1

A comparison of the coastline of south-eastern Australia (a) 18,000 years ago and (b) 14,000 years ago (modified after Bird and Frankel 1998)
No Ice Age lasts forever and around 14,000 years ago the ice began to melt and rain began to fall. The sea levels rose and water flooded once more across the Bassian Plain, leaving only the isolated hilltops of the Flinders and King island groups to mark the path of the bridge between Tasmania and Victoria.\textsuperscript{101,102,103} By 6,000 years ago, sea levels had risen rapidly to near present levels, 10-15 metres per thousand years.\textsuperscript{98} At some point the waters had surged through the heads to create Port Phillip Bay, an event reflected in Indigenous oral history.

Mr Robert Russell says that Mr Cobb talks to the blacks in their own language, and that the following is an account, given by them, of the formation of Port Phillip Bay: ‘Plenty long ago..............alonga Corio, men could cross, dry-foot from our side of the bay to Geelong.’ They described a hurricane – trees bending to and fro – and then the earth sank, and the sea rushed in through the heads, till the void places became broad and deep as they are today.\textsuperscript{104}

The climate changed to warmer, wetter conditions as erratically and variably as it had swerved away from them, creating pockets and periods of relative stability, before gradually settling into the patterns observed today.\textsuperscript{105,96}

The Aboriginal people, the Woi Wurrung, Wada Wurrung and Bun Wurrung moved across the changing landscape, understanding the ecology and seasonal availability of food or other resources.

At the time of first contact, Aboriginal society in southern and central Victoria is believed to have consisted of five major tribal or language groups (see table 3.1).

Each of these major tribes comprised a number of patrilineal clans.\textsuperscript{107,106} The Wada Wurrung are thought to have had some 25 clans at the time of European settlement; however, most of these lay outside the investigation area. Within the investigation area, the Bun Wurrung tribe of eastern Melbourne is thought to have included five separate clans while the Woi Wurrung included six main clans.

These clans were further subdivided into individual family groups, also known as bands.\textsuperscript{108} Social, ceremonial, or ritual gatherings between band, clan and tribe were common, sometimes of up to 800 people at a time.\textsuperscript{109,110,111}

These small family groups moved through their territories in response to seasonal abundance of food. They hunted a wide diversity of animals using spears and other weapons, but also trapped birds and fish in nets and traps.\textsuperscript{112,113,114} Eel harvesting using stone traps was widespread in south-eastern Australia.\textsuperscript{112,115} Despite the importance of hunting, plant material probably made up half of the diet of people on the basalt plains.\textsuperscript{116}

The underground tubers of the yam daisy or murnong \textit{Microseris scapigera} were a staple part of the diet, being abundant and available year round.\textsuperscript{117,118,119} Plant material also provided resources for utensils, string, baskets and clothing.

Evidence of trade and exchange between tribes has been preserved by the wide distribution of greenstone artefacts across Victoria. Greenstone, prized for the production of hatchet heads, primarily originates from a quarry at Mount William near Lancefield in central northern Victoria.\textsuperscript{109,120,110,111,121,122} The distribution patterns suggest close affiliation between clans that shared similar languages in central and north-western Victoria, south-western Victoria and south-eastern South Australia, but a paucity of trade with the Kurnai tribes of eastern Victoria.

Table 3.1

The five language groups of southern and central Victoria, encompassing the metropolitan Melbourne area (spelling of each clan or tribe following Clark 1990)\textsuperscript{106}

<table>
<thead>
<tr>
<th>NAME</th>
<th>SYNONYMS</th>
<th>TERRITORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bun Wurrung</td>
<td>Boon Wurrung, Bunurong</td>
<td>Mornington Peninsula and Western Port, north into the Dandenongs</td>
</tr>
<tr>
<td>Woi Wurrung</td>
<td>Wurundjeri</td>
<td>Yarra and Maribyrnong rivers and surrounding tributaries. To Mt Macedon, Mt William, Kilmore. East of the Werribee River</td>
</tr>
<tr>
<td>Wada Wurrung</td>
<td>Wathaurung</td>
<td>Bellarine Peninsula, Otway Ranges, west of the Werribee River to Stratham</td>
</tr>
<tr>
<td>Djadja Wurrung</td>
<td>Taungurung</td>
<td>Loddon and Avoca river catchments, Bendigo</td>
</tr>
<tr>
<td>Daung Wurrung</td>
<td>Taungurung</td>
<td>Kilmore to Euroa, east to Mt Buller, west to Kyneton</td>
</tr>
</tbody>
</table>
Woodlands Historic Park

Woodlands Historic Park is approximately 20 kilometres north-west of Melbourne, immediately north of Tullamarine Airport. Formerly known as Gellibrand Hill Park, Woodlands Historic Park encompasses over 700 hectares of significant remnant native woodlands and grasslands. The park is culturally significant as a surviving example of the 1840s agricultural landscape, complete with rare examples of early pioneer buildings.

There are 16 registered Aboriginal places within Woodlands Historic Park (eight artefact scatters, seven scarred trees and one place with multiple types of artefacts), reflecting Aboriginal land usage prior to European settlement. Artefact scatters result from stone tool manufacture, use or curation, often at the location of an ephemeral campsite, while scarred trees result from the removal of bark for housing material, carrying vessels, shields or watercraft. Immediately adjacent to the eastern boundary of the Woodland Historic Park is the Weeroona Aboriginal Cemetery. This contemporary cemetery is the final resting place of a significant number of Melbourne's Aboriginal community and so is of great significance to the community.

As a ‘cultural landscape’, the Woodlands Historic Park and environs provides tangible evidence of ancestral life prior to European occupation, highly valued natural environmental attributes, and a significant contemporary cemetery demonstrating a continued attachment to place.

Left: Woodlands Historic Park contains one of the greatest concentrations of Aboriginal scarred trees in the Metropolitan Melbourne Investigation area as well as a range of other culturally important sites.
Patterns of land use differed across the habitats within Indigenous territories. For many tribes, coastal areas offered a rich array of year-round resources. The resulting abundance of calcified remains in shell middens provides evidence of intense occupation along coastlines, in dunes, around lagoons, estuaries and swamps. Similarly, river and creek valleys were favoured occupation areas, providing shelter, firewood, freshwater, food, and materials for tool manufacture as well as travel routes. A rich array of archaeological material – artefact scatters, scarred trees, stone quarries, fish traps, human burials and earth mounds – scattered along the corridors of Melbourne’s waterways provides evidence of occupation for up to 40,000 years.

The open grasslands of the basalt plains also offered a wealth of plant foods, such as yam daisies, as well as good hunting of grazing animals. However, these activities leave little archaeological trace, reflected in the limited artefact locations and small campsites. This patchy evidence of land use may also suggest seasonal use given that the open plains offered little in the way of shelter from the elements or fuel for campfires. Use of the hills areas appears to have been even more sporadic, with the scattered archaeological evidence in hilly areas suggesting at most only periodic use. Both the hills and basalt plains are likely to have been less hospitable at different times over the last 40,000 years due to climatic variation, restricting the abundance of resources present and people’s ability to exploit them. For all locations, there is evidence of variable patterns in occupation over time suggesting that local climate variation may have been an important factor in determining land use at particular times and places.

There are thousands of archaeological sites and places including human burials, earth mounds, earth ‘rings’, shell middens, scarred trees, stone artefact scatters, fish traps, stone and historic places within the investigation area. The Victorian Aboriginal Heritage Register (VAHR) records Aboriginal sites and places and currently contains in excess of 30,000 site records from across Victoria. There are approximately 4,500 registered Aboriginal places within the Wurundjeri and Wathaurung Registered Aboriginal Party areas which comprise a large proportion of the investigation area.

3.2 Post-contact Indigenous history

Aboriginal people’s contact with Europeans in the late eighteenth and early nineteenth century was probably with early whalers and sealers and explorers. A permanent settlement in what was to become ‘Melbourne’ began in 1835 with John Batman’s treaty with the traditional owners.

In 1835, Batman attempted to purchase approximately 600,000 acres of land around Melbourne and Geelong from the traditional Aboriginal owners of the land (figure 3.2). However, the British Government later claimed the area as Crown land, refusing to ratify Batman’s treaties or recognise Aboriginal land ownership. Governor Bourke of the Colony of New South Wales declared the area known as the Port Phillip District open to European settlers in September 1836.

In the settlement period following this first contact, traditional Aboriginal culture and society was severely and irrevocably impacted. Aboriginal people experienced changes and encroachments into their traditional territories which severely altered a way of life that had allowed people to adapt and overcome the challenges of the preceding 40,000 years.

Throughout the early colonisation, various efforts were made by authorities to protect and control, integrate and assimilate local Aboriginal people into European social and political structures. Many of these activities are still evidenced by historic sites around Melbourne. An early mission established on a traditional corroborree ground and meeting place ‘Tromgin’ is now partially occupied by the Royal Botanic Gardens Melbourne. Evidence of the Port Phillip Aboriginal Protectorate system can be found at a reserve site at Yerrip Hills just north of Sunbury and at Narre Warren on the site of the old Native Police paddock. The original police barracks and ‘headquarters’ in Narre Warren were later moved to a paddock on what is now Yarra Park and then to a government reserve at the confluence of Merri Creek and the Yarra River.

Another important site was that of the Merri Creek Aboriginal School, which was used as a makeshift Aboriginal station. As a result of the activities of the Native Police, a corps of Aboriginal male elders, two Aboriginal men were hung near the Old Melbourne Gaol site in Russell Street for attacks on whalers and settlers. These men were the first people buried in an acre of land at the Old Melbourne Cemetery (now the site of the Queen Victoria Market) designated as an Aboriginal burial ground.
Despite the abandonment of the protectorate system in 1849, the three main metropolitan Aboriginal reserves established in this period remained a focus for Aboriginal activities. Aboriginal people were encouraged to relocate to sites outside of Melbourne.\textsuperscript{130,135,136} Regional land was allocated at Coranderrk, Ebenezer, Lake Tyers, Framlingham, Lake Condah, Ramahyuck and Yelta, establishing communities that were either church or government run.\textsuperscript{137} By the late 1880s most of these regional reserves had been closed and sold off. Many remaining residents moved to Lake Tyers in Gippsland or resisted relocation such as at Framlingham.\textsuperscript{137}

Aboriginal people were not classified as citizens and could not vote or buy property. Despite these restrictions, between 500 and 800 Aboriginal men served in the Australian Imperial Forces in World War One and 3,000 in World War Two. Those who returned were not eligible for land under the ‘Soldier Settlement Schemes’ (often on land appropriated from Aboriginal reserves), could not drink in public bars with other servicemen and received no support. This discrimination was pivotal to the growing Aboriginal land rights movement from the 1930s onwards.

By 1955, Victorian legislation was reviewed to promote a policy of assimilation and the abolition of remaining reserves.\textsuperscript{137,138} Despite many Aboriginal people now living in country towns or in suburbs like Collingwood or Fitzroy, connections to the old reserve sites remained strong. Movements to obtain community ownership of reserved lands were successful in Framlingham and Lake Tyers in 1970.

Despite early efforts to remove Indigenous culture from Melbourne’s landscape, recent movements have successfully re-established aspects of Melbourne’s Indigenous heritage. In 1985, skeletal remains of Aboriginal people from Museum Victoria whose home countries could not be identified, were ceremonially buried at Kings Domain with a commemorative plaque.\textsuperscript{131} Many landmarks now carry Woi Wurrung names such as Wurundjeri Way, the new Mullum Mullum Tunnel, Birrarung Marr and the sculptural installation Bunjil at Docklands. William Barak is honoured in the naming of the Bridge of the same name.

There are many historic places within the investigation area that have significance for, and strong links with contemporary Aboriginal people. Some of these are described in appendix 3.
European settlement history of Melbourne

Lieutenant John Murray was the first European to officially enter and explore Port Phillip Bay, in February 1802. He was followed six weeks later by Matthew Flinders, but it was not until the following year that Charles Grimes, the acting chief surveyor of New South Wales, located fresh water from the Maribyrnong and Yarra Rivers.

In October 1803, Lieutenant Governor David Collins camped at Sullivan Cove outside of the investigation area near Sorrento, with a large party of prospective settlers including 308 convicts. This was the first attempt to settle Europeans in what is now Victoria. But without fresh water the camp was soon abandoned in favour of Van Diemen’s Land. Four graves at the camp were reserved in 1875 (VHR H1050).

3.3.1 EARLY SETTLEMENT

In 1835, John Batman and John Pascoe Fawkner arrived as separate parties to establish private pastoral runs. They both settled on the Yarra, initiating the formation of a village, the rudimentary origin of the city of Melbourne. The settlement expanded rapidly and spread north and west along the Werribee and Moorabool Rivers. Within a year, nearly 200 settlers lived here along with 25,000 sheep. The Port Phillip District was belatedly opened for settlement by the New South Wales government in September 1836 and William Lonsdale was appointed Police Magistrate in charge of the district. All previous claims to land ownership – indigenous and settlers alike – were swept away and the entire region was proclaimed Crown land.

The new settlement was planned by Robert Hoddle, who formulated the grid bordered by Flinders, Spencer, Lonsdale and Spring Streets, characterised by wide streets and gardens. The grid paid as little heed to geography as it had to cultural history, imposing its structure over hills, swamps and tributaries in a model for future suburban expansion. Nature was confined within reserves for public purposes. This resulted in substantial parks including a block of land on ‘Western Hill’, a 50 acre (20 hectare) botanic gardens reserve on Batman’s Hill and large reserves east of the earliest river crossing site (now Princes Bridge).

The 1842 Act for the sale of ‘Waste Lands’ allowed authorities to set land aside specifically for recreation and public health. Applications, primarily from the Town of Melbourne, included sporting grounds, parks, gardens and acclimatisation grounds (the forerunner of zoological gardens). These reserves incorporated modern ideas about the need for breathing spaces in industrial cities and resulted in four square miles (1035 hectares) being set aside north of the town in 1845 (Royal Park); a new botanic garden site in South Yarra in 1846; Fitzroy Square in 1848 (Fitzroy Gardens); and the substantial Domain park in South Yarra.

Land use outside of the township was dominated by pastoral leases. Between 1834 and 1837 these extended north and south of the Yarra River settlement across the grassy flat coastal and volcanic plains. Only a few homesteads survive as evidence of this early activity including Woodlands Homestead (1840s), the Altona Homestead (1842) and Point Cook Homestead (1850s) (figure 3.3). At Werribee Park several farm buildings from 1861-2 also survive. Many of these historic locations are listed on the Victorian Heritage Register. The Yan Yean Reservoir Reserve includes Bear’s Castle constructed around 1844 (VHR H1420) while the remains of Viewbank Homestead (VHR J 1396) are contained within the Yarra Valley Parklands. But the continuing expansion of the townships over the surrounding agricultural land has left only patchy remains of the original settlement land use of these areas.

Figure 3.3
Woolshed of the former Chirnside property, constructed in 1860s (Point Cook Coastal Park).
3.3.2 THE GROWTH AND URBANISATION OF MELBOURNE

By 1847 Melbourne was officially proclaimed a city and by 1850 its population exceeded 20,000 people. The suburban villages of Carlton, Fitzroy, Collingwood and Richmond, Hotham (North Melbourne) and Sandridge (Port Melbourne) surrounded central Melbourne. St Kilda already thrived as a holiday destination, while Williamstown grew on the back of its deepwater port in Hobsons Bay. Across the Maribyrnong River, a new settlement of Saltwater (Footscray) had grown around the punt crossing.

Further afield, villages formed at the transport hubs of the pastoral hinterland. Pentridge (Coburg) was surveyed in 1837-8. Land sales extended east from Warrigul/Heidelberg and across the Plenty River. The foundations of Eltham village were planned in 1840 with the extension of the Heidelberg Road reaching the site in 1846 to further promote lands sales through the district. To the south east, small timber camps formed the basis of later developments in the foothills of the Dandenong Ranges.

Victoria achieved independence from New South Wales on 1 July 1851, an event which coincided with discoveries of gold across the state at Ballarat, Clunes, Warrandyte and Buninyong and official sanctioning of gold mining. Evidence of mining activity still survives across the state including in Melbourne, such as within Warrandyte State Park which also contains the diversion of the Yarra River at Pound Bend through a 300 metre tunnel (VHR H1260). Victoria’s population boomed, fuelling a rapid growth in government civic and urban infrastructure as well as unprecedented programs of land settlement and reservation.

It soon became clear to the government that Melbourne’s growing population needed an improved water supply. A large water store was constructed based on the Plenty River north of Melbourne at Yan Yean. To avoid the spread of infectious disease, clean water was piped from the reservoir to individual properties and households. Yan Yean Reservoir was completed in 1857 and, at the time of construction, was one of the largest reservoirs in the world.

By 1861, Melbourne’s population had increased to 140,000 comprising some 23 per cent of Victoria’s population. The central city saw much expansion with the development of port infrastructure, manufacturing and especially financial activity, as Melbourne effectively became the financial capital of Australia. Based largely on the production of gold and the growth of finance and banking industries, Melbourne was considered one of the great cities in the world and famously described as ‘Marvellous Melbourne’. The construction of the Exhibition Building between 1879 and 1880 (now World Heritage-listed), was designed to accommodate the International Exhibition of 1880, reflected the confidence and aspirations of the metropolis.

The period between 1861 and 1881 saw much suburban consolidation, mostly within a three mile arc around central Melbourne. While the population had swelled to 268,000, most of the population still lived within the most densely settled suburbs of Melbourne. From the west, these included Flemington, Kensington, North Melbourne, Fitzroy, Collingwood and Richmond. They extended east to Prahran, and south to St Kilda, Port Melbourne and South Melbourne. Williamstown and Footscray to the west, had developed as largely self contained suburbs, based on industry.

Melbourne’s famous land boom, which occurred during the 1880s, was driven in part by the significant expansion of the rail system across the suburbs. During this decade, more than sixty lines were constructed in Melbourne, in a radial pattern extending out to the suburbs and villages. Construction of the lines encouraged land speculation built on the increasingly flimsy foundations of building societies and land banks. The sale of many land estates was closely associated with construction of the lines and they were clustered around the new railway stations.

Much of this expansion occurred north and east of the city – including Hawthorn, Camberwell, and Malvern – and south east along Port Phillip Bay. Expansion in the east reflected a desire to avoid industrial areas and the flat ‘treeless’ plains that typified land to the west. Instead there was a preference for land seen as more fertile and able to provide opportunities for gardening and outdoor recreation and better situated for pleasant views. It is from this time that Melbourne’s characteristic sprawl of low density, single dwelling suburbs has developed.

Many railway stations remain as evidence of the significant expansion of the system around Melbourne during the 1880s. Brighton Railway Station reflected the progress of a rail line along the coast of Port Phillip Bay leading to not only residential and commercial expansion but the establishment of holiday resorts and coastal recreation opportunities. Many other railway stations demonstrate fine architecture and the immense wealth generated by gold and commercial development in Melbourne.

While the creation of parks and maintenance of open space was seen as one means of providing for the wellbeing of the community, wider health issues remained for Melbourne. With the land boom of the 1880s and rapidly expanding population, the spread of contagious...
disease escalated as a serious health threat due to lack of proper drainage and sewerage. The Sydney Bulletin coined a new term ‘Marvellous Smellboom’ to describe the increasing filth of Melbourne’s streets and waterways.\textsuperscript{143,145}

Some measures had already been undertaken to improve the city’s sanitation – relocation of noxious industries to the western suburbs, closure of the city’s cesspits and ‘night soil’ removal – but the disease and stench remained. Eventually the government was forced to take action and the Melbourne and Metropolitan Board of Works (MMBW) was established in 1891.

The MMBW comprised representatives from all of the municipalities in Melbourne and was given responsibility for the progressive construction of sewerage of Melbourne. In addition, the Board became responsible for the management of Melbourne’s water supply. In time, the MMBW would also take on planning responsibilities in the absence of an overall planning agency for greater Melbourne.

A number of engineering structures remain as evidence of the major engineering works undertaken by the MMBW to improve drainage and sewerage across Melbourne. Construction of the Spotswood Pumping Station, a key component of the new sewerage and draining system, was completed in 1896. The pumping station received water from Melbourne’s underground sewers, which was then pumped to Brooklyn and on to the Metropolitan Sewerage Farm at Werribee via the Main Outfall Sewer or channel constructed between 1892 and 1894 (VHR H1932).

Inevitably, the land boom of the 1880s collapsed, to be followed by severe depression in 1893. Many Melburnians left for rural areas or to try their luck on the recently discovered Western Australian goldfields. However, despite government concerns about depopulation, Melbourne’s population stabilised at 494,000 and future population growth remained steady over the next few decades.

By 1900, the worst of the depression was over and a period of slow recovery was underway. Federation in 1901 provided a boost to Melbourne’s confidence, with the new Commonwealth Government and its offices accommodated in Melbourne. Victoria’s parliament building housed the new federal parliamentarians while the Royal Exhibition Building operated as a temporary parliament until transfer of the Commonwealth Government to Canberra during the 1920s.

While the 1890s depression had set back the growth of Melbourne, most of the fledgling suburbs revived if they had good transport links – trains and/or trams – and possessed the features considered necessary for pleasant residential living, that is, opportunities for gardening and preferably higher land commanding views. More land in the south and eastern part of Melbourne met these conditions, resulting in the continuing lopsided growth of Melbourne. By contrast, suburban growth in the western suburbs was to flag for several decades.\textsuperscript{144}

Growth was slow up until the 1920s but increased after the return of World War One veterans seeking respite in the suburbs. Suburban development was also supported by the State Savings Bank with package deals for home ownership. The suburbs that expanded at this time are now regarded as Melbourne’s middle suburbs.

Suburbanisation during these years was accompanied by improvements to local infrastructure and the extension of some government services, including education. From the turn of the century, it was increasingly recognised that government education should extend beyond primary schools. Initially, several ‘Continuation Schools’ and Agricultural High Schools were set up to provide an extended state education, the first Continuation School being housed at the former Model School in Spring Street, Melbourne, in 1905. High Schools were established under the Education Act 1910 and the Melbourne Continuation School became known as Melbourne High School in 1912 and continued to educate students in Spring Street until its relocation to South Yarra in 1927 (VHR H1636). The former Essendon High School was the first suburban high school established in Melbourne (1914) (VHR H1294), but the Education Act 1910 restricted building high schools near existing (private) secondary schools. Consequently, most government high schools were built in rural areas at first and in Melbourne’s northern and western suburbs, such as Essendon, Williamstown and Coburg.

After the turn of the century, monuments and memorials also became a greater feature of the cultural landscape, with most monuments erected on public land, either in existing parks or within road reserves. The Shrine of Remembrance, Victoria’s main war memorial near the Domain reserve, was completed in 1934 (VHR H0848). MacRobertson Girls High School (VHR H1641), MacRobertson Bridge, and the Herbarium at the Royal Botanic Gardens (VHR H1459), were constructed with funds provided by the prominent confectioner and philanthropist, Sir MacPherson Robertson, to celebrate Victoria’s centenary celebrations in 1934.

A list of Victorian Heritage Register sites and places on public land in the investigation area is contained in appendix 4.
3.3.3 MELBOURNE’S PLANNING HISTORY

As Melbourne slowly expanded in the first decades of the twentieth century, concerns about planning and conservation emerged. To some extent, management of natural resources – including forests and water – had improved. Policies for closed catchments had been introduced and a new forest management agency established. However, protection of the natural environment on public land through reservation remained ad hoc.\textsuperscript{146,147} The development of tourism, along with a growing interest in outdoor recreation contributed to a new appreciation of nature conservation. There remained a pragmatic view that only land considered unsuitable for settlement should be reserved for conservation. Significantly, land reservation for conservation purposes tended to result from the efforts of concerned groups and individuals rather than a strategic approach by government agencies.

At the same time, urban planning in Melbourne was no more strategic. Greater Melbourne was administered by a multiplicity of local councils, and lacked a central planning agency. A pattern of ‘organic’ growth had predominated, based on a laissez-faire process of land speculation, given direction by public transport development and social and amenity aspirations.

Progress on planning reform was slow. In 1922, the Metropolitan Town Planning Commission was established with a charter to investigate Melbourne’s urban form and provide guidelines for development and planning improvement. A Plan of General Development was published in 1929 but was never to be implemented. It was not until 1944 that a new Town and Country Planning Act established a basic framework for planning in Melbourne.

In 1949, responsibility for a metropolitan wide planning scheme was given to the MMBW. With a massive increase in Government sponsored immigration, and a baby boom following World War Two, again Melbourne was faced with a wave of strong population growth and suburban expansion. The population doubled from around 1.1 million in 1946 to 2.2 million in 1966.

The drift of suburbia eastward towards the Dandenong Ranges during the 1940s and 50s raised further concerns about Melbourne’s planning strategies and resulted in a ‘Save the Dandenongs’ campaign. This led to the purchase and reservation of land to protect nature conservation values and recreational opportunities.\textsuperscript{146,148}

The MMBW planning scheme (1954) was designed to deal with Melbourne’s characteristic low density urban sprawl, traffic congestion, industrial development, and land use zoning. A chief feature of the plan was the identification of growth corridors and maintenance of ‘green wedges’ of agricultural land and open space in the form of parkland. This approach has been consolidated in various planning strategies and policies over the years since then, notably in the 1971 Planning policies for the Melbourne Metropolitan Region.

The 20th century saw continued expansion of Melbourne which, at the end of the Second World War had a population of around 1.2 million. The post war “populate or perish” slogan saw a rapid expansion in immigration to Australia and a significant wave of refugees from Europe. Melbourne has one of the largest Jewish populations of any Australian city as a result of this period. In the 1960s, migration from Yugoslavia, Turkey and Lebanon become more common, bringing Melbourne out of a period of recession and slow growth and creating a resurgence in public infrastructure projects. In the 1970s, changes to immigration policy saw an increase in Asian migration particularly from Vietnam, Cambodia and China. By 1976, the population had grown to 2.7 million.

During the 1970s, a wider public conservation movement developed amid continuing expansion of the suburbs. There was strong community support for green wedge policies and progressive development of a system of metropolitan parks designed to provide ‘breathing space’ in Melbourne’s urban area.\textsuperscript{149} These included the Yarra Valley Parklands, Horseshoe Bend on the Maribyrnong River at Brimbank (Maribyrnong Valley Parklands), Jells Park and parks at Lysterfield, Braeside and Point Cook.

By 1996, metropolitan Melbourne’s population had reached 3.3 million and its physical breadth was around 90 kilometres from Werribee to Pakenham (see figure 3.4). The beginning of the new century saw concerns being raised about this ongoing expansion of the city and its suburbs. In 2002, the Victorian Government implemented the urban growth boundary (UGB) ‘to set clear limits to Melbourne’s outward development’.\textsuperscript{1} This boundary was extended in 2005 and again in July 2010 due to unexpectedly rapid population growth.
Figure 3.4
Melbourne’s urban development (1851 to 2004)
Source: Department of Planning and Community Development.
3.4 The people of metropolitan Melbourne today and in the future

The previous sections of this chapter described cultural heritage and history of the people of metropolitan Melbourne. This section completes the story with an overview of Melbourne’s population today and projections for 2026.

3.4.1 MELBOURNE’S CURRENT POPULATION

Metropolitan Melbourne’s population reached 3.7 million people by 2006, with two in three Victorians living in Melbourne. Melbourne’s population density is highest in the inner and middle residential suburbs, which have been settled the longest, and areas along areas of Melbourne’s rail and tram network (see figure 3.5).

* These population figures are for all of metropolitan Melbourne including the Shires of Mornington Peninsula and Yarra Ranges. The investigation area had an estimated population of 3,459,140 in 2006.
The population of the investigation area has increased by about 430,000 people in the past ten years. Much of the growth over this period has been in the outer suburbs from new housing estates and in central Melbourne from inner urban gentrification and apartment development. Some parts of Melbourne have experienced local population declines such as in the outer suburbs in the north-west, west and east. This is largely due to young adults leaving the family home to move to other parts of the city.

Melbourne’s age structure varies greatly across the investigation area. Inner urban areas such as the City of Melbourne are dominated by young adults, reflecting the employment and entertainment options in these areas. Outer and growth areas, by contrast, are dominated by young families. Melbourne’s “middle ring” of established suburbs has a range of age groups, although they tend to contain a higher proportion of older residents than other parts of Melbourne.

Metropolitan Melbourne is recognised for its cultural diversity with one in three Melburnians born overseas. The highest proportion of overseas born are found around Footscray-Maribyrnong in the west, Preston-Coburg in the north, and Dandenong-Springvale in the south-east. These patterns reflect various waves of post-World War Two migration. More recent arrivals to Melbourne (since 2001) have tended to settle in inner Melbourne (often overseas students and skilled migrants) and around Werribee in the west and Dandenong in the south-east.
3.4.2 MELBOURNE’S FUTURE POPULATION

Metropolitan Melbourne’s population* is predicted to grow to about five million people by 2026. Population projections indicate that all municipalities within the investigation area will experience growth between 2006 and 2026 (see figure 3.7). The pattern of strong growth in central Melbourne and in growth areas designated for future urban development is projected to continue. The population density of the City of Melbourne, for example, is projected to double in the 20-year period to 2026. Slower rates of growth are anticipated for Melbourne’s middle and outer suburbs and north-east although the population in these areas will still continue to increase overall.

* These population figures include the Shires of Mornington Peninsula and Yarra Ranges.