HOBART
CITY COUNCIL

HOBART RIVULET CATCHMENT MANAGEMENT PLAN

2011-2016

Hobart Rivulet

Catchment Management Plan

Adopted by Council 8th August 2011

Prepared by Lynda Bonar

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Contact GPO Box 503, Hobart, Tasmania, Australia, 7001 or hcc@hobartcity.com.au or www.hobartcitycouncil.com.au.

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Acknowledgments

Hobart City council has developed the Hobart Rivulet Catchment Management Plan to highlight appropriate stormwater management practices for the Hobart Rivulet catchment and its subsequent sub-catchments. Actions have been developed with the aim to improve the overall long term stormwater quality within the entire catchment.

Sincere thanks are extended to the people who have contributed to the development of this plan. The valuable contributions from staff of the Environmental Engineering Unit, Open Space Group, City Planning Unit and Environmental Health Unit are acknowledged, with particular thanks to Geoff Lang, Darren Carlson, Adam Muyt, Jill Hickie, Rowan Moore and Felicity Edwards.

1. Executive Summary

This document is a management plan for the Hobart Rivulet catchment in Tasmania. The Hobart Rivulet Catchment is a sub-catchment of the Derwent Estuary Catchment. This Catchment Management Plan highlights appropriate stormwater management practices for the Hobart Rivulet catchment and its subsequent sub-catchments, including providing a list of actions to improve the overall long term stormwater quality within the entire catchment.

Improving stormwater quality can be achieved by minimising the contamination of stormwater at its source before it reaches the water of the Derwent Estuary. The installation of stormwater treatment devices and the implementation of effective stormwater management practices will ensure improved environmental conditions that are sustainable.

The actions outlined in this Catchment Management Plan will assist in the review of management process and the development of stormwater programs.

This plan has been influenced by the need to improve existing stormwater quality within the Hobart Rivulet and lower catchment area and to implement appropriate management strategies that will reduce stormwater pollution. There are three high level objectives that Council aims to meet via this Catchment Management Plan:

- To manage the Hobart Rivulet in an ecologically sustainable manner;
- To explore and develop environmentally sensitive engineering techniques (via programs and projects) to focus on contamination reduction solutions for the Rivulet;
- To improve and maintain the environmental amenity of the Hobart Rivulet for users of the catchment.

Complementary to these high level objectives, there are numerous focal points that are important for the management of the Hobart Rivulet and environs as a whole. A summary of the actions identified within this Catchment Management Plan are listed in Appendix B.

2. Introduction

Local governments in Tasmania are responsible for the management of drainage systems, including rivulets and the stormwater system.

The *State Policy on Water Quality Management 1997* requires that local governments prepare and implement a Catchment Management Plan. Whilst this State Government policy has been around for a while, there has been limited active follow up or assistance in its implementation.

There are a number of national, state and regional frameworks and guidelines that influence the management of stormwater in Tasmania (DEP, 2005).

The *Australian Guidelines for Urban Stormwater Management* (ANZECC and ARMCANZ, 2000b), *Urban Stormwater Best Practice Environmental Management Guidelines* (Victorian Stormwater Committee 1999) and *Water Sensitive Urban Design Engineering Procedures: Stormwater* (Melbourne Water, 2005) recommend that Stormwater Management Plans include current "best practices" for management of stormwater.

Best practices change over time as new technologies are tested and accepted. Current best practices aim to control water pollution at its source – managing stormwater in the catchment before it reaches downstream waterways (DEP, 2005).

Best practices also emphasise the need for a change in traditional council policies, planning and development controls (DEP, 2005).

Within Tasmania, the *State Policy on Water Quality Management 1997* and the *State Stormwater Strategy* (DPIPWE, 2009) guide stormwater management in Tasmania. The *State Policy on Water Quality Management 1997* outlines Council's requirement to produce Catchment Management Plans, including Protected Environmental Values and Water Quality Objectives. Whilst the Policy requires local governments to prepare and implement Catchment Management Plans (CMPs), there has been no active assistance from the State Government in the development of CMPs and as such, few CMPs have been prepared.

The State Government's recent *State Stormwater Strategy* (2010), is a non-statutory guideline and a tool to help protect Tasmania's waterways from the negative effects of stormwater runoff. It was developed in consultation with local government, which has primary responsibility for stormwater management in Tasmania, and is intended as a guidance document rather than a regulatory instrument in its own right. The Strategy, launched in December 2010, is based on best management practices currently in use at local, national and international levels. It provides practical guidance to assist local government and other organisations with responsibilities for stormwater management.

The *State Stormwater Strategy* re-affirms recommendations of the Tasmanian *State Policy of Water Quality Management 1997* which emphasises the need to manage stormwater at source and highlights the importance of managing stormwater in new developments at both the construction and operational stages.

Within Council, the responsibility for stormwater management often spans many departmental boundaries. Figure 1 below demonstrates the numerous departments within Council that may deal with stormwater and rivulet management.

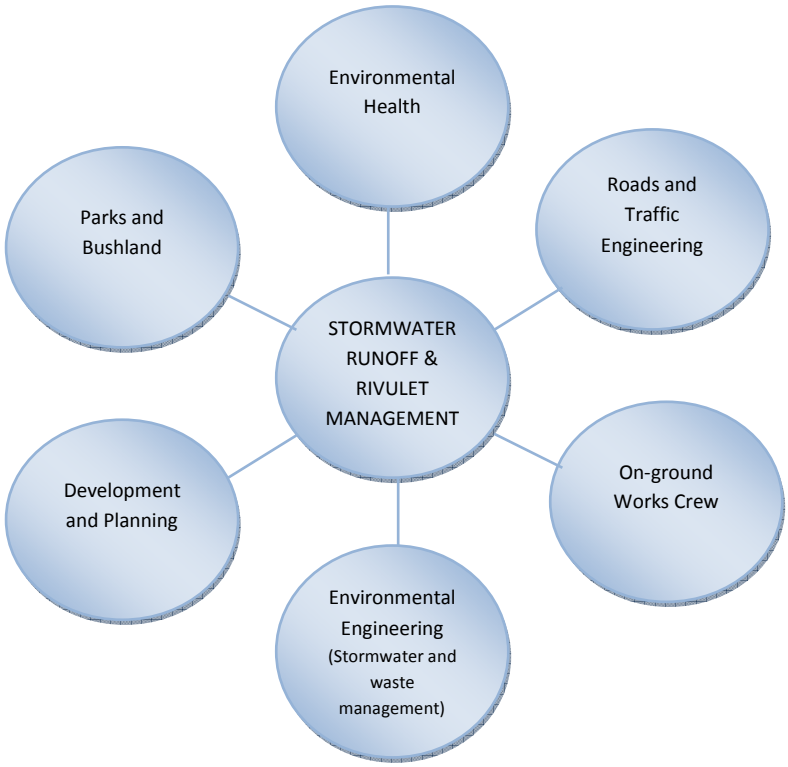


Figure 1: Various departments within Hobart City Council that may deal with stormwater and rivulet management
[Source: modified from DEP, 2005]

Different aspects of stormwater management are usually dealt with by a number of departments in Council. This may make it difficult to integrate stormwater management in the municipality. However, the Hobart Rivulet is an asset of the Hobart City Council's Environmental Engineering Unit.

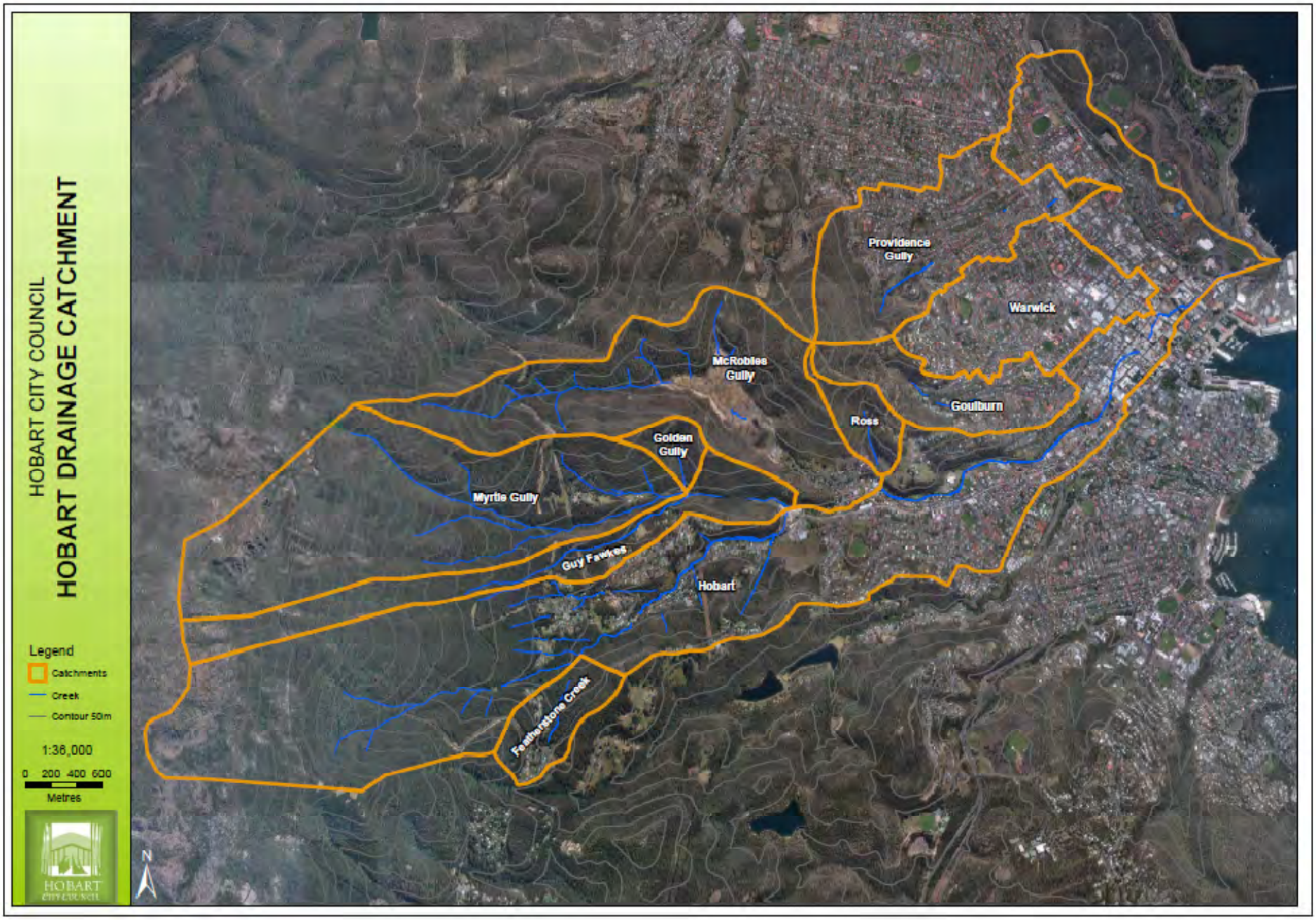
The Environmental Engineering Unit has developed the actions of the Hobart Rivulet Catchment Management Plan. The actions of this plan are driven by the need to improve water quality in the Hobart Rivulet and to identify the catchment activities and processes that are contributing to significant stormwater pollution and to improve the environmental amenity and ecological integrity of the catchment.

3. The Hobart Rivulet Catchment

The Hobart Rivulet serves as a major drainage point for a relatively large catchment area of approximately 2,217 hectares (Map 1) and is one of many tributaries into Hobart's Derwent Estuary in Southern Tasmania. Hobart Rivulet is a continuously flowing body of water that extends approximately 9.5 kilometres from its origin. The rivulet flows in its natural form throughout most of the catchment area and it is only when it reaches the periphery of the city urban centre that it changes and flows through concrete/stone lined channels, often underground.

The upper and mid catchment area is dominated by native vegetation and represents nearly 80% or approximately 1,770 hectares of the catchment area. Due to the natural state of this area, the surface is permeable and therefore has few problems associated with runoff unlike the lower areas of the catchment. In the remaining 20% or 440 hectares, the catchment is vastly different as the rivulet flows through the urban centre of Hobart. In this area the catchment surface is impervious, comprised of concrete and stone lined channels that form part of Hobart City's stormwater drainage system. The urban catchment includes the suburbs of South Hobart, West Hobart, North Hobart, Glebe and Hobart. Hobart supports various commercial and administrative uses and includes the central business district, which is the primary shopping centre of Metropolitan Hobart.

The Hobart Rivulet receives water from a number of smaller rivulets and tributaries throughout the catchment. These waterways include McRobies Gully, Guy Fawkes Rivulet, Providence Gully, Myrtle Gully, and Featherstone Creek. Within the larger Hobart Catchment area there exist a number of smaller sub-catchments that collect the water from these smaller streams and tributaries (refer to Map 1). The majority of these drainage lines flow in their natural form to the Hobart Rivulet, however many smaller urban tributaries have been modified for flood control and stormwater management. The sub-catchments within the greater Hobart Rivulet catchment include Hobart (981 ha), Warwick (147 ha), Providence Gully (176 ha), Goulburn (88 ha), Ross (32 ha), McRobies Gully (287 ha), Golden Gully (20 ha), Guy Fawkes (140 ha), Myrtle Gully (298 ha) and Featherstone Creek (48 ha). Maps of these sub-catchments are located in Appendix A.



Map 1: Hobart Rivulet Catchment

4. The History of Hobart Rivulet

The Hobart Rivulet originates near The Springs on Mount Wellington and ends at Macquarie Point where it flows into the Derwent Estuary. Historically, the Hobart Rivulet has been pivotal in the development of the city of Hobart and environs. In 1804 Lieutenant Governor Collins explored the rivulet for potential settlement. A diary entry explains his satisfaction with the Hobart Rivulet from his first encounter.

> "…the plain extensive and a continual run of water which is very excellent; it comes from the lofty mountain much resembling the Table Mountain at the Cape of Good Hope" (cited in Rayner, 1988).

Collins later went on to write to Lord Hobart (Secretary of State for the colonies in the British Government), his superior in London.

> "… I am as well placed as I could wish. I have land immediately about me, and in my neighbourhood, sufficient for extensive agricultural purposes. The Run [Rivulet] which supplies us with clear, wholesome water having its source in the adjoining mountain, leaves me no reason to doubt of its proving a constant supply" (cited in Rayner, 1988).

From early records it is evident that the Hobart Rivulet played a major part in Collins' decision to settle on its banks. Its proximity to the port and provision of constant fresh water were perhaps the most critical factors influencing early settlement. While Collins was aware of this natural asset, he also had the foresight to make provisions for its protection against contamination. He issued a general order to the people of the settlement indicating a specific place in the rivulet for general watering (Rayner, 1988).

The Hobart Rivulet was the centre and origin of the development of industry early in the colony's history where water was harnessed as the primary source of power for the flour and saw milling industries (Rayner, 1988). Water for domestic purposes, such as washing and drinking was also taken from the rivulet, however with population growth this practice soon became a health risk. The rivulet became not only a source of water, but in 1843 was sanctioned by legislation to be used as a public sewer (Petrow, 1994).

In the 1880's all household water closets emptied into the Hobart Rivulet and by 1886 this practice was deemed unsatisfactory following outbreaks of many typhoid disease epidemics (Kellaway, 1989). From that point in time it was declared that the Hobart Rivulet should only be used for natural stormwater drainage and thus the need for a metropolitan sewage system was initiated. It was some 11 years later that a sewage system was finally developed for the Hobart area (Blacklow, 1995).

Little interest was shown in the upper reaches of the Hobart Rivulet until the late 1820's (Rayner, 1988). In the 1820's, the water from several minor tributaries were being diverted into the Hobart Rivulet to provide a more constant water supply for industrial and domestic uses. In the 1860's that the main part of Hobart's water supply was diverted to Waterworks Valley and by the 1870's every stream coming from the mountain (between the Springs and North West Bay River) was utilised to flush the Hobart Rivulet (Rayner, 1988). Water from the rivulet was used to supply water to the

town and industrial premises along its banks and was integral to the development of the city of Hobart (Image 1).

Image 1: Hobart Rivulet supplies the Cascade Brewery with fresh mountain water

[Source: Hobart City Council, 2009]

The intensive historical use and surrounding urbanised land of the lower portion of the Hobart Rivulet has led to its current state, which is one of general poor water quality than that of the upper catchment. As development of the catchment proceeded, the number of roads and impermeable surfaces within the area increased. As a result, accelerated runoff and high pollutant loadings have become a problem for Hobart Rivulet. The extent and types of contamination present in the rivulet is discussed in detail in a later section of this management plan.

5. Characteristics of the Hobart Rivulet Catchment

5.1 Land Use

The majority of the land (78%) within the Hobart catchment is comprised of natural vegetation and occupies approximately 1,470 hectares (Blacklow, 1995). Some of these areas include parks and reserves and land owned and managed by the Council, including Knocklofty Reserve, and the bushland surrounding McRobies Gully. Wellington Park is managed by the Wellington Park Management Trust under the *Wellington Park Act 1993*. The Council owns the face of Mt Wellington which includes the upper catchment of Hobart Rivulet - this forms part of Wellington Park. The parks and reserves are set aside for the conservation and protection of the natural, cultural heritage and recreational values. The remaining 22% (366 ha) of the catchment supports various uses including residential, commercial and industrial developments and includes the CBD of Hobart.

The mountain and valleys surrounding the rivulet have been used since the 1830's for recreation and valued for aesthetics by the people of Hobart. The use of this area increased substantially after the 1870's and numerous huts and paths were constructed to allow access for people who wished to walk and picnic in the area (Rayner, 1988). Many of these tracks and facilities are still used by people today and area of great recreational value to the people of Hobart and visitors.

The Hobart Rivulet Catchment supports a population of approximately 15,791 people (Australian Bureau of Statistics, 2006). Domestic animals also exist within the catchment area and include dogs, cats and chickens however there are no data available on exact numbers of these animals.

The majority of residents within the catchment are concentrated in the major residential suburbs of Hobart including South Hobart, North Hobart and West Hobart. The major industrial activity in the mid-catchment is the Cascade Brewery, most of the commercial activity within the catchment is in the lower catchment, with a considerable number of businesses operating in the central city and business area.

5.2 Community Values

The community and users of the catchment express their value of the Hobart Rivulet in various ways. Some may use the rivulet on a regular basis for recreation while some may value the rivulet for its intrinsic value, just because it is there and can be enjoyed. No matter what value individual members of the community hold for the rivulet, they are all important and crucial to long-term management objectives.

Recently Hobart City Council's Open Space Group (Bushland & Reserves and Parks & Recreation Units) engaged consultants to prepare a strategic master plan which will guide the future management and development of parkland and open space along the Hobart Rivulet.

The intent of the plan is for the Hobart Rivulet to become an all-encompassing visitor and recreational experience extending from the River Derwent to Mt Wellington. As such, the study area for the Hobart Rivulet Strategic Master Plan extends along the Hobart Rivulet from its confluence with the Derwent Estuary through to Wellington Park.

The key focus of the project extends along Hobart Rivulet from Molle Street up into the rivulet's catchment to the boundary of Wellington Park.

The study area extends either side of the rivulet, including not only the Hobart Rivulet Linear Park, but also other nearby reserves, parks, public land and undeveloped open space or visitor spots that are strongly associated with the rivulet corridor. The study area also factors in places that neighbour and influence the linear park.

The project is primarily focused on Council owned land but will also investigate the potential opportunities for enhancing recreational linkages and visitor experiences throughout a wider Hobart Rivulet recreational corridor.

The project objective is to develop a strategic master plan that will guide the future development, management and extension of the Hobart Rivulet Linear Park, as one of Hobart's premier visitor experiences.

The key outcomes sought are:

(i) the identification of the values and significance of the Hobart Rivulet which will guide the development of a vision
(ii) polices and principles through which the vision will be realised
(iii) strategic actions to develop and upgrade the area over a 10 year period

It is envisaged that the final report of the Hobart Rivulet Strategic Master Plan will be published by the end of 2011.

5.3 Geology

The Hobart Rivulet catchment area is geologically diverse with undulating ground from sea level to the summit of Mount Wellington at 1,271 metres (Leaman, 1972). The dominant rock type within the catchment is Jurassic Dolerite, particularly in areas of high elevation. This type of substrate generates rocky soils that are slightly acidic, have high nutrient quality and vary in depth from 0.6-0.8 metres (Sinclair Knight Merz, 1999). The vegetation in these areas is represented by low woodland and open forest (Davies, 1988). In lower areas, various sedimentary materials dominate and are illustrated in Figure 2.

The Eastern slope of Mount Wellington is covered by a dolerite talus that obscures the Triassic Sandstone outcrop. Below this outcrop a range of Permian sediments begin to appear and include fossiliferous mudstone, fossiliferous sandstone and unfossiliferous quartz siltstone (Blacklow, 1995). Triassic sediments produce nutrient poor soils of neutral pH with a shallow soil profile of 0.3 metres and supports low woodland – open woodland vegetation (Davies, 1988). Permian sediments produce soil that is slightly acidic, has high to moderate permeability and is characterised by a shallow soil profile of 0.4-0.6 metres. This soil type supports vegetation types typical of low woodlands or open forests (Davies, 1988).

The substrate towards the city centre of Hobart is comprised predominantly of Triassic shales and sandstones with dolerite intrusions. Due to the urban nature of this part of the catchment, the vegetation that is present is largely introduced and is comprised of a range of exotic garden species.

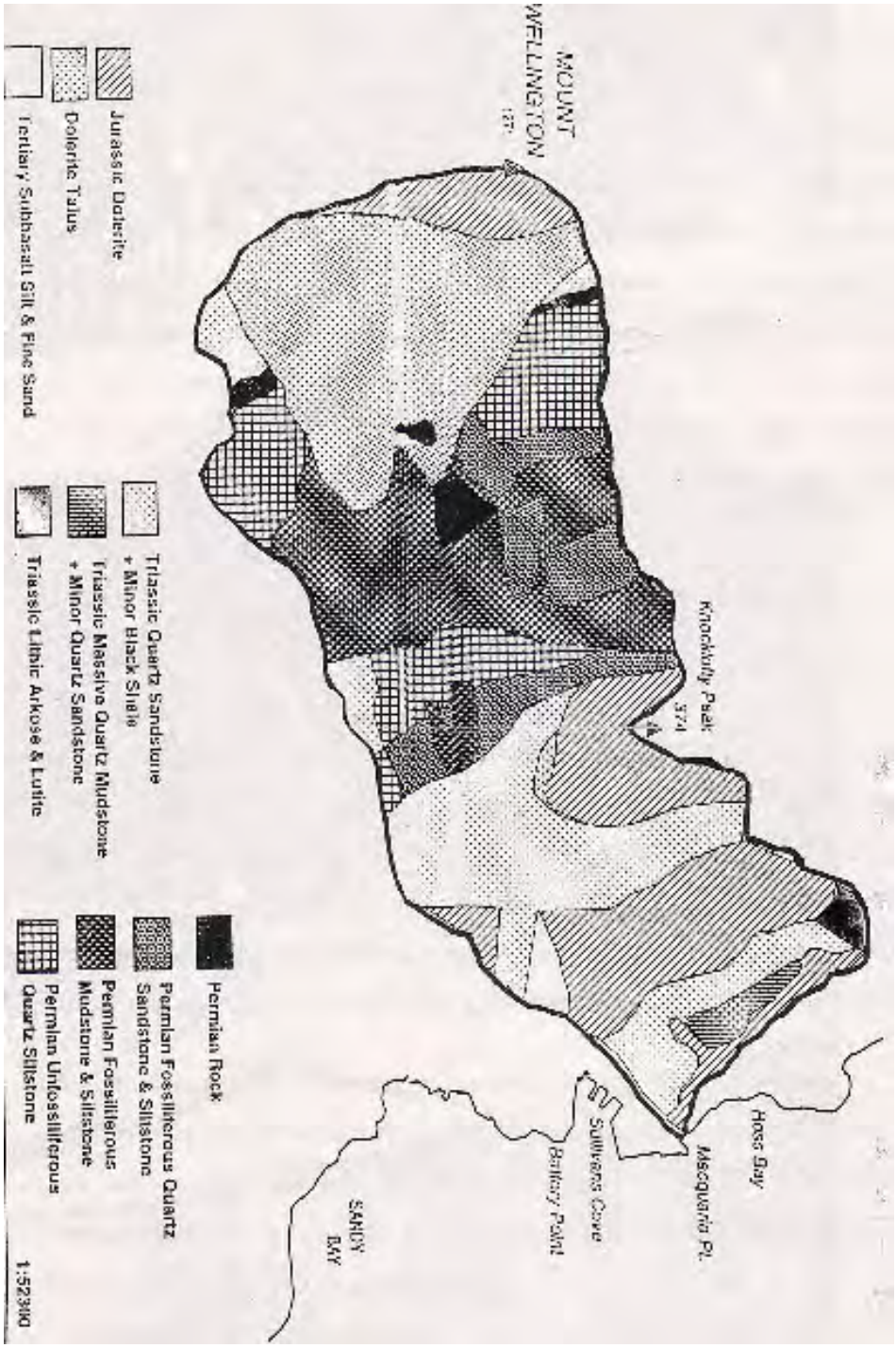


Figure 2: Geology of Hobart Rivulet Catchment

[Source: Sinclair Knight Merz, 1999]

5.4 Erosion

Bank destabilisation may lead to erosion and sediment movement into the waterway and as such may increase the turbidity of the Rivulet.

Turbidity from suspended solids reduces light penetration in water, affecting the growth of aquatic plants. When silts and clays settle, they may smother bottom dwelling organisms and disrupt their habitats. Since metals, phosphorous and various organics are adsorbed and transported with these particles, sediment deposits may lead to a slow release of toxins and nutrients in the waterway.

The key to erosion control and prevention is vegetation. Erosion is generally higher in areas were the riparian zone and vegetation has been disturbed and the land has been degraded. Soil erosion has particular consequences for aquatic environments, causing:

- Smothering of benthic environments.
- Increased turbidity in streams and water bodies.
- Increased nutrients in streams and water bodies.
- Increased salinity on land and in water bodies.
- Increased frequency and damage caused by flooding.
- Reduced aesthetic values of bushland and water bodies (adapted from DEH, 2002).

In 2005, Hobart City Council undertook a project to assess the status of the vegetation communities (native and introduced) along the rivulets and riparian corridors within Council's urban areas. Geomorphological (bank stability and channel integrity) surveys of the rivulets were also undertaken. This was a follow-up field project, to assess any changes from an initial survey undertaken in winter/spring 2002 and repeated in spring/summer 2004.

The aim of the geomorphological part of the project was to:

- Identify and list erosion types (ie bank scour, bank slumping, bank undercutting, down-cutting, bed scour, lateral bank erosion and blockages) and extent within urban rivulet/riparian corridors.
- Describe other built/development features located within the riparian zone.
- Plot the location and extent of erosion types and other built/development features within urban rivulet/riparian corridors.
- Photograph erosion areas and potential erosion areas within the rivulet/riparian corridor (Green, et al, 2005).

Stream condition results from the project undertaken by Green, et al, 2005 for the Hobart Rivulet are as per the table below:

RIPARIAN WATERCOURSE	EROSION CONDITION	THREAT/RISK	COMMENTS
Hobart Rivulet Upper (from first Strickland Avenue bridge to second Strickland Avenue bridge)	Good (Less than 25% of the rivulet is affected by erosion)	Low (Vulnerability to new or enhanced erosion is low)	Largely natural condition
Hobart Rivulet Middle (from second Strickland Avenue Bridge to Brewery)	Moderate	Medium	Mostly stable, rocky/boulder substrate
Hobart Rivulet Lower (from Brewery to Molle Street)	Moderate	Medium	Stabilised by willows and other weed species
Featherstone Creek (Upper tributary of Hobart Rivulet)	Very Poor (Most (75%-100%) of the rivulet is affected by erosion)	Very high (Vulnerability to new or enhanced erosion through factors such as bank instability, stormwater inputs or in-stream structures is very high)	Unnaturally high flow due to stormwater input and erosion prone soils. Severe gully erosion in places

Table 1: Summary of erosion condition and threat/risk of further erosion for Hobart Rivulet
[Source: Green, et al, 2005]

As can be seen from the results of this 2005 project, the Hobart Rivulet was found to be in reasonable condition with a moderate to low threat of further erosion damage. However, the one sub-catchment of Hobart Rivulet that was surveyed, Featherstone Creek, exhibited severe gully erosion caused by stormwater flow above Strickland Avenue. The steep gradients in the upper section of this Creek and the highly erodible soils in the lower reaches of the Creek contribute to the observed significant gully erosion.

Further details in relation to the erosion hazard survey work as part of the Green, et al, 2005 project can be located in the *Riparian Vegetation and Erosion Hazard Survey of the Urban Rivulets in the Hobart City Municipality* document, available from the Hobart City Council's Library.

ACTION: Undertake an erosion condition assessment of the Hobart Rivulet catchment.

ACTION: Provide erosion hazard mapping data onto the Hobart City Council website.

5.5 Hydrology

The Hobart Rivulet has a catchment area of approximately 16.2 km to Gore Street and 22.6 km to Campbell Street (HECEC, 1997). The Hobart Rivulet flows from the east face of Mount Wellington and descends from 700m to sea level over a distance of 9.5 kilometres, draining 2,190 hectares (Sinclair Knight Merz, 2000). Two major tributaries, Featherstone Creek and Guy Fawkes Rivulet feed the Hobart Rivulet along with several other smaller creeks within the catchment. While the majority of the catchment is in a natural state, there are several major roads and surrounding impervious surfaces that have altered the local hydrology of the rivulet (Sinclair Knight Merz, 2000).

A rainfall runoff model of the catchment area was completed in 1997 during the Hobart Rivulet Flood Study (HECEC, 1997) and was used to determine variations in rainfall depth throughout the catchment and areas that were prone to inundation or flooding. Figure 2 illustrates the catchment area and sub-catchment boundaries. Information derived from rainfall events is a useful tool in predicting catchment behaviours and stormwater design and is also crucial for the selection and placement of stormwater treatment devices.

A complete urban rainfall runoff analysis was conducted for the Hobart Rivulet during the 1997 Flood Study conducted by HECEC. A flood series analysis is included in that study along with extensive hydraulic modelling. The study identified areas prone to flooding within the Hobart Rivulet Catchment and to made recommendations concerning flood abatement for future developments within the catchment. A more detailed description of hydrology in the Hobart Rivulet is provided in Hobart Rivulet Flood Study [HECEC, 1997].

Following the Hobart Rivulet Flood Study, a Lower Hobart Rivulet Flood Emergency Action Plan (often referred to as the Flood Action Plan or FAP) was developed in order to detail the arrangements that need to be put in place when there is a risk of inundation of property and infrastructure resulting from an overflow of the Hobart Rivulet.

With the Hobart Rivulet Flood Study highlighting the area of inundation consisting of the City Hall/Grand Chancellor Hotel precinct (including the adjacent parts of Wapping, from the Rivulet to the docks across Macquarie and Davey Streets), the scope of the Lower Hobart Rivulet FAP is restricted to that open section of the Hobart Rivulet behind the Royal Hobart Hospital in Collins Street between Argyle Street and Campbell Street.

In the past, this area has been inundated with flood breakouts, including those of the 1954 and 1973 floods as pictured below in Image 2 and 3.

Image 2: Hobart Rivulet in flood, June 1954
[Source: The Mercury]

Image 3: Hobart Rivulet in flood, May 1973
[Source: Tasmanian Museum and Art Gallery (Q4904.7)]

The Lower Hobart Rivulet Flood Action Plan was developed under the authority of the Hobart Emergency Management Committee in accordance with the requirements of the Emergency Management Act 2006 (FAP, 2010).

The objectives of the Flood Action Plan can be summarised as follows:-

- To minimise the impact on property and infrastructure arising from the inundation;
- To mobilise the necessary resources to facilitate the planned protection measures;
- To ensure the warning system provides the necessary lead time;
- To provide for regular exercising of the plan;
- To identify the key stakeholders in the affected area; and
- To develop the appropriate communication protocols with key stakeholders (FAP, 2010).

5.6 Climate

The Hobart area is subject to a temperate marine climate and is dominated by the influence of Mt Wellington. Combined with the prevailing westerly winds, the position of the mountain results in higher rainfall, lower temperatures and less sunlight within the Hobart Rivulet Catchment (Sinclair Knight Merz, 2000).

The close proximity of the sea acts as a buffer dampening climatic extremes in Hobart (Ridder, 1998). The maximum average temperature varies between 21.6 degrees Celsius in February and 11.6 degrees Celsius in July. The minimum temperatures vary between 11.9 degrees Celsius in February and 4.5 degrees Celsius in July (Ridder, 1998).

Rainfall can vary considerably throughout the catchment and this is apparent in records from the Bureau of Meteorology. This is largely due to the position of Hobart in relation to Mount Wellington with the low-lying areas receiving less rainfall than suburbs at higher altitudes. Lower areas in Hobart receive between 40-60mm per month (around 600mm annually) while the upper reaches of the catchment around Fern Tree and the Springs at Mount Wellington can receive over 1000mm annually (Bureau of Meteorology).

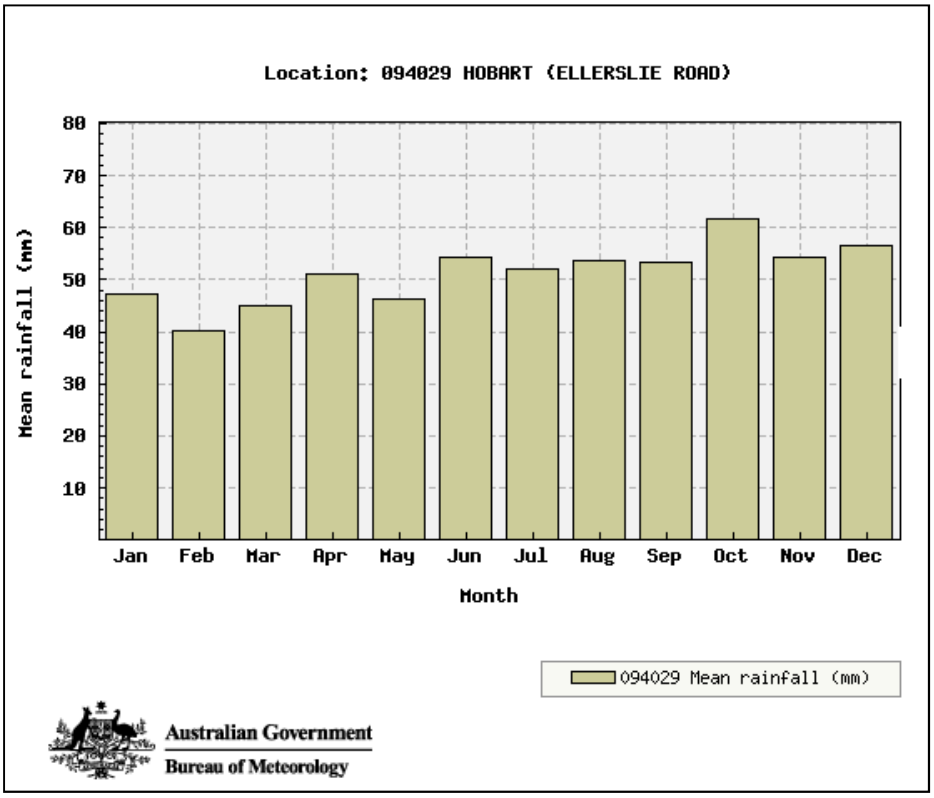


Figure 3: Hobart (Ellerslie Road) average monthly rainfall
[Source: Bureau of Meteorology, 2010]

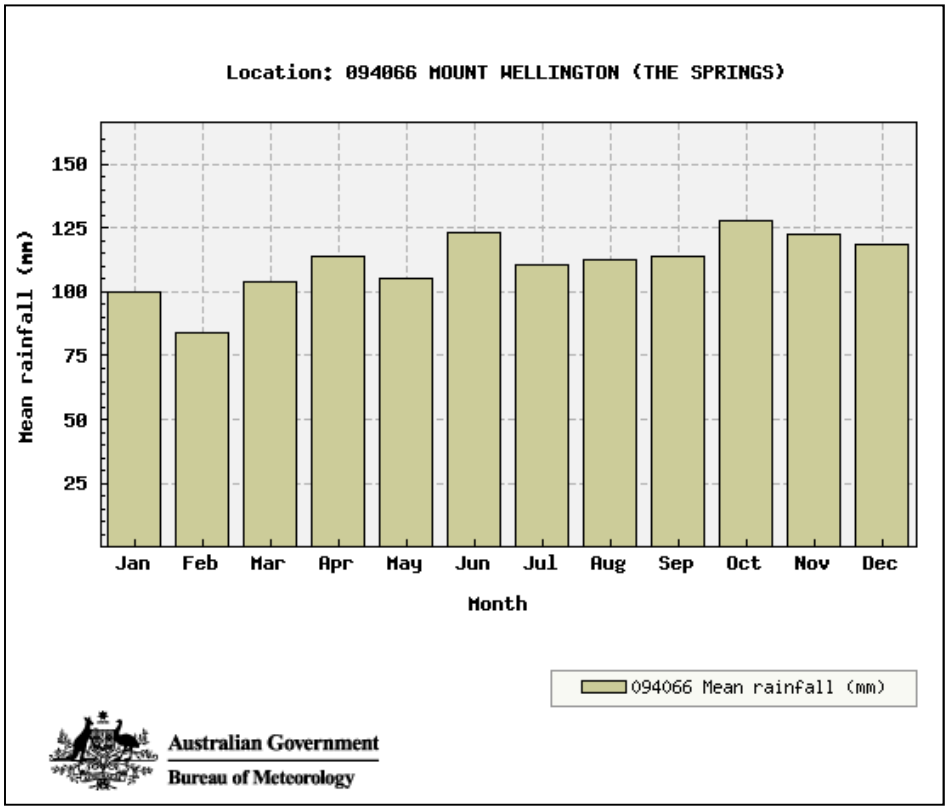


Figure 4: Mount Wellington (The Springs) average monthly rainfall
[Source: Bureau of Meteorology, 2010]

Hobart is Australia's southern most capital and lies about 43 degrees south of the equator (Ridder, 1998). Due to its latitude, Hobart experiences more variation in daylight hours than any other capital city in Australia, with approximately 15 hours of daylight in mid-summer and only 9 hours in mid-winter (Ridder, 1998).

The future climate of Hobart, including the Hobart Rivulet catchment is likely to be warmer and drier, with such trends also likely to increase evaporation. However in contrast to the predicted extended drier periods, there is also a potential for increase in extreme rainfall events with greater intensities.

Although average changes in temperature, rainfall intensities and evaporation will have long-term consequences of the catchment, the impacts of climate change are more likely to be felt through extreme weather events.

In summary, this equates to longer drier periods followed by more intense storms. These intense storms may lead to an increase in the velocity of the water, which in turn may lead to an increase in erosion and bank destabilisation and thus sediment pollutions within the waterways.

Lower flows and higher temperatures may also reduce water quality within the catchment. For example, low flows, higher temperatures and higher nutrient levels may create a more favourable environment for potentially harmful algal blooms. Decreases in runoff due to climate change may reduce the extent and function of tributaries flowing into the Hobart Rivulet. These tributaries may provide habitat for birds and other wildlife. Changes to the climate will have significant effects on the catchment's plants and animals. Reductions in stream flows are likely to have a negative impact on aquatic biodiversity and wetland ecosystems.

In order to assist local government, the Southern Tasmanian Councils Authority (STCA) have created the Regional Councils Climate Adaptation Project. The aim of this project is to assist councils in developing climate change adaptation plans at the regional; land-use and corporate levels.

A risk based approach is to be undertaken through which council process and function is assessed with respect to the available climate change data for the region. This project provides opportunity for discussion around the issue of asset management within local government, in the context of climate change (STCA, 2011).

ACTION: Continue involvement with the STCA's Regional Councils Climate Adaptation Project.

6. Vegetation within the Catchment

There have been numerous surveys on the types of flora and plant communities in the Mount Wellington Range. The *Cascades Landcare Group Action plan for the Upper Hobart Rivulet* (Sinclair Knight Merz, 2000) was completed in April 2000. While the focus of the document is not on the whole catchment, it does describe the vegetation in the upper, more natural part of the catchment. The Action Plan for the Upper Hobart Rivulet comprises the section of the Rivulet running from the Mount Wellington Park boundary through the suburbs of South Hobart, ending at the Cascade Brewery (Sinclair Knight Merz, 2000).

A full flora habitat identification and assessment was undertaken by North Barker and Associates in 2004 for the entire Hobart Municipality and reported in the *Flora and Fauna Habitat Identification and Assessment Process* (North Barker and Associates, 2004) which was completed in April 2004.

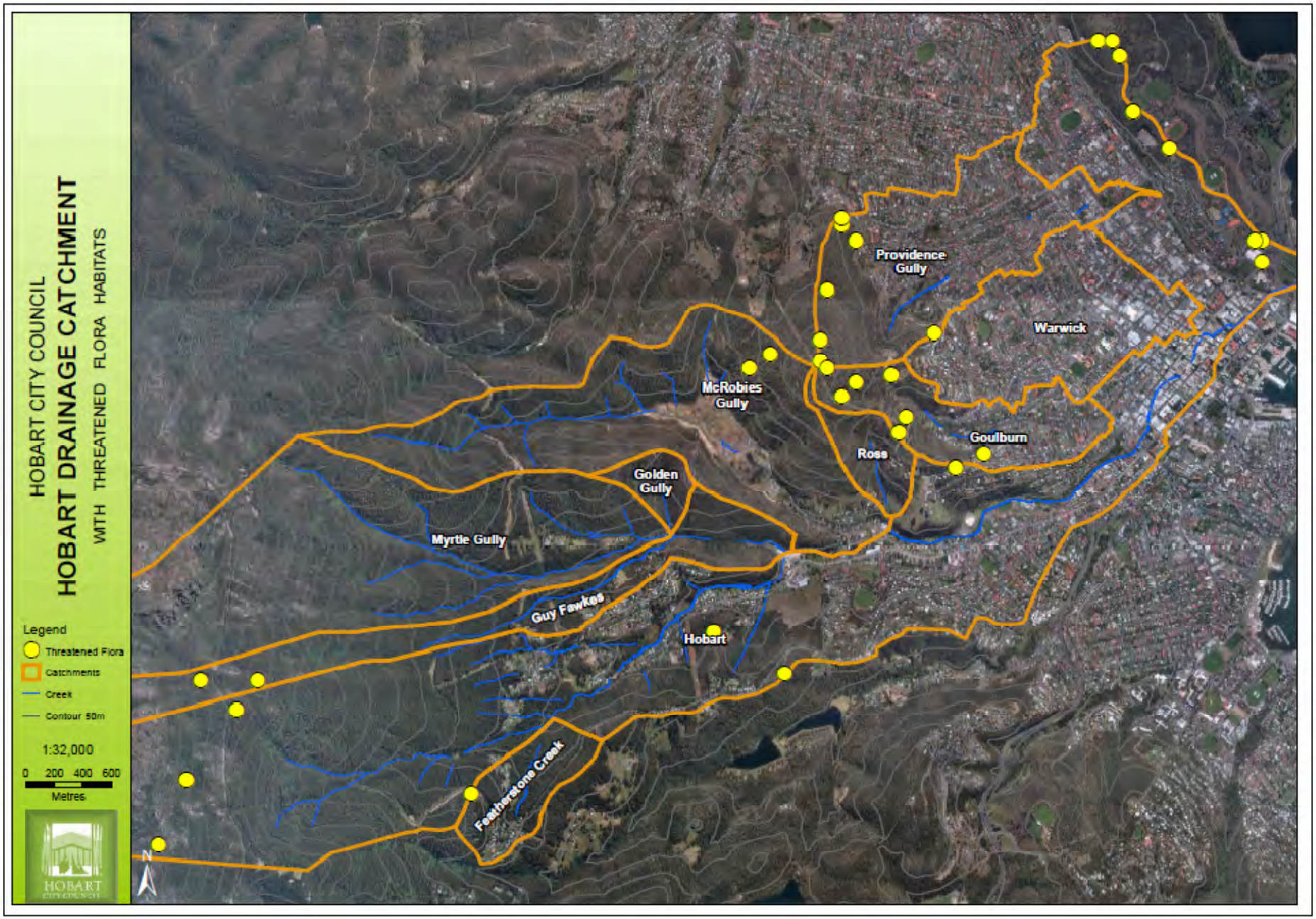
This document details the location and extent of significant biological conservation and biodiversity values within the Hobart City Municipality. It found that there were eight flora species listed on the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and forty-five plants species (including the eight above) listed on the Tasmanian *Threatened Species Protection Act 1995*.

The 2004 North Barker and Associates assessment formed the basis for the Hobart City Council's geographic information system (GIS) with vegetation mapping layer and threatened species mapping layer. Map 2 illustrates the threatened flora habitats within the Hobart Rivulet catchment.

Additional descriptions of the flora within the Hobart Rivulet Catchment include those completed by and North (1997) and North & Freeman (1996) in the *Botanical Surveys of Hobart Bushland*.

While these particular surveys were not specific to the Hobart Rivulet, the surveys were conducted in the near vicinity and therefore provide an overview of the types of vegetation in the Hobart Rivulet Catchment. Many of the plant communities and species present are similar to those found in other catchments on the slopes of Mount Wellington. The presence of species throughout the catchment varies in response to changes in soil, rainfall, drainage, aspect and mean daily temperatures.

There is currently no vegetation management plan for the Hobart Rivulet catchment. There is significant crossover of vegetation management within the Hobart Rivulet catchment between Council's Open Space Group (including the Bushland & Reserves Unit) and Council's Environmental Engineering (Stormwater and Waterways) Unit. As such, any planning in the development of a vegetation plan will need to take place in consultation with both Units.



Map 2: Threatened flora habitats within Hobart Rivulet Catchment

6.1 The South Hobart Precincts

North & Freeman (1996) have surveyed the South Hobart Precincts for vegetation types and plant communities in October 1996. The vegetation survey was conducted so to have accurate location information of areas that are considered to be of significance for the conservation of botanical values (North & Freeman, 1996). The information obtained from this survey has defined plant communities of conservation significance in Hobart City Council Reserves and Parks. The South Hobart Precincts included in this exercise are all fed by the water from Hobart Rivulet and upstream tributaries and creeks.

Plant communities records in the South Hobart Precincts are outlined in the table below.

FOREST TYPE	FLORISTIC COMMUNITY	CONSERVATION PRIORITY	PRECINCT NUMBERS (refer to City of Hobart Planning Scheme 1982
Grassy black peppermint	*E. viminalis, E. amygdalina, Dianella revoluta* grassy woodland	Critical	34
Grassy white peppermint	*E. pulchella, E. globulus, Acrotriche serrulata* grassy woodland	Urgent	41
Heathy silver peppermint	-	Urgent	34 41 42
Heathy black peppermint	-	Urgent	34 41
Shrubby stringy-bark on mudstone		Important	34 41 42
Shrubby stringy-bark on sandstone		Important	34 41
Wet stringy-bark	*E. obliqua, Acacia dealbata, Oleria argophylla* wet sclerophyll forest	Non-priority	34 41 42
Wet blue gum	*E. globulus, Poa labillardieri, Hypochaeris radicata* wet sclerophyll forest	Important	41
Wet swamp gum	*E. regnans, Acacia dealbata, Pomaderrris apetala*, *Olearia lirata* wet sclerophyll forest	Important	34

Table 2: Plant species of conservation significance in South Hobart – Precincts 34,41 and 42
[Source: North & Freeman, 1996]

There were several plant species of conservation significance found in South Hobart - Precincts 34, 41 & 42, many of which are rare. Rare species are defined by strict criteria relating to their known distribution. Rare plant species can be subdivided into three (3) distinct categories. These are **r1** (a species that has been recorded from an area less than 100 x 100 km), **r2** (a species that has been recorded from less than twenty 10 x 10 km grid squares throughout Tasmania), and **r3** (a species that is considered to be rare, but does not fit either category r1 or r2). Those rare species found in South Hobart – Precincts 34, 41 & 42 are outlined in the table below.

SPECIES	COMMON NAME	CONSERVATION STATUS	PRECINCT NUMBERS (refer to City of Hobart Planning Scheme 1982)
Vittadinia muelleri	Narrow-leaved New Holland daisy	Rare – r2	34
Acacia gunnii	Ploughshare wattle	Rare – r3	34
Olearia ericoides	Heathy daisy bush	Rare – r2	41
Deyeuxia spp.	Bent grass	?	34
Dichelachne inaequiglumis	Assymetric plumegrass	Rare – r2	41
Danthonia procera	Tall wallaby grass	Rare – r2	34, 41

Table 3: Plant species of conservation significance in South Hobart – Precincts 34, 41 and 42
[Source: North & Freeman, 1996]

In summary, the Hobart Rivulet catchment displays a dominant eucalypt and understorey character (North & Freeman 1996). Single plant communities also exist within the catchment due to previous fire regimes. An area between Strickland Avenue and Huon Road was not included in North & Freeman's (1996) survey; however, this area is dominated by Silver Peppermint (*Eucalyptus tenuiramis*). This area suffers extensively from weed infestation (North & Freeman, 1996).

The bushland in South Hobart is generally degraded due to frequent burning which has altered the species composition in favour of the more fire tolerant plant species (North & Freeman, 1996). Bushland areas in South Hobart are often prone to development high in the catchment and are therefore subject to receiving nutrient rich runoff from surrounding roads and stormwater. As a result these bushland areas are more susceptible to invasion from opportunistic weed species that are transported down the catchment. Major infestations of Blackberries (*Rubus fruticosus* sp agg.), Gorse (*Ulex europaeus*), Broom (*Cytisus scoparius*) and Spanish Heath (*Erica lusitanica*) have been recorded and mapped in the area (North & Freeman, 1996).

6.2 The McRobies Gully Landfill Buffer

North (1997) surveyed the vegetation of the *McRobies Gully Landfill Buffer* in 1997. The objectives of the survey were the same as the former vegetation survey conducted in South Hobart, to describe plant communities and to identify locations of plant species of conservation significance (North, 1997). The study area included private bushland within South Hobart (Precinct 35B) and several public reserves managed by Hobart City Council. For the purpose of this report these areas include Marlyn Road, Strickland Bends and Featherstone Creek, all of which feed the Hobart Rivulet with smaller tributaries. Information obtained from the survey included:

- Species data to provide locations of rare and threatened species and to enable plant community classification to be made.
- Boundary locations of each perceivable plant community.
- Locations of major environmental weed infestations.

North (1997) found that the area of bushland between McRobies Gully and Guy Fawkes Rivulet comprises shrubby *E. obliqua* dry sclerophyll forest and *E. globulus* wet sclerophyll forest. Both of these forest types are important in terms of biodiversity conservation (Sinclair Knight Merz, 2000). These plant communities are also found between Huon Road and Strickland Avenue. Plant species of conservation significance that were found in the specified areas are described in table below.

SPECIES	CONSERVATION STATUS	LOCATION	NOTES
Danthonia procera Tall Wallaby grass	Rare – r2	McRobies Gully	Widespread on dry sites on mudstone and dolerite
Lepidium psuedotasmanicum Tasmanian Peppercress	Rare – r2	Precinct 35B	Localised to dry sites beneath dense canopies
Olearia ericoides Heathy daisy bush	Rare – r2	McRobies Gully	Widespread on dolerite
Deyeuxia sp. Bent grass	-	McRobies Gully	Two localised pollutions. Specimens examined by the Tasmanian Herbarium to determine taxonomic status.

Table 4: Plant species of conservation significance
[Source: North, 1997]

Plant communities that were mapped in McRobies Gully and other Council Reserves are outlined in table below.

FOREST TYPE	FLORISTIC COMMUNITY	LOCATION
Eucalyptus pulchella grassy woodland	*E. pulchella, E. viminalis, Lepidosperma spp.*	Ridges each side of McRobies Gully
Grassy *Eucalyptus globulus* dry sclerophyll forest	*E. globulus, poa labillardierei, Hypochoeris radicata*	Eastern slopes of a hill north of McRobies Gully
Shrubby *Eucalyptus obliqua* dry sclerophyll forest	*E. obliqua*	McRobies Gully on north and east facing slopes
Eucalyptus obliqua, *Acacia dealbata* and *Olearia argophylla* wet sclerophyll forest	*E. obliqua*, *Acacia dealbata*, *Olearia agrophylla*, fire sensitive mesophytic species	South facing slopes and creek lines, McRobies Gully above tip face, slopes above McRobies Gully

Table 5: Plant communities found in McRobies Gully and some Council Reserves
[Source: North, 1997]

6.3 The Upper Hobart Rivulet Action Plan

The *Upper Hobart Rivulet Action Plan* developed for the Cascades Landcare Group has used the two-bushland surveys conducted by North and Freeman (1996) and North (1997) to describe vegetation within the Hobart Rivulet Catchment (refer to Tables 2 through to Table 5).

Two areas of significance within the catchment have been overlooked in all surveys and are therefore not included in any report or action plan. These areas are:

- The "Luge" area (below Old Farm Road and Jubilee Road), and
- Near Hobart Rivulet along Strickland Avenue below Strickland Falls.

A detailed account of all plant communities and species found in the Hobart Rivulet Catchment is provided in Appendix C.

6.4 Weed Species

Weeds are invasive, non-local plants and have significant impacts on catchments and waterways in numerous ways including:

- impeding and altering stream flows;
- accelerating erosion;
- reducing the effectiveness of stormwater infrastructure;
- impeding recreational access and enjoyment;
- displacing native vegetation;
- reducing native fauna habitat;
- increasing fire fuel loads;
- harbouring pest animals and diseases.

Weeds occur throughout the catchment, with the densest infestations found in the lower, developed reaches, in areas with elevated water and nutrient levels and in areas with a history of disturbance. In the natural and semi-natural upper reaches, weed populations are more scattered although significant localised infestations have established, usually in areas in close proximity to housing.

It is not realistic to expect to remove all weeds from the catchment due to the fact that in certain locations long-term disturbances have significantly altered site conditions to a point where weed species are now favoured over native species. This applies particularly to ground-flora weeds (i.e., grasses and other herbaceous species), which are commonly favoured by the elevated nutrient levels associated with urban waterways. However, in areas where conditions are not significantly altered or a particular species (or suite of species) poses a threat to particular catchment values, then weed removals are a desirable and realistic objective.

Significant work has been undertaken by Council and community groups in the last two decades to clear weeds and reduce their impacts on the catchment. In some locations, weed clearing has been followed by plantings of local native species as a means of stabilising banks, improving streamside access, improving amenity values and restoring habitat. However, the extent of weed invasion in

the catchment remains high and will require considerable planning and resources to significantly reduce impacts in the longer term.

The major invasive weeds of the catchment are listed in the following table:

COMMON NAME	BOTANICAL NAME	EXTENT
Willow	*Salix* spp.	Abundant below Tara Street, scattered elsewhere
Sycamore Maple	*Acer pseudoplatanus*	Abundant below Tara Street, occasional elsewhere
Old Man's Beard	*Clematis vitalba*	Locally abundant in several locations
Gorse	*Ulex europaeus*	Abundant throughout catchment
Blackberry	*Rubus fruticosus* spp. agg.	Abundant throughout catchment
Fuchsia	*Fuchsia magellanica*	Scattered above Cascades
Tutsan	*Hypericum androseum*	Occasional above Cascades
English / Scotch Broom	*Cytisus scoparius*	Abundant above Cascades
Montpellier Broom	*Genista monspessulana*	Abundant in several locations
Spanish Heath	*Erica lusitanica*	Scattered above Cascades
Sweet Briar Rose	*Rosa rubiginosa*	Locally abundant in several locations, scattered elsewhere
Tagasaste / Tree Lucerne	*Chamaecytisus proliferus*	Scattered above Cascades
Hawthorn	*Crataegus monogyna*	Locally abundant in several locations, scattered elsewhere
Cotoneaster	*Cotoneaster spp.*	Abundant below Strickland Avenue
Elisha's Tears	*Leycesteria formosa*	Scattered above Cascades
Holly	*Ilex aquifolium*	Scattered above Cascades
English Ivy	*Hedera helix*	Locally abundant in several locations, scattered elsewhere
Cape Ivy	*Delairea odorata*	Locally abundant below Tara Street, scattered elsewhere
Banana Passionfruit	*Passiflora tarminiana*	Scattered throughout catchment
Red Valerian	*Centranthus ruber*	Locally abundant in several locations, scattered elsewhere
St. Johns Wort	*Hypericum perforatum*	Single population below Anglesea Street
Montbretia	*Crocosmia X crocosmiiflora*	Locally abundant in several locations, scattered elsewhere
Mirror Bush	*Coprosma repens*	Scattered through catchment
Hemlock	*Conium maculatum*	Scattered through catchment
Blue Periwinkle	*Vinca major*	Locally abundant in several locations, scattered elsewhere

Note: Other major weeds may be identified after a formal weed survey is undertaken of the catchment.

Table 6: Major invasive weeds within the Hobart Rivulet catchment area
[Source: HCC Open Space Group]

6.5 Bushland and park management in the upper catchment

Important in maintaining a high standard of water quality in the upper catchment is the management of bushland. Hobart City Council's Bushland Management Strategy 2007-2017 (Hobart City Council, March 2008) identifies the aspects and influences bushland management practices may have on fluvial and riparian systems with actions identified as part of the Strategy. Detailed description of management of the upper, bushland reaches of the Hobart Rivulet Catchment are beyond the scope of this document, which focuses on the urbanised catchment. Ongoing management of the upper catchment will be undertaken through action plans identified the Bushland Management Strategy 2007-2017, including a comprehensive analysis of the impacts management practices have on water quality and quantity.

The key strategic actions relating to flora in the Bushland Management Strategy 2007-2017, include:

- Develop and implement a Hobart Weed Plan and implement plans for all reserves.
- Prepare and implement action plans for all areas of bushland under Council's control which shall include identification of priority plant and animals species, communities and habitats and the specific management actions required to ensure their survival. The larger reserves require more comprehensive management plans.
- Prepare and implement threatened plant species management plans for those species located on Council owned land in liaison with the DPIWE Threatened Species Unit.
- Produce a code of practice for Council activities and contractors operating in both private bushland and reserves to reduce disturbance-related impacts on bushland values, which includes rehabilitation of disturbed sites.
- Develop a protocol with the Tasmanian Herbarium and Threatened Species Unit (DPIWE) to formally notify Council regarding any new records of threatened flora and fauna located within Hobart.
- Make Council's GIS bushland mapping system available on Council's web site.

Hobart City Council also supports the Bushcare Program. Operating since 1993, Bushcare is a program in which community volunteers participate with Council to conserve and rehabilitate publicly owned natural bushland. The Hobart City Council through the Bushcare Program actively seeks to promote and support the work of Bushcare volunteers and facilitate best practice volunteer work standards combined with best practice bushland management practices (HCC Bushcare Policy, 2011). Bushcare's regeneration activities aim to restore degraded bushland, changing weed-infested areas back to healthy habitats with locally-occurring native plants.

ACTION: Develop a vegetation (including weed survey) strategy for the catchment in collaboration with Council's Open Space Group (including the Bushland & Reserves Unit).

ACTION: Investigate funding options to target priority weeds through the catchment, including new and emerging species.

ACTION: Work with Council's Open Space Group in regard to incorporating environmental values into Open Space planning adjacent to the Rivulet.

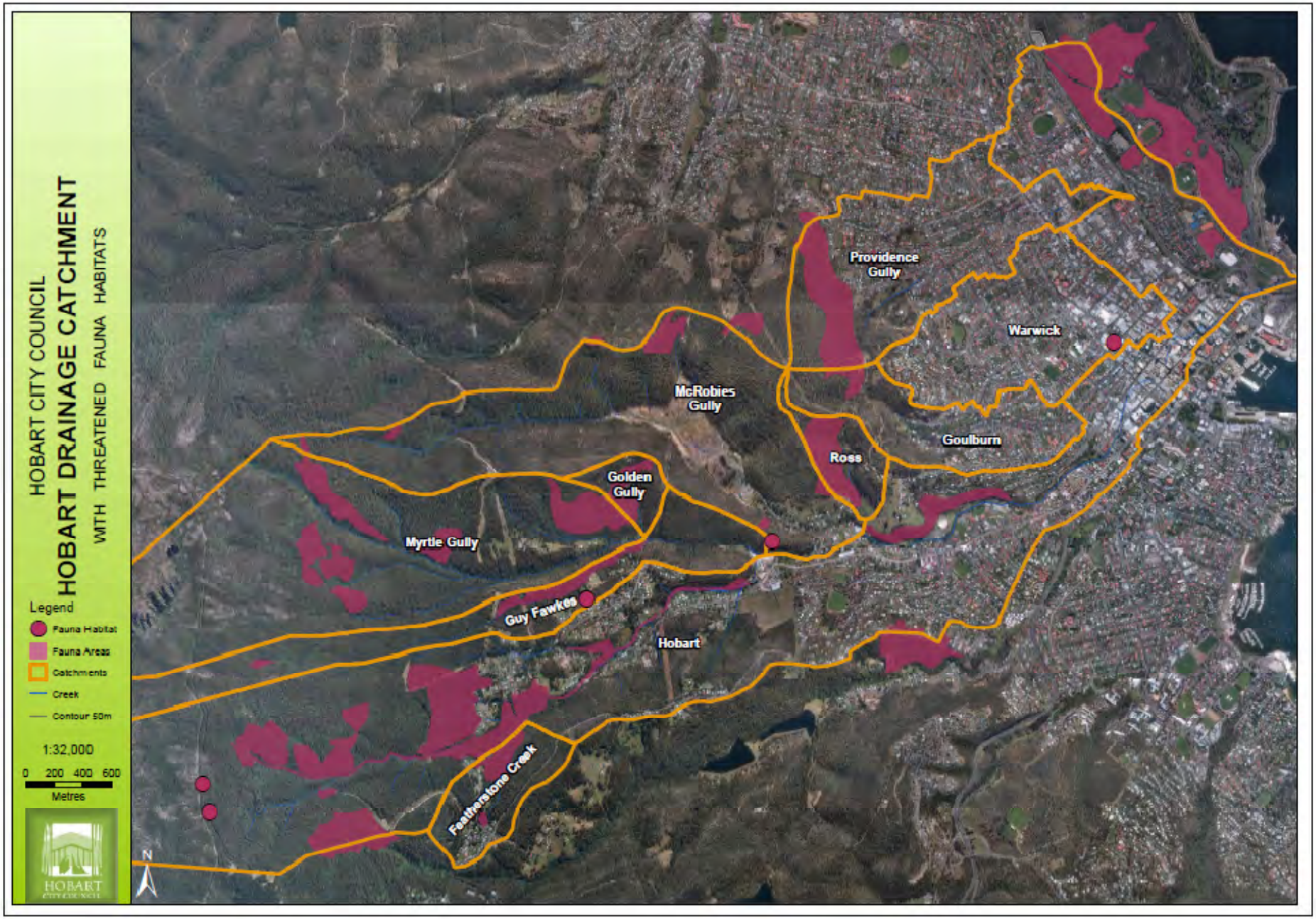
7. Fauna within the Catchment

A range of native fauna exists in the Hobart Rivulet Catchment. Hobart's faunal species diversity is high although the total number of species is unknown. The mapping and systematic survey of fauna is also inadequate. The priorities for the conservation of habitat are however, known, and the location of many rare and threatened species have also been determined (Bushland Management Strategy 2007-2017).

A full fauna habitat identification and assessment was undertaken by North Barker and Associates in 2004 for the entire Hobart Municipality and reported in the *Flora and Fauna Habitat Identification and Assessment Process* (North Barker and Associates, 2004) which was completed in April 2004.

This document details the location and extent of significant biological conservation and biodiversity values within the Hobart City Municipality. It found that there were five fauna species listed on the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and twelve fauna species (including three of the above) listed on the Tasmanian *Threatened Species Protection Act 1995*.

The 2004 North Barker and Associates assessment formed the basis for the Hobart City Council's geographic information system (GIS) with fauna habitat mapping layer and fauna areas mapping layer. Map 3 illustrates the fauna habitat and areas within the Hobart Rivulet catchment.



Map 3: Fauna habitats and areas within Hobart Rivulet Catchment

Species of conservation significance found within the catchment, include the Swift parrot (*Lathamus discolor*), Grey goshawk (*Accipter novaehollanidiae*), Bettong (*Bettongia gaimadi*) Eastern-barred bandicoot, (*Perameles gunni*) Mountain dragon, (*Rankinia diemensis*), Mount Mangana stag beetle, Hobart stag beetle, Geometric moth, Caddis fly (Mt Wellington) (*Hydrobiosella armata*), Hydrobiid freshwater snail (adapted from Sinclair Knight Merz, 2000).

Many species that would be expected in the bushland between Wellington Park and South Hobart are absent from this region. Fauna not recorded in this region includes the Bennett's Wallaby and animals rarely seen are wombats, Tasmanian Devils and the Eastern Quoll. This can be attributed to human disturbance (Sinclair Knight Merz, 2000).

The most common animals living on the slopes of Mount Wellington within the Hobart catchment are the Brush-tailed Possum, Bennett's Wallaby, Pademelon and the Potoroo. Smaller animals living in dense forest are the Ring-tailed Possum, Brown Bandicoot, Pygmy Possum, Little Pygmy Possum, Sugar Glider and the Dusky Antechinus (Rounsevell & Hewer, 1991).

Suitable streams draining Mount Wellington may support the Platypus and an ancient form of freshwater shrimp (*Anaspides tasmaniensis*). The Eastern Quoll (*Dasyurus viverrinus*) and the Tasmanian Devil are carnivorous marsupials that can live in the forests surrounding the mountain (Rounsevell & Hewer, 1991). Various lizards and skinks are also found in the catchment, particularly in the open forests and rock screes of the mountain.

A list of species known or likely to occur within the catchment is provided in Appendix D.

The management of the upper, bushland reaches of the Hobart Rivulet Catchment are beyond the scope of this document, which focuses on the urbanised catchment. The Bushland Management Strategy 2007-2017, itemises key strategic actions relating to fauna within the upper, bushland reaches of the Hobart Rivulet Catchment, these include:

- Prepare and implement threatened fauna species management plans for those species located on Council owned land in liaison with the DPIWE Threatened Species Unit.
- Develop and implement a protocol with the Threatened Species Unit to formally notify Council regarding any new records of threatened fauna located within Hobart.
- Develop and maintain an inventory of the assemblages of species, habitats and ecosystems of Hobart. The inventory should be included within the Council's bushland database.
- Develop and implement a backyard bushcare program that encourages retention and development of habitat gardens.
- Develop a wildlife watch program using community volunteers to record native fauna and maintain a database of sitings.
- Liaise with DPIWE on the development of management programs for feral animals including European wasps and rabbits.
- Work with and encourage the State government to develop cat control initiatives.
- Support research on the impact of dogs, cats and recreation on fauna.
- Make Council's bushland mapping system available on Council's website.

8. Water Quality

8.1 Hobart City Stormwater

The term "stormwater" is commonly used to describe water that runs over urban roads, footpaths, roofs, gardens, parks and car parks etc (Barry 2002). Stormwater run-off is the major cause of massive accumulations of toxic contamination in Australia's waterways (Waste Management and Environment 2001). It is the unique characteristics of a catchment area that may affect the quality of the stormwater and the way that the stormwater is managed within that catchment. These characteristics may include the permeable/impermeable surface ratios, population of the catchment, operational industries within the catchment, and human behaviour to name a few.

As stormwater flows over the impermeable surfaces present in urban areas, it collects pollutants such as oils, pathogens, litter, nutrients, metals and sediments. These pollutants are transferred to our waterways via run-off into the stormwater system and have the potential to cause toxic, organic, nutrient, pathogenic and sediment pollution of our rivers and oceans. A table outlining stormwater threats, sources and impacts on receiving waters is illustrated in Appendix E.

In urban areas, constructed drainage features are the norm and act as conduits for stormwater and its contaminants into natural waterways. On occasions streams are left in their natural state and are used as drainage systems, however, most often stormwater drains tend to superimpose the natural drainage pattern (Blacklow 1995). In most of the urban areas of Hobart, stormwater drains constructed of concrete or PVC have been installed to assist in the rapid removal of stormwater from urban areas during high rainfall periods (Blacklow 1995). Waterways that were originally located above ground such as the Salvator Rosa Glen (Goulbourn), the Murray St Rivulet (Warwick) and the Campbell St Rivulet (Providence Gully) now flow almost entirely underground as part of the Hobart City stormwater system (Blacklow 1995).

Many natural areas also exist within the catchment drainage. In the urban fringes, Hobart Rivulet is lined with stream bank vegetation, consisting of large trees, small shrubs, vines, and grass. As the rivulet encroaches on the boundaries of the CBD, some bank protection is provided by rock in mortar, sandstone and concrete retaining walls.

8.2 Water Quality Modelling

The Hobart Rivulet Catchment Management Plan is a forum that brings together the management of stormwater runoff quality and the protection of the values of the natural and built waterways that constitute a major component of a stormwater conveyance system.

Stormwater runoff quality and receiving waterway health will be addressed within the plan, with reference to the currently under development Hobart Master Drainage Scheme, leading to the integration of mitigation measures addressing both the quantity and quality aspects of stormwater runoff.

To evaluate stormwater quality within the catchment a water quality model of the catchment will be developed using MUSIC, the Model for Urban Stormwater Improvement Conceptualisation, developed by the eWater CRC. MUSIC provides the ability to simulate both quantity and quality of stormwater runoff from a single house block up to many square kilometres, and the effect of a wide

range of treatment measures on the quantity and quality on runoff on the downstream environment.

The following points summarise the proposed methodology for undertaking water quality modelling:

Basic Model Development

- Each drainage catchment, defined by its outlet into the Hobart Rivulet, will be divided into smaller sub catchment based on land use and permeability. The sub catchment delineation will follow that done for the Master Drainage Scheme where possible and appropriate.
- Land use, permeability and pollutant export characteristics will be assigned to each sub catchment forming a MUSIC source node. Pollutant export characteristics for various land uses will be based on Melbourne's in the absence of any developed for Hobart.
- The model will be set up with all nodes connected according to their hydrological connections.
- The model will be run for a range of historical periods to ensure that the results are representative of average conditions. Resultant annual average pollutant loads and annual mean concentrations will be derived for the ultimate developed scenario.

Treatment Planning

- Strategies and works required to protect and improve stormwater quality aimed at achieving industry standards and legislative requirements will be investigated and tested within the MUSIC model.
- The proposed strategy will take into account site opportunities and constraints identified during the study, and wherever possible, integration of the measures within existing water quantity infrastructure.
- The proposed mitigation measures will include but not be limited to sediment traps, wetlands, ponds, bio retention systems, swales and street scale retrofitting of Water Sensitive Urban Design (WSUD). MUSIC will be used for conceptual sizing, costing and testing the effectiveness of the various water quality treatment options.
- The treatment measures will be designed to minimise the impact of existing and proposed development within the Hobart rivulet catchment on receiving waters and will aim to achieve the water quality objectives outlined in the State Stormwater Strategy, DPIPWE, 2010.
- Stormwater reuse is becoming an increasingly important option when considering the overall management of water resources. This is in keeping with the development of integrated water cycle management approaches, which recognise the value of water and aim to improve water quality and aquatic ecosystems. The potential for stormwater reuse within the Hobart Rivulet catchment will be investigated using the yield analysis and water balance tools available within the MUISC model.

ACTION: Develop a MUSIC model to assist in the concept location and sizing of stormwater quality improvement devices.

ACTION: Use MUSIC model to assist in the identification and prioritisation of infrastructure upgrades.

8.3 Current Water Quality

The Tasmanian *State Policy on Water Quality Management 1997* includes a number of clauses applicable to local government concerning stormwater management. The purpose of the Policy is to achieve the sustainable management of Tasmania's surface water and groundwater resources by protecting or enhancing their qualities. One of the core objectives for the Policy is in the setting of *Protected Environmental Values (*PEVs) for all waters of the State, while allowing for sustainable development. The degree of protection is based in the values and uses of the environment for which a watercourse should be protected.

The Protected Environment Values (PEVs) listed in the Policy include:

1. Protection of Aquatic Ecosystems
   - (i) Protection of pristine or nearly pristine ecosystems
   - (ii) Protection of modified ecosystems
     - (a) from which edible fish, crustacea and shellfish are harvested
     - (b) from which edible fish, crustacea and shellfish are not harvested
2. Recreational Water Quality and Aesthetics
   - (i) Primary contact water quality
   - (ii) Secondary contact water quality
   - (iii) Aesthetic water quality
3. Raw Water for Drinking Supply
   - (i) Subject to coarse screening only
   - (ii) Subject to coarse screening plus disinfection
4. Agricultural Water Uses
   - (i) Irrigation
   - (ii) Stock watering
5. Industrial Water Supply

   (specify industry)

(Department of Primary Industries, Water and Environment, 2000).

The PEVs for Hobart Rivulet include Values 1, 2 and 5 within the catchment.

The State Stormwater Strategy (DPIPWE, December 2010) is a recently published document setting out key principles and standards for stormwater management in Tasmania and identifies accepted guidance documents. The document aids as a guide to managing stormwater in new developments; during construction stages; during operational stages; managing stormwater in established urban areas, and; maintaining natural drainage systems.

8.4 Current Water Quality Status for the Hobart Rivulet

Numerous studies have been conducted on the water quality of Hobart Rivulet. Three specific studies include, *A Microbiological Quality Assessment of Stormwater in the Hobart Rivulet* (S. Blacklow, 1995), *McRobies Gully Refuse Disposal Site Environmental Monitoring Results & Discussion* (Hobart City Council, 2000), *Rivulet and Stormwater Monitoring Program* (Y. Barry, 2002). Each of these studies reveals the water quality status of Hobart Rivulet and is discussed further in the following sections.

8.4.1 Microbiological Assessment of Hobart Rivulet Study

Hobart Rivulet has a long history of water quality problems that have been predominantly linked to domestic sewage and industrial effluent (Blacklow 1995). Despite the separation of sewage and stormwater by two distinct systems, faecal coliforms remain one of the most persistent types of contaminants and are of most concern to long term rivulet health. Studies prior to Blacklow's indicated that an increase in pollutants towards the city centre was most common.

Thus the aim of Blacklow's study was to monitor the microbiological quality of the Hobart Rivulet during both wet and dry weather and to investigate possible relationships between bacterial levels in the Hobart Rivulet with rainfall, flow rate and catchment characteristics. This knowledge would lead to a better understanding of the complexity of microbiological pollution in a typical urban stream and may lead to identifying the possible sources of stormwater faecal contamination in the Hobart Rivulet.

Blacklow's study found that dry weather faecal coliform concentrations were highly variable (300cfu/L-250,000cfu/L) and were most likely arising from infiltration of human sewage contaminated soils (Blacklow 1995). Faecal coliform levels were significantly higher downstream and also during rain events and peak flows. Wet weather faecal contamination was attributed to animal faeces entering the rivulet via surface run-off during rain periods. Faecal coliform concentrations were highest near the city centre with the most contaminated area occurring between the South Hobart Tannery and the Royal Hobart Hospital (RHH). Faecal coliform levels were consistently high at the RHH site. Blacklow suggested that this is likely to be related to sources such as sewage leaks, cross connections, illegal dumping or perhaps congregations of animal populations in one area (Blacklow 1995). Possible sources of faecal contamination in Hobart Rivulet in wet and dry conditions are outlined in the table below.

Contributing Factors	*Dry Weather*	*Wet weather*
Direct Input		
Defecating animals	May occur	Insignificant
Sanitary wastewater	Major	May occur
Indirect Input		
Animal faeces deposited on ground	Insignificant	Major
Infiltration of relatively uncontaminated soils	Minor	Minor
Natural infiltration of contaminated soils	Major	Minor
Exfiltration of sanitary sewage	Major	Minor
Septic tank systems	Minor	Minor
Leaking water storage tanks	Minor	Insignificant
Hazardous waste material	May occur	May occur

Table 7: Contributing Factors for Faecal Contamination in the Hobart Rivulet
[Source: Blacklow, S., 1995, p.135.]

Other pollutants that had an adverse impact on the water quality of Hobart Rivulet include sediment, hydrocarbons, litter and other toxicants (heavy metals, pesticides, industrial waste, and detergents). Blacklow found litter to be a significant problem for the Hobart Rivulet and estimated that 27kg (dry weight) of litter was entering the Derwent Estuary from Hobart Rivulet per week and included cigarette butts, plastic bags, bottles, cans, polystyrene foam and paper (Blacklow 1995). These findings facilitated the development of the Stormwater Improvement Project that was conducted in 2001 and is discussed later in this Plan.

8.4.2 McRobies Gully Landfill (Waste Management Centre) Public Environmental Report

The McRobies Gully Landfill Waste Management Centre is situated in the 287 hectare McRobies Gully catchment in South Hobart.

Image 4: McRobies Gully Landfill (Waste Management Centre)
[Source: Hobart City Council, 2010]

The site operates under the State Government's Environment Protection Authority (EPA) Environmental Protection Notice under the *Environmental Management and Pollution Control Act 1994*.

As a requirement under the landfill's Environment Protection Notice, testing of nearby watercourses are included as part of the Environmental Monitoring Program. Environmental monitoring is undertaken on a quarterly basis in accordance with the Landfill Sustainability Guide and forms a component of the site Environmental Management System, within its environmental monitoring schedule and program and as such is reported to the EPA.

Extensive Risk Assessment and Environmental Impact Assessments have been made to cover all aspects of the sites operations. Environmental Impacts are reviewed on an annual basis, as a requirement of the Environmental Management System that applies to the site (HCC, September 2009).

The existing underground stormwater system beneath the landfill is to be replaced with a surface drainage system around the western perimeter of the site. These works will ensure that stormwater from the upstream catchments are not contaminated with leachate from the landfill (HCC, 2010).

Hobart Rivulet and McRobies Gully creek are regularly tested as a component of the site Environmental Monitoring Program. Guy Fawkes Rivulet runs directly into Hobart Rivulet, above the site and the geology of the area is such that surface water and ground water from the site could not physically reach Guy Fawkes Rivulet (HCC, September 2009).

In accordance with the Landfill Sustainability Guide, several groundwater and surface water sampling points are monitored and reported directly to the EPA. Those areas that may directly influence the Hobart Rivulet, are points upstream of the landfill in McRobies Creek; the stormwater manhole immediately below the leachate point; the Hobart Rivulet, 5 metres above the 1500mm stormwater pipe entering the Hobart Rivulet; 5 metres below the 1500mm stormwater pipe; the leachate pond, and; three groundwater bore sites within the landfill area.

Samples are tested for *E. coli*, total suspended solids, nitrogen, phosphorus, pH, salinity, turbidity and some metals. Full details of the results for all sites are included in the McRobies Gully Landfill (Waste Management Centre) Public Environmental Report – 2006/07 to 2008/09 located on the Hobart City Council website.

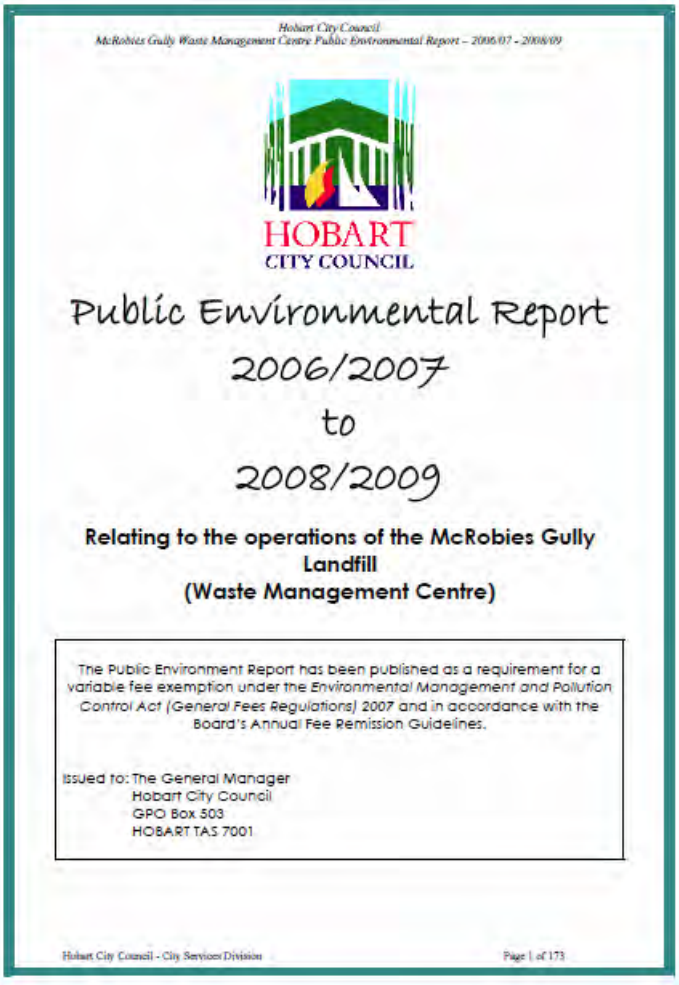


Image 5: Cover of the *McRobies Gully Landfill (Waste Management Centre) Public Environmental Report – 2006/07 to 2008/09* (Hobart City Council, 2009)
[Source: Hobart City Council, 2011]

8.4.3 Rivulet and Stormwater Monitoring Program

The Derwent Estuary Program commenced the Greater Hobart's *Stormwater and Rivulet Monitoring Program* in July 2002. This program ran for three years (2002-2005) and was a joint effort between the Derwent Estuary Program, Waterwatch groups and Hobart's Regional Councils. This program saw the collaboration of six local Councils and three Waterwatch groups collecting water samples each month from twelve rivulets (in both upper and lower catchment sites) and three stormwater dams, with 33 sites in total being monitored. Samples were analysed for total suspended solids, nutrients, heavy metals and faecal bacteria. The results of the three year monitoring program demonstrated a clear relationship of decreasing stormwater quality with increasing catchment urbanisation.

The Derwent Estuary Program has recently reintroduced the Urban Rivulet and Stormwater Monitoring Program for 2010-2011 as a joint effort between the six Hobart regional Councils as per the previous Program. Whilst this new program utilises the same monitoring protocol as in the previous program, this program will also look at determining the relationship between bacteriological, heavy metal and phosphorus pollution with suspended solids.

There are four (4) broad scale objectives of the program. These are:

- Characterise pollutants entering the Derwent Estuary via rivulets, indicating any marked increases or high levels of stormwater pollution, especially when compared with the 2002-2005 program results.
- Identify specific stormwater issues in each municipality so that councils can prioritise areas for stormwater management and better focus funding.
- Indicate the performance of stormwater management strategies in improving water quality.
- Information collected should be used to devise management strategies to improve water quality for the protection of the rivulets and the estuary (Barry 2002).

Each Council analyses stormwater pollutants taken from various sites within their municipality. The pollutants analysed are:

<u>Sampled each month:</u>

- Turbidity and Total Suspended Solids (TSS)
- Faecal coliforms and enterococci

<u>Sampled each quarter:</u>

- Nutrients (total nitrogen and total phosphorus)
- Oil and grease
- Heavy Metals
- Turbidity and TSS
- Faecal coliforms and enterococci

<u>Sampled bi-annually:</u>

- Turbidity and TSS
- Faecal coliforms and enterococci
- Nutrients (total nitrogen and phosphorus)

Results from this program will be compared to that of the previous program to ascertain whether rivulet and stormwater quality to has improved, remained similar or has declined. Overall the program will assist in identifying levels of stormwater pollutants that enter the Derwent Estuary, focusing on Rivulets. This will in turn allow Councils to identify and manage specific stormwater problems, improve water quality and protect the environmental values of waterways and receiving waters.

Image 5: Waterways sampling
[Source: Hobart City Council, 2011]

Aside from the recent DEP Rivulet and Stormwater Monitoring Program, water quality within the Hobart Rivulet is tested on a monthly basis in two locations – one at Tara Street below the McRobies outfall and the other at Collins Street at the rear of the Royal Hobart Hospital. Additionally, with the DEP Rivulet and Stormwater Monitoring Program, three other locations are monitored - the upper, forested catchment (at Strickland Falls); McRobies Gully Tip area; and at the Macquarie Point outfall where the stormwater enters the Derwent Estuary. At any monitoring site, if pollutants are detected in high numbers, water quality testing continues until the source of the pollution is located or the number of bacteria decreases to acceptable levels.

As the results demonstrated in the 2002-2005 DEP Rivulet and Stormwater Monitoring Program, it is generally the upper “pristine” areas of the Hobart Rivulet with good water quality, with the lower urban rivulet sites displaying high faecal contamination and nutrient levels which in the past has

suggested that human sewage may be infiltrating to the rivulet and stormwater system. During normal flow conditions turbidity, suspended solids and oils were not a problem for Hobart Rivulet, however this is likely to differ significantly after a rainfall event.

Following analysis of regular sampling and monitoring undertaken by the Council, it has been possible to identify major "hotspot areas" in Hobart Rivulet where there is typically higher concentrations of contaminants. These "hotpots" will be discussed in the following sections.

ACTION: Continue Council's involvement with the Derwent Estuary Program.

ACTION: Participate in and support the Derwent Estuary Program's Stormwater Taskforce.

ACTION: Review water quality monitoring program, including:

- location of monitoring sites;
- number of monitoring sites;
- event-based monitoring (ie during rainfall).

8.5 Stormwater Quality Improvement Devices

Managing stormwater can be both challenging and complex. Every catchment is different and therefore requires a management approach that is unique to the characteristics within that catchment. While there are several options for stormwater treatment, no single measure or strategy will solve stormwater pollution problems overnight. It will take years of combined effort between all tiers of government, community and businesses before the positive impacts of effective stormwater management can be seen. Perhaps one of the most effective ways in treating stormwater pollution is at the source of the pollution. Often the source is not so obvious and may require much investigation and rigorous water quality testing before the true source is actually isolated. Once isolated there are numerous options for treatment at the site. The treatment device selected for the problem area and level of treatment required is dependent on the pollutant type, location, hydraulic flow, access for maintenance and cost. The treatment techniques available and the types of pollutants captured are illustrated in Figure 5 below.

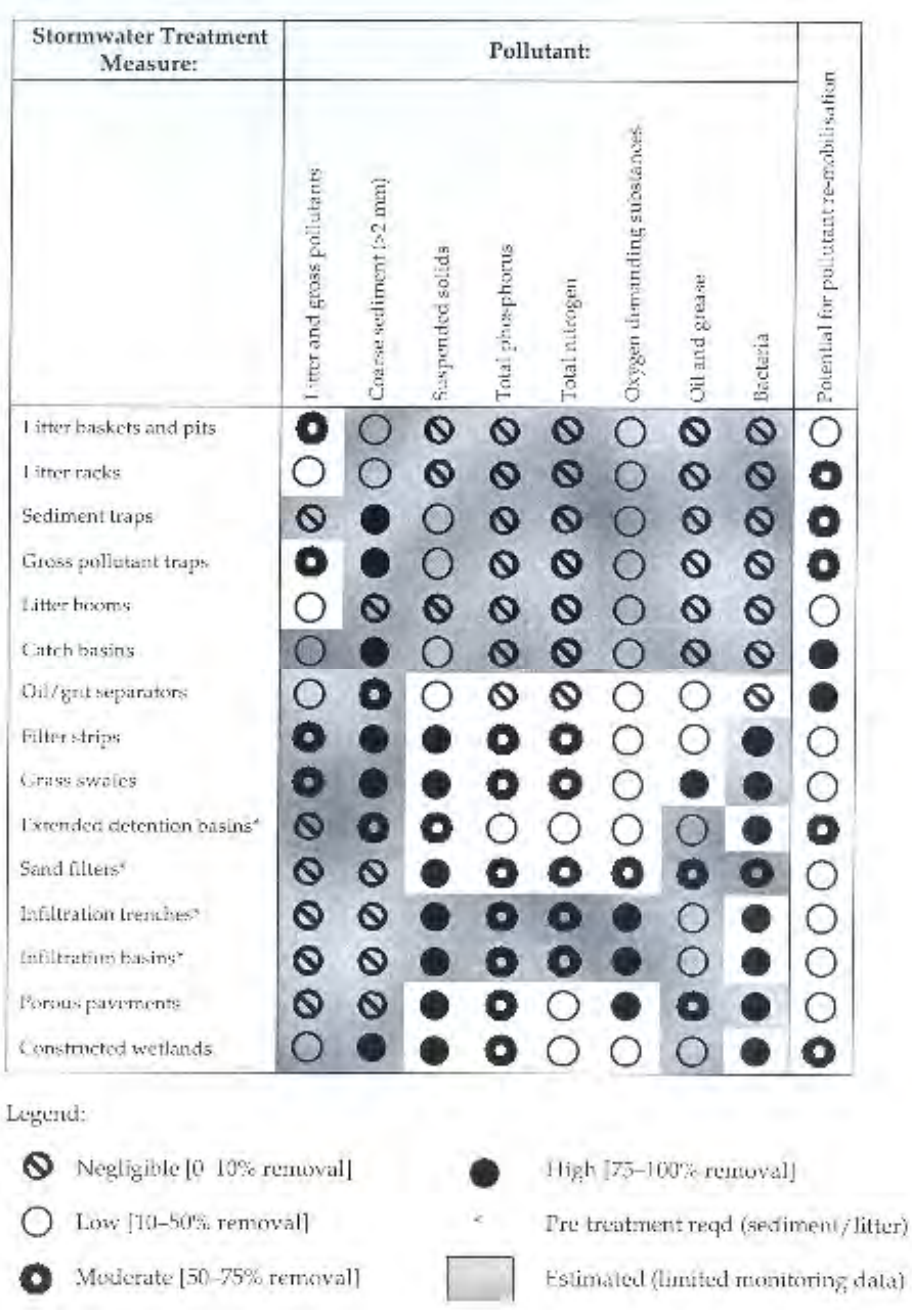


Figure 5: Treatment Techniques for Managing Urban Stormwater
[Source: NSW EPA, 1998]

ACTION: Continue to investigate alternative options for funding of stormwater quality improvement devices within the catchment.

ACTION: Ensure that existing maintenance staff are consulted during the selection of stormwater quality improvement devices, eg GPT's.

ACTION: Develop a list of prioritised existing stormwater "hot-spots" in the catchment, and provide recommendations for the retrofitting of stormwater quality improvement devices.

ACTION: Develop a comprehensive maintenance schedule of stormwater quality improvement devices, including inspection and maintenance frequency, collection/storage requirements, clean-out procedures, design details and supplier contacts.

ACTION: Identify current open sections, easement and stormwater quality improvement devices (including boulder traps and retention basins) so that formal internal maintenance/works manual and procedures can be developed in the future.

8.6 Existing Stormwater Management Facilities

Hobart City Council manages the stormwater system within the catchment. Throughout the Hobart Rivulet there are a number of stormwater controls that have been installed as flood control devices. These devices include a large boulder trap below Cascade Brewery (Image 6), a silt trap after the Goulburn catchment outfall (Image 7) and various litter/debris capturing devices in the upper catchment, one of which is located near Gore Street in South Hobart (Image 8).

Image 6: Boulder Trap below Cascade Brewery
[Source: Hobart City Council]

Image 7: Silt Trap after the Goulburn Catchment Outfall
[Source: Hobart City Council]

Image 8: Trash Rack near Gore Street, South Hobart
[Source: Hobart City Council]

Additional stormwater treatment devices exist within the Hobart catchment and are a direct result of a recent study by Hobart City Council into the litter loading within the stormwater system around the Hobart Docks and Salamanca area (Figure 6).

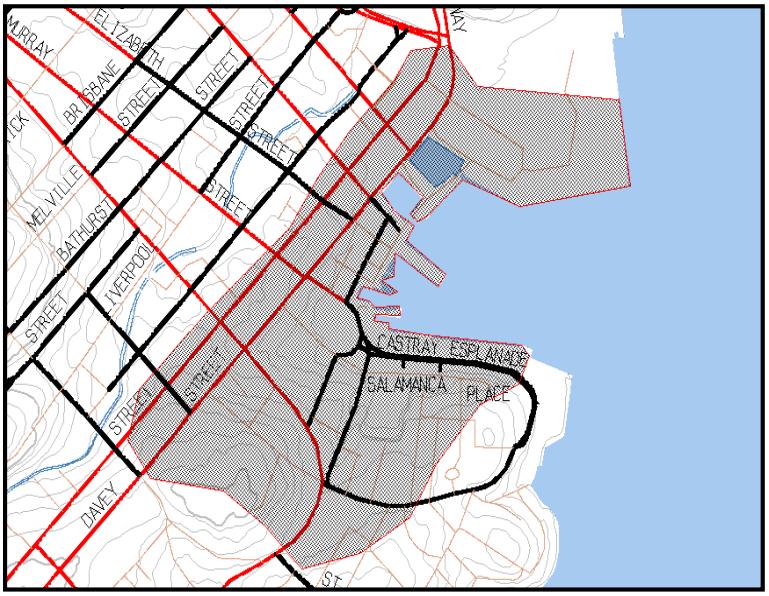


Figure 6: Location Map of Hobart Docks and Salamanca, Tasmania
[Source: Hobart City Council]

These areas receive high volumes of pedestrians with many pubs and cafes and are host to a number of special events including the weekly Salamanca Market, the Hobart Summer Festival and the Taste of Tasmania. The Hobart docks and Salamanca Project was initiated by Hobart City Council and was made possible though Coasts and Clean Seas Funding distributed through the Natural Heritage Trust (2001). The aim of the Project was to investigate ways in which stormwater quality could be improved in the lower urban areas of the Hobart Catchment where water quality was extremely poor. It is Hobart City Council's intention that the results of these investigations will lead to a reduction of contaminants entering the Derwent Estuary and will ultimately lead to more effective stormwater management practices.

8.7 Stormwater Litter baskets (entry pit traps)

A project was undertake to target gross litter, including cigarette butts, sediment from building sites, petroleum products from vehicles and road surfaces in Hobart's central city and business area. Diffuse-source pollutants from the area are difficult to manage because of their broad origins and the limitations in available technology.

Twenty Enviropod at-source stormwater entry-pit traps (see Image 9) were installed throughout the project area to capture litter, organic matter and sediment from approximately 1.9 hectares of near 100% commercial area.

These stormwater litter traps were selected as an alternative to gross pollutant traps, as gross pollutant traps are often impractical for decentralised stormwater networks and some traps can remobilise or resuspend captured pollutants back into the stormwater system, they may also be quite costly.

Image 9: Enviropod Unit
[Source: Hobart City Council]

For this particular project, monitoring of the traps was conducted on a monthly basis throughout the project area where the contents collected were weighed and recorded for contaminant characteristics. The monitoring and evaluation of the traps continued for the duration of 18 months.

Following this project, recommendations were made to install similar entry-pit traps in hotspot areas around the shopping and business precincts where litter loadings are problematic.

As such, since 2002, 475 litter traps have been installed in all of Hobart's major catchments and litter hot spot areas, with 210 in the Hobart Rivulet Catchment area - 138 within the Hobart CBD (Warwick and Hobart sub catchments) and 72 within North Hobart (Providence Gully sub catchment).

The location of these Enviropods are indicated in pink on the sub catchment maps in Appendix A.

Following further installation of the litter traps, additional monitoring was undertaken. During this monitoring, all the litter trap installations demonstrated high pollution capture, since the beginning of their programmed maintenance in July 2005 the litter traps have collected over 190 tonnes of polluted materials. This typically includes litter, contaminated sediment, vegetation, attached heavy metals, oils and greases. The at-source capture of this material prevents their discharge into local catchments and the Derwent River, and has been noted to have greatly improved urban water quality (Chrispijn, 2008).

Specifically in regard to the Hobart Rivulet catchment area, this additional monitoring illustrated the following average monthly removal rates as details below:

SUB CATCHMENT NAME	START DATE OF MAINTENANCE	MONTHLY CAPTURE	ANNUAL CAPTURE
Hobart CBD	10/07/2005	2.3 tonnes	28 tonnes
North Hobart	7/10/2007	1.9 tonnes	22 tonnes*

* Smaller data set (under 12 months) results extrapolated over a year

Litter traps represent one of the most effective stormwater treatment methods available, providing a pollution removal system that can be retrofitted into the existing drainage system, can treat a large decentralised catchment area and provide a high level treatment to comparative stormwater treatment systems. Their maintenance utilises existing Council equipment (inductor trucks) and their associated cleaning and disposal costs are significantly less than other stormwater treatment systems, however, these litter traps require more frequent cleaning.

It is noted however that this method requires extensive and ongoing operational costs. It is therefore considered that an in-line treatment method may capture more pollutants and be more cost-effective. This will be investigated in the future.

ACTION: Review effectiveness of entry pit traps.

8.8 Gross Pollutant Traps

High-density areas within an urban catchment generate high quantities of litter, sediment, heavy metals and hydrocarbons. In Hobart, a pedestrian mall, bus mall, public hospital, large public buildings and an array of shops comprise Hobart's CBD making it a high priority in terms of stormwater management. The BIEC National Litter Behaviour Study (1997) found that malls, shops and parks are areas where people most commonly littered. The most frequently found items were cigarette butts (67% for shops, 69% for malls and public buildings), beverage containers (4% for shops, 5% for malls and public buildings) and paper products (8% for shops, 4% for malls and public buildings). Similarly, Hobart City Council's investigations into litter in the Hobart Docks and Salamanca Project (Enviropod 2002) found that cigarette butts, beverage containers and paper products comprised the majority of litter items collected.

In Hobart City high-density litter areas include the Elizabeth Street bus mall, pedestrian mall, Collins Street, Liverpool Street and Macquarie Street. Under the *Hobart City Clean Stormwater Practices* Project (2003) it was proposed that a gross pollutant trap (GPT) be installed in-line (within the stormwater pipe) to capture and retain all gross litter and sediment generated from a major hotspot area within the city.

A GPT is designed to capture pollutants down to 3mm in size or sometimes smaller. The principal concept behind GPT's is that water borne pollutants flow into the GPT via the stormwater system. The GPT then captures and retains all litter while allowing stormwater to continue to flow through the remainder of the stormwater system to its exit point. The GPT is then cleaned out on a regular basis (the interval frequency of maintenance will vary for individual systems) and all litter and sediment is disposed of. Ultimately, the installation of a GPT in-line is an effective way in reducing large quantities of litter entering local waterways and causing environmental harm. The cost of installing these large systems is dependent on site location, manufacturer and type of GPT being used.

There is a range of GPT's available on the market that could be used in high-density urban catchments to capture litter and other water borne pollutants.

Hobart City Council has installed a GPT (Ecosol RSF 4000) in-line at Market Place (Image 10). The installation of this device allows for the capture of all solid pollutants, free oils, and fine sediments from Collins Street, a major litter hotspot and located within the city centre.

Image 10: Installation of the GPT at Market Place
[Source: Hobart City Council]

Following monitoring to assess its working performance, an appropriate maintenance regime for the in-line device was determined, with maintenance of the device to be undertaken every 3-4 months due to high litter loads in the area.

Hobart City Council has also installed a floating gross pollutant trap – a Bandalong Floating Litter Trap was installed in the Hobart Rivulet. This is a large floating device that has been installed at the Hobart Rivulet outfall at Macquarie Point and is the last site before the Rivulet enters the Derwent Estuary. This is an ideal location for such a stormwater pollution control device as it allows

treatment of stormwater from the lower portion of the urban catchment, inaccessible because of underground sections and also prevents gross litter and debris contaminants escaping into the Derwent Estuary. The gross litter and debris is directed via collection booms through a one way flap or gate, capturing and retaining the litter. Once inside the trap, the litter cannot be dislodged. Retained litter is removed via using a small crane with the litter basket being lifted out of the trap with litter and debris emptied into a truck and the empty basket returned back to the trap.

Image 11: Floating litter trap, Hobart Rivulet, Macquarie Point
[Source: Hobart City Council]

During and after heavy rainfall periods, much of the litter polluting Hobart Rivulet is pushed through the stormwater system and into the Derwent Estuary. On many of these occasions, large quantities of litter have been observed flushing out of the Hobart Rivulet outfall.

The floating litter trap can collect and retain large volumes of litter ensuring that the concentration of pollutants entering the Derwent Estuary will be significantly diminished. A reduction in litter pollution discharged from mainly the urbanised lower catchment area of the Hobart Rivulet ensures a healthier and cleaner estuarine environmental for marine life in the Derwent Estuary.

The trap has captured significant volumes of litter and debris that would have otherwise polluted the receiving waterways of the Derwent Estuary.

8.9 Water Sensitive Urban Design (WSUD)

WSUD is increasingly being seen as the best solution to urban stormwater pollution and urban stormwater volume-related problems.

WSUD incorporates water management features into the urban landscape and has multiple environmental and aesthetic benefits, such as:

- reducing stormwater flows and pollutant loads – thereby protecting downstream waterways – by collection and treating stormwater in wetlands, ponds, bioretention swales or grass swales;
- conserving potable water by collecting roof runoff and stormwater in rainwater tanks or underground storage for reuse in gardens and toilet flushing;
- minimising impervious surfaces by use of porous pavements (eg for carparks, roads and driveways) and minimising housing footprints;
- providing public open spaces for stormwater treatment (eg wetlands), recreation and visual amenity (which also increases land values).

WSUD applies to both urban and rural developments and can either be retrofitted into existing urbanised catchments or incorporated at the design stage of new developments (DEP, 2006).

Hobart City Council encourages all new developments or redevelopments of any scale to investigate the potential for incorporating WSUD techniques during their design phase. Council refers developers to the Derwent Estuary Program's Water Sensitive Urban Design Engineering Procedures for Stormwater Management in Southern Tasmania document and Council's Water Sensitive Urban Design Site Development Guidelines and Practice Notes document. Both of these documents are used as guideline documents in an attempt to guide local developers and designers in how they may better mange urban water at a site scale.

ACTION: Assist in the development of guidelines for Council's Development and Environmental Services Division on appropriate stormwater treatment system requirements for private developments through the planning process.

ACTION: Continue to encourage developers to utilise WSUD techniques where possible.

ACTION: Continue to promote the Derwent Estuary Program's *Water Sensitive Urban Design Engineering Procedures for Stormwater Management in Southern Tasmania* document and Council's *Water Sensitive Urban Design Site Development Guidelines and Practice Notes* document.

ACTION: Undertake a trial of rain gardens (WSUD) for street trees located within the CBD streetscape.

8.10 Stormwater harvesting and reuse

Each time it rains, water runs into roof gutters then enters the Council's stormwater system and ultimately, flows into the River Derwent.

A considerable amount of this water could be captured and stored, then used for other purposes. Stormwater harvesting would provide significant stormwater retention that:

- reduces runoff and downstream flooding;
- assists in reducting the quantity of stormwater through Council's infrastructure;
- value-adds stormwater as a resource supporting integrated water management;
- reduces the amount of treated water being used for purposes other than drinking;
- reduces the demand (and costs) for potable water supplies; and
- reduces the transfer of stormwater pollutants into the Derwent.

As such, stormwater collection, storage and re-use is of considerable benefit to the community. The reuse of stormwater can be undertaken on a number of different scales.

8.10.1 Infrastructure

Stormwater harvesting should be considered as an alternative strategy to upgrading stormwater infrastructure that has (or approaching) its design capacity for storm drainage standards. Stormwater harvesting may be a more cost-effective and environmentally sensitive approach than large public works projects to upgrade the stormwater system (DEP, 2009).

8.10.2 Residential

On a residential scale, there are many ways roof water could be reused on residential properties, including: watering the garden; washing the car; in the laundry; bathroom or toilet; as additional fire protection.

8.10.3 Public Open Space

Public open space and garden irrigation using drinking water supplies will be more closely scrutinised in the future. Stormwater is increasingly being viewed as a source for irrigation. With the scarcity and cost of water increasing, there is an increasing pressure on public open space managers to ensure that water used for irrigation is not wasted; that it is used in a sustainable and responsible manner; and to secure alternative water supplies such as stormwater.

ACTION: Review opportunities for stormwater harvesting within the Hobart Rivulet catchment.

ACTION: Review Council's policy on rainwater tank plumbing application processes.

ACTION: Liaise with Council's Open Space Group to assist in the identification of appropriate Council open space areas for stormwater harvesting and reuse.

8.11 Pollutant Hotspots within Hobart Catchment

There are many hotspot areas for pollution in the Hobart Rivulet. Five (5) major hotspot areas will be discussed in this section. These areas have been isolated as a result of water quality testing over several years.

The hotspot areas include:

(i) McRobies Gully Landfill (Waste Management Centre);
(ii) Strickland Avenue in South Hobart;
(iii) Sections of the rivulet where septic run-off is a consistent problem;
(iv) Uncontrolled soil and water runoff from building and construction sites.

These areas and the stormwater problems associated with them are discussed in the following sections.

8.11.1 McRobies Gully Landfill (Waste Management Centre)

The detection of stormwater pollutants from the McRobies Gully Site has been highlighted in section 8.4.2. The site remains a critical hotspot area due to its close proximity to the Hobart Rivulet (Figure 7). Contamination of groundwater from the site is also a critical management issue.

Figure 7: Location of the McRobies Gully Refuse Disposal Site & Hobart Rivulet
[Source: Ezzy, 2002]

A hydro-geological investigation into the effects of waste disposal on groundwater was conducted by Mineral Resources Tasmania in 2002 (Ezzy 2002). This investigation included the testing of 14 groundwater bores within or adjacent to the landfill. A chemical analysis on the groundwater revealed that there were only minor effects on groundwater at the McRobies Gully Site. However, a localised impact of high nitrate concentrations was observed in groundwater adjacent to the western gully of the landfill (Ezzy 2002). The report highlights that surface water inflows to the landfill area are critical in the management of the site.

While dry weather flows are diverted to sewer, in significant rain events excess diluted leachate is discharged to the Hobart Rivulet. Discharges into the rivulet may vary in water quality and flow rate based on the hydraulic conditions at the site at the time of rain (Ezzy 2002). Other inputs include run off from surrounding roads, pavements and houses. Often during high flow rates, discolouration and foaming effects are seen at the discharge point into the Hobart Rivulet during significant rain events.

Image 12: Outpour into the Hobart Rivulet from McRobies Gully including the litter sock [Source: Hobart City Council]

Previous investigations into the urban stormwater quality in Hobart (Jenkins 1991) revealed that the McRobies Gully disposal area was found to be a source of nutrients and dissolved solids in the runoff from the Hobart catchment. Extremely high suspended solid levels were also found in storm event run-off from this site (Jenkins 1991). Jenkins (1991) states, there was enough evidence to suggest significant leaching of nutrients and dissolved solids out of the disposal area that was polluting the Hobart Rivulet.

As mentioned in section 8.4.2, extensive works have recently been undertaken to reduce the frequency and volume of discharges flowing from the McRobies Gully catchment.

Currently at the McRobies Gully outlet into Hobart Rivulet, a litter sock is present to capture any gross pollutants from entering the waterways. This litter sock is simply a net attached to the outlet and is inspected frequently, including after heavy rainfall events.

To avoid further leachate contamination in Hobart Rivulet, the following changes have been made or are near completion at the McRobies Gully Site.

- Diversion of McRobies Gully Rivulet around the landfill will reduce the volume of leachate contaminated overflows by greater than 95%.
- Installation of an additional trash rack on the diversion drain prior to entry into the leachate pond.
- To better monitor the incidence of the leachate pond overflows to stormwater, telemetry and monitoring system has been installed.
- All flows from the leachate pond will be diverted to sewer. A level monitoring system is installed in the leachate pond to indicate overflows.
- All systems, whether sewer or stormwater is installed with flow measurement equipment.
- Additional monitoring of the leachate collection system includes an ultrasonic flow-metering instrument on the 1500 mm pipe directly below the leachate pond.

ACTION: Undertake an assessment of the effectiveness (water quality and gross pollutants) of the McRobies Gully diversion drain once construction has been finalised.

ACTION: Investigate alternative gross pollutant trap options for the McRobies Gully outfall.

ACTION: Investigate the use of automatic samplers for the assessment of the performance of the system (following recent changes) and stormwater flows into the Hobart Rivulet from McRobies Gully.

8.11.2 Strickland Avenue

Strickland Avenue is located in South Hobart and is a road that winds its way up in altitude towards the mountain suburb of Fern Tree (Figure 8). Over the length of Strickland Avenue, there exist old residences mixed with new housing developments. As a result, there are also a variety of land uses within the area. For example, some residences have enough surrounding land to support livestock. The livestock have access to sections of the Hobart Rivulet for water. The presence of livestock in close proximity to the rivulet can cause numerous problems. These are:

- Livestock defecating near or in the rivulet pollutes the rivulet and reduces water quality.
- Livestock using the rivulet for water can lead to stream bank erosion and compaction of surrounding soils.

- Livestock can trample or eat native vegetation that exists in the riparian zone and thus affects long-term water quality and sustainability.

Figure 8: Aerial photo showing Strickland Avenue, South Hobart
[Source: Hobart City Council]

Other problems include septic tank run-off into the upper reaches of Hobart Rivulet from properties further up the catchment. Agricultural practices are also cause for concern where run-off from surrounding pastures/land enters the Hobart Rivulet. General catchment hygiene is a major issue in this part of the catchment.

8.11.3 Septic Tank Run-off

In the upper reaches of the Hobart Rivulet catchment there are several residences and larger properties that are not connected to the city's sewer system. These properties use septic tanks as their only source of sewerage treatment and storage, and therefore are considered a potential contamination risk to the Hobart Rivulet. There may also be many properties that have old and disused septic tanks. While these are inactive, they may also be a point source of pollution if located nearby the Hobart Rivulet or connecting tributary.

The septic tank areas in Hobart are primarily located in Ridgeway and Fern Tree with some pockets in South Hobart, Mt Nelson and Lenah Valley. Hobart City Council investigates specific complaints relating to alleged septic tank run-off. If defective septic tank systems are isolated, it is the responsibility of landowners to fix the problem immediately.

It is advisable that for the long-term management of septic tanks and associated run-off, that a management regime is devised and administered through council. This may be in the form of short surveys sent to all homeowners with septic tanks and routine inspections by council staff. This would

ensure that any failing systems are identified in the early stages and furthermore minimising any long-term environmental damage to the rivulet habitat.

ACTION: Provide support to Council's EHO'S to improve onsite waste treatment management and /or remediation in problem sites, particularly in those sites in close proximity to the Hobart Rivulet (inspections/surveys/monitoring).

8.11.4 Uncontrolled soil and water runoff from building and construction sites

Sediment generated from soil erosion on building and construction sites can be a major source of pollution to local waterways. Any sediment that moves off-site typically enters stormwater drains, clogging the stormwater system and transporting attached pollutants including oils, heavy metals and hydrocarbons into local waterways. Excessive sediment that enters our waterways can kill fish and aquatic plants, silt up streams, and block stormwater pipes, which can lead to increased flooding (DEP, 2009).

The building and construction industry is responsible for soil and water management throughout all phases of a development. The Derwent Estuary Program and NRM South, with the support of local Councils, have developed a series of fact sheets aimed for use by builders and construction crews. These facts sheets are collated as a package in the Soil and Water Management on Building and Construction Sites (DEP/NRM South, 2009) folder. The fact sheets arm to provide practical measures to prevent pollution from building and construction sites. The implementation of an approved Soil and Water Management Plan is usually required as a condition of planning permits for developments requiring significant earthworks or in sensitive locations.

The Fact Sheets in the Soil and Water Management guidelines aim to assist builders and construction crews to minimise erosion and control sediment run-off from site, as well as providing other benefits including:

- greater compliance with the appropriate regulations including state environmental laws, thereby reducing the risk of fines and other penalties;
- improved wet weather working conditions, reduced downtime and earlier building completion;
- fewer public complaints and a better public image for your business;
- reduced stockpile losses and clean up costs;
- healthier waterways and a cleaner environment for everyone (DEP/NRM South, 2009).

The Soil and Water Management on Building and Construction Sites Fact Sheets are downloadable via the Derwent Estuary Program's website (www.derwentestuary.org.au).

ACTION: Continue to undertake compliance monitoring of stormwater related development conditions.

ACTION: Provide advice and further educational material for builders operating within the Municipality regard stormwater management and erosion and sediment control as well as legislative requirements, including the dissemination of the State Government's *Soil and Water Management on Building & Construction Sites* (DPIPWE, 2009) fact sheets to builders and private building certifiers operating within the Municipality.

ACTION: Develop and promote information on required compliance for soil and water management on building and construction sites within the Municipality through HCC website and other media.

ACTION: Undertake erosion and sediment control works on Council construction and maintenance sites internally through an appropriate site specific Soil and Water Management Plan.

ACTION: Continue to provide new Council staff (where appropriate) with environmental and stormwater education during the induction process and/or completion of a Soil and Water Management Plan and/or Job Safety and Environmental Analysis for each site.

ACTION: Provide detailed soil and water management details for Council design by:

- Developing a generic detailed Soil and Water Management Plan;
- Ensuring that a more site specific plan is developed from the generic plan for certain works, and providing subsequent detailed erosion control measures;
- Ensure that all issues regarding the implementation of SWMP's are adequately addressed at joint design/works meetings prior to works starting.

9. Development within the Catchment

Approximately 45% of the Hobart Rivulet catchment has already been developed, with uses including residential, commercial and recreational. The majority of this development as occurred in the lower and mid sections of the catchment.

The other section of the catchment is bushlands, much of which is publicly owned, either by Hobart City Council or bushland located in Wellington Park, which is protected by the *Wellington Park Act 1993* and managed by the Wellington Park Management Trust and Hobart City Council.

Current land use zones in the Hobart Rivulet catchment at time of publication (based on the City of Hobart Planning Scheme 1982) are:

- Bushland 53%
- Residential 37%
- Commercial 6%
- Recreation 3%

Map 4 illustrates the current land uses within the Hobart Rivulet catchment. These land uses have been derived from the current land use zones based on the City of Hobart Planning Scheme 1982. Please note that the "Special Use" marked on this map refers to Cascade Brewery Company Ltd land that currently permits development of land for light industry; warehouse; saleyard; transport depot, timber yard; or passive recreation, with discretionary use permitted for other development, including residential, commercial and shop development.

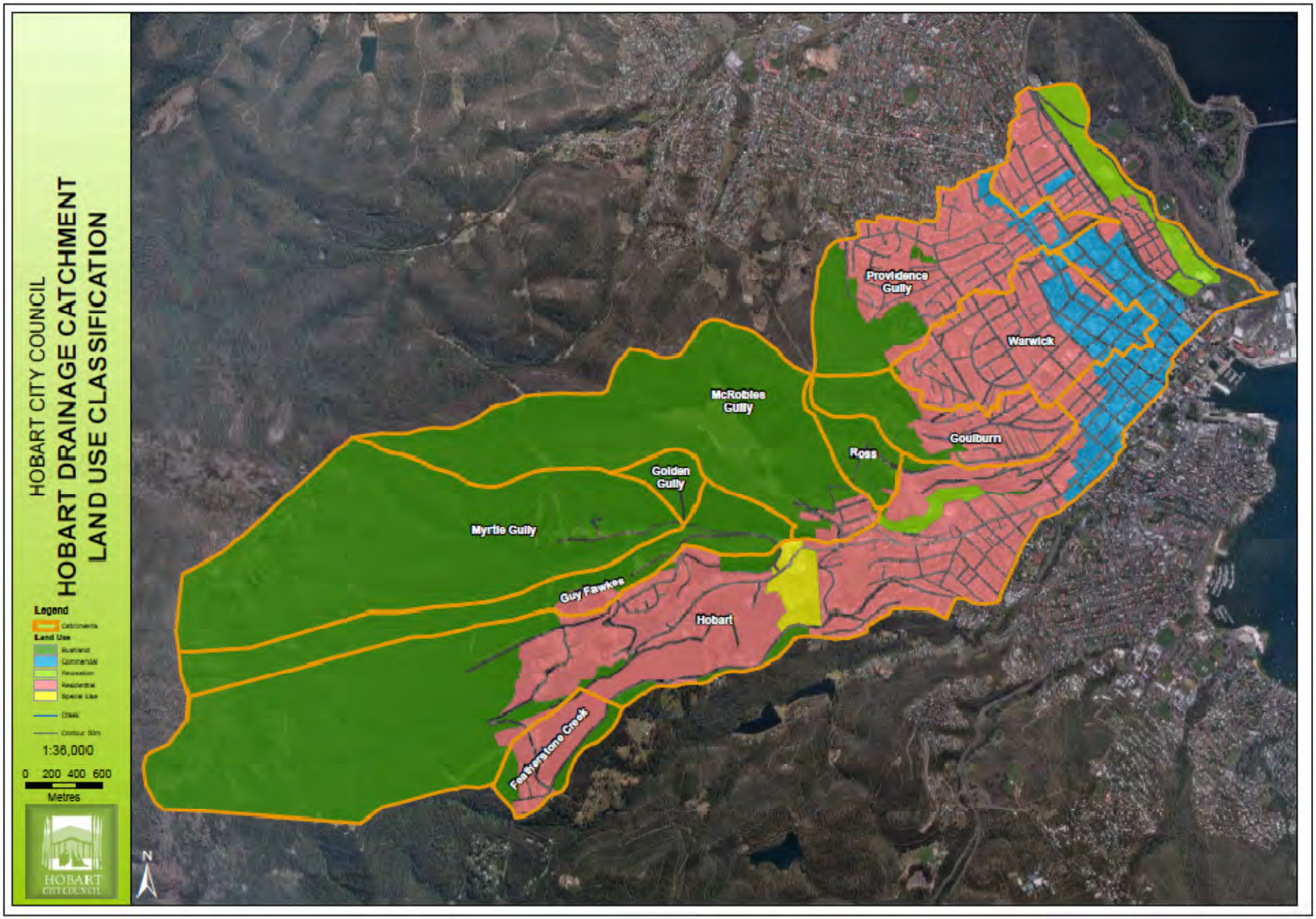
Whilst most of the development has occurred in the lower catchment, development is increasing in the mid to upper reaches of the catchment, however some areas are restricted due to planning restrictions under the current City of Hobart Planning Scheme 1982.

The current residential land use component within this catchment does not include residential lots that could be further developed with the subdivision and creation of one additional lot – often by splitting the existing house block into two.

Besides these one lot subdivisions or smaller multi-lot subdivisions, there is limited land within the catchment that is available for further large-scale development.

Council's City of Hobart Planning Scheme 1982 and the Battery Point Planning Scheme 1979 provide information in regard to land use planning zones. Land use zoning helps to guide both Council and developers on what is appropriate land uses and development activities in different regions of a catchment. Land use zoning and development controls may therefore be an important means of managing stormwater in the Hobart Rivulet catchment (DPIWE, 2005).

Hobart City Council's planning approval process regulates the use and development of land by assessing proposals against Council's Planning Schemes and the State's planning legislation. It particularly examines the impact of the proposed development or use on the surrounding area.



Map 4: Land Use Areas within Hobart Rivulet Catchment

9.1 Planning

Planning is vital for the orderly development of housing, business and community services into areas best suited for them. It involves both control of existing and new development, and 'strategic planning' to ensure our resources are carefully managed to match our future needs. Planning is a dynamic process that is constantly evolving in response to changes in community expectations.

Planning requirements placed equitably on all future developments represent one of the most effective means of achieving a satisfactory standard of water quality within the waterways of the Hobart Rivulet catchment.

In the past, as with many planning schemes throughout Tasmania, the City of Hobart Planning Scheme 1982 has not provided the tools to ensure a high standard of stormwater management in new developments. It is envisaged that with the introduction of a new planning scheme, such tools will be included, including sections relating to stormwater and water quality management and flood an storm surge.

A draft of a proposed new planning scheme for Hobart was released by the Council for community consultation on 29 June 2009 with the closing date for comments and submissions being 22 September 2009. The scheme (if approved) would replace the current City of Hobart Planning Scheme 1982 and the Battery Point Planning Scheme 1979. Council is currently reviewing the draft in the light of the submissions received and will make revisions it considers desirable. The draft Scheme includes specific schedules relevant to the management of stormwater and water quality including a water quality schedule, waterways schedule, storm/surge flood prone land schedule and an estuarine schedule.

However, finalisation of a new draft scheme has been complicated by the Southern Tasmania Regional Planning Project and the development of State-wide planning codes by the Tasmanian Planning Commission. The Regional Planning Project will lead to the mandatory replacement of current planning schemes with new interim planning scheme based on a regional land use planning strategy. It is anticipated that the proposed new interim planning schemes will be adopted in late 2011.

A number of new planning scheme codes will also be mandatory for all existing and new planning schemes through the Tasmanian Planning Commission planning directive process. Planning scheme codes are parts of a planning scheme containing provisions relevant to a specific issue (e.g. heritage, landslip and biodiversity) that are not zone specific. A water quality/stormwater code has been proposed however it is not clear at this time whether the code would be introduced State-wide through a planning directive or at a regional level via the interim planning schemes.

Until a new planning scheme is adopted with specific provisions for managing stormwater and waterways, development applications will continue to be assessed and conditioned as deemed appropriate by Council staff with reference to the general provisions of Part A of the Scheme. Such conditions and advice include:

- Where a development would involve significant earthworks' or would occur in a sensitive location (i.e. adjacent a waterway):
  Requirement to submit a Soil and Water Management Plan detailing proposed sediment and erosion control measures, to avoid the pollution and sedimentation of roads, drains and

natural watercourses that could be caused by erosion and runoff from the development and to comply with relevant State legislation condition.

- If planning exempt or the development's disturbed area is small and in a non-sensitive location:
  Soil and water management measures should be implemented on the site prior to commencement of works to prevent pollutants from entering waterways or the stormwater system advice.
- Developments that include significant areas of impervious surfaces that warrant stormwater treatment (i.e. developments with 6+ car spaces):
  Stormwater pre- treatment for stormwater discharges from the new car-parking/hardstand areas is to be installed. Details of the proposed treatment, including estimations of contaminant removal, must be included. A maintenance plan for the proposed treatment train must also be submitted. Suitable access to the treatment train must be provided.
- Works near Rivulets/Watercourses
  To ensure the protection of the riparian zone of the rivulet/watercourse and prevent potential flood water impediment. Not without the written consent of the Hobart City Council to erect or permit to be erected any building or structure or carry out any landscaping that may change the contours of the land or restrict the free flow of water over the land or cause erosion within 10 (ten) metres from the top of the watercourse embankment of (insert name of rivulet).

The State Stormwater Strategy (DPIPWE, 2010) states that:

> New developments should be designed to minimise impacts on stormwater quality and, where necessary, downstream flooding or flow regimes. Stormwater should be managed and treated at source using best management design practices (eg Water Sensitive Urban Design) to achieve the following stormwater management targets:
>
> - 80 per cent reduction in the annual average load of total suspended solids
> - 45 per cent reduction in the annual average load of total phosphorus
> - 45 per cent reduction in the annual average load of total nitrogen

Whilst these targets are considered current best practice, there are simply recommendations and not currently legislated.

In all cases, reference is made to the *Soil and Water Management on Building and Construction Sites* fact sheets and Hobart City Council's *Water Sensitive Urban Design Site Development Guidelines and Practice Notes* where applicable.

Often advice is provided on Permits including information in regard to the current best practice for stormwater treatment - an 80% removal of total suspended solids, a 45% removal of total nitrogen, and a 45% removal of total phosphorous.

ACTION: Condition Planning Permits as appropriate regarding stormwater treatment, with reference to the State Government's *State Stormwater Strategy* (DPIPWE, 2010).

ACTION: Encourage further cooperation with developers regarding best stormwater management practices by: providing educational material and advice for developers and contractors operating in the municipality regarding stormwater management and erosion and sediment control as well as legislative requirements; and promoting the *State Stormwater Strategy* (DPIPWE, 2010) and the *Soil and Water Management on Building & Construction Sites* (DPIPWE, 2009).

ACTION: Create a Council Policy in regards to the current best practice of stormwater management targets (80% reduction in TSS, 45% reduction in TP, 45% reduction in TN).

ACTION: Incorporate requirements of the *State Stormwater Strategy* (DPIPWE, 2010) into Council's new Planning Scheme.

ACTION: Assist in the development of guidelines for Council's Development and Environmental Services Division on appropriate stormwater treatment system requirements for private developments through the planning process.

10. Community Involvement

The long-term involvement of the community in aspects of the Hobart Rivulet is a key objective in managing a natural resource and fostering the development of a relationship between the catchment manager (Council) and the catchment users (community).

The community can be described as individuals whom reside within the catchment, volunteer interest groups and users of the catchment area. The community may utilised and value a Rivulet and its surrounding catchment through a number of ways, including aesthetics, recreation, education, history, culture, flora and fauna.

To assist in developing and a maintaining strong community network within the Hobart Rivulet catchment, the Hobart City Council utilises its Adopt-A-Waterway program.

The Adopt-A-Waterway program is an initiative of the Hobart City Council, and is applicable to those rivulets and waterways within the Hobart City region that come under the Council's jurisdiction. The program aims to include the local community in the care and maintenance of rivulets and waterways around Hobart.

The purpose of the Adopt-A-Waterway program is threefold. The first is to increase awareness among the community as to the state of the local waterways. By being active in the Adopt-A-Waterway program, the Council hopes to encourage the local community to be willingly responsible for the state of their local environment.

The second is to create an active partnership between the Council and the local community. Through the program the Council and the community will together be involved in preserving Hobart's environmental assets in making improvements to the water quality and aesthetics.

The third is to keep the Council actively aware of any problems occurring along its rivulets and waterways, making it easier for the Council to fix the problem in the shortest time possible. Incidents can be reported immediately, making it easier for the Council to assess the severity of the problem and ensuring that the right solution is implemented.

Participating in the Adopt-A-Waterway program presents many benefits for the community and the Council. It gives the participants the enjoyment and relaxation that comes from working in an outdoor environment, as well as a sense of achievement for having performed a service to the community.

The benefits for the Council include the close ties created between the Council and the community, as well as a structured program to keep the rivulets and waterways of Hobart clean.

Any community group and organisation can participate in the Adopt-A-Waterway program. These include:

- schools,
- community groups,
- Landcare, Coastcare, Bushcare & Waterwatch Groups,
- businesses, and
- Local Government Organisations.

Where possible, the Council will encourage groups & organisations to adopt a waterway that is located in their area. In cases where local support is high, individual residents will be encouraged to join the program in their neighbourhood.

The Adopt-A-Waterway program is also utilised to provide suitable native plants to those residents residing adjacent to the Hobart Rivulet and associated tributaries. This assists the catchment in providing suitable plant varieties for the area, providing bank stabilisation, erosion control, native wildlife corridor and aesthetic benefits in the area.

Overall the program is an initiative of Council to increase community awareness and appreciation of the waterways and foreshore areas.

ACTION: Continue to promote the Adopt-A-Waterway program.

11. Summary

The management objectives and actions that have been outlined in this Catchment Management Plan aim to achieve improved water quality and long-term sustainability for the Hobart Rivulet.

Implementation of the actions outlined in this Catchment Management Plan has already commenced and will continue to occur over the next few years. To ensure the success of these management actions, it is necessary for the Council to promote and encourage the community and developers to take on an active role in the maintenance and rehabilitation of their own backyards and development lots.

The Hobart City Council will be responsible for locating and controlling point sources of pollution within Hobart Rivulet. There are continuing investigations into illegal stormwater discharges that are contribution to pollution within the Rivulet. Measures will be taken to ensure that adequate stormwater treatment devices are installed or alternative methods are adopted to minimise stormwater pollution. It is envisaged that the majority of works remaining will involve riparian zone rehabilitation, water quality monitoring and weed removal from the banks of the Rivulet. Much of this work will be achieve through normal rivulet maintenance and consultation with Council's Open Space Group and interested community members who may become actively involved in the rivulets rehabilitation and sustainable management.

This Catchment Management Plan has been written for the Hobart Rivulet catchment to the present time and provides management actions that will have significant impact on the environmental problems that currently exist. Over time, circumstances may change, and therefore priorities for management within the Hobart Rivulet catchment may also change. Thus, this management plan should be referred to as a guide for action and will need to be modified as the need arises. As such it is envisaged to review this Hobart Rivulet Catchment Management Plan in 5 years time.

ACTION: Review Catchment Management Plan.

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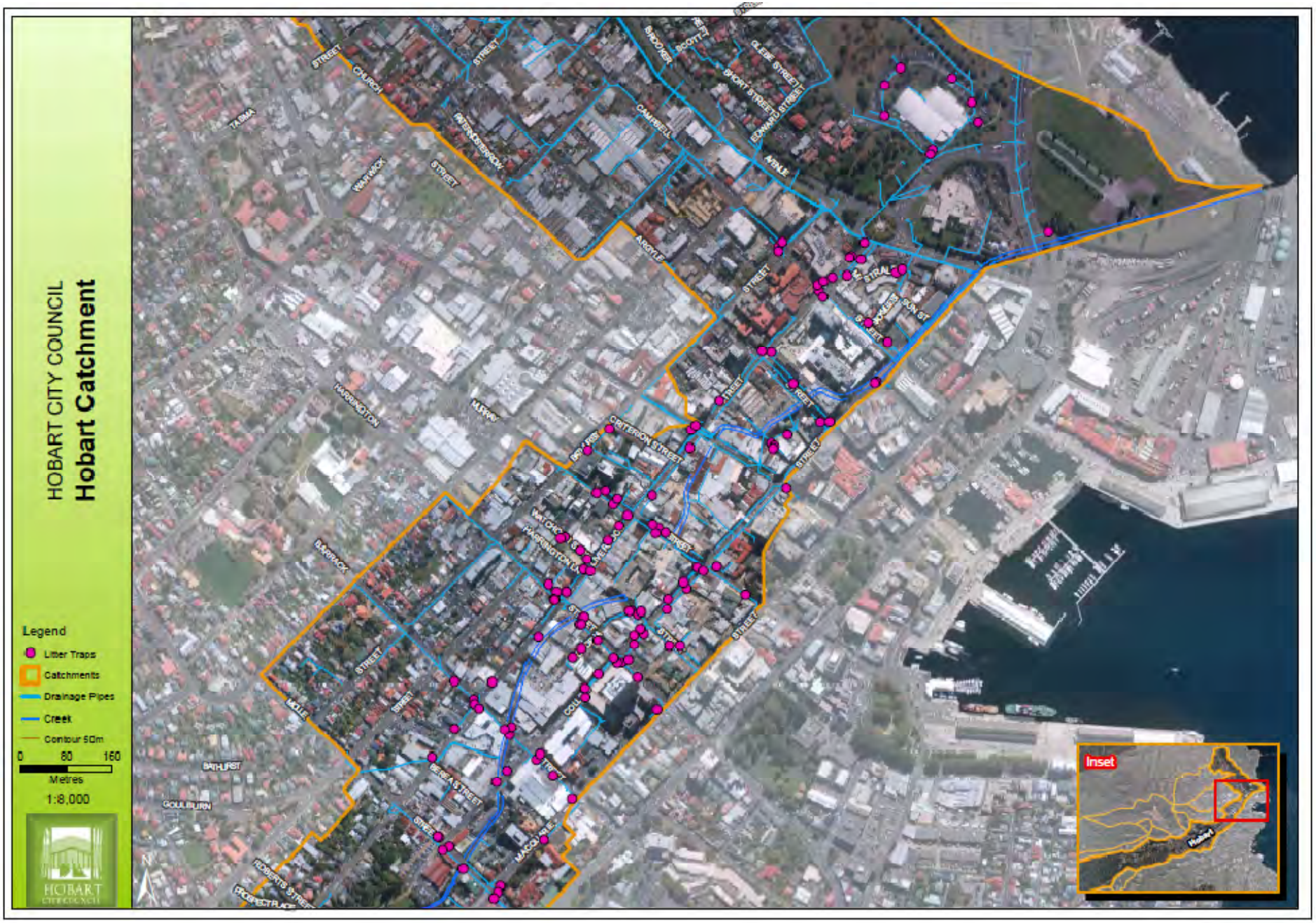
APPENDIX A

Maps of sub-catchments

Map 4: Hobart sub-catchment (1 of 5)



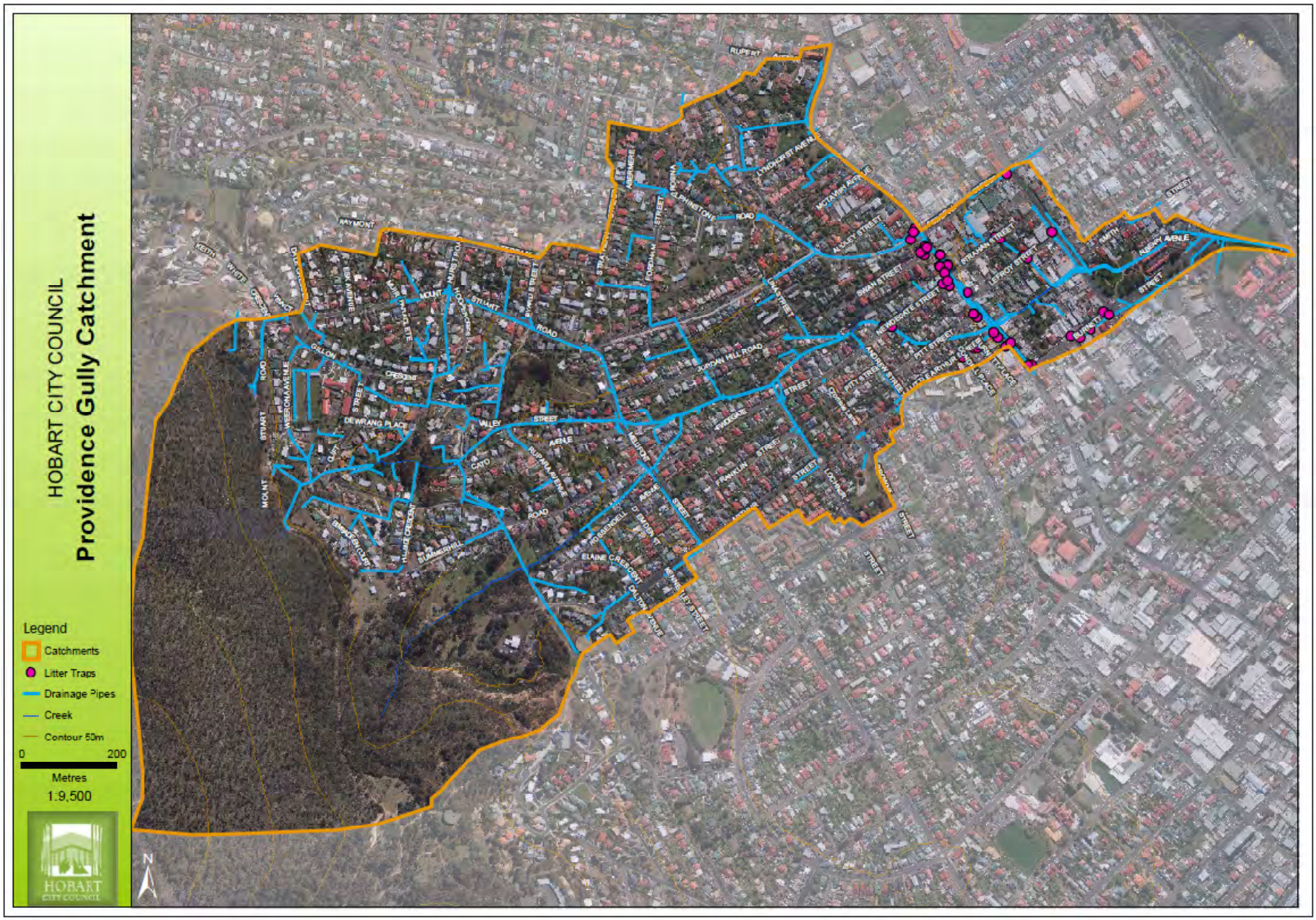
Map 5: Hobart sub-catchment (2 of 5)

Map 6: Hobart sub-catchment (3 of 5)

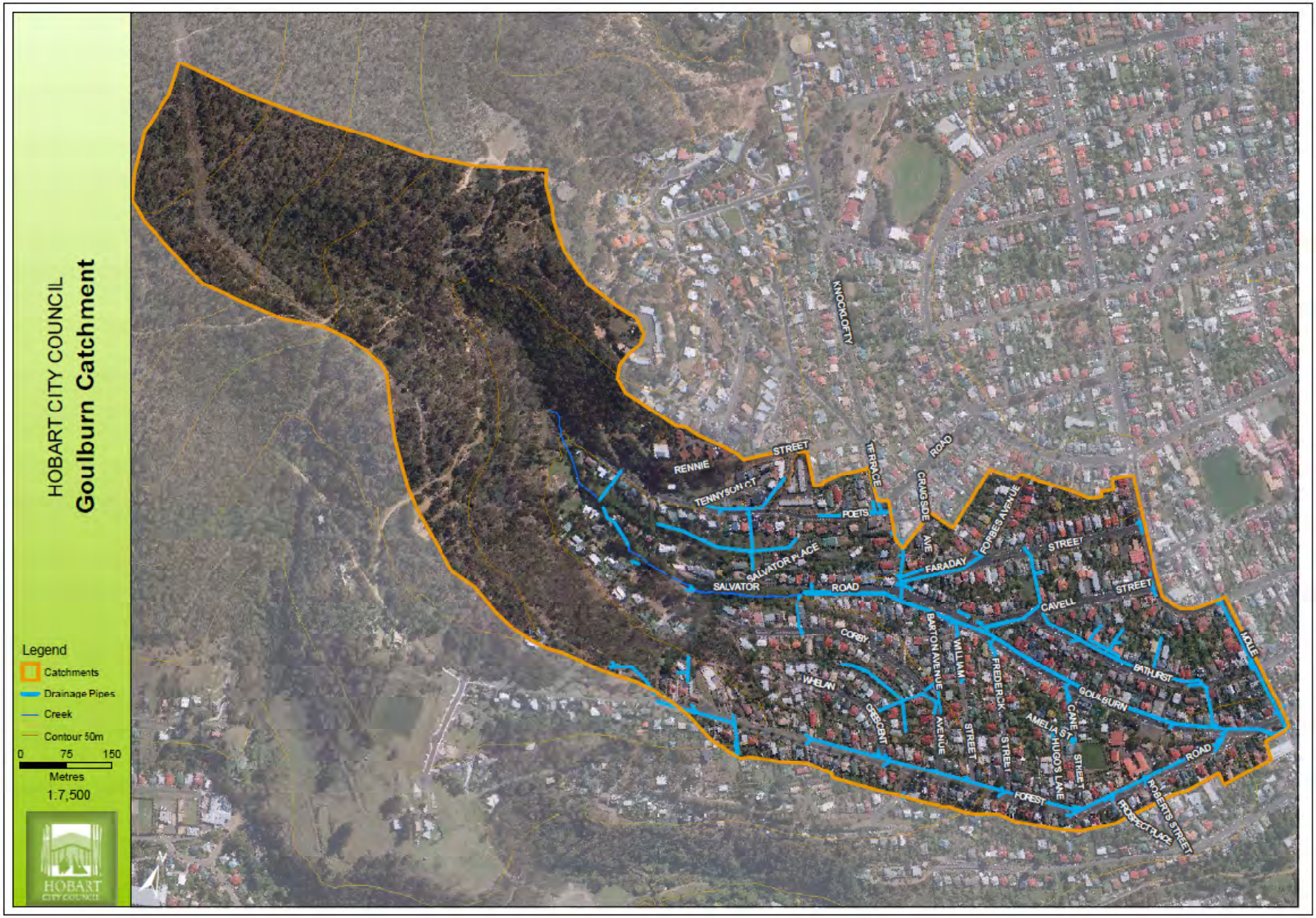
Map 7: Hobart sub-catchment (4 of 5)

Map 8: Hobart sub-catchment (5 of 5)

Map 9: Warwick sub-catchment



Map 10: Providence Gully sub-catchment



Map 11: Goulburn sub-catchment

Map 12: Ross sub-catchment

Map 13: McRobies Gully sub-catchment

Map 14: Golden Gully sub-catchment

Map 15: Guy Fawkes sub-catchment

Map 16: Myrtle Gully sub-catchment

Map 17: Featherstone Creek Gully sub-catchment

APPENDIX B

Summary of Actions - Ongoing:

SECTION	ACTION	TIMING
5.6	Continue involvement with the STCA's Regional Councils Climate Adaptation Project.	Ongoing
6	Work with Council's Parks area in regard to incorporating environmental values into Open Space planning adjacent to the Rivulet.	Ongoing
6	Investigate funding options to target priority weeds through the catchment, including new and emerging species.	Ongoing
8.4.3	Continue Council's involvement with the Derwent Estuary Program.	Ongoing
8.4.3	Participate in and support the Derwent Estuary Program's Stormwater Taskforce.	Ongoing
8.5	Continue to investigate alternative options for funding of stormwater quality improvement devices within the catchment.	Ongoing
8.5	Ensure that existing maintenance staff are consulted during the selection of stormwater quality improvement devices, eg GPT's.	Ongoing
8.9	Continue to encourage developers to utilise WSUD techniques where possible.	Ongoing
8.9	Continue to promote the Derwent Estuary Program's *Water Sensitive Urban Design Engineering Procedures for Stormwater Management in Southern Tasmania* document and Council's *Water Sensitive Urban Design Site Development Guidelines and Practice Notes* document.	Ongoing
8.11.4	Continue to undertake compliance monitoring of stormwater related development conditions.	Ongoing
8.11.4	Provide advice and further educational material for builders operating within the Municipality regard stormwater management and erosion and sediment control as well as legislative requirements, including the dissemination of the State Government's *Soil and Water Management on Building & Construction Sites* (DPIPWE, 2009) fact sheets to builders and private building certifiers operating within the Municipality.	Ongoing
8.11.4	Develop and promote information on required compliance for soil and water management on building and construction sites within the Municipality through HCC website and other media.	Ongoing
8.11.4	Undertake erosion and sediment control works on Council construction and maintenance sites internally through an appropriate site specific Soil and Water Management Plan.	Ongoing
8.11.4	Continue to provide new Council staff (where appropriate) with environmental and stormwater education during the induction process and/or completion of a Soil and Water Management Plan and/or Job Safety and Environmental Analysis for each site.	Ongoing
9.1	Condition Planning Permits as appropriate regarding stormwater treatment, with reference to the State Government's *State Stormwater Strategy* (DPIPWE, 2010).	Ongoing

Summary of Actions – Ongoing (continued):

SECTION	ACTION	TIMING
9.1	Encourage further cooperation with developers regarding best stormwater management practices by: providing educational material and advice for developers and contractors operating in the municipality regarding stormwater management and erosion and sediment control as well as legislative requirements; and promoting the *State Stormwater Strategy* (DPIPWE, 2010) and the *Soil and Water Management on Building & Construction Sites* (DPIPWE, 2009).	Ongoing
10	Continue to promote the Adopt-A-Waterway program.	Ongoing

Summary of Actions – 2011/2012:

SECTION	ACTION	TIMING
5.4	Undertake an erosion condition assessment of the Hobart Rivulet catchment.	2011/2012
5.4	Provide erosion hazard mapping data onto the Hobart City Council website.	2011/2012
8.2	Develop a MUSIC model to assist in the concept location and sizing of stormwater quality improvement devices.	2011/2012
8.4.3	Review water quality monitoring program, including: ▪ location of monitoring sites; ▪ number of monitoring sites; ▪ event-based monitoring (ie during rainfall).	2011/2012
8.5	Develop a comprehensive maintenance schedule of stormwater quality improvement devices, including inspection and maintenance frequency, collection/storage requirements, clean-out procedures, design details and supplier contacts.	2011/2012
8.5	Identify current open sections, easement and stormwater quality improvement devices (including boulder traps and retention basins) so that formal internal maintenance/works manual and procedures can be developed in the future.	2011/2012
8.9 & 9.1	Assist in the development of guidelines for Council's Development and Environmental Services Division on appropriate stormwater treatment system requirements for private developments through the planning process.	2011/2012
8.11.1	Undertake an assessment of the effectiveness (water quality and gross pollutants) of the McRobies Gully diversion drain once construction has been finalised.	2011/2012
8.11.1	Investigate alternative gross pollutant trap options for the McRobies Gully outfall.	2011/2012
8.11.4	Provide detailed soil and water management details for Council works and design by: • Developing a generic detailed Soil and Water Management Plan; • Ensuring that a more site specific plan is developed from the generic plan for certain works, and providing subsequent detailed erosion control measures; • Ensure that all issues regarding the implementation of Soil and Water Management Plan's are adequately addressed at joint design/works meetings prior to works starting.	2011/2012

Summary of Actions – 2012/2013:

SECTION	ACTION	TIMING
6	Develop a vegetation (including weed survey) strategy for the catchment in collaboration with Council's Open Space Group (including the Bushland & Reserves Unit).	2012/2013
8.2	Use MUSIC model to assist in the identification and prioritisation of infrastructure upgrades.	2012/2013
8.5	Develop a list of prioritised existing stormwater "hot-spots" in the catchment, and provide recommendations for the retrofitting of stormwater quality improvement devices.	2012/2013
8.7	Review effectiveness of entry pit traps.	2012/2013
8.9	Undertake a trial of rain gardens (WSUD) for street trees located within the CBD streetscape.	2012/2013
8.10	Review opportunities for stormwater harvesting within the Hobart Rivulet catchment.	2012/2013
8.10	Review Council's policy on rainwater tank plumbing application processes.	2012/2013
8.10	Liaise with Council's Open Space Group to assist in the identification of appropriate Council open space areas for stormwater harvesting and reuse.	2012/2013
8.11.1	Investigate the use of automatic samplers for the assessment of the performance of the system (following recent changes) and stormwater flows into the Hobart Rivulet.	2012/2013
8.11.3	Provide support to Council's EHO's to improve onsite waste treatment management and /or remediation in problem sites, particularly in those sites in close proximity to the Hobart Rivulet (inspections/surveys/monitoring).	2012/2013
9.1	Create a Council Policy in regard to the current best practice of stormwater management targets (80% reduction in TSS, 45% reduction in TP, 45% reduction in TN).	2012/2013
9.1	Incorporate requirements of the *State Stormwater Strategy* (DPIPWE, 2010) into Council's new Planning Scheme.	2012/2013

Summary of Actions – 2015/2016:

SECTION	ACTION	TIMING
11	Review Catchment Management Plan.	2015/2016

APPENDIX C

List of Plant Species for the Hobart Rivulet Catchment

Dry Heathy *E.amygdalina* on sandstone	
Eucalyptus amygdalina	*Billardiera longiflora*
Eucalyptus obliqua	*Persoonia juniperina*
Bedfordia salicina	*Coprosma hirtella*
Brachyscome spathulata	*Opercularia varia*
Cassinia aculeata	*Exocarpus cupressiformis*
Craspedia glauca	*Veronica calycina*
Helichrysum scorpioides	*Stylidium graminifolium*
Olearia argophylla	*Pimelea linifolia*
Olearia stellulata	*Tetratheca labillardeieri*
Ozothamnus obcordatus	*Isolepis cernua*
Ozothamnus purparescens	*Lepidosperma laterale*
Senecio linearifolius	*Schoenus apogon*
Wahlenbergia gymnoclada	*Diplarrena moraea*
Wahlenbergia stricta	*Juncus bufonius*
Astroloma humifusum	*Juncus pallidus*
Epacris impressa	*Juncus planifolius*
Leucopogon ericoides	*Luzula flaccida*
Styphelia adscendens	*Comesperma volubile*
Amperea xiphoclada	*Banksia marginata*
Aotus ericoides	*Dianella breviculmis*
Daviesia ulicifolia	*Caladenia gracilis*
Dillwynia sericea	*Thelymitra rubra*
Oxylobium ellipticum	*Danthonia setacea*
Gonocarpus tetragynus	*Deyeuxia contracta*
Gonocarpus teucrioides	*Dichelachne rara*
Asterotrichion discolor	*Ehrhata stipoides*
Acacia melanoxylon	*Lomandra longifolia*
Leptospermum scoparium	

Dry Shrubby *E.obliqua* on sandstone	
Bedfordia salicina	*Pultanaea juniperina*
Helichrysum scorpioides	*Goodenia lanata*
Olearia stellulata	*Gonocarpus tetragynuc*
Olearia viscosa	*Gonocarpus teucrioides*
Ozothamnus obcordatus	*Cassytha pubescens*
Ozothamnus purparescens	*Acacia dealbata*
Senecio glomeratus	*Acacia verticillata var. vert.*
Senecio linearifolius	*Eucalyptus globulus spp. Globulus*
Senecio minimus	*Eucalyptus obliqua*
Allocasuarina littoralis	*Eucalyptus viminalis*
Astroloma humifusum	*Oxalis perennans*
Epacris impressa	*Bursaria spinosa*
Leucopogon virgatus	*Banksia marginata*
Sprengelia incarnata	*Lomatia tinctoria*
Amperea xiphoclada	*Coprosma quadrifida*
Aotus ericoides	*Exocarpus cupressiformis*
Daviesia ulicifolia	*Leptomeria drupacea*
Dilwynia sericea	*Stylidium graminifolium*
Oxylobium ellipticum	*Tetratheca labillardierei*
Pultanaea daphnoides var. obocordata	*Vioa hederacea*

***E.regnans* wet sclerophyll forest**	
Eucalyptus regnans	*Bedfordia salicina*
Acacia dealbata	*Polystichum proliferum*
Acacia melanoxylon	*Pteridium esculentum*
Pomaderris apetala	*Dicksonia antarctica*
Coprosma quadrifida	*Gahnia grandis*
Olearia argophylla	*Acaena novae-zelandiae*
Cassinia aculeata	

***E.globulus* wet sclerophyll forest**	
Eucalyptus globulus	*Cassinia aculeata*
Eucalyptus obliqua	*Olearia argophylla*
Acacia melanoxylon	*Pteridium esculentum*
Acacia dealbata	*Polystichum proliferum*
Acacia verticellata	*Gahnia grandis*
Coprosma quadrifida	*Dianella tasmanica*
Pomaderris apetala	*Acaena novae-zelandiae*

Heathy *E.tenuiramis* forest	
Eucalyptus tenuiramis	*L.virgatus*
Eucalyptus viminalis	*Dillwynia glaberrima*
Acacia dealbata	*Amperea xiphoclada*
Banksia marginata	*Tetratheca glandulosa*
Exocarpus cupressiformis	*Pimelea linifolia*
Aotus ericoides	*Hibbertia fasciculata*
Allocasuarina monilifera	*Pteridium esculentum*
Bossiaea cinerea	*Lomandra longifolia*
Epacris impressa	*Diplarrena morea*
Leucopogon ericoides	

***E.obliqua* wet sclerophyll forest**	
Eucalyptus obliqua	*Bedfordia salicina*
Acacia dealbata	*Zieria arborescens*
Acacia melanoxylon	*Pteridium esculentum*
Pomaderris apetala	*Polystichum proliferum*
Coprosma quadrifida	*Dicksonia antarctica*
Olearia argophylla	*Blechnum nudum*
Olearia lirata	

Grassy *E.amygdalina* forest	
Eucalyptus amygdalina	*Stipa pubinodis*
Eucalyptus viminalis	*Ehrharta stipoides*
Acacia dealbata	*Deyeuxia quadriseta*
Exocarpus cupressifromis	*Dichelachne rara*
Bursaria spinosa	*Agrostis aemula*
Astroloma humifusum	*Wahlenbergia tadgelli*
Gonocarpus tetragynus	*Goodenia lanata*
Pimelea humilis	*Hypericum gramineum*
Bossiaea prostrata	*Helichrysum scorpioides*
Hibbertia riparia	*Oxalis corniculata*
Lissanthe strigosa	*Acaena echinata*
Tetratheca glandulosa	*Plantago varia*
Daviesia ulicifolia	*Gnaphalium spp.*
Poa labillardieri	*Stylidium graminifolium*
Danthonia pilosa	

[Source: Sinclair Knight Merz, 1999]

APPENDIX D

Fauna found within the Hobart Rivulet Catchment

Birds	
Brown Falcon	*Falco berigora*
Kelp Gull	*Larus dominicus*
Masked blackwing/lapwing	*Vanellus miles*
Common bronzewing pigeon	*Phaps chalocoptera*
Green Rosella	*Platycercus caledonicus*
Pallid cuckoo	*Cuculus pallidus*
Fantail cuckoo	*Cuculus flabelliformis*
Tawny frogmouth	*Podargus strigoides*
Welcome swallow	*Hirundo neoxena*
Tree Martin	*Hirundo nigricans*
Black-faced cuckoo shrike	*Coracina novaehollandiae*
Blackbird	*Turdus merula*
Flame robin	*Petroica phoenicea*
Scarlet robin	*Pertroica multicolor*
Dusky robin	*Melanodryas vittata*
Golden whistler	*Pachycephala pectoralis*
Grey thrike thrush	*Colluricincla harmonica*
Satin flycatcher	*Myiagra cyanoleuca*
Grey fantail	*Rhipidura fuliginosa*
Yellow wattlebird	*Anthocharea paradoxa*
Yellow throated honeyeater	*Lichenostomus flavicollis*
Strong billed honeyeater	*Melithreptus validirostris*
Black headed honeyeater	*Melithreptus affinis*
Crescent honeyeater	*Phylidonyris pyrrhoptera*
New Holland honeyeater	*Phylidonyris novaehollandiae*
Eastern spinebill	*Acanthorhynchus tenuirostris*
Spotted pardalote	*Pardalotus punctatus*
Striated pardalote	*Pardalotus striatus*
Silver eye	*Zosterops lateralis*
European goldfinch	*Carduelis carduelis*
European greenfinch	*Carduelis chloris*
House sparrow	*Passer domesticus*
Common starling	*Sturnus vulgaris*
Dusky wood swallow	*Artamus cyanopterus*
Grey butcherbird	*Cracticus torquatas*
Black currawong	*Strepera fuliginosa*
Grey currawong	*Strepera versicolor*
Forest raven	*Corvus tasmanicus*

Mammals	
Short-beaked echidna	*Tachyglossus aculeatus*
Southern brown bandicoot	*Isoodon obesulus*
Eastern barred bandicoot	*Perameles gunnii*
Common ringtail possum	*Pseudocheirus peregrinus*
Tasmanian bettong	*Bettongia gaimardi*
Swamp rat	*Rattus lutreolus*
Tasmanian long-eared bat	*Nyctophilus sp (sherrini form)*
Lesser long-eared bat	*Nyctophilus geoffroyi*
Chocolate wattled bat	*Chalinolobus morio*
Goulds' wattled bat	*Chalinolobus gouldii*
Little forest bat	*Vespadelus vulturnis*
Southern forest bat	*Vespadelus regulus*
Large forest bat	*Vespadeuls darlingtoni*
Rabbit	*Oryctolagus cuniculus*
Cat	*Felis catus*
Dog	*Canis minor*

Reptiles	
Metallic skink	*Niveoscincus metallicus*
Blotched blue-tongue	*Tiliqua nigrolutea*

Amphibians	
Common froglet	*Crinia signifera*
Brown tree frog	*Litoria ewingii*

Fish	
Common jollytail	*Galaxis maculates*
Mountain galaxis (spotted trout)	*Galaxis truttaceus*
Shortfin eel	*Anguilla australis*
Brown trout	*Salmo trutta*

Invertebrates	
Fresh water snail	*Potanopyrgus niger*

[Source: Sinclair Knight Merz, 1999]

APPENDIX E

Stormwater threats, sources and impacts on receiving waters

CATEGORY	IMPACTS	TYPICAL SOURCES	TYPICAL COMPONENTS
Pathogenic organisms	Closure of beaches Human infection Illness and disease	Sullage, sewer overflows, animals	Faecal coliforms, bacteria, viruses
Oxygen depleting substances	Low dissolved oxygen	Sullage, sewer overflows, animal waste, greass and leaf litter	Organic matter
Toxicants including metals and salts	Bioaccumulation Death of aquatic life	Cars, car parks, roads, processing industries, spills atmospheric deposition	Pesticides, herbicides, petroleum products, lead, zinc
Sediments, including suspended solids and turbidity	Muddy water Siltation Smothering of aquatic life	Stream erosion, construction sites, unmade roads, sand transport	Silt, sand, gravel, clays
Litter	Mainly visual Interferes with aquatic life	Commerical areas, fast food outlets, plant debris	Paper, plastic, leaves, dead vegetation
Nutrients	Promotes plant and algal growth, blue-green algal blooms (eutrophication)	Sullage, sewer overflows, animals, STP discharges	Phosphorus and nitrogen
Flow	Increased volume or velocity of flows can scour or erode receiving waters. Increased freshwater volumes can affect estuarine or marine environments.	Increased stormwater runoff	Volume, frequency, velocity

[Source: Barry, Y., 2002: The Steps to Preparing a Stormwater Management Plan]