Mornington Peninsula Shire Council Stormwater Management Plan Detailed Threats and Values

Prepared For:	Mornington Peninsula Shire Council
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Document:	R.W00215.003.00.detailed threats and Values.ns.doc
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Synopsis:	This report outlines the detailed threats and values associated Risk Assessment undertaken as part of the Mornington Peninsula Shire Council Stormwater Management Plan.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY	
0	12/1/00	CB		NLGS	

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1 INTRODUCTION

This document contains the detailed values and threats assessments undertaken as part of the development of the Mornington Peninsula Shire Council Stormwater Management Plan. The report includes:

- Information on typical threats and value types within the municipality;
- A summary of values and threat scores throughout the municipality; and
- A detailed analysis of threats and values within each study catchment.

For the purposes of this study the municipality has been divide into a series of eighteen catchments, as shown in Figure 1.1. These catchments, as outlined in Table 1.1, were selected in accordance with the hydrological boundaries of the waterways and predominant land uses across the municipality

Table 1.1 Waterway Reaches identified in the Mornington Peninsula Shire Council

Reach Number	Catchment Name	Waterway/s
1	Watsons Creek	Watsons Creek and Pearcedale South Drain
2	Olivers Creek	Olivers Creek and McKirdys Drain
3	Kings Creek and Hastings Township	Kings Creek and Hasting Local Drainage System
4	Warringine Creek	Warringine Creek
5	Crib Point	Crib Point Drain & Marmaduke Creek
6	Merricks Creek	Merricks Creek
7	Shoreham	Stony Creek, East Creek and Camp Buxton Creek
8	Flinders	Spring Creek and Manton Creek
9	Cape Schank	Main Creek, Burrabong Creek, Stockyard Creek and Tea Tree Creek
10	Nepean	Nepean Infiltration Area
11	Chinamans Creek	Chinamans Creek and Tootgarook Wetlands
12	Rosebud	Wonga Creek, Coburn Creek, Waterfall Creek and Rosebud South Creek
13	Dromana	Sheepwash Creek, Boundary Road Creek, Kangerong Creek and Dromana Local Drainage
14	Safety Beach	Brokil Creek and Dunns Creek
15	Mt Martha	Sheoak creek, Seaside Creek, Finlayson Creek Sunshine Creek and Hearn Creek
16	Balcombe Creek	Balcombe Creek
17	Mornington	Tanti Creek, Cook Street Drain, Manmangur Creek and Caraar Creek
18	Mt Eliza	Gunyong Creek, Earimil Creek, Ballar Creek and Kackeraboite Creek

The results of the threats and values assessment will be used to undertake a risk analysis to establish reactive management priorities across the municipality. Proposed magnitudes for threats and values have been based on:

- Preliminary assessments by the study team;
- Review by the project steering committee; and
- Discussion and review by the Project Working Group during the second PWG Workshop.

Figure 1.1 Study Catchments

2 THREATS ASSESSMENT

For the purposes of this study, stormwater threats are defined as activities or sources of pollution potentially resulting in adverse impacts to values of the receiving environment. Threats have been defined across the municipality in a generic context by considering:

- Dominant land uses whose runoff contribute to stormwater pollution;
- Specific activities which may generate stormwater pollution;
- Degraded areas including land uses and waterways which may generate pollution;
- Changes in hydrologic characteristics which may lead to pollution; and
- Advice from the Project Working Group in relation to Stormwater Pollution issues.

Generic threats were initially defined by considering issues across the entire municipality. The approach of defining generic threats, as opposed to site specific threats, was adopted due to the homogeneous nature of many of the land uses and activities which constituted threats.

Threats are ultimately assigned with a score to reflect their magnitude and exposure frequency in each catchment.

2.1 Threat Types and the Nature of Pollution

Table 2.1 summarises the range of generic stormwater threats that have been defined across the municipality, including details of the sources and types of pollutants associated with each threat and how they are generated. Table 2.2 identifies the nature of key pollutants listed in Table 2.1, including their potential impacts and time scale of impacts.

Table 2.1 Generic Threats adopted for the Mornington Peninsula Shire Council

Threat	Cause	Key Pollutants and Impacts
Residential Land Use Runoff	Atmospheric deposition and buildup from traffic, washing cars, fertiliser application, poor waste management (domestic refuse), lawn clippings and vegetation.	Increased flow, sediment, nutrients, litter, oxygen depleting material, hydrocarbons, pathogens, trace metals, pesticides surfactants
Industrial Land Use Runoff	Atmospheric deposition and buildup from traffic, poor waste management, accidental spills and illegal discharges.	Increased flow, sediment, nutrients, litter, oxygen depleting material, hydrocarbons, pathogens, trace metals, pesticides, surfactants
Commercial Land Use Runoff	Atmospheric deposition and buildup from traffic, poor waste management practices.	Increased flow, sediment, nutrients, litter, oxygen depleting material, hydrocarbons, pathogens, trace metals, surfactants
Major Road Runoff	Atmospheric and vehicular deposition and accumulation.	Sediment, litter, trace metals and hydrocarbons
Unsealed Road Runoff	Erosion of unsealed road surfaces	Sediments
Residential Development	Poor sediment and erosion control, uncontrolled wash down of equipment, deposition of sediments vehicles and spills from construction process (eg. concreting).	Sediments, nutrients
Building Site Runoff (Lot Scale)	Poor management of building site waste and materials.	Sediment and litter
Unstable and Degraded Waterways	Poorly controlled stock and recreational access, weed infestation, damage from waterway works, development encroachment, vegetation loss, eroded and unstable riparian zones.	Sediment, nutrients, oxygen depleting material
Flow Modification	Extraction of water for agricultural purposes.	Reduced flows
Landfill and Contaminated Sites	Runoff or leaching from landfills and contaminated sites.	Oxygen depleting material, pathogens, sediments, nutrients, litter, trace metals, hydrocarbons and toxicants
Septic and Sewer Leakage	Infiltration and overflow from sewerage systems.	Oxygen depleting material, pathogens and nutrients.
Agriculture	Poor management of agricultural areas leading to erosion, poor use and control of pesticides and nutrients	Sediment, nutrients
Docks and Wharves	Runoff from wharf areas including atmospheric deposition, spilt raw product, erosion from unsealed areas and accidental spills.	Sediment, raw product (oxygen depleting materials), oils and greases, trace metals and toxic substances
Other	Any other landuse within a catchment, e.g. golf courses, which may have an impact on Stormwater Quality	Dependent of threat type

Table 2.2 Pollutant Impacts and Time Scales

Parameter	Potential Impacts	Time Scale
Hydraulic Effects – Increased flow	Increased flow rates and velocities increase the frequency of bed disturbance Changes to substrate characteristics as a result of the removal of easily eroded materials Increased rates of bed erosion and nick point retreat Higher sediment transport rates Reduced opportunity for watercourse geomorphology to recover	Instantaneous to hours
Hydraulic Effects – Reduced flow	Reduced flushing and water turn over, increasing stagnation	Weeks to months
Suspended Solids	Reduced light penetration, affecting photosynthesis rates of algae, submerged macrophytes and seagrass beds Clogging of gills of fish and invertebrates Reduced substrate habitat value, including filling of voids in gravel substrates. This affects invertebrates and some fishes, who require voids for feeding and respiration Increased deposition of inert sediments can reduce food supplies for some invertebrates	Days to years
Nutrients	Increased algae concentrations, often favouring blue-green algae (cyano bacteria) Increased growth of aquatic macrophytes, but often reduced diversity Reduced diversity of invertebrates and fish Increased turbidity due to algal growth Lowering of dissolved oxygen levels due to algal decay	Months to years
Litter	Physical harm to aquatic biota Visual impact Reduction in habitat value	Weeks to years
Oxygen Demanding Materials	Reduced dissolved oxygen concentrations Reduced diversity of fish and invertebrates Change in the structure of macro invertebrate communities (e.g. domination by worms) Hindered respiration of fish, possibly reaching lethal levels Increased levels of bacteria and some algae (particularly filamentous green algae) Decreased growth of most macrophytes Very low oxygen levels may increase the release rate of nutrients and metals from sediments	Hours to weeks
Pathogens	Bacteria and other pathogens may affect human health	Less than 1 week
Toxic Organics (eg. Pesticides)	May be lethal to fish and invertebrates at high levels (rare in stormwater) and can bioaccumulate in the food chain, affecting predators Low levels may hinder reproduction by fish and invertebrates Herbicides may reduce the abundance of algae and macrophytes	Years
Toxic Trace Metals	Toxic to fish, invertebrates, algae and macrophytes and can bio-accumulate in the food chain, particularly affecting predators Generalised toxicity ranking of metals commonly found in stormwater is (high to low) as follows: Copper, cadmium, zinc, lead, aluminium, nickel, iron, chromium	Years
Oils and surfactants	High levels of hydrocarbons and surfactants are toxic to fish, invertebrates and macrophytes Reduction in photosynthesis, affecting algae and seagrass growth Fish respiration and feeding may be hindered by hydrocarbons	Hours to months

3 VALUES ASSESSMENT

Values defined within the receiving environment reflect the communities expectations regarding beneficial uses of the environment. These values play an important role in the development of the Stormwater Management Plan as they define the objectives of the management plan. As mentioned previously, the overall objective of the plan is the protection of values within the receiving environment threatened by stormwater. This document defines receiving environment values within each catchment of the municipality.

3.1 Adopted Approach For Identifying Values

Values have been identified in the receiving waterways and riparian environments of each catchment to assist in identifying priorities to address the threats that either currently or potentially threaten the values. Values have been identified in each study catchment based on:

- Review of background information supplied to the Study Team;
- The Project Working Group Workshops undertaken during this project; and
- Site visits.

Within each catchment detailed assessments were undertaken to characterise values in relation to:

- Environment (In-stream Habitat and Riparian Habitat, Geomorphology and Groundwater);
- Cultural Heritage (European and Indigenous Heritage);
- Amenity (Recreation and Visual and Landscape Amenity);
- Stormwater (Flood Conveyance and Water Quality Treatment);
- Economic (Property Value and Irrigation Supply); and
- Receiving Environment (Local and Regional).

4 SUMMARY OF SCORES FOR THREATS AND VALUES

This section presents a summary of the scores attributed for threats and values throughout the municipality.

The threats were attributed with qualitative ratings (ie. low, moderate, high and very high) reflecting the perceived significance of each threat in each catchment. The significance of a threat considers both the threats exposure and magnitude. Exposure refers to the potential frequency of the threat occurring, with threats that occur frequently posing a higher threat. The magnitude of the stormwater threat refers to the area and severity of exposure with large areas (eg. land uses) and high pollutant loadings having the highest magnitude.

Receiving environment values were also rated in accordance with their significance.

As part of Project Working Group Workshop 2, PWG members were asked to participate in assigning qualitative ratings for values and threats in five catchments. It was necessary to select five catchments, as it would be impossible, due to time constraints, to discuss all of the eighteen catchments during a workshop session. The following five catchments were selected, as they were considered to be representative of key values and threats throughout the municipality.

- Watsons Creek;
- Nepean;
- Chinamans Creek;
- Balcombe Creek; and
- Mornington

The PWG was presented with the Study Team's preliminary ratings for their consideration and discussion. A number of amendments were incorporated reflecting varying opinions on the importance of certain values and magnitude of different threats.

Tables 4.1 and 4.2 provide a summary of the scores assigned for threats and values in each catchment. The details of the catchment characteristics, values and threats and are contained within the following sections.

	Watsons Creek	Olivers Creek	Kings Creek and Hastings Township	Warringine Creek	Crib Point	Merricks Creek	Shoreham	Flinders	Cape Schank	Nepean	Chinamans Creek	Rosebud	Dromana	Safety Beach	Mt Martha	Balcombe Creek	Mornington	Mt Eliza
Residential Land Use Runoff	Mod	Mod	Mod	Low	Mod	Low	Low	Low		High	Mod	Mod	Mod	Low	Mod	M - H	M - H	High
Commercial Land Use Runoff	Low	Low	Mod	Low	Low			Low		High	Mod	Mod	Mod			Low	M - H	Low
Industrial Land Use Runoff	Low	Low	Mod	Mod	Mod								Low			Low	M - H	
Major Road Runoff	Low	Low	Low	Low						Low	Mod	Mod	Mod	Low		Mod	Low	Low
Unsealed Road Runoff	Mod	High	High	Mod	Mod	High	High	Mod	Mod	Mod	Low			Low	High	High	Low	
Residential Development	Low	Low	High	Low							Mod	Low			M - H	High		
Building Site Runoff (Lot Scale)	Low	Low	Mod	Low							Mod				M- H	High	Mod	
Unstable and Degraded Waterways	High	High	Mod	Mod	Low	High	High	Mod	Mod		High	High	Low	Low	Very High	High	High	High
Flow Modification	Mod	Mod	Mod	Low		Mod	Mod	Low	Low							Mod		
Landfill and Contaminated Sites										Mod	Mod					Mod		
Septic and Sewer Leakage	Mod	Mod	Low	Low	Mod	High	High	H - VH	Low	Very High	High - VHigh	Mod	Mod	Low		Low		
Agriculture	Very High	Low	Mod	Low		Low	Mod	Low	Mod	Low	Very High	Low	Low	Mod		Mod	Mod	Low
Docks and Wharves		Low																
Other (Golf Course)									Low	Mod	Mod					Low		

Table 4.1 Summary of Stormwater Threats throughout Mornington Peninsula Shire Council

		Watsons Creek	Olivers Creek	Kings Creek and Hastings Township	Warringine Creek	Crib Point	Merricks Creek	Shoreham	Flinders	Cape Schank	Nepean	Chinamans Creek	Rosebud	Dromana	Safety Beach	Mt Martha	Balcombe Creek	Mornington	Mt Eliza
Environmental	In-Stream Habitat	Low	Low	Low	Mod	High	High	High	Mod	Mod	High	Mod	Mod	Mod	Low	High	Mod	Mod	Mod
	Riparian Habitat	Low	Low	Mod	Mod	High	Mod	Mod	Low	Low	High	Mod	Mod	Mod	Low	Mod	Mod	Mod	Mod
	Geomorphology	Low	Low	Low	Low	High	Mod	Mod	Mod	Mod	High	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
	Groundwater	High	Mod	Mod	Mod	High	Mod	Low	Mod	Mod	H-VH	High	Mod	Mod	Mod	Mod	Mod	Mod	Mod
Cultural Heritage	European Heritage																	Low	Mod
	Indigenous Heritage	Low			Mod					High						High		Mod	Mod
Amenity	Recreation	Low	Mod	Mod	High	Low	High	High	Low	Very High	High	High	High	High	Low	Mod	High	Low	Low
	Visual and Landscape	Mod	Mod	Mod	High	High	High	High	Mod	High	High	Low	Very High	Very High	Mod	High	High	High	High
Stormwater	Flood Conveyance	Low	High	Mod	Mod		Low	Low	Low		Low	High	Low	Mod	Mod		High	High	Low
	Water Quality Treatment						Low				Low	High	Low				Mod		
Economic	Property Value	Low	Low	Mod	Mod	Low	Mod	Low	Low		Mod	Mod	Low	Low	Low	High	Low	Mod	Mod
	Irrigation Supply	Mod	Low	High	Mod		Mod	Mod	Low	Low		Mod					Low		
Receiving Environmental Values	Local (Estuarine)	Very High	Very High	High	Very High	Very High	Very High	High	High	High	High	High	High	High	High	High	Very High	High	High
	Regional	Very High	Very High	Very High	Very High	Very High	Very High	High	High	High	High	High	High	High	High	High	High	High	High

Table 4.2 Summary of Stormwater Values throughout Mornington Peninsula Shire Council

5 WATSONS CREEK

5.1 Overview

The Watsons Creek catchment consists of both Watsons Creek and Pearcedale South Drain. Watsons Creek is a permanent stream that forms in Frankston South and flows in a south easterly direction to Western Port. Pearcedale South Drain is an ephemeral drain that flows through farmland to Western Port. Both streams have been highly modified with much of the riparian vegetation cleared and extensive works carried out to realign streams and increase hydraulic capacity. Most of the catchment areas are used for agricultural purposes, with agricultural industries including poultry farms, market gardens, vineyards and grazing properties.

Table 5.1 Summary of Watsons Creek catchment characteristics

Catchment Area	39 km^2
Major Landuse Zones	Rural (Pastoral and Market Garden Areas) – 67% (20.3 km^2) Low Density Residential Areas – 11% (4.2 km^2) Residential Areas 9% (3.5 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Quail Island and Western Port

5.2 Key Stormwater Threats

5.2.1 Agriculture

Very High

The market garden areas within this catchment are likely to be contributing high nutrient loads to surface and groundwater. This catchment supports a large number of market gardens. The high productivity of the market gardens requires the use of large amounts of fertilizer and regular irrigation. Observations made during the site visit found little evidence of management activities undertaken with the aim of minimising the export of nutrients. Manure from poultry farms is often used as fertiliser. The manure is dumped adjacent to garden areas and typically is not contained or managed.

The garden areas are also frequently cultivated and most of the tracks within the properties are unsealed. Material is frequently conveyed onto roads within the catchment by agricultural vehicles. This material often reaches the stormwater system.

5.2.2 Unstable and Degraded Waterways

High

Development of agricultural areas throughout the catchment has resulted in significant losses of riparian vegetation. The loss of vegetation and the access of livestock to the waterways are contributing to the ongoing export of sediments from the catchment.

5.2.3 Residential Land Use Runoff

Moderate

Low and medium density residential areas of Baxter and Somerville drain to this reach. The combined area of residential landuse areas is less than 15% of the catchment area and the nature of development would be expected to be having limited impact on water quality.

5.2.4 Unsealed Road Runoff

Moderate

The catchment has numerous unsealed roads within the rural areas that are expected to export sediments following rainfall events. The contribution of an individual road to the pollutant load exported from the catchment will depend on the condition of the road, its traffic volume and the distance to the main drainage line.

5.2.5 Flow Modification

Moderate

On stream storages in the upper parts of the catchment have been reported to significantly reduce dry weather flows during summer.

5.2.6 Septic and Sewer Leakage

Moderate

Many of the properties within this catchment, particularly in the low density residential areas, are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown and it is expected that older systems are likely to be under designed or not meeting performance objectives due to a lack of maintenance.

5.3 Values

5.3.1 Environmental

Environmental values associated with the waterways of this catchment are generally poor as a result of the modifications to the drainage system (AWT Pty Ltd, 1998). The modifications include the loss

of aquatic habitats from the excavation and clearing of channels to maintain hydraulic capacity and realign channels (Pat Condina and Neil Craige, 1998).

The impact on the waterways is reflected by historically poor water quality within the catchment. The water quality was rated as poor during 1997 (Melbourne Water, 1998) and very poor during 1998 (Melbourne Water, 1999), characterised by low water clarity and elevated nutrient levels. The degraded water quality and loss of instream habitat has impacted on the fauna, as a fish survey in 1998 reported by AWT Pty Ltd (1998) found exotic species dominated the fish community.

The values of the riparian fringes are low for similar reasons to the in stream areas, with modifications to waterways having significant impacts. The stream condition along Watsons Creek varied from fair to poor when assessed in 1997 (Melbourne Water, 1998). Much of the degradation is associated with channelisation of the waterway through the flood plain, which has led to a loss of riparian habitat. There is evidence that the channels are unstable in several places and have required the construction of structures to stabilise the creek in the past (AWT Pty Ltd, 1998). Rural activities have had significant impact on the riparian areas due to the re-alignment of streams and the clearing of vegetation.

No sites of geomorphological significance have been identified within the catchment. However, the area around Quail Island and the mouth of Watson Creek are identified as having State Significance (Western Port Regional Planning and Co-ordination Committee, 1992).

The following is a summary of environmental values adopted within this reach.

In-Stream Habitat *Low*

Riparian Flora and Habitat *Low*

Geomorphology *Low*

Groundwater *High*

5.3.2 Cultural

European Heritage *NA*

No sites of European heritage have been identified within this catchment.

Indigenous Heritage Low

Several sites of indigenous heritage value have been identified within this catchment. However none appear to be adjacent to the waterways.

5.3.3 Amenity

Recreation *Low*

Much of the creek system is contained in private holdings and has minimal areas of public open space along it. As a result limited recreational opportunities exist throughout the majority of the catchment.

Visual and Landscape *Moderate*

This catchment contains modified land cover set within a macro scale setting of gently sloping topography. The lowland rural quality of landscape contrasts with western upland settled zones.

5.3.4 Economic

Property Value *Low*

The Watsons Creek catchment is mostly rural and it is not expected that the waterway adds significantly to waterway values. In the urban areas within the catchment the creek is contained within culverts or open drains, and is unlikely to be a high value asset.

Irrigation Supply *Moderate*

Watsons Creek provides some water supply to the market garden areas, although much of the irrigation supply is drawn from groundwater aquifers.

5.3.5 Stormwater

Flood Conveyance *Low*

Much of the length of Watsons Creek runs through rural areas and has been modified to maintain its hydraulic capacity.

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

5.3.6 Receiving Environment Values

Watsons Creek drains to Western Port near Quail Island. The area immediately surrounding the creek mouth is of regional and botanical significance, as it contains a large area of mudflats and mangroves (AWT Pty Ltd, 1998).

Western Port has significant aquatic and terrestrial habitats and is listed under the RAMSAR convention (Western Port Regional Planning and Co-ordination Committee, 1992). The bay is fringed with large areas of mangroves and contains extensive areas of sea grass.

Western Port also has important recreation and visual amenity values. Western Port is used for recreational boating, fishing and sight seeing, attracting visitors from throughout the region.

Local (Estuarine) *Very High*

Regional *Very High*

6 OLIVERS CREEK

6.1 Overview

Olivers Creek contains both Olivers Creek and McKirdys Drain. Olivers Creek is the major waterway, forming upstream of Tyabb and discharging into Western Port at Hastings. McKirdys Drain is an ephemeral stream that forms to the north of Hastings and flows to Western Port. Most of the catchment is used for rural activities, with areas of grazing, viticulture, poultry and market gardens. Residential development within the catchment is focussed around Tyabb and Hastings. Hastings is a conventional urban area with residential and industrial areas draining to Olivers Creek. Tyabb is a small township with a core of residential, commercial and industrial landuses surrounded by an area of low density residential subdivisions. The other major landuse within the catchment is the industrial area at Hastings, which contains the BHP Western Port Works and Esso/BHP Petroleum Complex.

Table 6.1 Summary of Olivers Creek catchment characteristics

Catchment Area	36 km^2
Major Landuse Zones	Industrial – 54% (19.5 km^2) – including Western Port Works Esso/BHP (Note: Much of this site is undeveloped and used for grazing) Rural – 20% (7.3 km^2) Low Density Residential Areas – 14% (5 km^2) Residential – 2% (0.7 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Western Port

6.2 Key Stormwater Threats

6.2.1 Unsealed Road Runoff

High

The catchment has numerous unsealed roads within the rural areas that are expected to export sediments following rainfall events. The impact of individual roads depends on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

6.2.2 Unstable and Degraded Waterways

High

Development of agricultural areas throughout the catchment has resulted in significant losses of riparian vegetation. The loss of vegetation and the access of livestock to the waterways are

contributing to the ongoing export of sediments from the catchment. Pat Condina and Neil Craige (1998) cite numerous examples of erosion heads and areas of localised bank erosion throughout the catchment.

6.2.3 Residential Land Use Runoff

Moderate

This catchment contains the township of Tyabb, which consists of a medium density residential area surrounded by low density residential areas.

6.2.4 Flow Modification

Moderate

On stream storages in the upper parts of the catchment have been reported to significantly reduce the dry weather flows during summer.

6.2.5 Septic and Sewer Leakage

Moderate

Many of the properties within this catchment are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown and it is expected that older systems are likely to be under designed or failing to meet performance objectives due to a lack of maintenance.

6.3 Values

6.3.1 Environmental

Olivers Creek has has been modified over time as a result of from agricultural activities and drainage works. These works have realigned streams and removed much of the riparian vegetation. The remnant riparian areas are small and dominated by weeds such as blackberries or willows. Limited information was available regarding environmental values for Olivers Creek. However, given the level of disturbance that has occurred in the streamlines throughout the catchment it is likely that the instream and riparian habitat values will be low.

Given the degree of modification that has occurred throughout the catchment and the erosion that has been noted in the waterways (Pat Condina and Neil Craige, 1998), it is unlikely that any sites of geomorphological value are present in the catchment.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Low*

Riparian Flora and Habitat *Low*

Geomorphology *Low*

Groundwater *Moderate*

6.3.2 Cultural

European Heritage *NA*

No sites of European heritage have been identified adjacent to waterways in this catchment.

Indigenous Heritage *NA*

No sites of indigenous heritage have been identified within this catchment.

6.3.3 Amenity

Recreation *Moderate*

Extensive recreational opportunities exist in lower sections of catchment where Olivers Creek enters Watsons Inlet. Upper catchment is in private ownership and has minimal open space recreational opportunities.

Visual and Landscape *Moderate*

Highly modified landcover in the majority of the upper and middle catchment contrasts with intact wetland vegetation at Hasting Bight. The flat to undulating topography in the lower reaches of the catchment compliments the macro scale rural landscape of the upper catchment.

6.3.4 Economic

Property Value *Low*

There is no major urban development along the waterways within this catchment.

Irrigation Supply *Low*

The waterways in this catchment supply a small amount of water for irrigation and stock watering.

6.3.5 Stormwater

Flood Conveyance *High*

Areas within Tyabb regularly flood and recent works have been undertaken to minimise the flood risk. Outside of Tyabb, Olivers Creek passes through a predominantly rural catchment and the potential impact of flooding is significantly reduced.

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

6.3.6 Receiving Environment Values

Olivers Creek and McKirdys Drain flow into areas with very high environmental values. At the downstream end of waterway is an area of remnant melaleuca swamp, salt marsh and mangrove areas (Western Port Regional Planning and Co-ordination Committee, 1992; Pat Condina and Neil Craige, 1998). The salt marsh and mangrove areas are identified as being of high value as they are one of the few remaining examples of this type of landscape in southern Australia (Western Port Regional Planning and Co-ordination Committee, 1992). The coastline near the outfall of McKirdys Drain is also identified as being of state and regional significance for its flora and bird habitat.

The regional receiving environmental values reflect those for Western Port.

Local (Estuarine) *Very High*

Regional *Very High*

7 KINGS CREEK AND HASTINGS TOWNSHIP

7.1 Overview

Kings Creek and Hastings Township contains most of the developed area of the Hastings Township. Kings Creek forms in Tuerong and Moorooduc, flowing through an extensive flood plain before discharging into Hastings Bight. Much of the catchment has been cleared to establish agricultural and residential areas. The area of the Hastings Township that drains to this reach includes medium density residential areas, industrial areas and the commercial area. The township is drained by a conventional underground drainage system, discharging directly to either Kings creek or Western Port. The natural waterways within this catchment have been heavily modified to increase hydraulic capacity and realign the original watercourses.

Table 7.1 Summary of Kings Creek and Hastings Township catchment characteristics

Catchment Area	16 km^2
Major Landuse Zones	Rural – 66% (10.4 km^2) Residential – 17% (2.8 km^2)
Waterway Features and Characteristics	Extensively modified natural and constructed drainage lines
Receiving Environment	Western Port

7.2 Key Stormwater Threats

7.2.1 Residential Development

High

The high threat associated with the residential development within this catchment is associated with new residential area being constructed on the southern fringe of Hastings. The development is occurring immediately adjacent to mangroves and the riparian area of Warringine Creek. The development does not have any sediment and erosion controls in place and is likely to be having a significant impact on the areas it adjoins.

7.2.2 Unsealed Road Runoff

High

The catchment has numerous unsealed roads within the rural areas that are expected to export sediments following rainfall events. The impact of individual roads depends on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

7.2.3 Residential Land Use Runoff

Moderate

The residential landuse is confined to the Hastings township and consists of areas of medium and low density development. The catchment still contains large areas that are to be developed and the magnitude of the threat will rise as more of the catchment is developed.

7.2.4 Industrial Land Use Runoff

Moderate

Hastings has industrial areas to its north and south. This catchment contains the northern industrial area. The areas support a variety of small businesses that include mechanics, panel beaters, workshops and garden supplies.

7.2.5 Commercial Land Use Runoff

Moderate

The commercial area within Hastings is small and includes a number of small shops and a supermarket. The commercial areas and associated parking areas are likely to produce high loads of litter, particulates (sediments and heavy metals) and hydrocarbons.

7.2.6 Building Site Runoff (Lot Scale)

Moderate

Several areas of new building are proceeding or are about to commence within the catchment. The combined area is small, but areas such as that previously identified to the south of Hastings have the potential to have a significant impact on riparian areas.

7.2.7 Unstable and Degraded Waterways

Moderate

Pat Condina and Neil Craige (1998) identified several sites where erosion heads have formed and stock have access to the waterway, causing ongoing erosion.

7.2.8 Flow Modification

Moderate

On stream storages in the upper parts of the catchment have been reported to be significantly reducing the dry weather flows during summer.

7.2.9 Agriculture

Moderate

The upper reaches of the catchment contain areas of intensive agriculture and are likely to be generating high sediment and nutrient loads. Farming activities also tend to impact on riparian areas through stock and works to re-align waterways.

7.3 Values

7.3.1 Environmental

Upstream of Boes Road the instream habitat of the creek has been significantly altered by agricultural activities. Works have been undertaken on streams to clear vegetation, realign streams and construct water storages (Pat Condina and Neil Craige, 1998). There is evidence in the stream of elevated nutrient levels (Pat Condina and Neil Craige, 1998) and has had a sewage treatment plant discharging to it in the past.

Downstream of Boes Road the creek contains more of its original characteristics as the stream has been less disturbed and maintains some of its riparian vegetation.

Upstream of Boes Road the riparian values are very low, as the stream has been altered significantly for agricultural purposes. As is typical of many of the catchments in this area of the municipality, much of the riparian vegetation has been cleared.

Downstream of Boes Road the riparian areas are more intact with areas of maintained remnant vegetation maintained. The riparaian areas have been degraded by litter from the adjacent residential areas and weeds such as blackberry (Pat Condina and Neil Craige, 1998).

Given the degree of channel modifications along the length of the waterways within this reach it is unlikely that it retains any geomorphologic values.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Low*

Riparian Flora and Habitat *Moderate*

Geomorphology *Low*

Groundwater Moderate

7.3.2 Cultural

European Heritage *NA*

No sites of European heritage have been identified within this catchment.

Indigenous Heritage *NA*

No sites of indigenous heritage have been identified within this catchment.

7.3.3 Amenity

Recreation *Moderate*

Upper catchment areas afford minimal recreational opportunities with creek systems located in private realm. Lower catchment zones have numerous recreational opportunities at Hastings Foreshore Reserve.

Visual and Landscape *Moderate*

Low to moderate visual quality in upper catchment zones with minimal land cover. Moderate landscape quality exists at Western Port interface with a variety of landscape settings and vistas of settlement areas, open water and large intact vegetation.

7.3.4 Economic

Property Value *Moderate*

In the lower reaches of the catchment many areas of public open space are aligned along the waterways.

Irrigation Supply *High*

The agricultural area upstream of Boes Road uses Kings Creek as a water supply for market gardens. Numerous storages have been constructed on the tributaries of Kings Creek (Pat Condina and Neil Craige, 1998).

7.3.5 Stormwater

Flood Conveyance *Moderate*

Several areas within the catchment are flood prone, in particular Boes Road and the downstream development where levee banks have been constructed (Pat Condina and Neil Craige, 1998). The area through Hastings adjacent to Marine Parade has also been identified as subject to inundation (Pat Condina and Neil Craige, 1998), although its impact on developed areas is likely to be limited.

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

7.3.6 Receiving Environment Values

Kings Creek drains into high value areas. At the downstream end of waterway is an area of remnant melaleuca swamp, salt marsh and mangrove areas (Western Port Regional Planning and Co-ordination Committee, 1992). These areas are identified as being of high value as they are one of the

few remaining examples of this type of landscape in southern Australia (Western Port Regional Planning and Co-ordination Committee, 1992).

Regional	*Very High*
Local (Estuarine)	*High*

8 WARRINGINE CREEK

8.1 Overview

Warringine Creek catchment lies to the south of Hastings, with the creek forming the southern boundary of the Hastings Township. The upper reaches of the catchment are used for a variety of agricultural purposes, including grazing, poultry, market gardens and viticulture. Hastings is fringed by an area of low density rural living, that is characterised by large area allotments. The creek has several reserves running along its length.

Table 8.1 Summary of Warringine Creek catchment characteristics

Catchment Area	24 km^2
Major Landuse Zones	Rural – 61% (13.6 km^2) Low Density Residential – 23% (5.5 km^2) Residential – 6% (1.4 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Sandstone Island and Western Port

8.2 Key Stormwater Threats

8.2.1 Industrial Land Use Runoff

Moderate

Hastings has industrial areas to its north and south. This catchment contains the southern industrial area. The areas support a variety of small businesses that include mechanics, panel beaters, workshops and garden supplies.

8.2.2 Unsealed Road Runoff

Moderate

The upper parts of the catchment has numerous unsealed roads within the urban and rural areas. The magnitude of this threat has been selected based on the number of unsealed roads within the catchment and the nature of the slopes and layout of roads. The impact of individual roads will depend on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

8.2.3 Unstable and Degraded Waterways

Moderate

The upper reaches of Warringine Creek have been impacted upon by channel straightening and agricultural activities. Some of these activities are continuing including stock access to the waterway are continuing and are contributing to the sediment load generated by the catchment.

8.3 Values

8.3.1 Environmental

The in-stream values vary considerably over the length of Warringine Creek. The lower sections of this reach (downstream of Hendersons Road) are in good condition with much of the instream habitat intact (Pat Condina and Neil Craige, 1998). Upstream of Hendersons Road the channel has been modified to maintain hydraulic capacity. Some vegetation has re-established in several places and has improved its in-stream values. Pat Condina and Neil Craige (1998) found evidence of bed aggradation and degradation throughout the catchment, this is likely to reduce the habitat values.

The riparian values reflect the values identified for the in-stream areas, with low values upstream and high values in the lower sections of the reach, where the riparian areas have been preserved. Below Hunts Road and Carpenters Lane the riparian area of Warringine Creek is protected by open space reserves. Upstream of the open space reserves the riparian areas have been impacted by clearing and on stream works associated with the agricultural landuse.

Given the degree of channel modifications along much of the waterways within this catchment few of the original geomorphologic values have been retained.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Low*

8.3.2 Cultural

European Heritage

No sites of European heritage have been identified within this catchment.

Indigenous Heritage *Moderate*

A site of indigenous heritage has been identified within the catchment downstream of Henderson Road.

8.3.3 Amenity

Recreation *High*

Numerous recreation opportunities exist within Warringine Heritage Park, which are linked with the Bittern Coastal Wetlands boardwalk. The upper catchment is located within private landholdings and the stream system affords minimal recreation opportunities with no link to Devil Bend Reservoir.

Visual and Landscape *High*

Numerous high quality vistas are evident in the lower catchment at Western Port interface, with a diverse pattern of settlement areas mixed with open water and large intact vegetation zones. Upper catchment has rolling topography that adds variety to the macro scale rural setting.

8.3.4 Economic

Property Value *Moderate*

Several developments have been designed to overlook the creek and wetlands area in Hastings.

Irrigation Supply *Moderate*

Water is extracted from the creeks in agricultural areas for irrigation and stock watering.

8.3.5 Stormwater

Flood Conveyance *Moderate*

Pat Condina and Neil Craige (1998) identified several sections of Warringine Creek between Coolart Road and the Western Port outfall as flood prone. Many of the flood prone areas are contained within open space areas or low density residential areas, where development is generally set back from the flood plain.

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

8.3.6 Receiving Environment Values

At the downstream end of Warringine Creek is an area of remnant melaleuca swamp, salt marsh and mangrove areas (Western Port Regional Planning and Co-ordination Committee, 1992) that now form part of the Bittern Coastal Wetlands (R Jaremovic, R Davies et al., 1992). The Bittern Coastal Wetland Area is an important habitat for a variety of bird species, with 210 bird species observed in the vicinity (R Jaremovic, R Davies et al., 1992). The significance of the bird species varies from state to local, with nineteen of the species listed on the JAMBA and CAMBA treaties (R Jaremovic, R Davies et al., 1992). The area also contains a number of significant plant communities, with one of high regional significance (grassy woodland) and several examples of high local significance. The tidal flats at the mouth of Warringine Creek are of state significance geologically and geomorphologically (R Jaremovic, R Davies et al., 1992).

Regional	*Very High*
Local (Estuarine)	*Very High*

9 CRIB POINT

9.1 Overview

Crib Point catchment represents the area of the municipality that drains to Hanns Inlet and Crib Point. The catchment contains several waterways, including Crib Point Drain, Naval Depot Creek and South Beach Road Creek. All of the waterways have small catchments and discharge to tidal areas. The catchment supports a variety of landuses including rural areas, residential areas in Bittern and Crib Point, a former refinery and the HMAS Cerberus Naval Base.

Table 9.1 Summary of Crib Point catchment characteristics

Catchment Area	35 km^2
Major Landuse Zones	Commonwealth 54% (14.9 km^2) – HMAS Cerberus Naval Base Rural 22% (7.9 km^2) Residential 8% (3.1 km^2) Low Density Residential 8% (2.8 km^2)
Waterway Features and Characteristics	Natural and constructed drainage lines
Receiving Environment	Hanns Inlet and Western Port

9.2 Key Stormwater Threats

9.2.1 Residential Land Use Runoff

Moderate

Residential landuse within the catchment is a combination of medium and low density development.

9.2.2 Unsealed Road Runoff

Moderate

The magnitude of this threat has been selected based on the number of unsealed roads within the catchment and the nature of the slopes and layout of roads. The upper reaches of the catchment contain numerous unsealed roads and highly variable traffic volumes depending on the specific landuse along the road. The impact of individual roads depends on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

9.2.3 Septic and Sewer Leakage

Moderate

Many of the properties within this catchment are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown, and it is expected that older

systems are likely to be under designed or failing to meet performance objectives due to a lack of maintenance.

9.3 Values

9.3.1 Environmental

Crib Point Drain is an excavated channel that is subject to sedimentation and requires frequent cleanouts. As a result it has minimal environmental values. The creeks draining to Hanns Inlet contain relatively intact melaleuca swamps and have high environmental values (Pat Condina and Neil Craige, 1998). The scores for each of the value categories summarised below:

The groundwater resource in this catchment is listed as being of Segment A2 of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *High*

Riparian Flora and Habitat *High*

Groundwater *High*

Geomorphology *High*

9.3.2 Cultural

European Heritage

No sites of European heritage have been identified adjacent to waterways within this catchment.

Indigenous Heritage

NA

No sites of indigenous heritage have been identified within this catchment.

9.3.3 Amenity

Recreation *Low*

Minimal recreational opportunities are available within the catchment. Limited bridle trails are located along roads. Lorna Triangle natural bushland reserve is contiguous with HMAS Cerberus creating a distinctive resource potential.

Visual and Landscape *High*

HMAS Cerberus Naval Base dominates the catchment. The base has extensive intact land cover at a range of natural settings representing a high quality landscape and visual resource on a prominent western port site. The remainder of the catchment has been extensively cleared with minimal topographical relief and low to moderate landscape quality.

9.3.4 Economic

Property Value *Low*

The high value waterways within this catchment are mostly contained within the HMAS Cerberus Naval base and do not add significantly to the value of any properties.

Irrigation Supply *NA*

The waterways in this reach do not provide any irrigation supply.

9.3.5 Stormwater

Flood Conveyance NA

No areas within this catchment have been identified as flood prone.

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

9.3.6 Receiving Environment Values

The receiving environment for this reach is an extension of the Hastings Township and Kings Creek reach and is expected to have similar values. The coastal area within the HMAS Cerberus Base was not considered in the R Jaremovic, R Davies et al. (1992) study but given that the area is largely undisturbed, it is expected the values will be similar to the adjacent area.

Regional *Very High*

Local (Estuarine) *Very High*

10 MERRICKS CREEK

10.1 Overview

Merricks Creek is a large catchment draining to Western Port. The catchment is predominantly used for a variety of agricultural purposes that includes grazing, viticulture and orchards. The agricultural activities within the catchment have resulted in the clearing of most of the catchment, which has had a significant impact of the condition of riparian areas and catchment hydrology. The catchment contains the townships of Balnarring, Somers and Merricks. The outlet of Merricks Creek to Western Port is a site of regional geomorphological significance as it provides a good example of a multiple barrier system.

Table 10.1 Summary of MerricksCreek catchment characteristics

Catchment Area	62 km^2
Major Landuse Zones	Rural 88% (54.2 km^2) Residential 8% (4.9 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Western Port

10.2 Key Stormwater Threats

10.2.1 Unsealed Road Runoff

High

The catchment has numerous unsealed roads on steep slopes within the rural areas. These roads are expected to deliver high sediment loads to the waterways following rainfall events. The magnitude of this threat has been selected based on the number of unsealed roads within the catchment and the nature of the slopes and layout of roads. The impact of individual roads depends on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

10.2.2 Unstable and Degraded Waterways

High

Merricks Creek is subject to ongoing erosion throughout the catchment. Many of the erosion sites correspond to sections of the creek where the riparian vegetation, melaleuca scrub, has been removed (Pat Condina and Neil Craige, 1998). Agricultural practices are also contributing to the waterway degradation, with stock access and overgrazing removing the vegetative cover and disturbing the banks. Tullum Creek, a tributary of Merricks Creek, has been excavated previously and is subject to ongoing bed erosion despite some stabilisation works (Pat Condina and Neil Craige, 1998).

10.2.3 Septic and Sewer Leakage

High

Many of the properties within this catchment are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown and it is expected that older systems are likely to be under designed or fail to meet performance objectives due to a lack of maintenance.

10.2.4 Flow Modification

Moderate

Numerous farm dams have been established throughout the catchment and are significantly reducing summer flows.

10.3 Values

10.3.1 Environmental

The environmental values throughout the Merricks Creek catchment vary significantly. In the upper reaches much of the riparian vegetation has been removed or has been damaged by overgrazing (Pat Condina and Neil Craige, 1998). These conditions have led to bed and bank erosion at many sites throughout the catchment. The areas of remnant vegetation are often degraded by weeds.

The catchment contains the Coolart Wetlands, which are part of a large wildlife sanctuary and have high in-stream, geomorphological and riparian values.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *High*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *High*

10.3.2 Cultural

European Heritage *Moderate*

Coolart homestead and wetlands are listed on the Victorian Heritage Register.

Indigenous Heritage *High*

Several sites of indigenous heritage have been identified along the waterways within the catchment.

10.3.3 Amenity

Recreation *High*

High quality continuous foreshore affords a range of recreational opportunities including the Coolant Wetlands path system. There are a limited range of open space areas and linkages to upland areas. Merricks Creek is in public domain for a short section near Buckley Reserve, the remainder of the watercourse is located in private landholdings.

Visual and Landscape *High*

High quality landscape settings with extensive rural vistas punctuated with topographic interest. The ridge lines to Red Hill and rolling terrain in upland inland areas contrasts with flat expanses of Somers.

10.3.4 Economic

Property Value *Moderate*

Most properties within the catchment overlook Western Port and it is thought that views over Merricks Creek will have limited impact on property values compared to views over Western Port.

Irrigation Supply *Moderate*

In the agricultural areas numerous dams have been constructed over natural drainage lines to harvest runoff.

10.3.5 Stormwater

Flood Conveyance *Low*

Marmaduke Creek, a minor waterway within the catchment, has been identified as having some minor flooding issues.

Water Quality Treatment *Low*

The retarding basin on Parklands Avenue Drain contains a wetland that will improve runoff quality. Unfortunately the catchment area above the wetland is very small.

10.3.6 Receiving Environment Values

The Merricks Creek estuary is of very high value due to its environmental and amenity values. The estuary is identified as having regional geomorphological significance as it has a multiple bar system at its outlet. The recreational and visual amenity offered by the estuary and adjacent foreshore contributes significantly to the character of Balnarring Beach.

Regional *Very High*

Local (Estuarine) *Very High*

11 SHOREHAM

11.1 Overview

The Shoreham catchment consists of three waterways draining to Western Port. The waterways in this catchment are Stoney Creek, Camp Buxton Creek and East Creek. The upper sections of the catchments are rural areas that have been extensively cleared, although some areas of natural vegetation have survived. The township of Shoreham is a small township with areas of low and medium density residential development.

Table 11.1 Summary of Shoreham catchment characteristics

Catchment Area	35 km^2
Major Landuse Zones	Rural 90% (31.4 km^2) Low Density Residential 4% (1.4 km^2) Residential 3% (0.9 km^2)
Waterway Features and Characteristics	Slightly modified natural and constructed drainage lines
Receiving Environment	Flinders Bight and Western Port

11.2 Key Stormwater Threats

11.2.1 Unsealed Road Runoff

High

The catchment has numerous unsealed roads on steep slopes within the urban and rural areas. The roads within the urban areas are expected to deliver high sediment loads to the waterways following rainfall events as they are steep, can convey relatively high traffic volumes (depending on the time of year) and drain directly to the beach.

11.2.2 Unstable and Degraded Waterways

High

Waterway degradation is widespread throughout the catchment with stock having access to many streamlines, reducing the vegetative cover and causing erosion. Erosion heads have been identified on two tributaries of East Creek [Pat Condina, 1998 #6] and it has been recommended that they be monitored and stabilised.

11.2.3 Septic and Sewer Leakage

High

The small townships within this catchment are not sewered and rely on septic systems. The high variation that occurs in seasonal loading and poor maintenance has resulted in some systems failing. Failure of the septic systems results in the release of sewage to surface and groundwaters.

11.2.4 Flow Modification

Moderate

On stream storages in the upper parts of the catchment have been reported to be significantly reducing the dry weather flows during summer.

11.2.5 Agriculture

Moderate

Intensive agriculture in the upper reaches of the catchments is increasing with the establishment of market gardens, vineyards and orchards. These industries require high inputs of nutrients and pesticides. The agricultural practices also require large areas of bare soil throughout the year. Depending on on-farm practices these areas have a high potential to export pollutants to stormwater.

11.3 Values

11.3.1 Environmental

The waterway values vary across the catchment depending on the degree of clearing that has occurred adjacent to the waterway. Where the remnant melaleuca swamps have been retained the environmental values are higher as the waterways appear to be more stable (Pat Condina and Neil Craige, 1998). Where riparian areas are cleared and particularly where stock have access the environmental values are significantly reduced, with frequent occurrences of erosion heads. Weeds were identified in the riparian zones of many reaches (Pat Condina and Neil Craige, 1998). The construction of numerous farm dams in the upper part of the catchment was identified by (Pat Condina and Neil Craige, 1998) as being likely to significantly impact the in-stream environment, as summer flows would be significantly reduced.

The groundwater resource in this catchment is listed as being of Segment C of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *High*

Riparian Flora and Habitat *Moderate*

Groundwater *Low*

Geomorphology *Moderate*

11.3.2 Cultural

European Heritage *NA*

Indigenous Heritage *NA*

No known archaeological sites have been identified within the catchment.

11.3.3 Amenity

Recreation *High*

Extensive recreational opportunities exist along western port edge with limited linkage to upland areas. Limited open space areas exist in Red Hill area. Merricks Rail Trail affords excellent upland/lowland linkages.

Visual and Landscape *High*

The catchment has high visual values, with vegetation backdrops and rolling terrain ensuring a range of landscape settings. The majority of the watercourses have limited vegetation cover and have limited impact on visual quality.

11.3.4 Economic

Property Value *Low*

Very few of the houses within Shoreham are adjacent to the waterways.

Irrigation Supply *Moderate*

Many farm dams have been constructed in the upper reaches of the catchment.

11.3.5 Stormwater

Flood Conveyance *Low*

Minor overland flow path were identified in Shoreham

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

11.3.6 Receiving Environment Values

The local values are high reflecting the high recreational and visual amenity provided by the foreshore area at Shoreham and Point Leo. Both areas are the focus of recreational activities throughout the year and particularly in summer, when the foreshore camping grounds are utilised.

The regional values reflect those of the area of Western Port outside of the RAMSAR listed area and of Bass Straight. The large areas of open water contribute significantly to the visual amenity values. These area are also important aquatic habitats and have high environmental values.

Regional	*High*
Local (Estuarine)	*High*

12 FLINDERS

12.1 Overview

Flinders is a small catchment that contains the township of Flinders. Dodds Creek and Spring Creek are the main waterways in this catchment. The upper reaches of the catchment consist of rural areas, which have been extensively cleared. The Flinders Township is located near the coast and is mostly a medium density residential area with a small commercial area in the centre of town. The town is not sewered and it is thought that discharges from septic systems may impact the water quality within Dodds Creek.

Table 12.1 Summary of Flinders catchment characteristics

Catchment Area	16.2 km^2
Major Landuse Zones	Rural 80% (13.0 km^2) Residential 10% (1.7 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Kennon Cove, Western Port and Bass Strait

12.2 Key Stormwater Threats

12.2.1 Septic and Sewer Leakage

High

The small townships within this catchment are not sewered and rely on septic systems. The high variation that occurs in seasonal loading and poor maintenance has resulted in some systems failing. Failure of the septic systems results in the release of sewage to surface and groundwaters.

12.2.2 Unsealed Road Runoff

Moderate

The catchment has numerous unsealed roads on steep slopes within the urban and rural areas. The magnitude of this threat has been selected based on the number of unsealed roads within the catchment, the nature of the slopes and layout of roads. The impact of individual roads will depend on the traffic volume along the road, condition of the road drainage and the distance of the road from the main drainage paths.

12.2.3 Unstable and Degraded Waterways

Moderate

Pat Condina and Neil Craige (1998) identified an active erosion head with the township and reported that in general the waterways were degraded from surrounding landuses.

12.3 Values

12.3.1 Environmental

The upper reaches of both catchments have been significantly disturbed by land clearing activities and stream works such as re-alignment. Where regeneration has occurred, the environmental values of the streams have improved. The lower reaches of the waterways in the township area are significantly impacted upon by the invasion of weeds into the riparian areas.

The groundwater resource in this catchment is listed as being of Segment C of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Low*

Groundwater *Moderate*

Geomorphology *Moderate*

12.3.2 Cultural

European Heritage *NA*

Indigenous Heritage *NA*

No sites of archaeological significance have been identified along the waterways within this catchment.

12.3.3 Amenity

Recreation *Low*

The catchment contains limited recreational areas and linkages except to the Westernport foreshore. Punty Lane bridle trail exists as a north/south link across a section of catchment. Mornington Peninsula National Park not linked to upland areas due to the limited trail network.

Visual and Landscape *Moderate*

Highly scenic catchment with a range of landscape settings and coastal vistas. Extensively modified land cover exposes interesting tolling to hilly topography.

12.3.4 Economic

Property Value *Low*

Very few of the houses within Flinders are adjacent to the waterways.

Irrigation Supply *Low*

Waterways are dammed for stock watering purposes

12.3.5 Stormwater

Flood Conveyance *Low*

Some minor flooding reported within Cook Street (Pat Condina and Neil Craige, 1998).

Water Quality Treatment *NA*

This reach does not contain any specific water quality devices.

12.3.6 Receiving Environment Values

The local receiving environment values are high reflecting the high recreational and visual amenity provided by the foreshore area. The foreshore area is the focus of recreational activities such as swimming and walking. The cliffs along the coastline add to the visual amenity as do the views over open water.

The regional values reflect those of the area of Western Port outside of the RAMSAR listed area and of Bass Straight. The large areas of open water contribute significantly to the visual amenity values. These areas are also important aquatic habitats and have high environmental values.

Regional *High*

Local (Estuarine) *High*

13 CAPE SCHANK

13.1 Overview

Cape Schank is a large catchment draining to Bass Strait and Western Port. The catchment does not contain any urban areas and is not considered in detail in this study.

Table 13.1 Summary of Cape Schank catchment characteristics

Catchment Area	99 km^2
Major Landuse Zones	Rural 82% (81.7 km^2) Open Space 17% (16.9 km^2) – Mornington Peninsula National Park
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Flinders Bight, Western Port, Cairns Bay, Bushrangers Bay and Bass Strait

13.2 Key Stormwater Threats

The Cape Schank catchment does not contain any major stormwater pollution threats. The threats within the catchment are associated with the agricultural landuse and unsealed roads.

13.3 Values

The major values within this catchment are associated with the recreational amenity and visual and landscape amenity. Extensive passive recreation opportunities, including Two Bay walking track, Mornington Peninsula National Park and beaches. The topography of the area provides rich and workable landscape settings, including upland areas and cliff edges. Large intact areas of vegetation contrast with extensive areas of modified land cover. The catchment also contains several high value indigenous heritage sites that have been identified along waterways.

14 NEPEAN

14.1 Overview

Nepean refers to the area of the Nepean Peninsula west of the Selwyn Fault. The area contains Quaternary sedimentary deposits that include sands and dune limestone. The soils in the catchment are highly permeable and this combined with the dunal topography results in a landscape that does not have any waterways. Stormwater drainage within the area is achieved by the use of infiltration basins distributed throughout the catchment. The area is low lying and has a groundwater table that is often within 1 or 2 metres of the surface. The lower end of the catchment is a highly developed residential area containing several commercial precincts.

Table 14.1 Summary of Nepean catchment characteristics

Catchment Area	77 km^2
Major Landuse Zones	Rural 38% (28.8 km^2) Residential 34% (25.9 km^2) Open Space 15% (11.7 km^2) – Mornington Peninsula National Park
Waterway Features and Characteristics	Surface waters infiltrate to groundwater
Receiving Environment	Bass Strait, Port Phillip Bay

14.2 Key Stormwater Threats

14.2.1 Septic and Sewer Leakage

Very High

This catchment is not sewered and relies on septic systems to treat household and commercial effluent. Many of the systems are old and were installed with inadequate capacity or have not been maintained. The failure of septic systems has resulted in the pollution of the groundwater aquifer with pathogens and nutrients.

14.2.2 Residential Land Use Runoff

High

Residential landuse is a threat to the groundwater aquifers within this catchment. Stormwater and garden water are infiltrating into groundwater, causing the water table to rise.

14.2.3 Commercial Land Use Runoff

High

The catchment contains major commercial areas at Sorrento, Blairgowrie and Rye. These areas have conventional drainage systems draining to Port Phillip. The commercial areas are strip shopping

centres with a variety of businesses, many of which are takeaway food outlets servicing the tourist industry. These commercial areas are believed to be generating significant litter loads in peak periods due to the high level of usage.

14.2.4 Unsealed Road Runoff

Moderate

The catchment has numerous unsealed roads servicing the urban areas. The magnitude of this threat has been selected based on the number of unsealed roads within the catchment, the relatively low traffic volumes and the flatness of the terrain.

14.2.5 Other (Golf Course)

Moderate

The catchment contains a number of golf courses. Golf courses require high inputs of fertilizer and water to maintain the fairways and greens. In this catchment, due to the geology, there is a risk that nutrients will be conveyed to the groundwater table.

14.3 Values

14.3.1 Environmental

As this catchment does not contain surface drainage lines the environmental values of this catchment have been assessed differently to other catchments. Receiving environmental values have been assessed for the groundwater aquifer and the areas of open water within the catchment.

The catchment contains several water bodies. These water bodies are surface expressions of the groundwater table and may have relatively small catchments. The systems, based on limited observations, appear to have healthy ecosystems and provide habitat for a range of avifauna. The riparian values are indicative of the areas that fringe the open water bodies.

The geomorphology of the area is significant as the dunal topography is unique on the Peninsula.

The groundwater resource in this catchment is listed as being of Segment A of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *High*

Riparian Flora and Habitat *High*

Groundwater *High*

Geomorphology *High*

14.3.2 Cultural

European Heritage *NA*

Indigenous Heritage *NA*

No sites of European or Indigenous heritage have been identified adjacent to waterways within this catchment.

14.3.3 Amenity

Recreation *High*

Distinctive linear park systems, which are continuous along Bass Strait and South Sand foreshore edge, afford high quality recreational experience. There are no cross-peninsula links.

Visual and Landscape *High*

High quality landscape settings at local drainage ”soaks ” provide an interest at micro level with rolling to gentle topography, with intact vegetation forming extensive green backdrops.

14.3.4 Economic

Property Value *Moderate*

In several places residential subdivisions overlook lagoons in the dune system. It would be expected that the views and amenity offered by the lagoon adds significantly to the properties value.

Irrigation Supply *NA*

14.3.5 Stormwater

Flood Conveyance *Low*

No significant overland flow paths have been reported within this reach.

Water Quality Treatment *Low*

Although this reach does not contain any specific water quality devices there are numerous infiltration basins and several open water bodies. These sites will have an impact on water quality prior to its infiltration to the groundwater aquifer or discharge to Port Phillip.

14.3.6 Receiving Environment Values

The local values are high reflecting the high recreational and visual amenity provided by the foreshore areas within Port Phillip and along the Bass Strait coast. Both areas are the focus of recreational activities throughout the year and particularly in summer. The local receiving environment is a key factor in the economy of the local area as it attracts tourists to the area. Parts of the local receiving environment form the Harold Holt Marine Reserve and the Bass Strait coastline are part of the Mornington Peninsula National Park.

The regional values reflect those of the area of Port Phillip and Bass Straight. The large areas of open water contribute significantly to the visual amenity values. Port Phillip is a large relatively sheltered

body of water and provides an important recreational destination for fishing, sailing and diving activities.

Regional	*High*
Local (Estuarine)	*Very High*

15 CHINAMANS CREEK

15.1 Overview

Chinamans Creek is a large catchment draining to Port Phillip. Chinamans Creek and the Drum Drum Alloc creek are the major tributaries within the catchment, which also contains the Tootgarook Swamp. The Tootgarook swamp is a significant natural asset covering 450 hectares (approximately 10% of the catchment), the area is extremely low lying and the water surface within the swamp reflects the surrounding groundwater level. The swamp has been impacted upon significantly over time as it has been partly drained, filled, grazed and used for intensive agriculture. The catchment contains a large area of market gardens upstream of the wetland. The downstream end of the catchment adjacent to Port Phillip is heavily developed, with medium density residential areas and several commercial areas.

Table 15.1 Summary of Chinamans Creek catchment characteristics

Catchment Area	41 km^2
Major Landuse Zones	Rural 70% (29.2 km^2) Open Space 17% (6.8 km^2) Residential 10% (4.1 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Port Phillip Bay

15.2 Key Stormwater Threats

15.2.1 Agriculture

Very High

Chinamans Creek contains large areas of market gardens. Market gardens require high inputs of nutrients and irrigated water to maintain productivity and farming practices result in large areas of soil being exposed. Therefore there is a high potential for pollutants to be exported via surface and ground waters to stormwater.

15.2.2 Septic and Sewer Leakage

High to Very High

This catchment is similar to Nepean as it is not sewered and relies on septic systems to treat household and commercial effluent. Many of the systems are old and were installed with inadequate capacity or have not been maintained. The failure of septic systems has resulted in the pollution of the groundwater aquifer with pathogens and nutrients.

15.2.3 Unstable and Degraded Waterways

High

Waterway degradation within this catchment is mostly associated with the degradation of the Tootgarook Swamp. The Swamp is currently grazed and this activity is having a significant impact on the environmental values of the swamp. Erosion of the waterways has been reported in Drum Drum Alloc Creek with several erosion heads present.

15.2.4 Residential Land Use Runoff

Moderate

Residential landuse is mostly medium density areas comprising 10% of the catchment. Stormwater pollution would be generated from the road surfaces and the usual activities associated with residential areas.

15.2.5 Commercial Land Use Runoff

Moderate

The catchment contains several commercial areas in Rosebud. These areas consist of a number of shops of varying size and large car parking areas. They are located adjacent to Port Phillip and are likely to be generating high litter, particulate (sediment and heavy metals) and hydrocarbon loads.

15.2.6 Major Road Runoff

Moderate

This catchment contains lengths of Point Nepean Road and the Mornington Peninsula Freeway. Both have high traffic volumes and do not have any devices installed to improve the quality of stormwater running from them.

15.2.7 Residential Development

Moderate

Several areas of residential development are occurring within the catchment. The largest developments are occurring in Rosebud West and are directly adjacent to Chinamans Creek. The sites do not have any sediment and erosion control measures in place and are likely to be exporting sediments from the large areas that have been stripped.

15.2.8 Building Site Runoff (Lot Scale)

Moderate

The catchment contains several small areas of new development in Rosebud West. Building practices in the new developments are typical of those throughout the municipality and greater Melbourne, with little regard given to the management of on-site waste and sediments by builders.

As a result litter and sediments often enter the stormwater system. The magnitude of this threat reflects the area of development that is currently occurring within the catchment.

15.2.9 Other (Golf Course)

Moderate

The catchment contains a number of golf courses. Golf courses require high inputs of fertilizer and water to maintain the fairways and greens. In this catchment, due to the geology, there is a risk that nutrients will be carried by excess water to the groundwater table.

15.3 Values

15.3.1 Environmental

The waterways and habitats within this catchment are significantly modified from a range of human activities and weed infestations. In places the creek has been re-aligned, cleared, is encroached upon by residential and golf course developments and heavily silted or eroded. These impacts have significantly reduced the environmental values for all the parameters.

The groundwater resource in this catchment is listed as being of Segment A of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *High*

Geomorphology *Low*

15.3.2 Cultural

European Heritage

Indigenous Heritage *NA*

There is no European or Indigenous heritage sites identified adjacent to waterways within this catchment.

15.3.3 Amenity

Recreation *High*

Extensive recreational opportunities exist adjacent to Port Phillip within the foreshore fringe. The waterways lack significant riparian areas and do not act as linkages to the upper reaches of the catchment. The catchment contains numerous golf courses in the lowland areas.

Visual and Landscape *Low*

Cropping landuses dominates upper catchment and contrasts strongly with residential landuse at the Port Phillip edge. Extensively modified landcover exposes rolling upland terrain, providing a variable green backing to residential and cropping areas

15.3.4 Economic

Property Value *Moderate*

Several properties including the retirement village overlook Chinamans Creek.

Irrigation Supply *Moderate*

Chinamans Creek provides water supply for the market garden areas within the catchment.

15.3.5 Stormwater

Flood Conveyance *High*

The lower reaches of the catchment including the Tootgarook Wetlands are extremely flood prone. Measures have been undertaken to upgrade the drainage capacity of culverts and open channel systems and construct retarding basins upstream of the urban areas.

Water Quality Treatment *High*

The Tootgarook Wetland is expected to have a significant impact of the quality of runoff entering it. The large wetland area would be expected to significantly reduce sediment and nutrient loads from stormwater.

15.3.6 Receiving Environment Values

Regional *High*

Local (Estuarine) *High*

The Local Receiving Environment value reflects Recreational and Visual Amenities offered by the foreshore. The foreshore is the focus for recreational activities, particularly during summer when the foreshore is used for camping.

The Regional Receiving Environmental values reflect those of Port Phillip.

16 ROSEBUD

16.1 Overview

Rosebud catchment considers the waterways that drain Arthurs Seat. Arthurs Seat, a large granitic outcrop, dominates the catchment. The catchment is characterised by steep streams running off Arthurs Seat through the flat coastal fringe prior to discharging to Port Phillip. The majority of the catchment is urbanised and contains predominantly medium density residential areas. Several commercial precincts are located along Point Nepean Road. The upper reaches of the catchment contain agricultural areas and the Arthurs Seat State Park.

Table 16.1 Summary of Rosebud catchment characteristics

Catchment Area	20 km^2
Major Landuse Zones	Residential – 46% (9.4 km^2) Open Space - 28% (5.6 km^2) Rural - 14% (2.9 km^2) Road – 7% (1.4 km^2)
Waterway Features and Characteristics	Moderately modified natural and constructed drainage lines
Receiving Environment	Port Phillip Bay

16.2 Key Stormwater Threats

16.2.1 Residential Land Use Runoff

High

The catchment contains a large residential area of established medium density development. It is located along the foreshore and extends inland up the slopes of Arthurs Seat. The pollutant load would be generated from a variety of activities typically associated with residential areas.

16.2.2 Commercial Land Use Runoff

Moderate

The catchment contains two commercial areas in Rosebud. The shopping centres include major retail outlets, fast food outlets, small retail outlets and parking areas. It is expected that these areas will produce high loads of litter, particulates and hydrocarbons. The magnitude of the threat reflects the size of the commercial areas.

16.2.3 Major Road Runoff

Moderate

The catchment contains two major roads, Point Nepean Road and Mornington Peninsula Freeway. Both roads have high traffic volumes and are likely to be generating high loads of particulates, litter and hydrocarbons. Point Nepean Road poses a particular threat as it adjoins the foreshore and stormwater discharges directly to the beach and Port Phillip.

16.2.4 Septic and Sewer Leakage

Moderate

Many of the properties within this catchment are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown and it is expected that older systems are likely to be under designed or do not meet performance objectives due to a lack of maintenance.

16.3 Values

16.3.1 Environmental

The environmental values of this reach vary considerably throughout the catchment. In the urban areas the waterways have been disturbed from drainage activities with some reaches realigned and others piped. Much of the riparian vegetation throughout the urban areas has been removed and the remnants are dominated by weed communities, which are reported to be providing much of the current stream stabilisation (Pat Condina and Neil Craige, 1998). The environmental values in the upper reaches, particularly in the State Park, are high with much of the riparian vegetation retained.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Moderate*

16.3.2 Cultural

European Heritage *NA*

Indigenous Heritage *NA*

No Indigenous or European heritage sites have been identified within this catchment.

16.3.3 Amenity

Recreation *High*

Numerous recreational opportunities exist in a variety of settings and include both active and passive uses. Upper catchment includes Arthurs Seat State Park. Indistinct linkages to extensive McCrae water edge reserve exist.

Visual and Landscape *Very High*

Highly scenic vegetated backdrop afforded by intact upper catchment. Moderate visual landscape quality to lowland edge.

16.3.4 Economic

Property Value *Low*

The waterways through the residential areas in this catchment are significantly modified and are often contained in underground culverts.

Irrigation Supply *NA*

16.3.5 Stormwater

Flood Conveyance *Low*

Few flooding problems have been reported in the drainage systems in this catchment due to the steep topography.

Water Quality Treatment *Low*

This catchment contains several GPT's.

16.3.6 Receiving Environment Values

Regional *High*

Local (Estuarine) *High*

The Local Receiving Environment value reflects Recreational and Visual Amenity offered by the foreshore. The foreshore is the focus much of the recreational activity, particularly during summer when the foreshore is used for camping.

The Regional Receiving Environmental values reflect those of Port Phillip.

17 DROMANA

17.1 Overview

Dromana encompasses the catchments of Sheepwash Creek, Boundary Road Creek and local drainage within the Dromana Town Centre. The catchments form on the northern and western slopes of Arthurs Seat and drain through the suburban areas of Dromana. The upper reaches of the catchment are either rural areas or part of Arthurs Seat State Park.

Table 17.1 Summary of Dromana catchment characteristics

Catchment Area	19km^2
Major Landuse Zones	Rural – 40% (7.5 km^2) Residential - 28% (5.2 km^2) Open Space - 22% (4.0 km^2) – Arthurs Seat State Park
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Dromana Bay and Port Phillip

17.2 Key Stormwater Threats

17.2.1 Residential Land Use Runoff

Moderate

The catchment contains an area of established medium density development. It is located along the foreshore and extends inland up the slopes of Arthurs Seat. The pollutant load would be generated from a variety of activities typically associated with residential areas.

17.2.2 Commercial Land Use Runoff

Moderate

Dromana has a commercial area on Point Nepean Road. The shopping centre contains a number of small retail outlets.

17.2.3 Major Road Runoff

Moderate

The catchment contains two major roads, Point Nepean Road and Mornington Peninsula Freeway. Both roads have high traffic volumes and likely to be generating high loads of particulates, litter and hydrocarbons. Point Nepean Road poses a particular threat as it adjoins the foreshore and stormwater discharges directly to the beach and Port Phillip.

17.2.4 Septic and Sewer Leakage

Moderate

Many of the properties within this catchment are either unsewered or not connected to the reticulated system. The condition of many of the septic systems is unknown and it is expected that older systems are likely to be under designed or fail to meet performance objectives due to a lack of maintenance.

17.3 Values

17.3.1 Environmental

The environmental values in this reach are similar to those in the previous reach. The waterway environment has been significantly degraded due to channel works, land clearing and the infestation of weeds.

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Moderate*

17.3.2 Cultural

European Heritage

Indigenous Heritage *NA*

No Indigenous or European heritage sites have been identified adjacent to waterways within this catchment.

17.3.3 Amenity

Recreation *High*

Numerous recreational opportunities exist in the upper catchment with limited linkage to foreshore reserve.

Visual and Landscape *Very High*

High quality green backdrop created by intact upper catchment. Foreshore edge of reasonable quality with moderately modified land cover to foreshore edge.

17.3.4 Economic

Property Value *Low*

The waterways within this catchment are significantly modified and it is unlikely that the value of any properties benefits from being adjacent to them.

Irrigation Supply *NA*

17.3.5 Stormwater

Flood Conveyance *Moderate*

Several potential areas of flooding have been identified in the catchment

Water Quality Treatment *NA*

No specific water quality devices were identified within the catchment.

17.3.6 Receiving Environment Values

Regional *High*

Local (Estuarine) *High*

The Local Receiving Environment value reflects Recreational and Visual Amenity offered by the foreshore. The foreshore is the focus much of the recreational activity, particularly during summer when the foreshore is used for camping.

The Regional Receiving Environmental values reflect those of Port Phillip.

18 SAFETY BEACH

18.1 Overview

Safety Beach refers the area drained by Dunns and Brokil Creek. It is a large catchment draining a central region of the Mornington Peninsula to Dromana Bay in Port Phillip. The catchment is predominantly an agricultural area with an urban fringe at its downstream end. The urban area is part of the township of Safety Beach

Table 18.1 Summary of Safety Beach catchment characteristics

Catchment Area	50 km^2
Major Landuse Zones	Rural - 87% (43.1 km^2) Residential - 4% (2.2 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Dromana Bay and Port Phillip Bay

18.2 Key Stormwater Threats

18.2.1 Unstable and Degraded Waterways

High

Pat Condina and Neil Craige (1998) identified a number of sites of ongoing erosion within the catchment. Knick points are propagating upstream causing bed and bank erosion. The erosion is causing excessive sedimentation within the lower reaches of the creeks.

18.2.2 Agriculture

Moderate

Agriculture is the predominant landuse within this catchment occupying 87% of the catchment. The catchment is mostly used for grazing although several vineyards are located in the catchments upper reaches. Many of the watercourses within the rural area are not fenced, allowing stock access and resulting in a loss of in-stream and riparian habitats.

18.3 Values

18.3.1 Environmental

In general, the watercourses within this catchment are significantly degraded. The lack of protection of riparian areas within the agricultural areas has resulted in a significant loss of in-stream and riparian habitats.

The groundwater resource in this catchment is listed as being of Segment C of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Low*

Riparian Flora and Habitat *Low*

Groundwater *Moderate*

Geomorphology *Moderate*

18.3.2 Cultural

European Heritage

Indigenous Heritage *NA*

No sites of Indigenous or European cultural heritage have been identified adjacent to waterways within the catchment.

18.3.3 Amenity

Recreation *Low*

Limited recreational opportunities exist, with poor linkage to upland zones of catchment. Some east/west aligned horse trails exist. A beach zone at Dromana Bay includes sailing and boat access.

Visual and Landscape *Moderate*

Dromana Bay edge is a highly modified landscape with residential areas contrasting with large regions of intact zones in the upper catchment. Distinctive Green backdrop afforded by upland zones. Watercourses have highly modified land cover and have low to moderate visual quality

18.3.4 Economic

Property Value *Low*

Very few properties within this catchment overlook the waterways.

Irrigation Supply *NA*

18.3.5 Stormwater

Flood Conveyance *Moderate*

Areas of flood inundation have been identified in urban areas at the downstream ends of Brokil Creek and Dunns Creek.

Water Quality Treatment *NA*

No specific water quality devices have been identified within this sub-catchment.

18.3.6 Receiving Environment Values

Regional *High*

Port Phillip is the Regional Receiving Environment for this reach.

Local (Estuarine) *High*

The Local Receiving Environment of this catchment is Dromana Bay. The foreshore is a focal point for active and passive recreation, supporting a sailing club and Boat Ramp. Dromana Bay supports an aquaculture industry that grows mussels.

19 MT MARTHA

19.1 Overview

Mt Martha is a small catchment that includes the waterways draining from the Mt Martha Escarpment to Port Phillip. There are several short steep creeks within this reach including Hearn Creek, Sunshine Creek and Finlayson Creek. Most of the catchment is an established residential area, although the upper reaches of the catchment do contain areas of public parks and a golf course. The waterways in this reach are deeply incised and this has restricted the encroachment of development into the riparian area.

Table 19.1 Summary of Mt Martha catchment characteristics

Catchment Area	7 km^2
Major Landuse Zones	Residential - 64% (4.3 km^2) Open Space - 17% (1.1 km^2) – Mt Martha Public Park Private Establishment - 5% (0.4 km^2) – Joseph Harris Scout Park
Waterway Features and Characteristics	Natural and constructed drainage lines
Receiving Environment	Port Phillip Bay

19.2 Key Stormwater Threats

19.2.1 Unstable and Degraded Waterways

Very High

The Very High threat posed by Unstable and Degraded Waterways reflects the condition of Hearn Creek. The creek has extensive bed and bank erosion sites, many of which are still active (Pat Condina and Neil Craige, 1998). Works have occurred in the past and are currently in progress to further stabilise the creek.

19.2.2 Unsealed Road Runoff

High

This catchment contains numerous unsealed roads on steep slopes within the urban areas. Many of the roads run directly up and down the slope and are badly eroded due to flow travelling along the road. It would be expected that significant sediment loads would be delivered to the drainage system following rainfall events.

19.2.3 Residential Land Use Runoff

Moderate

The majority of this catchment is devoted to residential areas. Pollutant export within the catchment will be associated with a range of activities associated with normal residential use. In some areas the steepness of the catchment and the nature of the drainage network will exacerbate the generation of stormwater pollution.

19.3 Values

19.3.1 Environmental

Limited data is available to quantify the environmental conditions of the Mt Martha watercourses, assessments have been based on the findings of Pat Condina and Neil Craige (1998). The high In-Stream habitat rating is based on the observations of water quality and in-Stream habitat throughout the catchments. The riparian areas are degraded due to erosion and the invasion of weds such pittosporum.

The groundwater resource in this catchment is listed as being of Segment C of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *High*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Moderate*

19.3.2 Cultural

European Heritage *NA*

No sites of European Heritage have been identified adjacent to waterways within this catchment.

Indigenous Heritage *High*

Several sites of archaeological significance have been identified at the downstream end of the waterways and along the coast within this sub-catchment.

19.3.3 Amenity

Recreation *Moderate*

There is a range of passive recreational opportunities along the numerous watercourses within this catchment. There are no waterway or foreshore walking links. Significant opportunities exist along Sunshine Creek as it has a wide drainage corridor in public ownership.

Visual and Landscape *High*

Variable topography and extensive intact vegetation combine to create a distinctive and memorable range of landscape settings of high visual quality. The watercourses and their relationship to the residential development contribute strongly to local sense of place.

19.3.4 Economic

Property Value *High*

A number of properties overlook the waterways.

Irrigation Supply *NA*

19.3.5 Stormwater

Flood Conveyance *NA*

No areas of flooding were identified within this catchment.

Water Quality Treatment NA

This reach does not contain any specific water quality treatment devices.

19.3.6 Receiving Environment Values

Regional *High*

Local (Estuarine) *High*

The Local Receiving Environment of this catchment is Dromana Bay. The foreshore is a focal point for active and passive recreation, supporting a sailing club and Boat Ramp. Dromana Bay supports an aquaculture industry that grows mussels.

The regional receiving environment for this reach is Port Phillip

20 BALCOMBE CREEK

20.1 Overview

Balcombe Creek is the largest drainage catchment on the Peninsula. The catchment supports a diverse range of landuses with much of the upper reaches of the catchment are rural areas and the lower reaches containing established and developing urban areas. The tributaries of Balcombe Creek have a trellised drainage pattern, with most of the waterways having either a north-westerly or south-westerly alignment. The drainage behaviour of Balcombe Creek during floods is unusual as the Moorooduc Plain can overtop and the excess flow enter Watsons Creek

Table 20.1 Summary of Balcombe Creek catchment characteristics

Catchment Area	110 km^2
Major Landuse Zones	Rural - 63% (69.1 km^2) Open Space - 17% (19.2 km^2) – Devilbend Reservoir Residential - 9% (10.5km^2) – Much of this is still to be developed
Waterway Features and Characteristics	Extensively modified natural and constructed drainage lines, including Devilbend Reservoir
Receiving Environment	Port Phillip Bay

20.2 Key Stormwater Threats

20.2.1 Unsealed Road Runoff

High

The catchment has numerous unsealed roads many of which are on steep slopes. In many cases the layout of the roads, i.e. running up and down the slope, is likely to encourage erosion. The impact of individual roads on stormwater pollution will depend its traffic volume, the condition of the road drainage and the distance of the road from the main drainage paths. The high rating was selected based on the number of unsealed roads within the catchment and their condition as perceived by the Project Working Group.

20.2.2 Residential Development

High

The Balcombe Creek catchment contains the major residential development area within the municipality. New subdivisions are being established in Mornington, Osborn and Mt Martha. It is expected that the subdivisional activity will continue for several years as approximately half of the area zoned for residential development is yet to be subdivided. Works associated with the establishment of roads and the drainage system are generating large pollutant loads (sediments and nutrients). The absence of sediment and erosion control measures is resulting in these pollutants being delivered to Balcombe Creek.

20.2.3 Building Site Runoff (Lot Scale)

High

Building works associated the residential subdivision are generating high litter and sediment loads as many sites do not adequately manage building materials and waste. Most sites have waste bins on-site and these are having a significant impact on controlling building waste where they are utilised. Sites where bins are not used or are overflowing are often having litter blown off the site.

Many sites are contributing to sediment export due to a lack of sediment and erosion control measures and poor site management. Few sites were observed to have any sediment and erosion control measures in place and most are completely cleared allowing sediments to be mobilised and exported from the site. Access on and off sites is often uncontrolled resulting in sediment loads being deposited on the road surface.

20.2.4 Unstable and Degraded Waterways

High

The upper reaches of Balcombe Creek have been degraded through agricultural activities and stream works. In many reaches the access of stock to the waterways is uncontrolled and has resulted in damage to the riparian vegetation, stream bed and banks. During runoff events the mobilised sediment is exported and further erosion occurs. Clearing and stream re-alignment works contribute to the export of sediment as the removal of vegetation, particularly melaleuca swamps, has resulted the formation of erosion heads throughout the catchment. Pat Condina and Neil Craige (1998) identify the location of a number erosion heads throughout the catchment.

20.2.5 Residential Land Use Runoff

Moderate to High

This rating reflects that Balcombe Creek will eventually have 10 km^2 of residential subdivision and that much of the current development drains directly to the estuarine section of the creek.

20.2.6 Major Road Runoff

Moderate

The catchment has several major roads and road reserves running through it and this landuse will occupy 2% of the catchment when the Mornington Peninsula Freeway is completed. Major roads are expected to contribute high sediment and heavy metal loads to stormwater.

20.2.7 Flow Modification

Moderate

On stream storages in the upper parts of the catchment have been reported to significantly reduce the dry weather flows during summer.

20.2.8 Landfill and Contaminated Sites

Moderate

20.2.9 Agriculture

Moderate

This catchment contains a number of small grazing properties and stables surrounding the Mornington Racecourse. These properties have the potential to export organic waste and sediment where paddocks are heavily grazed.

20.3 Values

20.3.1 Environmental

Throughout the Balcombe Creek catchment the condition of waterways varies significantly. Some areas, such as the lower reaches and estuary are in good condition. In 1997 Balcombe Creek was found to have a good fish communities, fair water quality and fair aquatic macroinvertebrate community (Melbourne Water, 1998). In 1998 the same reach was classified as having very good water quality and aquatic macroinvertebrate community (Melbourne Water, 1999). In the upper reaches of the catchment, upstream of , the condition of the waterway environment decreases (Melbourne Water, 1999; Melbourne Water, 1998). The decline in environmental values is associated with losses of habitat as a result of activities such as clearing adjacent to waterways and re-alignment of streamlines. The instream and riparian environmental values have been defined as moderate reflecting the variation within catchment. The high values associated with estuary reach of the creek are also considered in the Local Receiving Environmental value, which is discussed in section 20.3.6.

The high geomorphologic value reflects the values associated with the remnant wetlands in the creeks lower reaches and the trellised pattern of the watercourses.

The groundwater resource in this catchment is listed as being of Segment C of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *High*

20.3.2 Cultural

European Heritage *High*

The European Heritage value is associated with the Briars Historic Park. The remnant vegetation and creek are a key component of the Briars site and any reduction in these assets would impact on the value of the park.

Indigenous Heritage *NA*

No sites of indigenous heritage sites have been identified adjacent to waterways within this catchment.

20.3.3 Amenity

Recreation *High*

Diverse recreational opportunities with linear like systems exist, including Balcombe Creek and major open spaces areas such as Devil Bend Reservoir. Numerous horse trails exist. Beach areas at Balcombe Bay exist. Limited linkages occur in upper and middle catchment zones.

Visual and Landscape *High*

Upland mid slope and lowland areas combine with extensive rolling terrain and rural landuses to create a range of macro scale, moderate quality landscape settings. Land cover of most of the catchment is modified except for intact side slopes or "walls" in upland areas near Mt Eliza.

20.3.4 Economic

Property Value *Low*

This value reflects that a number of houses within the catchment benefit from being adjacent to or have views of Balcombe Creek.

Irrigation Supply *Low*

In the rural areas of the catchment water is extracted from the creeks for stock watering.

20.3.5 Stormwater

Flood Conveyance *High*

Pat Condina and Neil Craige (1998) identify several areas with the catchment that are prone to flooding. These are pronounced Baxter in the upper reaches for the catchment.

Water Quality Treatment *Moderate*

Works are currently underway to construct a combined wetland and retarding basin in Mornington East to treat proposed and existing residential areas.

20.3.6 Receiving Environment Values

Regional *High*

The regional receiving environment for this reach is Port Phillip

Local (Estuarine) *Very High*

The Local Receiving Environment of this catchment is the Balcombe Creek estuary. The estuary has a Very High value due to:

- the high value of its aquatic and riparian habitats and geomorphology, which are of local and regional significance,
- the visual and landscape amenity the estuary provides and its proximity to the Mt Martha township ; and Port Phillip; and
- The recreational opportunities that exist along the banks of the creek in the areas of remnant vegetation.

21 MORNINGTON

21.1 Overview

Mornington is a small catchment draining to Port Phillip. The catchment is characterised by several short and steep catchments. Major drainage lines within the sub catchment include Manmangur Creek and Tanti Creek. The predominant landuse within the catchment is residential areas and it also contains significant commercial and industrial precincts.

Table 21.1 Summary of Mornington catchment characteristics

Catchment Area	14 km^2
Major Landuse Zones	Residential - 54% (8 km^2) Rural - 12% (1.8 km^2) Industry – 7% (0.7 km^2) Open Space – 8% (1.2 km^2) Mornington Golf Club – 4% (0.6 km^2)
Waterway Features and Characteristics	Moderately modified natural and constructed drainage lines
Receiving Environment	Port Phillip Bay

21.2 Key Stormwater Threats

21.2.1 Industrial Land Use Runoff

Moderate to High

There are two industrial areas within this catchment; they are located on Nepean Highway and Mornington-Tyabb Road respectively. The industrial area on Nepean Highway contains a number of small manufacturing and whare housing and distribution sites. The precinct is partially developed and is not expected to be generating significant stormwater pollution loads. The area on Mornington-Tyabb Road contains a number of industries, including a transfer station, dog pound and a number of storage yards.

21.2.2 Unstable and Degraded Waterways

High

The waterways within this catchment are characterised by small steep catchments flowing through the highly erosive Baxter Sandstone formation. The catchments have been highly urbanised over time, with large areas of riparian vegetation removed, streams realigned or altered to improve hydraulic capacity and the natural flow regime significantly altered. The combination of the natural catchment characteristics and human impacts has resulted in several sites of erosion, which were identified by Pat Condina and Neil Craige (1998). Works have been undertaken along several reaches of Tanti Creek to stabilise points of erosion and improve channel capacity.

21.2.3 Commercial Land Use Runoff

Moderate to High

Mornington is a major commercial area at the Northern end of the Peninsula. The precinct extends from Nepean Highway to the Esplanade along Main Street. The precinct includes a variety of shops such as supermarkets, car yards, take away food shops and restaurants. The area has high traffic and pedestrian volumes and large areas of car parking. The area would be expected to generate high litter, sediment and hydrocarbon loads.

21.2.4 Residential Land Use Runoff

Moderate to High

Residential areas dominate the landuse within the Mornington catchment, occupying 8 km^2 (54%) of the catchment. The residential areas are mostly medium density with some areas of low-density development.

21.2.5 Building Site Runoff (Lot Scale)

Moderate

Building works are proceeding within the catchment and are mostly confined to redevelopment of existing sites.

21.2.6 Agriculture

Moderate

The catchment supports a variety of landuses including vineyards, grazing areas and stables. It is thought that the stables could be contributing to stormwater pollution due to wash off of sediment and fecal material.

21.3 Values

21.3.1 Environmental

Very little data is available describing the environmental condition of creeks within this catchment. The rankings adopted reflect the findings of (Pat Condina and Neil Craige, 1998) and (Environmental Protection Agency, 1997).

(Pat Condina and Neil Craige, 1998) found the waterways within this catchment to be significantly degraded due to both natural processes and impacts associated with urbanisation. The geology of Mount Eliza is dominated by the Baxter Sandstone Formation, which is highly erodible and most of the creeks have evidence of bed and side slope erosion. Changes to the hydrologic regime following urbanisation have increased the rate erosion and have significantly impacted on the instream habitats and geomorphology of the streams.

The riparian areas have been similarly impacted with urban development encroaching on the waterways and much of the riparian areas dominated by weeds.

The groundwater resource in this catchment is listed as being of Segment B of the groundwater environment (Environmental Protection Agency, 1997).

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Moderate*

21.3.2 Cultural

European Heritage Low

No sites of European Heritage have been identified adjacent to waterways.

Indigenous Heritage *Moderate*

Several sites have been identified along the coast near the outfall of Manmangur Creek.

21.3.3 Amenity

Recreation *Low*

Numerous recreational opportunities exist on the foreshore edge. However, few of the waterways within the catchment are bordered by continuous areas of open space. The lack of riparian areas reduces recreational opportunities and reduces linkages with the upper parts of the catchment.

Visual and Landscape *High*

Extensively modified land cover combined with residential landuse for the majority of the catchment contrasts with other areas in the shire. Scenic interest is enhanced with a range of landscape settings at the bay edge.

21.3.4 Economic

Property Value *Moderate*

Several properties are located adjacent to waterways within the catchment and it is expected that the waterways will have moderate impact on property values.

Irrigation Supply *NA*

21.3.5 Stormwater

Flood Conveyance *High*

Tanti Creek has been identified as providing an important flood conveyance function to adjacent properties. Works have been undertaken near Nepean Highway to maintain the capacity of the channel by removing vegetation along the banks.

Water Quality Treatment *NA*

21.3.6 Receiving Environment Values

Local (Estuarine) *High*

Regional *High*

The local receiving environment value considers both environmental and recreational values associated with the beaches in this catchment. The beaches are the focus of active and passive recreational activities throughout the year and particularly in summer.

This catchment drains to Port Phillip.

22 MT ELIZA

22.1 Overview

Mount Eliza is located on the municipality's northwest boundary. Waterways within the catchment include Gunyong Creek, Earimil Creek, Ballar Creek and Kackeraboite Creek. The waterways are characterised by small steep catchments and erosion of creek beds and valley slopes. Established residential areas make up most of the catchment. The catchment also contains a commercial precinct within Mt Eliza, several parks and a number of schools. The southern part of the catchment is a rural area.

Table 22.1 Summary of Mt Eliza catchment characteristics

Catchment Area	15 km^2
Major Landuse Types	Residential – 80% (12.1 km^2) Rural – 8% (1.3 km^2)
Waterway Features and Characteristics	Highly modified natural and constructed drainage lines
Receiving Environment	Port Phillip Bay

22.2 Key Stormwater Threats

22.2.1 Unstable and Degraded Waterways

High

The waterways within this catchment are characterised by small steep catchments flowing through the highly erosive Baxter Sandstone formation. The catchments have been highly urbanised over time, with large areas of riparian vegetation removed and the natural flow regime significant altered. The combination of the catchment characteristics and human impacts has resulted in several sites of ongoing erosion. Several sites of erosion were identified by Pat Condina and Neil Craige (1998) along the waterways.

22.2.2 Residential Land Use Runoff

High

The major landuse within the catchment is residential development. The residential developments are predominantly medium density and the residential areas are fully developed. Stormwater pollution is likely to be generated by normal activities associated with residential areas and is posing a high threat.

22.3 Values

22.3.1 Environmental

The environmental values for Mornington have been adopted for this catchment.

In-Stream Habitat *Moderate*

Riparian Flora and Habitat *Moderate*

Groundwater *Moderate*

Geomorphology *Moderate*

22.3.2 Cultural

European Heritage *Moderate*

Norman Lodge, adjacent to Gunyong Creek, is listed on the municipal heritage register. It is not clear what impact stormwater will have on the heritage values of the property.

Indigenous Heritage *Moderate*

Several sites of indigenous heritage have been identified along the coast and near the outlet of streams. The moderate ranking reflects that the sites are not located on the streams and are therefore unlikely to be impacted by stormwater.

22.3.3 Amenity

Recreation *Low*

Numerous recreational opportunities exist on the foreshore. Some of the waterways have open space corridors running along them, eg. Earimil Creek. Many have minimal open space along the waterway significantly limiting recreational opportunities.

Visual and Landscape *High*

Extensively modified landcover combined with residential landuse for the majority of the catchment contrasts with other areas in the shire. Scenic interest is enhanced with a range of landscape settings at the bay edge.

22.3.4 Economic

Property Value *Moderate*

The impact of the waterways on property value is limited to properties that back onto waterways and the open space areas that adjoin them.

Irrigation Supply *NA*

22.3.5 Stormwater

Flood Conveyance *Low*

No specific flooding problems are reported in Pat Condina and Neil Craige (1998).

Water Quality Treatment *NA*

22.3.6 Receiving Environment Values

Local (Estuarine) *High*

The local receiving environment includes Canadian Bay and Daveys Bay. The coastal area supports a number of boat clubs and would be a focus for passive and active recreational activities, particularly in summer months.

Regional *High*

Port Phillip is the regional receiving environment for this catchment.

APPENDIX A: BILIOGRAPHY

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