Wayne Rivulet

Catchment Management Plan

Hobart City Council

August 2000

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Executive Summary

This management plan for the Wayne Rivulet Catchment is based on the vision of the staff and students of the Fahan School, members of the catchment community and Hobart City Council. It aims to provide sustainable solutions and outcomes for the long-term management of the area and for Wayne Rivulet, a natural feature of the urban catchment. This management plan has been developed and prepared through Hobart City Council with the assistance of funding through the River Works Tasmania Program, funded by the Natural Heritage Trust.

This management plan addresses the natural, cultural, educational and social values of the catchment and surrounding community, and provides a range of management actions that serve as a guideline in managing the catchment area for future generations. This management plan examines the hydrological nature of Wayne Rivulet, highlighting existing problems and providing improvement strategies that comply with Australian Safety Standards. The outcomes of this management plan are a result of a coordinated approach in community consultation, school involvement and input from the Catchment Steering Committee, Local and State Government.

This management plan has been divided into 8 chapters, the first of which outlines the *objectives of the project* and a *description of the catchment area*. The second chapter focuses on *project development* and the third chapter provides an account of the *catchment history and use*. The fourth chapter outlines the *protective legislation* that is pertinent to the sustainable management of natural resources and support the objectives stated in this management plan. Subsequent chapters focus on the particular management issues within the Wayne Rivulet catchment such as *water quality*, *vegetation management*, *weed control* and *catchment planning strategies*. Chapter 7 includes a detailed section on the implementation of this management plan and highlights the *works* that are to be undertaken in various stages, followed by concluding comments in Chapter 8. Within these chapters there are a list of recommended management actions that serve as a guideline in the sustainable management of an urban catchment.

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Glossary

ANZECC	Australian and New Zealand Environment and Conservation Council
ATCV	Australian Trust for Conservation Volunteers
DO	Dissolved Oxygen
DPIWE	Department of Primary Industries, Water and Environment
EMPCA	Environmental Management and Pollution Control Act
EMS	Environmental Management System
EPA	Environment Protection Authority
ESD	Ecologically Sustainable Development
HCC	Hobart City Council
ICM	Integrated Catchment Management
ISO	International Standard Series
LUPAA	Land Use Planning and Approvals Act
NHT	Natural Heritage Trust
NTU	Nephlometric Turbidity Unit
PAF	Parents & Friends
RMPS	Resource Management and Planning System
SoER	State of the Environment Reports
SPPA	State Policies and Projects Act
UNCED	United Nations Conference on Environment and Development

Chapter 1 Introduction

'Falling Water

Pitter pattering down

Peaceful site, annoying noise cold

A spring'

By Caitlin (Fahan School)

1.1 Background

This document is a management plan for the Wayne Rivulet catchment in Sandy Bay, Hobart, Tasmania and is a result of an application for Riverworks funding through the Natural Heritage Trust (NHT), submitted by the Fahan Presbyterian Girls College and supported by Hobart City Council. The Wayne Rivulet Management Plan has been developed in partnership with Hobart City Council, the Fahan school and the community of the Wayne Rivulet catchment. The management plan is based on the vision of the staff and students of Fahan, the community surrounding the rivulet and the Hobart City Council. The vision for Wayne Rivulet is:

> *To improve the water quality of the Wayne Rivulet catchment;*
> *To develop and implement a catchment management plan for the area, whilst preserving the existing natural, social and educational values of the rivulet for future generations.*

The rivulet flows through the school grounds of Fahan and contributes to a significant educational component of the school curriculum. Results from a class project in monitoring water quality and collecting scientific data initiated the development of a management plan for Wayne Rivulet. The results from water quality monitoring at the Fahan school revealed there was indeed a need for further research into the water quality of the rivulet, the point sources of contamination and the necessary management strategies to ensure its long-term health and sustainability.

The management plan aims to address the environmental issues associated with stormwater quality, catchment use and community values by recommending strategies that can be taken in managing the catchment area and highlighting the actions necessary in implementing a management plan for Wayne Rivulet. This management plan incorporates the principles of Integrated Catchment Management (ICM) and highlights the importance of community involvement in the sustainable management and rehabilitation of natural resources. A central theme of the Wayne Rivulet Management Plan is the concept of sustainability and inter-generational equity. The objectives of this project are thus consistent with the principles of ecologically sustainable development (ESD). ESD is defined by Australia's National Strategy for Ecologically Sustainable Development as:

> using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased (Australia's National Strategy for ESD 1996, p.1)

Moreover, this theme is reflected in the suite of State legislation that is in place for the long-term environmental protection and sustainability of natural resources. This plan incorporates the legislative mechanisms that exists within Tasmania's Resource Management and Planning System (RMPS) 1994, and includes the relevant principles of *Local Agenda 21* 1992, the *National Strategy for ESD* 1992, and the *Local Government Act* 1993. This management plan is based on the environmental management system principles stated in the International Standard series ISO14000.

The management plan for Wayne Rivulet is comprised of an abstract which summarises the plan, background information on the site, catchment description, historical information, detail on environmental characteristics and catchment planning schemes. Recommendations for approaches in implementing the plan are also made, and are in accordance with the objectives of this project.

1.2 Objectives of the Wayne Rivulet Catchment Management Plan

The objectives of the Wayne Rivulet Catchment Management Plan have been developed by the Wayne Rivulet Catchment Steering Committee and the staff and students of the Fahan school. The objectives are divided into the following categories:

1.2.1 Water Quality

- To continue the ongoing water quality monitoring programs conducted by the students and staff of Fahan
- To improve and maintain acceptable levels of water quality in the Wayne Rivulet catchment and in the River Derwent Estuary at Little Sandy Bay through community consultation and onground works

1.2.2 Water Quantity

- To improve the flow of Wayne Rivulet through the removal of vegetative debris that occupies the rivulet bed and surrounding banks and the installation of energy dissipaters at the catchment outlets
- To monitor and record the variances in stream flow throughout the year to detect any changes or improvements

1.2.3 Community

- To continue to involve the staff and students and their families in the ongoing monitoring and management of Wayne Rivulet
- To involve community members that reside in the vicinity of Wayne Rivulet in its environmental monitoring through an education and awareness program
- To involve members of the community in working bees and community field days

1.2.4 Vegetation

- To restore the natural vegetation around the banks of the rivulet
- To rehabilitate the area surrounding the rivulet with native vegetation in a stage by stage process

1.2.5 Weeds

- To remove exotic weed species from the banks of the rivulet in stages

- To control the spread of invasive weed species from neighbouring urban gardens through raising educational knowledge on weeds and their potential impact on the native environment

1.2.6 Riparian Zone

- To improve and maintain bank stability of the rivulet by planting native vegetation near to the riparian zone
- To improve the environmental condition of the riparian zone to increase the habitat available for riparian animal and plant species
- To construct a pond area (ephemeral) that can be used as an educational tool in studying wetland/riparian ecology for the Fahan school and other institutions and to improve overall water quality

1.2.7 Wildlife

- To increase and improve the area available for wildlife habitat by increasing native vegetation
- To create a native urban bushland area that will attract native wildlife and provide opportunities for research into species ecology and life cycle
- To raise the awareness of community members about the importance of bushland links in urban settings

1.2.8 Aesthetic

- To improve the aesthetic value of the rivulet through rehabilitation and transform a degraded site into a place of beauty that will become an asset to the school of Fahan and the surrounding community
- To maintain the cultural and recreational values of the rivulet for the community and the teachers and students of Fahan School

1.2.9 Educational

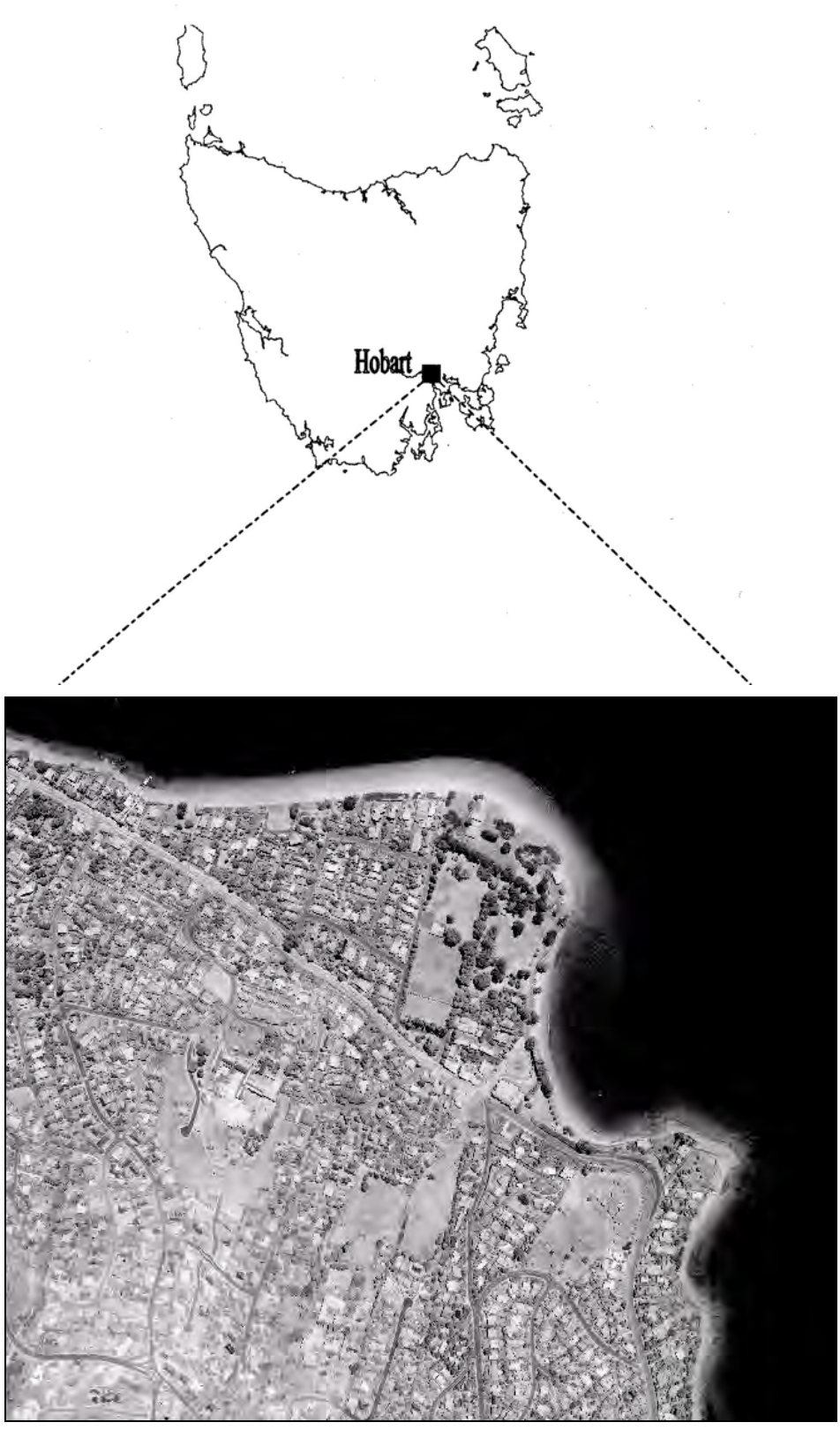
-
- To provide a learning opportunity for the staff and students of Fahan in catchment processes and implementing management strategies
- To provide a training opportunity for employees of local government in catchment management strategies and monitoring procedures
- To educate the surrounding community on the natural and historical values of the rivulet

1.3 Catchment Description

1.3.1 Location

The Wayne Rivulet catchment is one of the smaller urban catchments that exists within the Hobart municipality. The catchment area comprises 90.8 hectares, originating from the top of Mount Nelson in Hobart, extending down the mountain slopes where it flows into the Derwent River estuary at Little Sandy Bay (Figure 1.1). The water source originates from rising springs at the top of the catchment combined with underground urban reticulation from private dwellings within the catchment. The catchment is typical of modern urban catchments where problems associated with storm water run-off, development and contaminants exist. The extent of urbanisation within the catchment is illustrated in Figure 1.1.

Figure 1.1 Location Map of the Wayne Rivulet Catchment



Scale: 1:7000, 1997.

The Wayne Rivulet catchment is a steep catchment with a northerly aspect. The length of the storm water reticulation for the catchment extends 22570 metres underground and channels the flow of the rivulet. There is an exposed section of the rivulet that flows through the grounds of the Fahan school. This exposed section extends for 86 metres and comprises the middle section of the rivulet (Figure 1.2).

The aerial photograph of Wayne Rivulet shows the rivulet following the line of trees that are growing across the grounds of the Fahan school, in the centre of the photograph. From the boundaries of the school grounds, the rivulet continues underground through a piped section of storm water drain that continues into Little Sandy Bay at Sandy Bay Beach. There are two minor tributaries within the catchment which remain unnamed. The number of private dwellings in the Wayne Rivulet catchment is estimated at 801.

Figure 1.2 Aerial Photograph of the exposed Section of Wayne Rivulet

Scale: 1:5000, 1984.

1.3.2 Hydrology

The hydrology of the Wayne Rivulet Catchment is determined by rainfall, stormwater and urban reticulation. The average annual rainfall for the Wayne Rivulet catchment area is 622 mm/yr based on rainfall data over the past 118 years (Bureau of Meteorology data). The average annual rainfall shows a slight increase towards the upper reaches of the catchment on the top of Mount Nelson due to an increase in elevation. Here the average rainfall has been recorded at 666mm/yr (Bureau of Meteorology data). The Wayne Rivulet catchment area displays a general trend in seasonal rainfall, with rainfall decreasing over summer and beginning to increase around autumn. Thus, the extent of flow in the rivulet is quite variable, often existing as a slow trickle in dry weather to a rivulet with substantial flow in periods of heavy rain. The rivulet has flooded on several occasions in the grounds of the Fahan school, however these events have been infrequent.

Teachers and students from Fahan have been monitoring stream flow and rainfall as part of an educational program in environmental monitoring and data collection. Stream flow monitoring occurred in the year of 1997 and gives an accurate representation of the variable flow rates the rivulet displays (Table 1.1).

Table 1.1 Stream Flow Results of Wayne Rivulet in 1997

Date	Rate of Flow (m3/min)
18/02/97	6.5
25/02/97	17
04/3/1997 (rain)	97
11/3/1997	8.6
18/03/97	-
25/03/97	15.7
08/7/1997	20.5
15/07/97	20.2
22/07/97	22

Rainfall intensities have been estimated for the catchment and are illustrated in the Rainfall Intensity Frequency Diagram (IFD) in Appendix 1. An IFD is an effective tool used to predict the rainfall intensities for a catchment area over time. An IFD enables the duration (minutes) of rainfall (mm) to be estimated for a 1in 1 year to a 1 in 100 year period. The

information derived from an IFD can be used in predicting catchment behaviours and stormwater design.

Urban run-off and stormwater are important issues in urban catchment management. Stormwater carries many pollutants which may take many forms, ranging from litter to microscopic particles dissolved in water. Pollutant loads are generally higher in urban areas due to an increase in run-off volumes and pollutant sources (CRC 2000). Understanding the characteristics of stormwater run-off and pollutants is essential in determining the various methods and locations for treating or controlling the impact of pollutants on urban waterways.

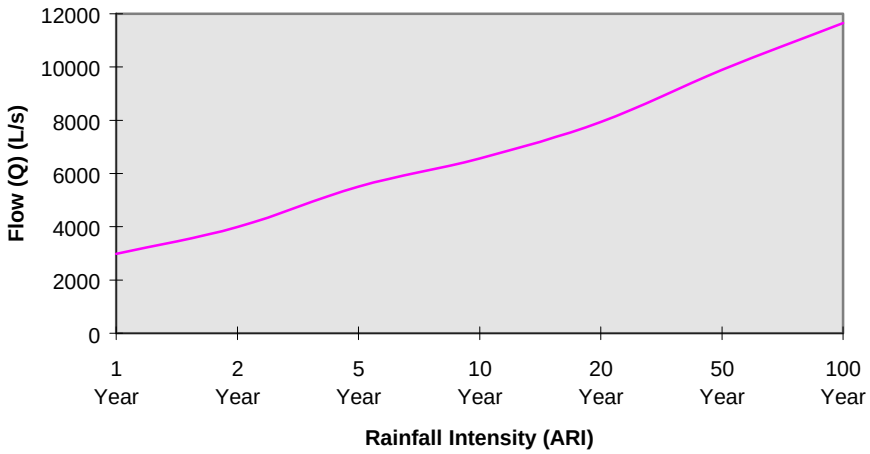
Run-off coefficients can be calculated for a catchment area using the ratio of pervious to impervious surfaces within a catchment area. The information derived from this calculation can be used to determine stormwater pipe requirements and ensures that pipe diameters are suited to the catchment hydrology. This form of analysis is a useful tool in determining whether existing pipes are under capacity or over capacity for the catchment, and in isolating areas where flow problems may occur.

The run-off coefficients for the Wayne Rivulet Catchment are calculated using the partial area analysis which is based on Rational Method. The formula used for this calculation is: Q = 2.78 CIA, where
c= run-off coefficient, I = rainfall intensity (mm/hr), A = catchment area in Ha.

The ratio of pervious to impervious surfaces were calculated for 3 areas of the catchment, so that the C Value (run-off coefficient) could be determined. The 3 areas included (i) the area at the top of the catchment that is mostly vegetated and where the origins of Wayne Rivulet form; (ii) areas of the catchment that are developed and have a high proportion of impervious surfaces; and (iii) areas of the catchment that have both pervious and impervious surfaces. The run-off coefficients for these areas are 0.35, 0.85 and 0.7 respectively. Table 1.2 illustrates rainfall intensities within the catchment over a 1 in 1 year to a 1 in 100 year (ARI).

Table 1.2

Run-off Coefficients for the Wayne Rivulet Catchment



A comprehensive breakdown of the run-off coefficients for the Wayne Rivulet Catchment, including all pervious and impervious surfaces, are included in Appendix 1.

1.3.3 Hydraulics

Hydraulic information on the catchment is necessary to determine whether the existing culverts are within the capacity necessary for storm events. Stormwater culvert capacity is determined by assessing both the inlet and outlet conditions under existing flow patterns. If the flow is under capacity then the system is considered satisfactory. However, if the flow is over capacity then alternative options may need to be applied to increase the systems carrying capacity.

There are several options that can be considered under these circumstances. One is to provide upstream storage, however, this is often difficult in urban catchments. A second option is to change the inlet conditions by modifying the headwall to improve headwater conditions, and finally, increasing the pipe size in the stormwater system. When assessing culvert characteristics, both the inlet and outlet conditions of the culvert are taken into consideration. Different inlet conditions result in varying degrees of headloss which, in turn, affect the capacity of the culvert. Improving the inlet conditions can result in a significant increase in overall capacity. The rudimentary methods used to calculate culvert capacities are based on a combination of Manning's equations and basic culvert design principles. From this

combination, flow is determined which is calculated based on the values associated with pipe diameter, pipe length, pipe grade, and pipe roughness. Pipe roughness is deemed most important as this factor dictates friction characteristics.

An hydraulic analysis on Wayne Rivulet reveals that all culverts in the catchment are at or under capacity for a 1 in 20 storm event (ARI). One culvert is significantly under capacity and will now be recognised and referred to as a floodplain area. Under these conditions, the addition of a 45 degree bevel to the inlet headwall will bring the capacity of the system in accordance with a 1 in 20 ARI. Actions will be taken to increase culvert capacity at this location, however despite this, the area is likely to flood in a 1 in 20 ARI. Measures will be taken to ensure that flooding events are minimised or controlled on site. Appropriate safety precautions and signage will be applied to this location in the future. The location of this site and culvert analyses are detailed in Appendix 8.

1.3.4 Geomorphology

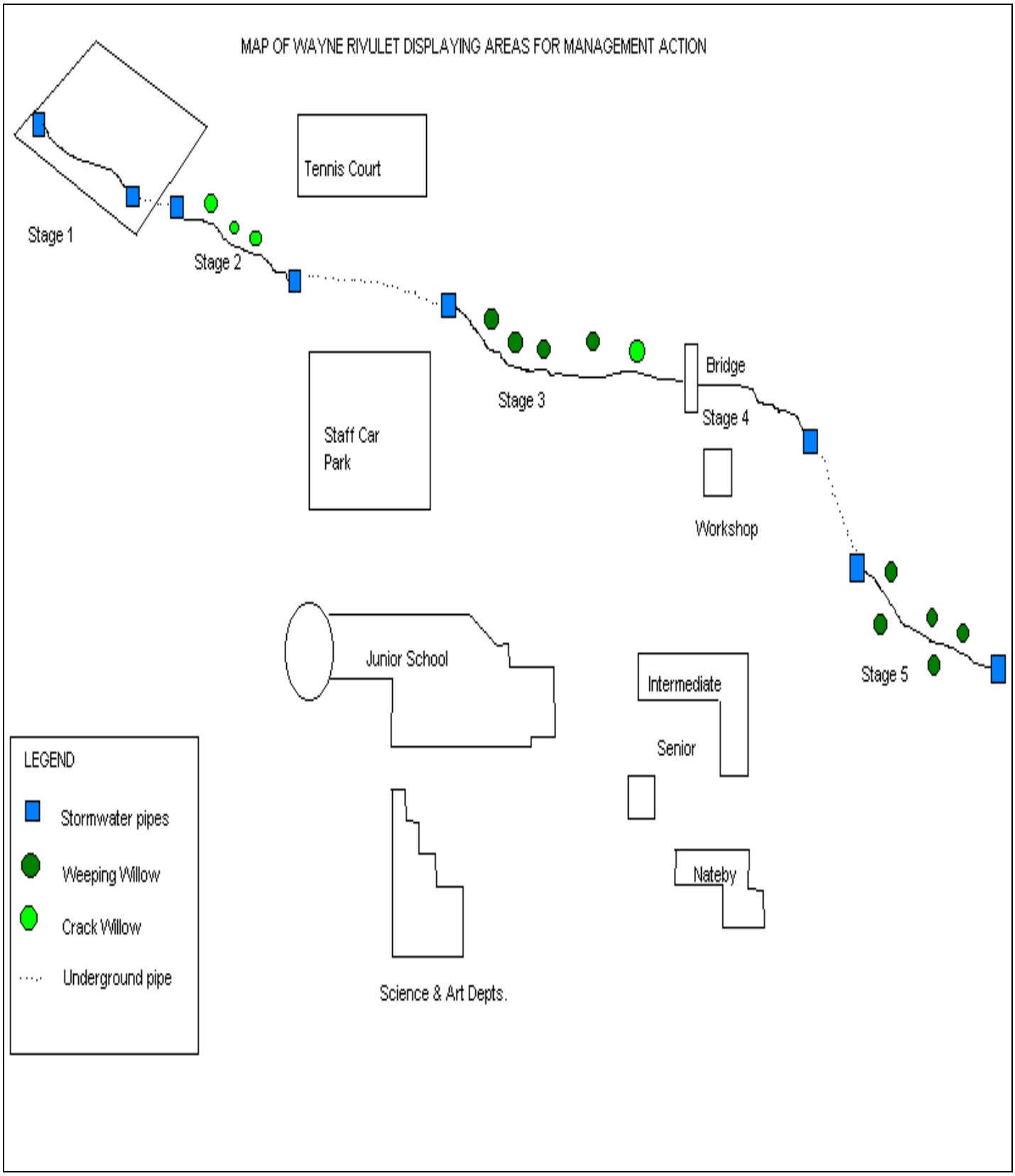
Wayne Rivulet originates from the top of Mount Nelson which stands approximately 340 metres above sea level. The rivulet runs virtually in a direct line from the top of the mountain to the Derwent River estuary at Little Sandy Bay, and follows the natural contours of the mountain slope.

The catchment is predominantly developed for a residential urban environment, mixed with some commercial use, and an educational institution. The majority of the rivulet has been diverted underground and flows through storm water pipes, emerging briefly through the grounds of the Fahan school, before continuing to the Derwent River estuary via storm water pipes. Thus, the rivulet in its current state is largely modified through human activity and urban development.

The Wayne Rivulet catchment has been categorised into five stages according to both geomorphic and rivulet characteristics (Figure 1.3). Stage 1 is the section of the rivulet that exits the stormwater pipe in the upper grounds of the Fahan School, and is also the site selected for the development of the community native garden. Stage 2 is the section of the rivulet that is to be developed into a wildlife corridor to the native garden up slope. This area requires extensive willow removal and weed control strategies. Stage 3 defines the section of the rivulet that remains exposed and flows through the grounds of the Fahan school. Stage 4

comprises the section of the rivulet that flows behind the Fahan workshop and Stage 5 is the section of the rivulet that is dominated by weeping willows and is the point where the rivulet runs underground from the Fahan school and onto the Derwent River estuary.

Figure 1.3 Map of Wayne Rivulet and the Areas Designated for Rehabilitation



1.3.5 Geology

The Wayne Rivulet catchment area is comprised of Jurassic dolerite sediments in the upper reaches of the catchment near the summit of Mount Nelson and extends almost to the lower reaches of the catchment to include the grounds of the Fahan school. Jurassic Dolerite is the most extensive rock type found in the greater Hobart area and is approximately 170 million years in age (Hofto *et al.* 1991). Dolerite is resistant to erosion, therefore eroding more slowly than neighbouring rock types (Hofto *et al.* 1991). Weathering of this rock type is variable, both in the vertical and lateral extent, especially where fine-grained intrusions occur (Hofto 1990).

A 50-70 metre belt of Permian sediments exist toward the lower end of the catchment between the residential dwellings and Little Sandy Bay. A small pocket of Tertiary sediment exists in this area and is positioned between Long Beach at Little Sandy Bay and Blinking Billy Point. Blinking Billy Point forms the boundary of the catchment area for Wayne Rivulet and is comprised of Tertiary Basalt, and is the site of previous basalt lava extrusions. Basalt is a fine-grained chemical equivalent of dolerite, with many similarities in engineering and soil-forming properties (Hofto *et al.* 1991). Obvious similarities are in the immense strength and hardness of the bedrock, and its resistance to erosion, causing weathering of this substrate to be extreme and variable (Hofto 1990).

1.3.6 Vegetation

The natural vegetation of Wayne Rivulet is largely restricted to the upper reaches of the catchment where remnant dry sclerophyll forest remains. Within the plant communities found in this area there exists a range of plant species that are typical of dry sclerophyll communities that are ecologically valuable. The vegetation in this area is also of aesthetic value as it is associated with the scenic views from the Derwent River and forms part of the back drop to the city of Hobart.

The vegetation type encountered in the upper section of the catchment is dominated by the Eucalypt species *Eucalyptus pulchella, E.globulus,* and *E.viminalis*. It is classified as a grassy/shrubby dry sclerophyll forest (Gulson & North 1995) that is well reserved. A list of native plant species that make up the communities in the top section of the catchment are detailed in Appendix 2. The plant communities found at the top of the catchment are not listed as plant communities of local significance (Gulson & North 1995).

The remainder of the catchment area is scattered with a mixture of both native and exotic vegetation which exist in urban gardens, but has been largely modified due to residential development.

The section of the rivulet that remains exposed through the grounds of the Fahan school is a site that has great potential for the rehabilitation and restoration of its natural values. This area of the rivulet is scattered with remnants of native vegetation, however is presently dominated by exotic plant species that have been planted by early settlers or have escaped from neighbouring gardens. Many species may have been transported downstream via the storm water drains from the upper catchment. A description of both native and exotic plant species found in Area 3 of the catchment area are listed in Appendix 3.

1.3.7 Fauna

The diversity in native fauna is largely restricted to the upper reaches of the catchment area in Mount Nelson where the diversity in vegetation types and communities provide a suitable habitat for native fauna. This area of the catchment remains in a natural state primarily due to the absence of housing development that otherwise dominates the area.

Data on the range of fauna that exists in the area remains incomplete as there is no information available on bats or invertebrates. The list of species found in the upper catchment area is based on the abundance and distribution of species found in the Mount Nelson region. The upper reaches of the Wayne Rivulet catchment is not considered to be an area of faunal significance (Gulson & North 1995). A species list of the fauna found in the Mount Nelson area is detailed in Appendix 4. The species in this list represent native plant communities that are widespread in the north-facing slopes of Mount Nelson, and therefore include species that are also found in the Nutgrove catchment, Lipscombe Rivulet catchment and the Folder catchment.

Additional fauna within the Wayne Rivulet catchment area include domestic pets, feral cats and migratory avian fauna. Introduced bird species can facilitate the spread of exotic plant species such as Cotoneaster (*Cotoneaster* spp.) through seed dispersal. It is important to establish native plant communities along the banks of the rivulet to provide habitat for native birds and to discourage the presence of introduced bird species.

Marine fauna that live in and utilise the Little Sandy Bay area are also subject to being affected by catchment processes as the stormwater pipe extends at least 50 metres into Little Sandy Bay. The impact that stormwater has on the marine environment needs to be addressed in the long-term management of the Wayne Rivulet catchment. Coastal studies on this section of the catchment have not been conducted, therefore there is scope to involve students in the monitoring of the foreshore environment and the surveying the life that exists within it over time.

1.4 The Catchment Management Plan

Hobart City Council, in partnership with the Commonwealth and State Governments through the River Works Tasmania Program, is conducting the investigation into the Wayne Rivulet Catchment, with the assistance of Fahan school. River Works Tasmania is the public name of the Tasmanian Regional Environmental Remediation Program, a wide reaching initiative aimed to improve and protect the unique environment of Tasmania by reducing and removing sources of pollution (Natural Heritage Trust 1999). The program unites community consultation with and environmental science to develop a range of individual projects to enhance the water quality and social amenity of Tasmania's key waterways.

The primary aim of the investigation into Wayne Rivulet and its associated catchment, is to develop a catchment management plan that aims to improve the water quality in the rivulet and in the Little Sandy Beach area. The plan has been developed in close liaison with the Fahan school, where projects in environmental monitoring and data collation are incorporated into the school curricula.

A Steering Committee for the project has been established to ensure that a holistic approach to the management of the area is achieved. The Steering Committee share a vision for the rivulet and catchment area in that natural values should be restored and preserved to benefit the surrounding community and future generations. The committee representatives as at November 1999 are:

Ed	Kleywegt	Hobart City Council - Project Manager
Ben	Ridder	Hobart City Council - Environmental Planner
Kirsten	Weller	Hobart City Council - Catchment Planner

Peter	Davies	University of Tasmania - Scientific Adviser
Peter	Lelong	Fahan School - Project Coordinator

The development of the plan and implementation of associated projects are discussed in the next Chapter.

Project Development

2.1 Wayne Rivulet Steering Committee

In May 1998, Hobart City Council applied for funds from the Riverworks Tasmania funding (which is administered by the State and funded through the ***Natural Heritage Trust***) to compile a Catchment Management Plan for Wayne Rivulet and to initiate some stages of the plan's implementation.

A Steering Committee was first established for the Wayne Rivulet Management Project on December 17, 1998 as stipulated in Section 10 of the Riverworks submission. Section 10 of the submission states that the proposed steering group will include:

- An academic from the University of Tasmania
- A qualified adviser experienced in developing catchment management plans
- An engineer experienced in hydrology and hydraulics
- A scientist experienced in fresh water and marine ecology for the land an water assessment.

The Committee was formed by the Hobart City Council and constituted the committee's first meeting. The Steering Committee consisted of 4 members, 2 representatives from Hobart City Council, 1 representative from Fahan and a scientific adviser from the University of Tasmania.

Funding for the development of the Wayne Rivulet Catchment Management Plan was announced in December 1998 and granted in February 1999 and thus included in the Riverworks Tasmania program.

At the first meeting the Steering Committee produced a revised program that addressed issues associated with historical research into catchment use, the monitoring of water quality within Wayne Rivulet, and the initiation of a land-use study within the catchment. The objectives of the project were outlined in the first meeting and were aimed at identifying the key stages of the project, establishing an implementation program for the first stage of the program and producing a realistic time frame for the program's implementation.

In September 1999, Hobart City Council advertised for applications for the position of Catchment Planner for the development and part-implementation of the management plan. A Catchment Planner for Wayne Rivulet was selected in October 1999, to commence work on the plan in November 1999.

2.2 Project Structure

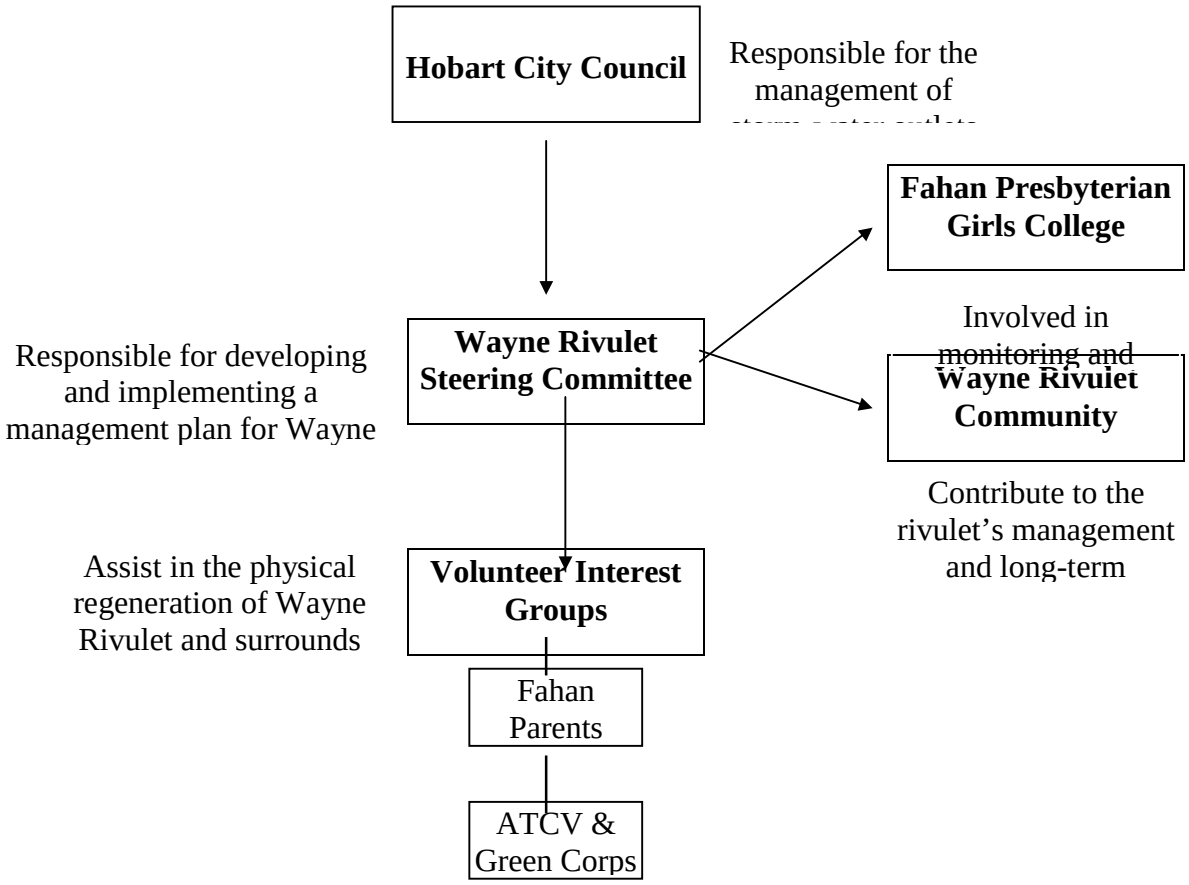
Hobart City Council is the responsible Local Authority for the management of local waterways within the Wayne Rivulet catchment and aims to address the concept of ICM in the long-term management of the rivulet. An integrated approach to the management of Wayne Rivulet addresses the concept of integrated land and water management whilst assisting the transition towards a more sustainable future. The management of the catchment, then, needs to be addressed by Hobart City Council and members of the community who live within and use the catchment area.

The structure of the management plan for Wayne Rivulet is based on the natural, social and cultural values of the catchment and includes a strong educational component that addresses issues of resource sustainability and improving environmental literacy within the community. The implementation of the plan is focused on community education, and acknowledging environmental responsibility and accountability for the condition of Wayne Rivulet. The involvement of teachers and students from Fahan in the ongoing management of Wayne Rivulet fosters

environmental awareness in the younger generations and encourages the development of a stewardship ethic. The project aims to improve the quality of the water course for the people of the Sandy Bay community.

The project structure can be best summarised by the following diagram (Figure 2.1).

Figure 2.1 Project Structure of the Wayne Rivulet Catchment Management Plan



2.3 Management Plan Implementation

Implementation of the Wayne Rivulet Management Plan will commence following its approval from the Wayne Rivulet Steering Committee (Hobart City Council), the

Fahan school and the community. Implementation of the plan will proceed according to the priorities that are outlined in the management plan and will be subject to the availability of persons to carry out those management actions.

Many of the management actions will be carried out alongside the development of the management plan as some actions require immediate attention, such as bank stabilisation of the rivulet and the installation of silt traps prior to on-ground works. Moreover, the educational aspect attached to the management plan requires the involvement of teachers and students and members of the community at an early stage. Management actions of this kind are linked to water quality monitoring, habitat identification, community workshops involving weed removal and tree planting and constructional work on stormwater pipes.

While early stages of implementing the plan are the responsibility of Hobart City Council, it is envisaged that the teachers and students of Fahan, the Parents & Friends Committee and community members will maintain the monitoring and management of Wayne Rivulet and its surrounding habitat.

2.4 Role of the Community

There are numerous benefits associated with community involvement in the management of natural resources. Aside from being an effective tool in raising community awareness about environmental issues, it allows community members to become involved in the planning and monitoring of public or private land. Community involvement of this kind generally results in a management regime that has improved long-term sustainability (Wood 1990).

Responsibility for the implementation of the Wayne Rivulet Management Plan should, whenever possible, be placed in the hands of the local school and surrounding community. An increase in the control and management responsibilities for local people brings resources, volunteers, enthusiasm and a sense of ownership to environmental management (Foster 1997). Greater participation by the Wayne

Rivulet catchment community is essential in increasing project efficiency and effectiveness and encouraging self-reliance in resource management action.

In summary, involving members of the community in the management and ongoing monitoring of Wayne Rivulet:

- Allows community members to actively participate in the preservation and sustainable use of their natural environment
- Creates valuable partnerships between educational institutions, members of the community and local government
- Provides cost-effective methods to obtain valuable baseline ecological data that provides a powerful educational tool in raising community awareness, and
- Improves the local management of the Wayne Rivulet area through pressure exerted on management sectors by an informed and motivated community.

Hobart City Council and the Fahan school have initiated this project and is driven by the management objectives described in Chapter 1. The management objectives are based on consultations with the teachers and students from Fahan, and input from members of the community at the time of consultation.

Chapter 3 Catchment History

3.1 Introduction

In the past, stormwater drains and rivulets were seen as a means in which to remove surplus water as quickly as possible to avoid flood damage to nearby properties. Its presence in the urban environment was for flood mitigation purposes only with little regard given to the pollutants being received into these urban waterways. Today, stormwater run-off is responsible for transporting many of the pollutants responsible for degrading urban rivulets (Hunter 1999), including hydrocarbons, heavy metals and organic nutrients. With an increased awareness about stormwater issues, we have seen the emergence of community-based action and willingness to amend the errors made in the past. Thus, the value of urban streams as a natural resource has been realised by members of the community and as a result, attempts are being made to restore the natural values of areas and manage them sustainably for generations to come.

This Chapter addresses the historical values associated with Sandy Bay Rivulet, including its early settlement to modern day use. Included in this Chapter are the values that are associated with the Sandy Bay Rivulet, and the associated management objectives that have been extrapolated from these values. The many values of the Sandy Bay Rivulet have been derived from members of the community who reside on the banks of the rivulet, and those individuals who use the rivulet environment.

3.2 Catchment History

Prior to European settlement, the Mouheneenner and Nuenonne bands of Aborigines hunted and gathered in the rivulets and foreshores of the Derwent Estuary for thousands of years. The coastal zone of the river provided these people with fresh fish and shellfish where they gathered mussels, limpets, oysters and crayfish (Goc, 1997). The lightly wooded foothills of this region consisted of dry schlerophyll forests with an abundance of native fauna for food. The aboriginal bands of this area fed on speared kangaroo, wallaby, emu and possum. The rivulet's that carved their way down the mountain side were places where aboriginal women and children searched for thick white grubs in the banksias and rotting logs that lay beside the streams (Goc, 1997).

The arrival of the European's in February 1804 forced the aboriginal families to retreat into the sanctity of neighbouring woodlands. In the months and years that followed the landscape was transformed from one of traditional hunting grounds to widespread European settlement. The Mouheneenner and Nuenonne bands were driven from their homes by encroaching settlement and had little choice but to disappear from the area, never to return (Goc, 1997).

3.2.1 Early Settlement

Between early European settlement in 1804 and the late 19th Century, most of Hobart's population was centred in the immediate Hobart district. The Sandy Bay Rivulet formed Hobart Town's southern most boundary, with all outlying areas primarily used for farming (Sinclair Knight Merz 1999). The development of this

area began as early as 1805 when 100 acres of land behind the beach and beside the Sandy Bay Rivulet was granted to Captain William Sladden (Rowntree 1959).

In 1892, the Queenborough Health Board and the Hobart Corporation received several complaints from landowners about the dumping of night soil into the rivulet in Battery Point. The dumping of night soil into the rivulet was seen by many as polluting the rivulet and was deemed a health issue for local residents (Goc 1997). It was not until 1900 that the Queenborough Town Board and the Hobart Corporation agreed to combine efforts in improving the quality of the Sandy Bay Rivulet. However, the pollution of the rivulet and Marieville Esplanade remained a contentious issue for decades (Figure 3.1).

The Sandy Bay area surrounding the rivulet became known as the district for market gardens, nurseries and orchards (Rowntree 1959). These properties were described as having water on three sides, and were bound by the water of the Sandy Bay Rivulet and Marieville Esplanade. Further up the rivulet, areas of land were much larger and were used for dairy farming and grazing pastureland. Aside from agricultural practices, there is also evidence that an industrial activity such as a flock mill was established in the Romilly Street area (Sinclair Knight Merz 1999).

Figure 3.1 Pollution of Marieville Esplanade from Sandy Bay Rivulet
This photo was taken in the 1930's to illustrate the end of pipe pollution from Sandy Bay Rivulet into Marieville Esplanade.
Source: Goc, 1997.

In 1914, the Queenborough district (otherwise known as Sandy Bay) was to be included in the Hobart drainage scheme, which was completed in 1912 (Paltrow 1995). In 1920 a sewerage system was installed for Queenborough residents, however it took many years before the system was operationally effective. The most prominent change to the Sandy Bay Rivulet occurred in 1997 when the wood lining at

the end of the rivulet was removed due to the smell and rotting wood. The wood lining was previously installed as a flood mitigation measure, and then replaced with a cement channel for the same purpose in 1997. In combination with the new cement lining a new siltation trap was installed and litter traps were erected to minimise the amount of gross litter entering the Derwent Estuary. Although the cement lining of the rivulet aids in flood mitigation, this section of the rivulet is where it varied most from its natural state further upstream (Andrews 1997).

3.2.2 Modern Day Use of the Catchment

The Sandy Bay Rivulet Catchment area is utilised for a range of land use activities. Natural vegetation comprises the majority of the catchment area, particularly in the upper reaches of the catchment where little development has occurred. Vegetated areas (including all forest types) make up 402 hectares of the total 574 hectares (Landsat Landuse Classification 2001). Urban areas utilise 106 hectares of which there are approximately 800 private houses, 20 public buildings, roads, driveways and parking areas, with an estimated catchment population of 3100 (Andrews 1997). Other land use areas are classified as agricultural (53 ha), clear or bare land or water (6.6 ha).

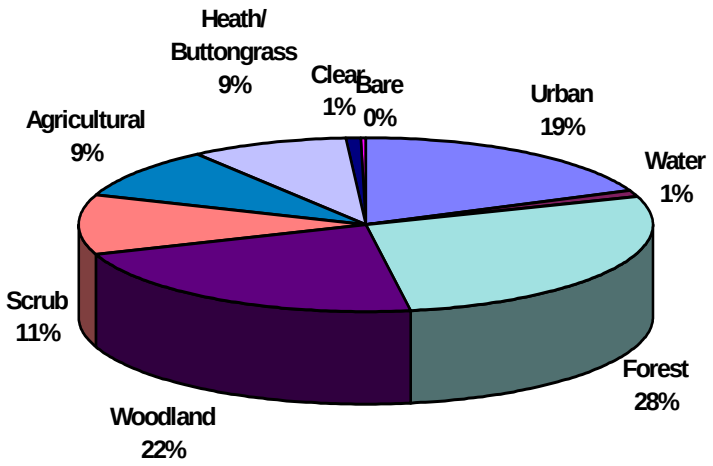


Figure 3.2 Land Use Classification of the Sandy Bay Catchment
Source: Department of Primary Industries, Water & Environment, 2001.

Within the urban area of the Sandy Bay Rivulet Catchment, (the area of the catchment from the Southern Outlet to Marieville Esplanade), many commercial businesses operate. Approximately 20 restaurants and cafes, 2 major supermarkets, 2 service stations and 3 Hotels operate within the urban area. Many of these businesses have the need to dispose of liquid trade waste from the business premises. Trade waste is defined as:

> *" any waste liquid and any substance contained in it, which is produced at the premises of an industrial, commercial or institutional activity, but does not include normal domestic wastewater"* (Liquid Trade waste Policy 1998).

It is the environmental responsibility of these businesses to ensure that all liquid trade waste is disposed of through the sewerage system and that adequate measures are in place to ensure the protection of stormwater quality. The stormwater system must only be used for the disposal of uncontaminated stormwater runoff. Guidelines for the control of trade waste are outlined in Hobart City Council's *Liquid Trade Waste Policy* (1998). Businesses in the Sandy Bay business area are monitored regularly by Hobart City Council to ensure that they comply with the specifications for stormwater drainage outlined in the policy.

While disposal methods are provided for liquid trade waste, many businesses provide the public with car parking facilities. Car parking areas in the lower Sandy Bay business district will often include areas that have impermeable surfaces and therefore contribute to significant amounts of run-off entering the stormwater system. The run-off from these sites will often contain high levels of petrol, oil and hydrocarbons, all of which are detrimental to urban stream health. It is therefore vital that source control measures are put in place on site to prevent contamination of the stormwater system and the Sandy Bay Rivulet. Coupled with the installation of these devices, the general public and business community need to be better informed about stormwater and it's potential impact on the Sandy Bay Rivulet. Recommendations on the range of options available for stormwater treatment will be discussed in following chapters.

3.3 Catchment Values

The catchment values associated with the Sandy Bay Rivulet include the natural, cultural and intrinsic values held by the surrounding community and users of the catchment. These values were derived from individual community members who reside within the catchment via a survey, the details of which are outlined in Appendix 3. It is important that from these community values the management objectives for the Sandy Bay Rivulet catchment are formulated and is the foundation on which sustainable management practices can be built.

Involving members of the community in the catchment's environmental monitoring and management is crucial to the long-term sustainability of the rivulet and to the achievement of Integrated Catchment Management (ICM). ICM is defined as:

> *The co-ordinated and sustainable use and management of land, water, vegetation and other natural resources on a regional water catchment basis so as to balance resource utilisation and conservation.*
> (Department of Primary Industries, Water and Environment 1999, p1.)

ICM includes the integration of physical planning, water management, nature conservation and general environmental management directed towards catchment processes (Glasbergen & Klijn 1991). With this in mind, it is important to develop management strategies that are seen to address both the environmental qualities and functions of a catchment whilst at the same time acknowledging the values held by community members and users of the catchment area. The following sections discuss the responses given by community members of the catchment in relation to the community survey. Results of the survey highlight those values that are considered

most important to the community members and users of the Sandy Bay Rivulet catchment area.

3.3.1 Waterworks Valley Landcare Group

The Waterworks Valley Landcare Group is comprised of community members who are interested in preserving and protecting the Waterworks Valley area in an ecologically sustainable manner. The Waterworks Valley Management Plan area has been defined as the area from below Waterworks Reserve to the Fitzroy Gardens along the Sandy Bay Rivulet (Sinclair Knight Merz 1999). The Management Plan area connects the surrounding suburbs to a place of natural beauty and recreation and links the urbanised lower rivulet and the natural bush land of the upper catchment. The area is valued for its native flora and fauna, and for its cultural and recreational value to the users of the catchment.

The Waterworks Valley Landcare Group is actively involved in the monitoring and rehabilitation of the Water works Valley area. The group initiated the development of a Management Plan for the Waterworks Valley through funding provided by the Natural Heritage Trust. The Plan examines the uses and values if the Waterworks Valley and provides a range of Action Plans that aim to protect and enhance the identified values of the Waterworks Valley.

This Plan is written to link with other management plans that are written for the catchment and is complementary to the Waterworks Master Plan and Management Review (Draft 1998) and the City of Hobart Open Space Strategy (1997). The objectives and Action Plans outlined in the Waterworks Valley Management Plan will be supported throughout the development of the Sandy Bay Rivulet Catchment Management Plan. It has been previously stated that the Rivulet Catchment Management Plan will focus on the lower urbanised area of the catchment, that is the area of Sandy Bay located from the Southern Outlet to Marieville Esplanade. The primary focus of this Management Plan will be on the Sandy Bay Rivulet itself, its surrounds and point sources of pollution.

The remainder of this Chapter highlights the community values of the Lower Sandy Bay Rivulet Catchment. Individual values have been determined through extensive community consultation with residents of the lower catchment area. These values are discussed in further detail throughout this Chapter and include an Action Plan for each value, highlighting the primary goal and recommended actions for each community value expressed.

3.3.2 Community Value and Action Plan

The long-term involvement of the community in aspects of the Sandy Bay Rivulet Project is a key objective in managing a natural resource and fostering the development of a stewardship ethic towards the environment. There are numerous ways in which to describe a community, but for the purpose of this management plan, the community referred to throughout this document includes all individuals who reside within the catchment, volunteer interest groups and users of the catchment area.

It is evident, that through community-based programs such as Landcare, Waterwatch and school involvement, that environmental action via the community is an integral component in raising community awareness about catchment processes and environmental issues. Community involvement in projects such as this enables individuals to contribute to important decision-making processes regarding the management of natural assets. The following table outlines the community values concerning Sandy Bay Rivulet residents and the ways in which their values can be addressed in future management strategies.

Results of the community survey reveal that members of the Sandy Bay Rivulet community value the rivulet and surrounds in many ways, but particularly for its natural beauty and intrinsic value. The community survey was distributed to 120 households that are positioned along the banks of the Sandy Bay Rivulet of which seventy two percent (72%) of households responded. The purpose of the community survey was to ascertain those values held by community members regarding the rivulet (Appendix 3) what concerns they had about the rivulet's future, and how they wished to be involved in the rivulet's long-term management and health. People within this community utilise the rivulet through a number of ways including;

- Aesthetics
- Recreation/Play
- Education
- History/Culture
- Flora and Fauna

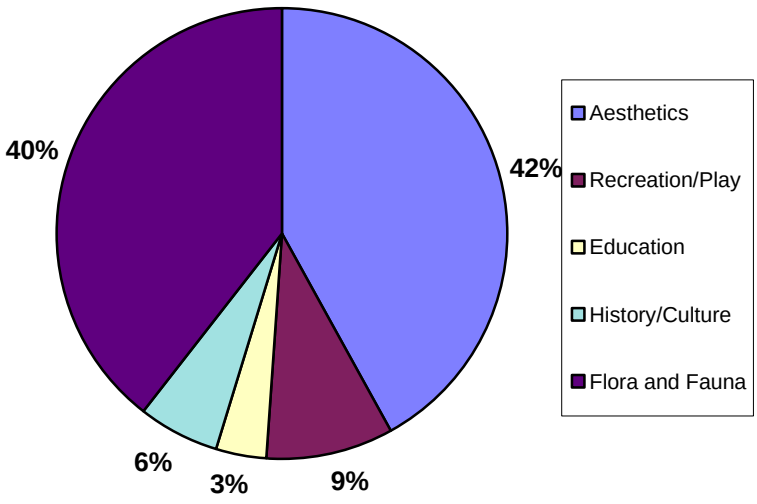


Figure 3.3 Community Values for Sandy Bay Rivulet

The results obtained from additional questions within the survey have been outlined in Appendix 3.

A series of Project Data Sheets have been complied for various projects that may be initiated in the Lower Sandy Bay Rivulet Catchment. These data sheets can be used as a guideline for project development and implementation. A range of projects have been selected from some of the goals outlined in this management plan and are all included in Appendix 4 in Project Data Sheets. The project data sheets can be easily

adapted for other projects within additional catchment areas, but for the purpose of this management plan, are specific to Sandy Bay Rivulet.

Community Values Action Plan

GOAL: To develop and maintain a strong community network in the active management of the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
1. To involve members of the community in the long-term management of Sandy Bay Rivulet	1. Determine the willingness of community members through a consultative process and distribution of a survey 2. Encourage residents living along the rivulet to extend their backyard care to the rivulet 3. Conduct information field days for community members and practical workshops	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Community members Sandy Bay Rivulet Project Officer
2. To keep the community informed on environmental change (positive and negative) on a regular basis	1. Develop and distribute community newsletters to members of the community 2. Establish a database that can be accessed by the public for information on water quality and other testing results	Community members with the assistance of the Sandy Bay Rivulet Project Officer Community member/school with the assistance of the Sandy Bay Rivulet Project Officer
3. To inform school children and teachers on the ecological values of urban streams and create educational packages on how we can all contribute to cleaner waterways	1. Give small talks on stream ecology to interested schools 2. Involve school children in elements of water quality testing and bug identification	Sandy Bay Rivulet Project Officer Waterwatch Sandy Bay Rivulet Project Officer

3.3.3 Cultural Heritage Value and Action Plan

The aboriginal heritage of the Sandy Bay Rivulet Catchment has been discussed earlier in this Chapter (Section 3.2) and acknowledges that the Sandy Bay Rivulet and surrounding areas were once used for foraging and hunting grounds for aboriginal people. Extensive development and urbanisation now predominates the area, however it is important to acknowledge that the rivulet area remains an important element of aboriginal history.

The heritage associated with the early settlement in this catchment remains evident in some of the older homes and buildings that still remain in the area.

The Heritage Schedule (Schedule F) in the City of Hobart Planning Scheme 1982 states that those parts of the Planning Area shown as Heritage Areas or listed on the Council's Heritage Register shall be conserved (Section F.3). Any development that is proposed will be consistent with those characteristics of the Area that contribute to its cultural significance (City of Hobart 1982).

Cultural Heritage Value Action Plan

GOAL: To address all cultural and heritage values associated with the Sandy Bay Rivulet Catchment Area

Objectives	Actions	By Whom
1. Identify and record the sites along the length of the rivulet that have cultural heritage values	1. Ensure that those sites or values are acknowledged and addressed in future management strategies	Hobart City Council
2. Inform community members on the cultural significance and value of those areas concerned	1. Inform residents on culturally significant areas via information flyers or during personal consultation.	Sandy Bay Rivulet Project Officer

3.3.4 Natural Value and Action Plan

The natural values associated with Sandy Bay Rivulet are centred on the ecological integrity of the rivulet itself. It is often rare to see a stream still existing in an urban environment, and not being replaced with pipes and culverts to hide it from view. Like many of the smaller rivulets around Hobart, Sandy Bay Rivulet has been modified over time and has been perceived as a creek, a drain and a natural waterway by the people who have resided in the area.

It is important to improve and maintain the water quality of Sandy Bay Rivulet as it is home to a range of macro-invertebrates and is one of the few rivulets in Hobart that have abundant fish populations of native trout. The rivulet and its fish populations have been subject to numerous studies over the past 10 years. Dr Peter Davies from the University of Tasmania has been conducting the studies and regarded the Sandy Bay Rivulet as relatively healthy breeding grounds, despite the presence of contaminants (Andrews 1997). These native fish have been located in many lower lying areas of the rivulet and are not present in the upper reaches of the catchment due to physical barriers such as the highway. It is therefore crucial that the lower, heavily urbanised section of the rivulet is managed effectively so that the integrity of native fish populations is not compromised. In addition to this factor, the waters of the Sandy Bay Rivulet discharge into the Derwent Estuary, which provides habitat for many marine species, some of which are endangered. The quality of the water within the rivulet also affects species within the Derwent as waters are received along with any contaminated sediment or discharge.

The flora within the catchment varies considerably between the upper and lower reaches. While the native vegetation in the lower reaches of the catchment has been replaced with European garden species the upper catchment area remains in its native form, providing refuge for a range of native fauna. The vegetation types within the catchment have already been discussed in Chapter 1 (Section 1.3.2) and will not be discussed any further in this section. The following table outlines the objectives of this management plan and actions required in relation to the long-term management of the catchment's natural values.

Natural Value Action Plan

GOAL: To enhance and protect the natural values within the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
1. To inform community members on the diversity of fauna that utilise the Sandy Bay Rivulet area	1. Distribute information in the way of newsletters and flyers that highlight the ecological importance of the rivulet	Sandy Bay Rivulet Project Officer
	2. Provide ways in which members of the community can become	Sandy Bay Rivulet Project Officer

	actively involved in the monitoring and management of native areas through hands on workshops 3. Integrate the above mentioned actions with the current Bushcare Program within Hobart City Council	 Hobart City Council
2. To implement effective protection measures for the species of the catchment	1. HCC to include appropriate land use and management policies in its planning for natural areas of the catchment 2. Any development or proposed works undergo and assessment for ecological impacts prior to development	Hobart City Council Hobart City Council
3. To actively involve members of the community in the management of the rivulet in their back yard Refer to Project Data Sheet 1 (Appendix 4)	1. Provide the community group with advice on ways in which they can add to their backyard amenity 2. Assist with the provision of native plants and materials to re-vegetate the riparian zone and to improve bank stability	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Hobart City Council Bushcare Program

Schedule 1 Clearing of Land in the City of Hobart Planning Scheme states in its assessment criteria (Clause 1.4) that when considering applications for the destruction and removal of soil or vegetation, Council will take into account:

- The protection of the amenity value of the vegetation and the general area, including cultural landscape and heritage significance, and
- The protection of biodiversity, including species, genetic and ecosystem diversity, rare, vulnerable or endangered species, habitat and wildlife corridors (City of Hobart 1982).

3.3.5 Intrinsic Value and Action Plan

The intrinsic values people place on an area is an important factor in the management of natural resources. These values are as equally important as those values that are

cultural or natural. An intrinsic value can be described as something that is valued for its existence alone. An individual may value a rivulet because it provides them with a sense of relaxation, peace and tranquillity. A natural bush area may provide hours of satisfaction for an avid bird watcher. Thus, the individual determines the intrinsic value of a location and in what way they utilise the catchment area.

Intrinsic Value Action Plan

GOAL: To consider the intrinsic values associated with the catchment area in the management and planning of the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
To acknowledge the intrinsic values community members have for the Sandy Bay Rivulet Catchment	Include the community's intrinsic values in the long-term management and planning strategies	Hobart City Council

The aforementioned goals and management actions are supported by those legislative mechanisms in place for the protection of natural waterways and resources. Policy development plays an integral role in the protection of natural assets and contributes to the development of local planning schemes. There are many Acts and Policies in place for the protection and management of urban waterways, all of which are pertinent to improving the quality and sustainability of Sandy Bay Rivulet. Stormwater pollution is becoming a major problem and hampering efforts in nationwide efforts to protect and enhance the value of natural waterways. As a result there has been a recent increase in the number of policies and management plans that address stormwater pollution issues. The following Chapter examines this legislation from a State and local level.

Chapter 4 Protective Legislation for Rivulets in Tasmania

4.1 Introduction

Legislative mechanisms at the State level are influential in the sustainable management of natural resources. Within Tasmania there exists a Resource Management and Planning System (RMPS) that was established in 1994. This planning system consists of a tiered framework (detailed in Figure 4.1) designed to integrate State and Local Government planning (Haynes 1996), and to offer protection and guidelines for the management and planning of the environment.

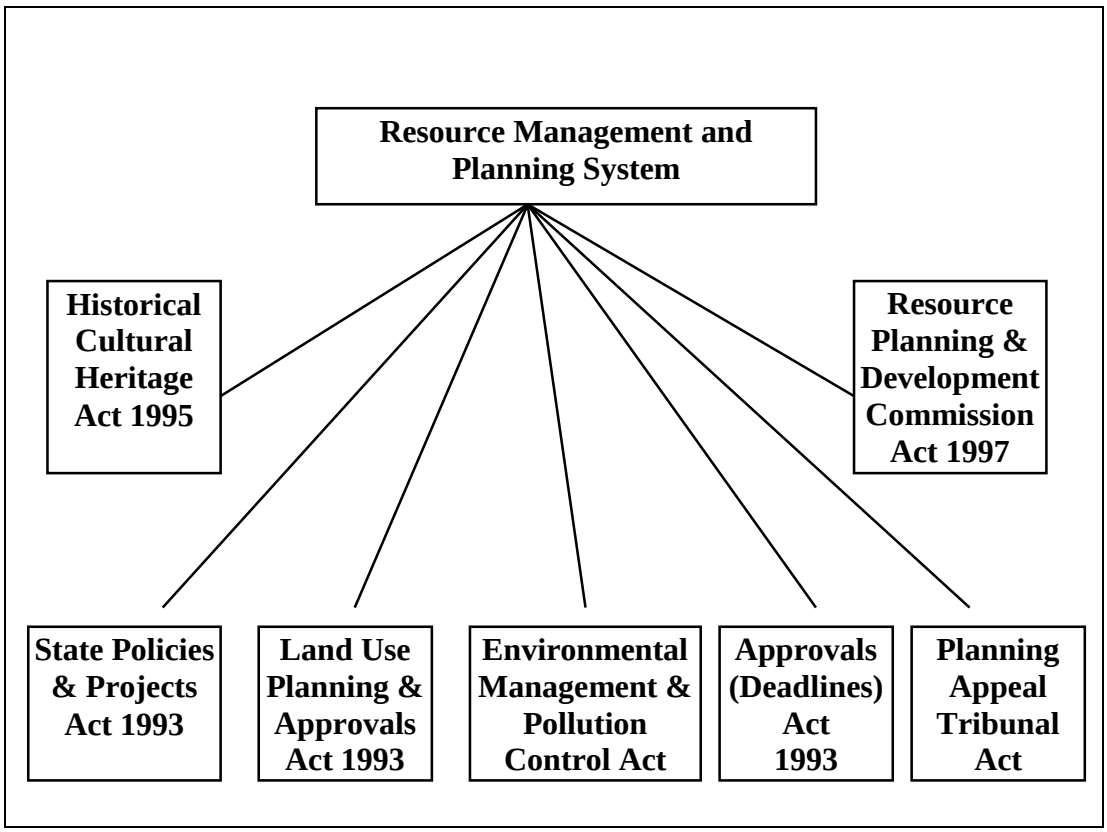


Figure 4.1 Tasmania's Resource Management and Planning System
Source: Department of Primary Industries, Water & Environment 1999.

The objectives of the Resource Management and Planning System are:

- To promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity
- To provide for the fair, orderly and sustainable use and development of air, land and water
- To encourage public involvement in resource management and planning
- To facilitate economic development in accordance with the preceding objectives, and
- To promote the sharing of responsibility for resource management and planning between the community and industry in the State (Department of Primary Industries, Water & Environment 1999).

The aforementioned objectives focus on the potential environmental and cumulative impacts associated with development, whilst encouraging sustainability and an integrated approach to management. The Acts and Policies that are pertinent to the management of water resources in Tasmania, and therefore Sandy Bay Rivulet, are discussed in the following sections.

4.1.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) is a joint initiative developed by the Commonwealth, State and Territory Governments under the auspices of the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC). The strategy aims to provide a nationally consistent approach to water quality management (ARMCANZ & ANZECC 2001).

The Strategy's objective is to:

> "**achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development".**

Within one of the suite of documents in the NWQMS, ***Draft Guidelines for Urban Stormwater Management 1996 have*** been developed. These guidelines provide a national framework for the management of urban stormwater in an ecologically sustainable manner. The Guidelines aim to:

1. **Highlight limitations of many existing stormwater management practices;**
2. **Incorporate catchment wide issues in decision-making processes;**
3. **Assist the community and water managers to formulate and implement stormwater management plans that are most appropriate to local interests and takes into account the environmental, social and economic concerns of the community;**
4. **Promote the protection of the agreed environmental values and the need to determine the maximum concentrations and loadings of pollutants that meet the environmental values;**
5. **Determine the management practices across urban catchments necessary to limit the transfer of pollutants consistent with sustainable levels.**

The Draft Guidelines for Urban Stormwater Management (1996) provides the framework in which States and Territories are able to develop policies and strategies that suit their specific legislative and resource management situations (NWQMS 1996).

4.1.2 State Legislation

The *Sewers and Drains Act* 1954 is an Act to make better provisions for schemes and systems of sewerage and drainage (Tasmania 1954). Included in this Act if the management of 'natural water', which includes water, found naturally on land from rain, snow, natural flow in watercourses or over the ground, and through soakage (Tasmania 1954). This Act addresses the management issues associated with a sewerage system or an urban drainage system of a district or catchment area.

The *Land Use Planning and Approvals Act* (LUPAA) 1993 provides for the making and amendment of planning schemes. LUPAA permits the assessment of a wide range of planning matters and is founded on a permit system, where a permit is required from planning authorities prior to development (Tasmania 1993). It also provides for development control, enforcement and agreements between planning authorities and landowners (Department of Primary Industries, Water & Environment 1999).

In 1997, an amendment was made to the *Land Use Planning and Approvals Act* 1993, to issue a model framework for use by planning authorities in the development of planning schemes (Department of Primary Industries, Water & Environment 1999). The framework is designed to bring consistency to the drafting of planning schemes in Tasmania and to ensure that use or development in the planning is in accordance with the objectives of the RMPS (Resource Development & Planning Commission 1998). It's adoption by local council's may represent the transition from traditional zoning practices to criteria-based performances that address issues of sustainability.

The *Environmental Management and Pollution Control Act* (EMPCA) 1994 facilitates the protection of the environment by negotiating outcomes through environmental audits, impact assessments, improvement programs and agreements (Haynes 1996). The Act permits the management of point sources of pollution; a major problem encountered in urban waterways. The Act facilitates a more co-ordinated approach by councils to planning assessment and environmental management.

The *State Coastal Policy* 1996 and the *State Policy on Water Quality Management* 1997, were developed under the *State Policies and Projects Act* (SPPA) 1993. The SPPA provides for the making of State Policies, integrated assessment of Projects of State Significance and for State of the Environment Reports [SoER] (Department of Primary Industries, Water & Environment 1999). The *State Coastal Policy* and the *State Policy on Water Quality Management* are implemented at a statewide level with each local government obliged to adopt them in their planning schemes. The Policies are statutory documents that aim to set standards for water quality and the management of the coastal zone.

The *State Policy on Water Quality Management* 1997 includes a number of clauses applicable to local government concerning stormwater management, particularly the achievement of improved water quality and appropriate management strategies. 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 while allowing for sustainable development in accordance with the objectives of Tasmania's Resource Management and Planning System. (Schedule 1 of the *State Policies and Projects Act 1993*). 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 on the values and uses of the environment for which a watercourse should be protected. The 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 course 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 *Water Management Act* 1999 is an Act to provide for the management of Tasmania's water resources and for other purposes (Tasmania 1999). Schedule 1 of the Act addresses the objectives of the RMPS and the sustainable management and protection of Tasmania's natural and physical resources.

The integration of the aforementioned Acts into the regional planning system provides the framework for the sustainable management of urban waterways. Under the *Local Government Act* 1993, municipal government is granted greater responsibility in the planning and management of the environment, particularly where land use control and catchment management are concerned (Tasmania 1993). An integrated approach to the management of the environment is encouraged through strategic and operational plans that local councils are required to submit for their municipal areas.

4.1.3 Hobart City Council and Sandy Bay Rivulet

A priority for Hobart City Council is to involve members of the community in the long-term management and monitoring of Sandy Bay Rivulet. This transition towards community-based management and integration is a principal theme within *Local*

Agenda 21 where marshalling the capabilities of groups within a community is seen as primary environmental care. The Agenda also states that an integrated approach to management provides the framework for land use planning and the establishment of processes for public participation, which in turn, lead to resource stability and long-term sustainability (UNCED 1992).

Hobart City Council's *Liquid Trade Waste Policy* 1998 provides for the protection of stormwater by ensuring that liquid waste is discharged to the sewerage system. Under the *Environmental Management and Pollution Control Act 1994*, Council is responsible for any polluted waters from stormwater outfalls under its control and therefore the stormwater system must only be used for the disposal of uncontaminated stormwater runoff. It is illegal to discharge waste, other than uncontaminated stormwater, either directly or indirectly to a stormwater drain or system (Hobart City Council 1998).

The Catchment Management Plan for Sandy Bay Rivulet is based in the environmental management system principles stated in the International Standard Series ISO 14000. The environmental management system is viewed as an organising framework that should be continually monitored and periodically reviewed to provide direction for environmental activities in response to changing internal and external factors (Australian/New Zealand Standard 1996). The principles and elements of the Environmental Management System (EMS) are:

1. **Commitment and Policy**: An organisation should define its environmental policy and ensure its commitment to EMS;
2. **Planning**: An organisation should formulate a plan to fulfil its environmental policy;
3. **Implementation**: An organisation should develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets;
4. **Measurement and Evaluation**: An organisation should measure, monitor and evaluate its environmental performance;
5. **Review and Improvement**: An organisation should review and continually improve its environmental management system, with the objective of improving its overall environmental performance (Australian/New Zealand Standard 1996).

The Sandy Bay Rivulet Catchment Management Plan highlights the importance for ongoing environmental monitoring and the implementation of best management practices for urban stormwater. The involvement of the catchment community is viewed as a crucial element to the project in that community participation increases public ownership of resources and generates broader decision-making perspectives. It is important to Hobart City Council that the community values and concerns are explored, resulting in the identification of responsive strategies.

The following Chapter is devoted to highlighting the water quality associated with Sandy Bay Rivulet. Results that have been obtained through regular water quality testing will be discussed, including their effect on the long-term sustainability and health of the catchment. The next Chapter will also highlight the management actions that are considered necessary to achieve improved water quality within Sandy Bay Rivulet, including ways in which individual members of the community can work together to restore and preserve some of the natural values in the catchment area.

Chapter 5 Stormwater and Sewerage Infrastructure and Water Quality Issues

5.1 Introduction

A river, floodplain and all tributaries within a catchment are recognised as a single functioning unit, but each catchment has its own individual characteristics, which in turn, give a stream its unique presentation. These characteristics are extremely variable and may include the permeable/impermeable surface ratios, population of the catchment, operational industries within the catchment, and human behaviour to name a few. It is the latter that causes much concern in controlling urban stormwater pollution, and is now recognised as a major issue that required immediate action. In Australia at least $50 million is being spent annually on efforts to improve the health of streams, particularly through programs such as the Natural Heritage Trust (Rutherford ***et al***. 2001).

Stormwater run-off is the major cause of massive accumulations of toxic contamination in Australia's waterways (Waste Management and Environment 2001). The current state of our waterways confirms that the current methods of managing stormwater run-off are inadequate for capturing and retaining silt and sediment and completely ineffective against toxic dissolved pollutants. These pollutants enter our waterways via run-off from building sites, surface cleaning activities and erosion resulting from earthworks (Waste Management and Environment 2001) (Plate 5.1).

The water quality in Sandy Bay Rivulet has been the topic of investigation for many years. There has been a series of studies and reports produced for the rivulet including *Quantification of Urban Stormwater and Land Use in the Sandy Bay Rivulet, Hobart, Tasmania* (Andrews 1997), *Sandy Bay Rivulet Flood Study* (HECEC 1999), and *The Transport and Deposition of Suspended Sediment in the Sandy Bay Rivulet* (Tuit 2001). The Waterworks Valley Landcare Group initiated the development of the *Waterworks Valley Management Plan* (Sinclair Knight Merz 1999), which includes a section on water quality, urban stormwater pollution and results of water quality testing.

The Wellington Park Management Trust manages the upper reaches and origin of the Sandy Bay Rivulet. The Trust has developed the *Wellington Park Management Plan* (January 1997), which incorporates management objectives for the Natural Zone, or areas of relatively undisturbed forested landscapes and some alpine areas (Wellington Park Management Trust 1997). The Plan states that it is important to protect and preserve water quality within these undisturbed areas.

Plate 5.1 Litter accumulating in the streets and entering river systems via stormwater

Water quality within Sandy Bay Rivulet is directly linked to the activities that occur within the catchment boundaries. Activities that involve water use and water disposal have considerable impact on the quality of water that flows throughout the catchment. It is therefore necessary to inform members of the catchment community (the users) about the linkages between human behaviour and urban stream water quality. Individual actions, no matter how small, are the key in improving and maintaining stormwater quality for generations to come.

Stormwater pollutants may be derived from a number of sources which are transported to waterways by a number of natural and constructed drainage features (Andrews 1997). In urban areas, constructed drainage features are the norm and act as conduits for stormwater and its contaminants into natural waterways. In order to reduce stormwater pollution it is necessary to gain an understanding on the common sources. These are outlined in Table 5.1.

This Chapter of the management plan examines the Best Management Practices (BMP's) for urban stormwater and discusses the current state of the Sandy Bay Rivulet in terms of water quality. Results from water quality testing in Sandy Bay Rivulet depict the appropriate management strategies required to improve the rivulet's current water quality status. These results are outlined in section 5.2 of this Chapter.

Table 5.1 The Common Sources of Stormwater Pollutants

Type of Pollutant	Residential Activities	Vehicles and Roads	Construction Activities	Industrial Activities	Atmospheric Deposition
Sediment	erosion	pavement wear	erosion		airborne dust

Nutrients	organic matter	roadside fertiliser		solvents	airborne dust
Phosphorus	fertiliser			cleaners	
Nitrogen	cleaners			waste water	
Pathogens	organic matter septic systems sewerage system				
Toxic materials	herbicides pesticides	fuels herbicides pesticides	herbicides pesticides	fuels herbicides pesticides	PCBs herbicides pesticides
Heavy metals	Cd, Cr, Cu, Pb, Zn corrosion pesticides herbicides fertilisers roofs paint weathering	Cr, Cu, Pb, Zn, Fe, Cd, Mi, Mn bearings emissions brake wear tyre wear lubricants		Cd, Cr, Cu, Fe, Ni metal finishings combustion products	
Litter	litter	litter	litter wastes	litter	
Oil and Grease	paint solvents	lubricants motor fluids		oil lubricants	

Adapted from Andrews 1997, p.13.

5.1.1 Faecal Contamination of Stormwater

Stormwater is potentially the major contributor to faecal pollution in the Derwent Estuary, particularly after rainfall where a large amount of contaminated run-off is received by urban rivulets (Green & Coughanowr 2000). It has been estimated that stormwater contributes to 80-91% of total faecal input into the Derwent Estuary (Green 1997). Faecal bacteria counts have been conducted on many of the rivulets within Hobart, including Sandy Bay Rivulet, and have revealed counts well above the recommended guidelines for primary and secondary contact. These guidelines are 150 colony forming units (cfu)/100ml for primary contact and 1,000 cfu/100ml for secondary recreational contact (Green & Coughanowr). Sandy Bay Rivulet has displayed faecal coliform bacteria counts in the range of 0-1,600 cfu (Andrews 1997) and reflects localised sources of contamination.

In Hobart the sewerage system operates independently from the stormwater system. The sewage system can also contribute to faecal contamination within the Sandy Bay Rivulet via spills and leakages and cross-connections to the stormwater system. The majority of households are connected to a sewerage system that was constructed in 1912 (Sinclair Knight Merz 1999). The sewerage system is therefore extremely old in many parts of Sandy Bay and is therefore susceptible to cracking and leaking into the rivulet via the stormwater system. Regular water quality monitoring for faecal coliform bacteria in the Sandy Bay Rivulet is conducted by Hobart City Council and is a method by which the bacteria can be detected early and traced to the source.

5.2 Water Quality Results for the Sandy Bay Rivulet

5.2.1Bacteria

Hobart City Council conducts regular water quality testing on major rivulets every 3 months, including Sandy Bay Rivulet. Tests are conducted for faecal coliforms and *E.coli* bacteria. Regular and continued monitoring of the rivulet's water quality ensures that any variation or fluctuation in bacteria is detected at an early stage. Measures of faecal coliform bacteria in urban waterways indicate the presence of excrement from humans, pets or wildlife. The Draft ANZECC Guidelines (1999) state that the bacterial indicator index over the bathing season should not exceed 800 for faecal coliform or 300 enterococci per 100ml of water. Intensified monitoring of water quality needs to be initiated when the bacterial index exceeds 550 for faecal coliform or 200 for enterococci (Recreational Water Quality and Public Health 1997). The Draft Australian & New Zealand Conservation Council's (ANZECC) Guidelines 1999 state that in secondary recreational contact, such as boating, the bacterial index should not exceed 5000 for faecal coliform or 2000 for enterococci per 100ml of fresh or marine water.

Table 5.2 details the recommended levels of various parameters for fresh water streams and estuaries and are based on water quality standards outlined in the ANZECC Guidelines. The following table can be used as a guideline to assist in interpreting results for the management and ongoing monitoring of urban streams. Standards for point source pollution should be based on these standards.

Table 5.2 Recommended Water Quality Standards for Freshwater and Estuaries

Element	Fresh Water	Estuary
Dissolved Oxygen (DO)	6mg/L	>6mg/L
Biological Oxygen Demand (BOD)	<2mg/L	<2mg/L
pH (acidity)	6.5-9.0	-
Orthophosphate (mg/L)	<0.008	<0.02
Soluble Phosphate	-	5-15 µg/L
Nitrates (NO3-N)	-	10-100µg/L
Ammonia (NH3-N)	5µg/L	5µg/L
Faecal Coliform	Median <cfu/100mL	Median <150cfu/100mL
Conductivity (µS/cm)	20-500	51-500
Turbidity (NTU's)	<5	-

Source: Adapted from the Huon Catchment Healthy Rivers Project 1997, p.25.

5.2.1.1 Bacteria Results

Over the past 12 months the number of faecal coliforms found during testing in the Sandy Bay Rivulet have been in the range of 280 - 40,000 colony forming units

(cfu)/100ml. On occasions where counts have been above the recommended 200 cfu, a thorough investigation by the Hydraulic Engineering Unit within Hobart City Council is conducted. Smoke and dye testing procedures are performed to locate possible leakages, spillages or cross-connections from the sewer to stormwater system. It is also possible that faecal contamination can also occur as a result of septic tank overflows that may occur further up the catchment and then be transported down the catchment via the rivulet. In these instances, regular monitoring is required in septic tank areas to detect sudden changes in the levels of bacteria early. Figure 5.1 illustrates the results from faecal coliform testing in the Sandy Bay Rivulet for the year 2001.

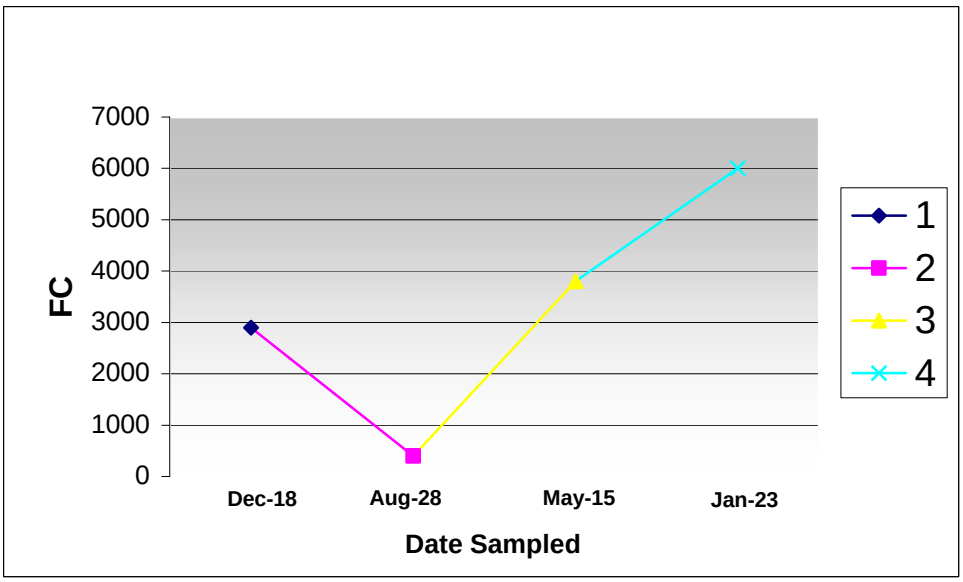


Figure 5.1 Faecal Coliform Bacteria Counts for Sandy Bay Rivulet 2001

The results outlined in Figure 5.1 indicate that there have been several incidents where faecal coliform bacteria counts that have been sporadic in nature and have exceeded the recommended limits. All water quality samples were taken during periods when water flow was normal and no samples were taken during or after high rainfall events. On occasions, through follow up testing, a cracked sewage pipe or sewage overflow has been discovered and repaired immediately. However, the main source of faecal coliform contamination is from urban run-off washing the faeces of cats and dogs from the streets into the stormwater system and into the rivulet (Andrews 1997).

5.2.2 Water Quality Parameters

Local schools in the Sandy Bay district are also involved in water quality monitoring and are guided by Waterwatch. Two local primary schools regularly monitor water quality in the Sandy Bay Rivulet and test for a range of water quality parameters. The parameters include:

- *Temperature* – is important to record at the time of sampling. Water temperature will vary depending on the season, time of day, depth of the water and the amount of

cover provided by riparian vegetation. Variations in temperature determine the available oxygen in the water for aquatic life. Water low in temperature has high oxygen availability whereas water high in temperature has low oxygen levels. Variations in temperature can also change the rate at which both chemical and biological processes can occur, and what type of macro-invertebrates can live in the water body.

· *Turbidity* - refers to the cloudiness of water and is the result of suspended particles in the water. Turbid water affects the amount of light that can penetrate the water for plant growth and reduces the level of oxygen available for aquatic life. Silt, microorganisms, plant material, chemicals, and soil erosion can cause high turbidity. Turbidity is measured in units called Nephlometric Turbidity Units (NTU's) and is logarithmic. A tube is used to measure turbidity in relative terms, based on the ability of light to penetrate the water. The ANZECC Guidelines for turbidity in fresh water aquatic ecosystems should not exceed <1000 NTU's.

5.2.2.1 Turbidity Results

Turbidity in the rivulet was one of the variables measured during Tuit's study (2001) on the transport and deposition of sediment in the Sandy Bay Rivulet. Tuit's results indicate that the range of turbidity values in the rivulet during dry weather conditions was quite variable and site specific. Turbidity readings were collected from 15 sites along the length of the rivulet including natural, semi-urban and urban areas. Higher turbidity readings were measured in sites located within the semi-urban land-use zone, whereas the forested and urban land-use zones obtained clear turbidity readings. Tuit recorded the turbidity readings using a Hach DR/2000 Direct Reading Spectrophotometer that recorded turbidity in Formazine Turbidity Units (FTUs) as opposed to the Nephelometric Turbidity Units (NTUs). Despite the difference in units, one NTU is still comparable to one FTU (Radtke *et al.*, 1998, cited in Tuit 2001). Figure 5.2 illustrates the average turbidity of all sites sampled from in the Sandy Bay Rivulet.

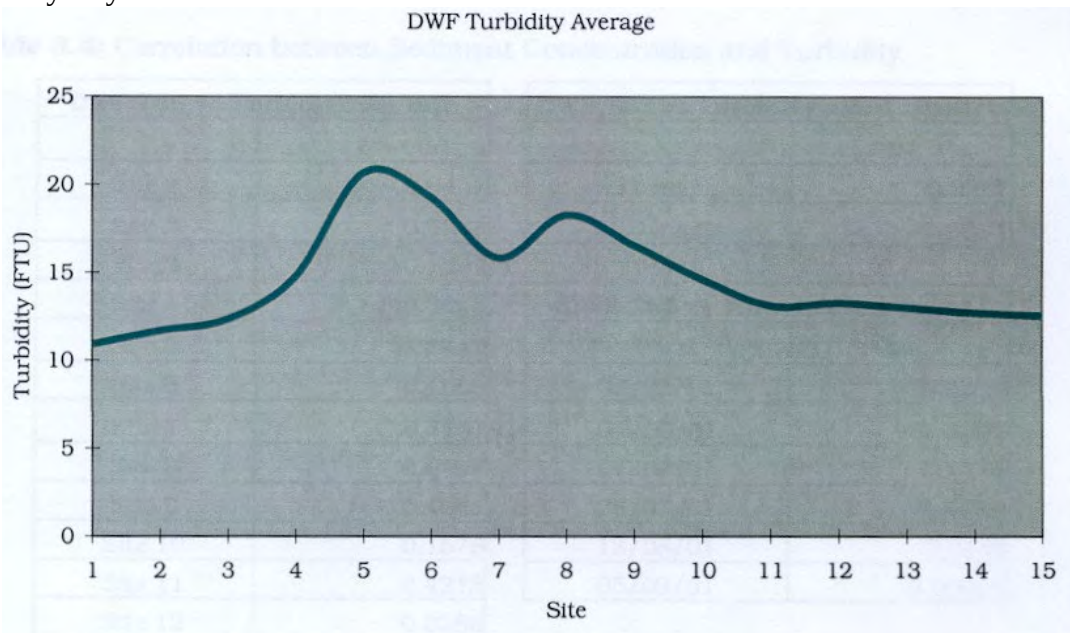


Figure 5.2 Average Turbidity during Dry Weather Flow in the Sandy Bay Rivulet
Source: Tuit (2001)

Despite low levels of suspended sediment Tuit highlighted that there remained a significant level of fluctuation in turbidity values (>10%) at each sampling site and therefore breached the ANZECC Guidelines.

Waterwatch have been monitoring several sites in the Sandy Bay Rivulet in the semi-urban and urban areas of the catchment. High levels of turbidity are indicated in the results throughout the sites and visual observations of rocks being coated in silt have been noted. This is perhaps due to works further up the catchment below the Waterworks Reserve area, and highlights the need for the improved silt management of sites where works are being conducted.

· *Conductivity* - is one way to measure inorganic materials in the water such as chloride, nitrate, sulphate, sodium, ammonium, aluminium and iron. Conductivity is also called salinity or total dissolved solids (Waterwatch 1996). When inorganic materials dissolve they produce ions that are required by aquatic plants and animals for growth (Waterwatch 1996). Conductivity is affected by temperature, geology, water flow discharges and removal of vegetation. If conductivity levels increase above the recommended range, outlined in Table 5.4, sensitive species of the recommended community can become stressed and will disappear.

5.2.2.2 Conductivity Results

Conductivity was also measured during Tuit's (2001) study on the transportation and deposition of sediment in the Sandy Bay Rivulet. Tuit's findings revealed some important trends where conductivity increased throughout the natural areas of the catchment, but declined in the semi-urban zone, only to rise again throughout the urban zone. Tuit concluded that this result was expected due to the nature of the catchment. An increase in conductivity throughout natural areas can be attributed to the presence of organics in the rivulet from surrounding escarpments and farms. Throughout the semi-urban zone a decline in conductivity is expected due to the distance between the rivulet and major roads in the area. An increase in the urban area of the catchment can be explained by an increase in pollutant levels via stormwater run-off that effects the water quality during base flow conditions (Tuit 2001). Figure 5.3 illustrates the average sediment load during dry weather flow.

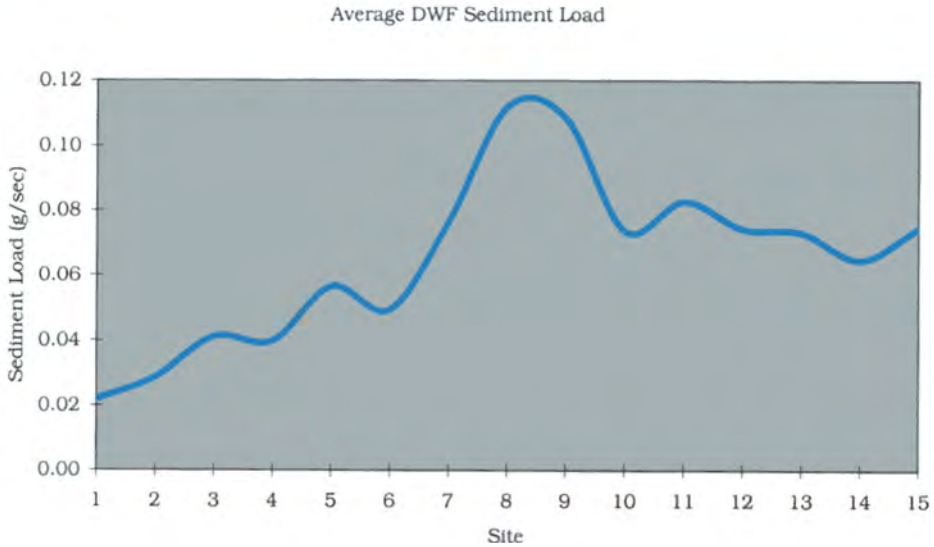


Figure 5.3 Average Sediment Load during Dry Weather Flow
Source: Tuit (2001)

- *pH* – is used determine the acidity of water in a stream; the pH is measured on a scale of 0 to 14, with 7 representing a neutral measurement (that the water contains an equal amount of H ions and OH ions). The pH for fresh water usually lies between 6.5 and 8.2, however wide variations may occur due to catchment geology and unnatural changes. These unnatural changes may include urban and industrial run-off, sewage and other waste management issues.

- *Dissolved oxygen* - (DO) is the small amount of oxygen gas that is dissolved in the water and its presence is essential for the respiration of aquatic animals, microorganisms and aquatic plants (Waterwatch 1996). If a healthy and diverse aquatic ecosystem is to be maintained, dissolved oxygen levels must be high (see Table 5.2). At low DO levels the aquatic environment is limited to those species that are hardy and have low oxygen demands.

- *Reactive orthophosphorus* – measures very low concentrations of phosphorus, down to 0.01mg/L. Very low concentrations can have considerable impact on waterways. Phosphorus is a nutrient that occurs naturally at low concentrations in water and is essential for all forms of aquatic life. An increase in phosphorus in streams has the potential to accelerate plant growth, algal blooms, low dissolved oxygen and the death of certain species.

5.2.2.3 Phosphorus Results

A study by Andrews (1997) on the Quantification of Urban Stormwater and Land Use in the Sandy Bay Rivulet measured reactive phosphorus levels in numerous sites in the rivulet. Andrews states that phosphorus levels at all sites were generally low, however two distinct peaks were noted. Both of these peaks in phosphorus levels occurred following a rain event.

Similarly, a Waterwatch group sampled for phosphorus levels in the rivulet near the Fitzroy Gardens approximately 30 minutes after a rain event. The phosphorus levels showed a significant increase from 0.03 mg/L in dry flow weather to greater than 0.14 mg/L following the rain event. An increase of this magnitude is detrimental to the existence of aquatic stream fauna and therefore requires prompt action in attempting to trace the source and remedy the problem. It is possible that periods of high flow during rain events can remobilise phosphorus levels from the sediment resulting in an upset in natural nutrient balance. Large amounts of phosphorus can also accumulate on urban impervious surfaces and can then be released into the rivulet via run-off through the stormwater system.

- *Macro-invertebrate sampling* - in a stream can indicate the nature of the water quality based on the individual species tolerance to pollutants. Tolerance levels include sensitive species (e.g. Stonefly nymphs), medium tolerance species (e.g. Backswimmers and Water Boatmen), tolerant species (e.g. Leeches and Crane fly larva) and very tolerant species (e.g. Mosquito larvae and Bloodworms). Species that are tolerant and very tolerant of pollutants in the water will dominate degraded environments (Waterwatch 1996).

5.2.2.4 Macro-Invertebrate Sampling Results

Actively involved community groups and Waterwatch conduct macro-invertebrate sampling on a regular basis. The majority of sampling is conducted in the urban and semi-urban areas within the catchment. Results to date indicate that there is a decrease in the diversity of macro-invertebrates between the top of Waterworks Reserve and Fitzroy Gardens in Sandy Bay. The section of the rivulet in the Waterworks Road vicinity, approximately 500 metres above Lynton Avenue, displays a wide diversity of organisms including dragonfly nymphs and mayfly nymphs, both of which are indicative of good water quality. Conversely, below this site in the urban land-use zone near Fitzroy Gardens only tolerant species remain, including flatworms, snails and other worm species. The presence of tolerant species only and the absence of more sensitive species indicate poor water quality in this area of the catchment. Macro-invertebrate sampling has not been conducted below the Fitzroy Gardens site due to limited access and the channelisation of the rivulet.

5.2.3 Community Involvement in Sandy Bay Rivulet

The students of the primary schools test these water quality parameters approximately 4-5 times a year over the Sandy Bay Rivulet Catchment in eight sites. Testing of these sites has been occurring over the last 2 years and has led to a better understanding of water quality issues within the rivulet and its significance as a habitat for stream fauna. One of these sites has also been a site that has been monitored over the last 4 years by an aquatic ecologist from the Department of Primary Industries, Water and Environment. This site has been the focus of a study that has assessed both water quality parameters and macro-invertebrate diversity.

The presence or absence of specific stream fauna is an important indicator of stream health. AUSRIVAS (Australian River Assessment System) is a prediction system used to assess the biological health of Australian rivers developed under the National River Health Program (NRHP) by the Federal Government in 1994. AUSRIVAS produces a biological assessment that can be used to indicate the overall ecological health of the site and includes river systems, riffle, edge, pool and bed habitats. The AUSRIVAS predictive model and associated sampling methods are appropriate for use by community groups, managers and ecologists and provide the basis for the ecological assessment of the Sandy Bay Rivulet.

The Waterworks Valley Landcare group are also involved in monitoring water quality within a large section of the Sandy Bay Rivulet. The section monitored is in the Waterworks Valley region, that being the section of the rivulet that flows between the lower reservoir at Waterworks Reserve to the section adjacent to the Fitzroy Gardens in Sandy Bay. It appears that this section of the rivulet is subject to high loads of sedimentation and transportation of sediment downstream. The Landcare group actively works in this area and has become an environmental advocate for the region. As a result, a number of sites have been isolated in regard to contamination by grey water or illegal stormwater connections to the rivulet itself. Once isolated these sites are investigated by the Hydraulic Engineering Unit within Hobart City Council and prompt action is taken to rectify existing problems.

5.2.4 Sedimentation of the Sandy Bay Rivulet

A recent study in the Sandy Bay Rivulet (Tuit 2001) revealed that there are several sites along the rivulet that are identified as point sources of erosion. These are the McDermott's Gully and the Romily Trail land clearance site, both of which contribute large amounts of suspended sediment during dry and wet weather flow. Tuit (2001) also stated that during dry weather flows, transported sediments come primarily from the semi-urban and rural land use zones, while the source of wet weather sediment lies primarily in the urban zone. The urban sector of the catchment contributes most to pollutant loads due to the high amount of run-off from surrounding areas.

Plate 5.2 Stormwater outlets are a source of contamination from road run-off

Photo courtesy of J.Tuit 2001

Results of Tuit's study (2001) clearly show that the cumulative transportation of sediment that occurs during dry flow conditions is negligible in comparison to the cumulative transportation of sediment that occurs during storm events. The first flush is a common phenomenon during rain events in the Sandy Bay Rivulet and evidence indicates that pollutants are transported largely during the initial stages of the rain event discharge. The first flush is the characteristic response of the rivulet to rainfall (Tuit 2001). The urban sector of the catchment therefore has a large influence on the sediment loads that are discharged during storm events, since the first flush phenomenon is strongly tied to urban catchments. An example of the first flush effect is illustrated in Figure 5.4 where a storm event on the 22/03/01 reveals a peak concentration in sediment that is 55 times greater than the average dry weather sediment concentration.

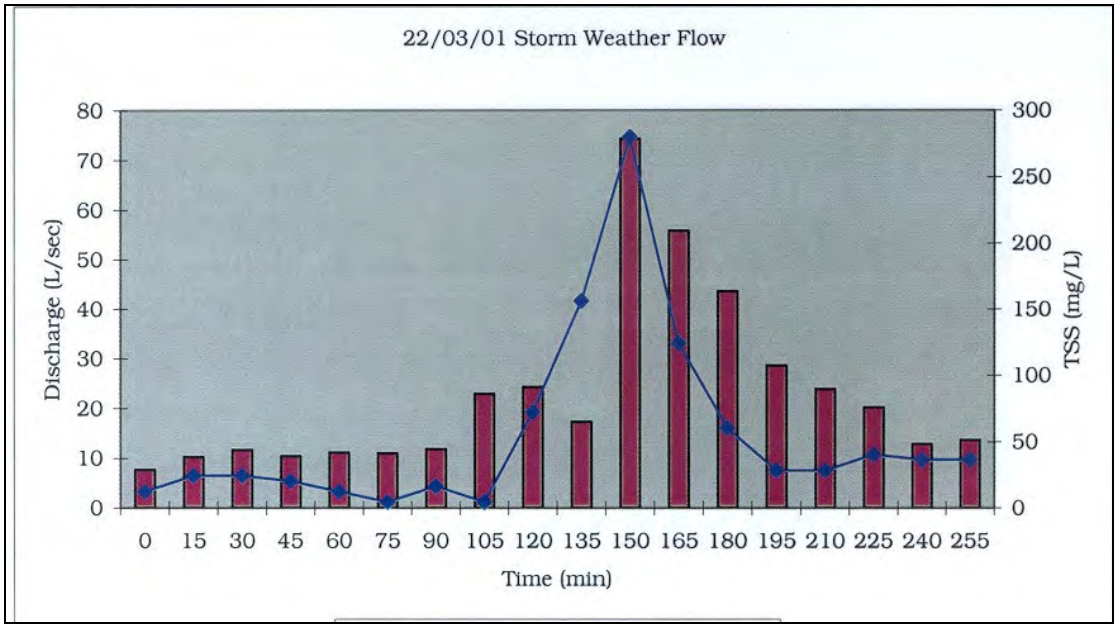


Figure 5.4 Storm Event in Sandy Bay Rivulet – 22/03/01
Source: Tuit, J, 2001.

5.2.5 Litter Control in Sandy Bay Rivulet

Litter is often the most visible source of pollution in a rivulet and Sandy Bay Rivulet is no exception. Due to the largely urban nature of the lower catchment area, litter enters the rivulet via the stormwater system. The majority of litter is derived from human use and is comprised of any solid material such as packing, paper products, food and drink containers and cigarette butts. The presence of litter in urban waterways is a major concern for our larger river systems, as most rivulets are conduits for such material. The accumulation of litter in Sandy Bay Rivulet reduces the aesthetic value of the stream environment and can have serious consequences to the hydraulic capacity of the rivulet through blockages that can result in localised flooding.

In an attempt to control and manage litter pollution in the rivulet, a litter trap was installed in 1997. The trap was designed to trap any gross litter travelling down the rivulet in periods of high and low flow. During rain events the trap was disconnected from its brackets to minimise obstruction and to mitigate localised flooding. The net from the trap was taken away to be emptied and replaced once water levels returned to normal dry flow conditions. Although the litter trap was effective in trapping gross litter items, several problems arose in the maintenance of the trap during high rainfall events.

During high flows the trap rapidly became blocked with debris and large litter items from further up the catchment and required prompt removal before flooding occurred. The litter nets were difficult to remove and were extremely hazardous for personnel during high flows as the chain to lift the nets from the rivulet needed to be manually connected. In low flow conditions the litter trap was flushed back in the opposite direction due to the tidal nature of the rivulet environment and the traps proximity to the coastal zone. The presence of the trap in its current location blocked the natural

migration route for native fish in the rivulet. With these problems in mind, the trap was removed in December 2000 during a high rainfall event and has not been replaced. Staff from the Hydraulic Engineering Unit are currently designing an alternative trap that will allow for easy maintenance, minimise localised flooding and will allow for the easy migration of fish species. Project Data Sheet 2 (Appendix 4) highlights some of the options available for reducing litter and pollutants in urban waterways.

Plate 5.3 Quayle Street Litter Trap During a High Rainfall Event

Plate 5.4 Sedimentation of the Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

Plate 5.5 The sediment trap in Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

5.3 Best Management Practices for Urban Stormwater

While the conventional methods of urban stormwater management focused on the provision of efficient drainage systems, a more holistic approach to urban stormwater management is emerging and is one that involves multiple objectives (Wong 2000). This holistic approach to stormwater management includes the use of preventative measures in combination with control measures to minimise stormwater pollution. Preventative measures, or source controls, are management techniques that reduce the amount of pollutants transported by water (Watershedss 2001). Control measures are designed to reduce the levels of pollutants in stormwater that have already been exposed to pollutant sources.

5.3.1 Preventative Measures

Preventative measures in mitigating stormwater pollution can be summarised as source reduction practices. It is more effective and less costly to prevent a pollutant from entering a waterway to begin with, rather than to remove or treat it once the stormwater has already become contaminated. There are numerous ways in which

stormwater pollution can be prevented through source reduction practices. These include:

1. **Animal Waste Collection -** animal waste contributes to the numbers of bacteria and organic matter in stormwater run-off.
2. **Curb Elimination -** elimination of curbs assists in reducing pollution entering the aquatic environment. Curbs function as channels for stormwater, whereas without curbs, run-off can be spread over large vegetated areas where sediments and pollutants can settle and be taken up by plants or grass. Curb elimination is most suitable for proposed development sites and is not always practical in well established urban areas.
3. **Removal of Debris -** stormwater control structures such as litter grates and trash racks accumulate litter and debris that enters the stormwater system. It is essential that the removal of debris and litter from these sites is included in a regular maintenance program.
4. **Educational Programs -** educational programs are a crucial factor in reducing the number of pollutants that enter urban streams, rivers and other waterways. Changes in human behaviour stem from people who are informed about stormwater issues and the best practices for maintaining healthy ecosystems.
5. **Minimisation of Pollutants -** stormwater pollution can be significantly reduced through the removal or minimisation of pollutants within the catchment area. This can be achieved through a number of ways including:
   - **The collection and recycling of hazardous wastes and waste oil in the community,**
   - **Diverting water discharges from vehicle washing areas to the municipal sewer system to prevent discharges into the stormwater system,**
   - **Using alternatives to toxic and hazardous materials, such as water-based products, to reduce the amount of solvents and chemicals entering local waterways.**
6. **Parking Lot and Street Cleaning -** street cleaning on a regular basis assists in reducing pollutants that accumulate in the gutters and roadside. Street sweepers can pick up fine material therefore reducing the transport of sediment-bound pollutants.
7. **Stream Bank Stabilisation -** stream bank erosion is a common problem in urban streams that generally result in increased sediment loads discharging into the stream (Weller 2001). Through bank stabilisation techniques the possibility of mass bank failures is minimised and the amount of sediment entering a stream through erosion is drastically reduced. Stream bank stabilisation can be achieved by re-vegetation, soil bioengineering and hardened structural techniques.
8. **Buffers and Easements -** buffer zones or strips of vegetation along a rivulet or stream edge is important for trapping sediment and attached pollutants, encouraging filtration and slowing stormwater flows over a wide area.

5.3.2 Control Measures

Stormwater pollution control measures can be divided into two categories, source control and structural control. Source control measures aim to limit changes to the quantity and quality of stormwater at or near the source, whereas structural control

measures aim to improve water quality and control stream flow discharges (CSIRO 1999).

Source controls can be used to avoid stormwater impacts and involve areas associated with land-use planning, education, regulation and operational practices. Attention to stormwater source control in these areas will assist in limiting changes to the quality or quantity of urban run-off before it enters the stormwater system (CSIRO 1999).

Structural control involves the construction and installation of infrastructure that reduces or delays stormwater flows and intercepts or removes pollutants after they enter the stormwater system. There are a number of options available for structural control of stormwater pollutants and can include at source, in-line and end-of-line treatments. The range of devices and methods available for stormwater treatment are too many to mention in detail in this management plan and new products are continually being developed and are under trial. There is much information available on the range of products, their suppliers and efficiency in stormwater treatment. Specific details on some of the devices available are outlined in Project Data Sheet 2 in Appendix 4.

5.4 Management Objectives and Action Plan

GOAL: To identify source of pollutant(s), to improve and maintain water quality in Sandy Bay Rivulet

Objectives	Actions	Action by
1. Educate the community on urban links to water quality	1. Prepare and distribute educational material on the importance of water use and role of water in the catchment (where wastes & water go when they leave urban homes) 2. Provide ways in which members of the community can become actively involved in the monitoring and management of water quality (use of pesticides, detergents etc)	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer
2. Reduce the amount of sediment, oil and grease and nutrients entering the Derwent Estuary via the Sandy Bay Rivulet **Refer to Project Data Sheet 2 in Appendix 4**	1. Locate point sources of pollution in the rivulet 2. Continue to monitor water quality in consultation with Water Watch 3. Audit local businesses within the Sandy Bay Catchment for illegal stormwater discharges and	Hobart City Council Sandy Bay Rivulet Project Officer Hobart City Council

	encourage the installation of stormwater treatment devices	
3. Minimise the amount of contaminated road-runoff entering the rivulet	1. Prioritise those sites near to Sandy Bay Rivulet where major road run-off has detrimental impact on the biological health of the stream 2. Encourage improved stormwater management practices for local businesses including the installation of stormwater treatment devices such as Enviropod, Ecosol products (see Project Data Sheet 2).	Hobart City Council Hobart City Council
4. Minimise sewage contamination of Sandy Bay Rivulet	1. Monitor sewage and stormwater infrastructure to detect any areas where infiltration is occurring 2. Ensure that sewage overflows are managed effectively and promptly to avoid contamination of the rivulet	Hobart City Council Hobart City Council
5. Maintain a regular water quality monitoring regime **Refer to Project Data Sheet 3 in Appendix 4.**	1. Involve local schools in water quality monitoring (including pH, conductivity, turbidity and macro-invertebrate levels) 2. Transfer water quality monitoring data to Waterwatch groups to allow the wider public to access information	Local schools Waterwatch Sandy Bay Rivulet Project Officer Stormwater Management Officer (DPIWE)

	3. Continue regular water quality monitoring and conduct follow up reports on abnormal or high fluctuations in results	Waterwatch Sandy Bay Rivulet Project Officer Waterworks Valley Landcare Group

The goals and management actions that are mentioned for water quality are supported by the *Derwent Estuary Environmental Management Plan – Consultation Draft – July 2001*. The *Environmental Management and Pollution Control Act* (EMPCA) 1994 enforces the management of point sources of pollution; a major problem encountered in urban waterways. The *State Coastal Policy* 1996 created under the *State Policies and Projects Act* 1993 promotes the sustainable development of natural resources and identifies the need to protect the coastal zone. The aforementioned water quality management strategies are consistent with the principles under the *Local Government Act* 1993, where municipal government is granted greater responsibility in the planning and management of the environment, land use control and catchment.

The following Chapter highlights the options for vegetation management within Sandy Bay Rivulet. The management of vegetation is directly linked to water quality and is relevant to the preservation of natural values in the area. The next Chapter will also highlight the management actions that are considered necessary to manage vegetation in the lower Sandy Bay catchment.

Chapter 6 Vegetation within the Catchment

6.1 Introduction

In implementing management strategies that facilitate sustainability, it is important to understand the natural movement of watercourses and their associated linkages within the catchment, including vegetation. Riparian vegetation is classified as vegetation that is found on the banks of a river or stream and plays a crucial role in maintaining bank stability and controlling erosion in streams, which can be directly linked to water quality issues. Riparian vegetation with the Sandy Bay Rivulet Catchment is considerably different and varied between the top and more natural areas of the catchment to that vegetation found in the lower densely urbanised reaches, of which this management plan is the focus.

Plate 6.1 Vegetation in the upper Sandy Bay Rivulet catchment

Photo courtesy of J.Tuit 2001

Plate 6.2 Vegetation in the lower reaches of the Sandy Bay Rivulet catchment

Photo courtesy of J.Tuit 2001

6.2 Non-Native Vegetation

Sandy Bay Rivulet courses its way through hundreds of back yards in Sandy Bay to its final destination at Short Beach in Battery Point. The vegetation found along the banks of the rivulet in this area are predominantly non-native species that have found their way to the stream banks from neighbouring gardens. These 'escapees' take up residence on the banks and while many are beautiful flowering species, most end up choking the natural water way or displacing other native species. Many of these non-native species are hardy and opportunistic and they take advantage of any site recently disturbed. The invasion of native vegetation by environmental weeds diverts resources from native plants and animals (Kirkpatrick 1991). Non-native plant species spread through a range of vectors including animals, people, vehicles, birds and wind. Once environmental weeds become established, they have the capacity to displace native plant species, out-competing them for resources and can result in the local extinction of some or native species in that area.

The success of the environmental weed in the natural environment is influenced by a number of factors. These factors may include:

- The degree of disturbance of the natural environment,
- The environmental flexibility of the environmental weed,
- The presence of both male and female plants (where reproductively necessary),
- Climatic suitability,
- The pollination and seed dispersal mechanisms,
- The environmental weed's capacity to avoid predation,

- The fire tolerance levels of the weed (Kirkpatrick 1991).

All of the above-mentioned factors need to be considered when attempting to manage environmental weeds. There are several environmental weeds within the Sandy Bay Catchment area that require more vigorous management if they are to be eradicated from the area. These environmental weeds that are of primary concern for the lower catchment are outlined in the following sections.

6.2.1 Crack Willow

Crack Willow (***Salix fragilis***) along Tasmanian rivers and rivulets has established due to vegetative reproduction where pieces of the tree have broken off due to winds, floods, or falling over and have developed into mature trees (Parker & Bower 1996). As a result, the Crack Willow can be found colonising the banks of streams and rivers state wide and will require a long-term commitment if these species are to be removed from river and stream systems. Willows are generally considered undesirable along watercourses for the following reasons:

- Willows have the potential to modify the shape of river channels and the flow of water that may result in: stream-bank erosion, channel movement, and increased flooding. Willow trees growing in the middle of the Sandy Bay Rivulet have the potential to cause localised flooding during high rainfall events. All willow trees that have the potential to obstruct stream flow have been removed, in accordance with the recommendations made in the Sandy Bay Rivulet Flood Study (HECEC 1999).
- Willows inhibit the growth of native vegetation due to vigorous growth and shading
- Willow invasion can lead to a monoculture of vegetation resulting in decreased biodiversity
- The deciduous nature of willows provides an altered seasonal food supply to rivers that is much higher than the litter received from native vegetation over summer
- The willows root system spreads extensively underground and in urban areas can cause complications with both stormwater and sewer pipes.
- Willow leaves break down quickly so provide a brief food supply to aquatic insects as opposed to Eucalypt leaves which takes much longer to break down (Green 1999).

Poor management of Crack Willow results in willows that reproduce vigorously at a speed that may quickly displace native vegetation. It is therefore necessary to implement effective management and follow-up procedures in order to restore the natural values of the riparian zone. Willows are beneficial in some circumstances where they enhance bank stability, control run-off and filter excess nutrients (Green 1999). Other benefits include the screening and privacy these large trees give to residents living in Sandy Bay Rivulet. It is therefore imperative that extensive consultation occurs with all residents who may be affected by the removal of a willow tree.

Plate 6.3 Crack Willow in Sandy Bay Rivulet

6.2.2 Blackberry

Blackberry (***Rubus fruticosus*** sp agg.) is a common environmental weed throughout Tasmania and is often found in neglected or disturbed sites. Dispersal of this plant is exacerbated by birds and animals, but can also spread through stem tips that establish roots in the soil. The control methods for the Blackberry are suggested in the following text and are recommended by the Department of Primary Industries, Water & Environment (DPIWE 1996).

- Hand grubbing, slashing or bulldozing
- Grazing by cattle and goats
- A range of herbicides (approximately 50 products are registered)
- Biological control methods include a strain of Rust fungus that has been introduced from Europe and is currently being tested
- Burning in autumn when the weed dies back and follow-up treatment in spring to remove new growth.

Blackberries are present in many locations along the urbanised areas of Sandy Bay Rivulet. They are found in areas that are overgrown with other weed species and have poor access for maintenance. Routine maintenance and inspection of the rivulet ensures that weed species are kept under control and do not obstruct of block the water flow from the rivulet. While blackberries are invasive and opportunistic, its presence on the banks of the rivulet can often be an advantage. In many sections of Sandy Bay Rivulet, the blackberry is stabilising the bank and providing habitat for native birds such as the Superb Blue Wren (***Malurus cyaneus***). In this circumstance it is best to gradually replace sections the blackberry bush with native plant species until

the bank is well stabilised and alternative habitat is provided. Once native species are established, it is then possible to remove the blackberry bush altogether without risk of mass stream bank failure and habitat displacement.

Plate 6.4 Blackberry infestation in lower Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

6.2.3 Other Weeds

There are additional environmental weeds present along the urbanised section of Sandy Bay Rivulet. These weeds also require effective management and control to allow for native species to germinate and thrive. Other weed species found in the area include:

English Ivy (*Hedera helix*)
Bridal Creeper (*Myrsiphyllum asparagoides*)
Wandering Jew (*Tradescantia albiflora*)
Blue Periwinkle (*Vinca major*)
Mirror Bush (*Coprosma repens*)
Cotoneaster (*Cotoneaster* spp.)

Plate 6.5 Exotic weed species thrive in the riparian zone of Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

It is recommended in this Management Plan that all of the environmental weeds indicated are removed systematically to minimise the extent of disturbance on the ecosystem in a short time period. This can be achieved with the involvement of the residents who live along the rivulet and who stand to benefit most from an integrated approach to weed management. Community groups can be established which focus on rivulet rehabilitation, or individual residents can be encouraged and involved in restoring and improving sections of the rivulet flowing adjacent to their property boundary.

6.3 Management Objectives and Action Plan

GOAL: To protect and conserve existing native vegetation within the catchment and to adopt sustainable approaches in its management

Objective	Actions	Action by
1. Educate the community on the importance of native vegetation and involve them in its conservation	1. Prepare and distribute educational material on strategies in which to minimise the spread of exotic plant species i.e. 'Garden Plants are Going Bush". 2. Encourage the development of a local Backyard Rivulet Care Group who focus on weed management and regeneration in backyard sections of the rivulet	Hobart City Council Sandy Bay Rivulet Project Officer
2. Encourage interest in the management of the rivulet among local residents	1. Hold workshop days on getting to know Sandy Bay Rivulet 2. Organise field days to collect and propagate native seeds for future planting 3. Involve residents in tree-planting and weed removal working bees along their own section of the rivulet	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer
3. Control and manage the number of exotic plant species that exist in the heavily urbanised section of the rivulet Refer to Project Data Sheet 4 in Appendix 4	1. Map the distribution of environmental weeds prior to removal as a future monitoring tool 2. Remove or eradicate exotic plant species by mechanical or chemical methods 3. Continue to monitor and remove exotic species that re-occur in the region 4. Inform members of the community of the factors that affect the success of	Sandy Bay Rivulet Project Officer Hobart City Council Local residents Volunteer/Landcare Groups Hobart City Council Local residents Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project

	an environmental weed 5. Discuss the adverse effect of backyard dumping of garden refuse into the rivulet	Officer
5. Control and manage the presence of Crack Willow in sections of the Sandy Bay Rivulet	1. Remove Willows selectively through appropriate methods outlined in the 'Willow Management Guidelines" and consultation with the community 2. Implement follow-up procedures to monitor and remove new growth on cut willows	Hobart City Council Sandy Bay Rivulet Project Officer Hobart City Council
6. Remove and manage Blackberry growth along Sandy Bay Rivulet	1. Assess the role the blackberries play in stream bank stabilisation and habitat prior to removal 2. Remove blackberries using mechanical methods and appropriate chemical means 3. Follow-up on blackberry management by removing new growth as it appears	Sandy Bay Rivulet Project Officer Hobart City Council Local residents/ Landcare Groups

Conclusion

The management objectives and actions that have been outlined in this management plan aim to achieve improved water quality and long-term sustainability for Sandy Bay Rivulet. This management plan for the Sandy Bay Rivulet catchment is based on the natural, cultural, educational and social values of the catchment and surrounding community. These values were ascertained through public consultation with local interest groups and the residents living within the catchment.

Implementation of the management plan will occur in stages and will involve extensive consultation with those residents who will be affected by on-ground works. To ensure the success of these management actions, it is necessary for members of the community to take on an active role in maintaining and preserving the work that is done in stages of the rivulet's rehabilitation. While Council has the capacity to achieve management objectives, it is vital that the community are included in all aspects of the catchment's natural restoration. Acknowledgment of community values in the planning and remediation stages instils a sense of ownership and responsibility for the natural environment among community members. There are currently many community members living within the catchment who are actively involved in managing their backyard and neighbouring sections of the rivulet in a sustainable manner.

Hobart City Council will be responsible for locating and controlling point sources of pollution within Sandy Bay Rivulet. There are continuing investigations into illegal stormwater discharges that are contributing 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 achieved through normal rivulet maintenance and the in kind support provided by interested community members who become actively involved in the rivulets rehabilitation and sustainable management.

This management plan has been written for the Sandy Bay 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 Sandy Bay 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. It is essential, however, that communication between local council and community members is maintained to ensure sustainable outcomes in the management of this urban stream.

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Appendix 1 Plant Species Recorded in the Waterworks Reserve

Vascular Plant Species Recorded in the Waterworks Reserve	
Community	**Community**
DICOTYLEDONS	**DICOTYLEDONS**
APIACEAE	Pultanaea daphnoides var.
Hydrocotyle hirta	obocordata
ASTERACEAE	Pultanaea gunnii
Bedfordia salicina	Pultanaea juniperina
Brachyscome spathulata	Pultanaea pedunculata
Cassinia aculeata	GERANIACEAE
Craspedia glauca	Geranium potentilloides
Helichrysum scorpioides	GOODENIACEAE
Olearia argophylla	Goodenia lanata
Olearia stellulata	Goodenia ovata
Olearia viscosa	HALORAGACEAE
Ozothamnus obcordatus	Gonocarpus tetragynus
Ozothamnus purpurascens	Gonocarpus teucrioides
Senecio bisseratus	LAMIACEAE
Senecio glomeratus	Prostanthera lasianthos
Senecio linearifolius	LAURACEAE
Senecio minimus	Cassytha pubescens
Senecio quadridentatus	MALVACEAE
CAPRIFOLIACEAE	Asterotrichion discolor
Sambuxus gaudichaudiana	MIMOSACEAE
CAMPANULACEAE	Acacia dealbata
Wahlenbergia gracilis	Acacia gunnii
Wahlenbergia gymnoclada	Acacia melanoxylon
Wahlenbergia littoricola	Acacia terminalis
Wahlenbergia stricta	Acacia verniciflua
CARYOPHYLACEAE	Acacia verticillata var. vert.
Stellaria flaccida	MYRTACEAE
CASUARINACEAE	Eucalyptus amygdalina
Allocasuarina littoralis	Eucalyptus globulus ssp.
CRASSULACEAE	globulus
Crassula sieberana	Eucalyptus obliqua
DROSERACEAE	Eucalyptus tenuiramis
Drosera peltata ssp auriculata	Eucalyptus viminalis
EPACRIDACEAE	Leptospermum scoparium
Astroloma humifusum	OXALIDACEAE
Epacris impressa	Oxalis perennans
Leucopogon ericoides	PITTOSPORACEAE
Leucopogon virgatus	Billardiera longiflora
Lissanthe strigosa	Bursaria spinosa
Sprengelia incarnata	Pittosporum bicolor
Styphelia adscendens	Rhytidosporum procumbens
EUPHORBIACEAE	POLYGALACEAE
Amperea xiphoclada	Comesperma volubile
FABACEAE	PROTEACEAE
Aotus ericoides	Banksia marginata
Bossiaea prostrata	Lomatia tinctoria
Daviesia ulicifolia	Persoonia juniperina
Dillwynia sericea	RANUNCULACEAE

Indigofera australia Oxylobium ellipticum	Clematis aristata
Community	**Community**
DICOTYLEDONS	**MONOCOTYLEDONS**
RHAMNACEAE	CYPERACEAE
Pomaderris apetala	Carex breviculmis
Pomaderris eliptica	Gahnia radula
ROSACEAE	Isolepis cernua
Acaena novae-zelandiae	Isolepis inundata
RUBIACEAE	Lepidosperma elatius
Coprosma hirtella	Lepidosperma ensiforme
Coprosma quadrifida	Lepidosperma laterale
Opercularia varia	Schoenus apogon
RUTACEAE	IRIDACEAE
Zieria arborescens	Diplarrena moraea
SANTALACEAE	JUNCACEAE
Exocarpus cupressiformis	Juncus bufonis
Leptomeria drupacea	Juncus pallidus
SCROPHULARIACEAE	Juncus planifolius
Veronica calycina	Juncus flaccida
STACKHOUSIACEAE	LILIACEAE
Stackhousia monogyna	Dianella breviculmis
STYLIDIACEAE	Dianella revoluta
Stylidium gramnifolium	Dianella tasmanica
THYMELIACEAE	Drymophila cyanocarpa
Pimelea drupacea	ORCHIDACEAE
Pimelea humilis	Caladenia gracilis
Pimelea linifolia ssp.linifolia	Calochilus robertsonii
TREMANDRACEAE	Chiloglottis gunnii
Tetratheca labillardierei	Chiloglottis grammata
VIOLOACEAE	Chiloglottis triceratops
Viola hederacea	Glossodia major
	Microtis unifolia
	Pterostylis aff. longifolia- all forms
	Thelymitra rubra
	Thelymitra sp.
	POACEAE
	Danthonia setacea
	Danthonia tenuior
	Deyeuxia benthamiana
	Deyeuxia contracta
	Deyeuxia monticola
	Deyeuxia quadriseta
	Dichelachne rara
	Ehrhata distichophylla
	Ehrhata stipoides
	Poa labillardierei
	Poa rodwayi
	Poa sieberiana
	XANTHORRHOEACEAE
	Lomandra longifolia

Source: North, A., 1997.

Appendix 2 Fauna within the Sandy Bay Catchment

FAUNA WITHIN THE SANDY BAY CATCHMENT	
MAMMALS	
Common Name	**Species**
Echidna	***Tachyglossus aculeatus***
Eastern Quoll	***Dasyurus viverrinus***
Southern Brown Bandicoot	***Isoodon obesulus***
Eastern Barred Bandicoot	***Peramelesgunnii***
Dusky Antechinus	***Antechinus stuartii***
Little Pygmy Possum	***Cercartetus lepidus***
Eastern Pygmy Possum	***Cercartetus nanus***
Common Ringtail Possum	***Pseudecheirus peregrinus***
Common Brushtail Possum	***Trichosurus vulpecula***
Long-nosed Potoroo	***Potorous tridactylus***
Tasmanian Bettong	***Bettongia gaimardi***
Red-bellied Pademelon	***Thylogale billardieri***
Bennets Wallaby	***Macropus rufogtiseis***
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***
Eastern Falsistrelle	***Falsistrellus tasmaniensis***
Little Forest Bat	***Vespadelus vulturnis***
Southern Forest Bat	***Vespadelus regulus***
Large Forest Bat	***Vespadelus darlingtoni***
Rabbit	***Oryctolagus cuniculus***
Cat	***Felis catus***

BIRDS	
Common Name	**Species**
Pacific Black Duck	***Anas superciliosa***
White-faced Heron	***Ardea novaehollandiae***
Brown Falcon	***Falco berigora***
Masked Lapwing	***Vanellus miles***
Pacific Gull	***Larus pacificus***
Kelp Gull	***Larus dominicus***
Common Bronzewing	***Phaps chalcoptera***
Brush Bronzewing	***Phaps elegans***
Green Rosella	***Platycercus caledonicus***
Swift Parrot	***Lathamus discolor***
Pallid Cuckoo	***Cuculus pallidus***
Fan-tailed Cuckoo	***Cuculus pyrrophanus***
Horsefields Bronze-Cuckoo	***Chrysococcyx basalis***

Shining Bronze-Cuckoo	***Chrysococcyx lucidus***
Masked Owl	***Tyto novaehollandiae***
Southern Boobook	***Ninox novaeseelandiae***
Tawny Frogmouth	***Podargus strigoides***
Australian Owlet-nightjar	***Aegotheles cristatus***
Superb Fairy Wren	***Malurus cyaneus***
Spotted Pardalote	***Pardalotus punctatus***
Striated Pardalote	***Pardalotus striatus***
Tasmanian Scrubwren	***Sericornis frontalis***
Brown Thornbill	***Acanthiza pusilla***
Tasmanian Thornbill	***Acanthiza ewingii***
Yellow Wattlebird	***Anthochaera paradoxa***
Yellow-throated Honeyeater	***Lichenostomus falvicollis***
Strong-billed Honeyeater	***Melithreptus validrostris***
Black-headed Honeyeater	***Melithreptus affinis***
Crescent Honeyeater	***Phylidonyris pyrrhoptera***
New Holland Honeyeater	***Phylidonyris novaehollandiae***
Eastern Spinebill	***Acanthorhynchus tenuirostris***
Scarlet Robin	***Petroica multicolor***
Flame Robin	***Petroica phoenica***
Pink Robin	***Petroica rodinogaster***
Dusky Robin	***Melanodrynas vittata***
Golden Whistler	***Pachycephala pectoralis***
Olive Whistler	***Pachycephala olivacea***
Grey Shrike-thrush	***Collurincla harmonica***
Satin Flycatcher	***Myiagra cyanoleuca***
Grey Fantail	***Rhipidura fuliginosa***
Balck-faced Cuckoo-shrike	***Coracina novaehollandiae***
Dusky Woodswallow	***Artamus cyanopterus***
Grey Butcherbird	***Cracticus torquatis***
Black Currawong	***Strepera fuliginosa***
Grey Currawong	***Strepera versicolor***
Forest Raven	***Corvus tasmanica***
Welcome Swallow	***Hirundo neoxena***
Tree Martin	***Cecropis nigricans***
Silvereye	***Zosterops lateralis***
Bassian Thrush	***Zoothera dauma***
Blackbird	***Turdus merula***

REPTILES AND AMPHIBIANS	
Common Name	**Species**
Mountain Dragon	Tympanocryptis diemensis
Three-lined Skink	Bassiana duperryi
She-oak Skink	Cyclodomorphus casuarinae
Delicate Skink	Lampropholis delicata
White's Skink	Egernia whitei
Tasmanian Tree Skink	Niveoscincus pretiosus
Metallic Skink	Niveoscincus metallicus
Ocellated Skink	Niveoscincus ocellatus
Southern Grass Skink	Pseudemoia entrecasteauxii
Blotched Blue-tongue	Tiliqua nigrolutea
Lowlands Copperhead	Austrelaps superbus
White-lipped Snake	Drysdalia coronoides
Tiger Snake	Notechis scutatis
Common Froglet	Crinia signifera
Brown Tree Frog	Litoria ewingii

Appendix 3 Community Survey

SANDY BAY RIVULET CATCHMENT COMMUNITY SURVEY

All completed surveys that are returned by August 10, 2001 will enter the draw for a chance to win a guided tour of the Wishing Well Waterway for 4 people. The draw will take place at the Hobart Council Centre on Monday August 13, 2001. If you wish to enter the draw, please provide your name and telephone number so that you can be contacted.

NAME:_____
ADDRESS:_____
PHONE NUMBER_____

Please indicate your answer by ticking the designated box ☐

1. Do you or any member of your family use/value the Sandy Bay Rivulet?

   Yes ☐
   No ☐

2. If yes, for what purpose do you most value the Sandy Bay Rivulet? Please order in preference from 1-5, with 1 representing the value of most importance.

   Aesthetics ☐
   Recreation/Play ☐
   Education ☐
   History/Culture ☐
   Flora and Fauna ☐
   Other ☐_____

3. Please indicate the issues that concern you about the Sandy Bay Rivulet. Please order in preference from 1- 6.

Flooding ☐
Water quality ☐
Personal/Property safety ☐
Appearance ☐
Regular Maintenance ☐
Cultural Heritage ☐
All of the above ☐
Other
☐_____

_____

4. As a community member would you support the development of a 'Rivulet Care Group'?

Yes ☐
No ☐
Unsure ☐

5. If a 'Rivulet Care Group' was established, which of the following projects would you be interested in?

Managing your own backyard section of the rivulet ☐
Managing your own and neighbours' sections of the rivulet ☐
Writing Newsletters for the community ☐
Distributing newsletters within the community ☐
Becoming a 'Rivulet Watchdog' and notifying Council of sudden changes e.g. rubbish dumping, vandalism. ☐
Planting trees along the banks of the rivulet ☐
Removing invasive weeds from rivulet banks ☐

None of the above ☐
All of the above ☐
Other _____

6. Are you aware of the Waterworks Valley Landcare Group?

Yes ☐
No ☐
Current Member ☐

7. Would you like to receive more information about the Waterworks Valley Landcare Group?

Yes ☐
No ☐

8. In your opinion, what do you consider to be a major priority in terms of the maintenance of Sandy Bay Rivulet? Please order in preference from 1- 4.

Flood Control ☐
Improving Water Quality ☐
Effective Weed Control ☐
Routine Council Inspections ☐
Other ☐
_____

9. Would you be interested in learning more about the Sandy Bay Rivulet environment?

Yes ☐
No ☐

Unsure ☐

10. If yes, which of the following workshop types would you be interested in attending?

Guided tour of the Rivulet ☐
Water quality monitoring ☐
Catching and Identifying Water 'Critters' ☐
Looking after your rivulet backyard ☐
Tree planting along the rivulet ☐

11. Do you have any further suggestions that may lead to the improved management of Sandy Bay Rivulet?

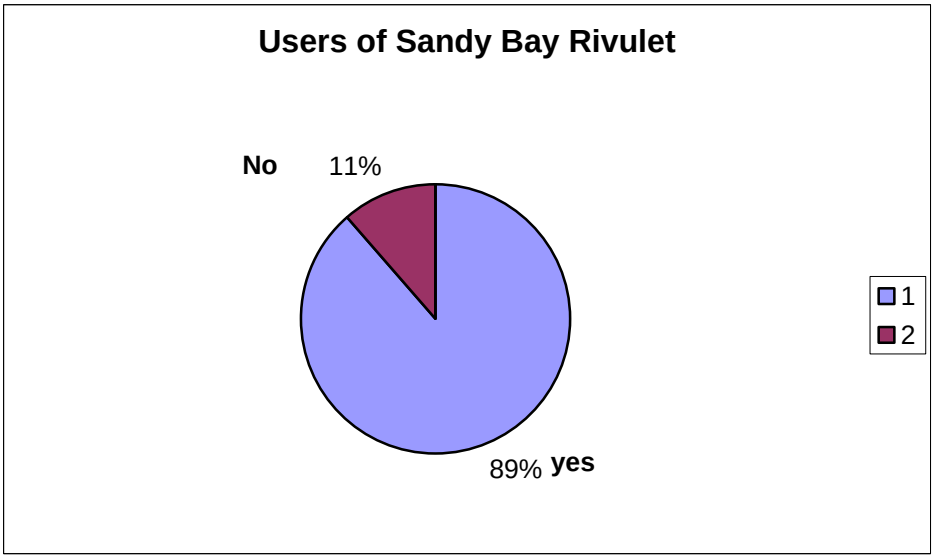
Yes ☐
No ☐

12. If yes, please indicate how the current management of the rivulet can be improved.

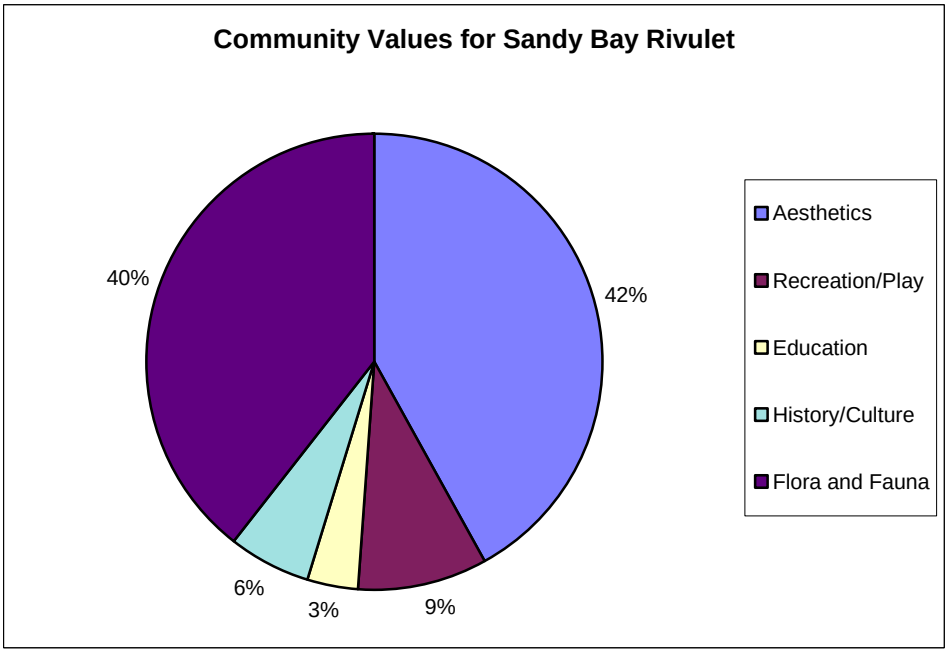
_____
_____
_____
_____
_____
_____

For further enquiries please contact:
Kirsten Leggett
Sandy Bay Rivulet Catchment Planner
Hobart City Council
Phone: 62382106
Email: leggettk@mailnet.hcc.tas.gov.au

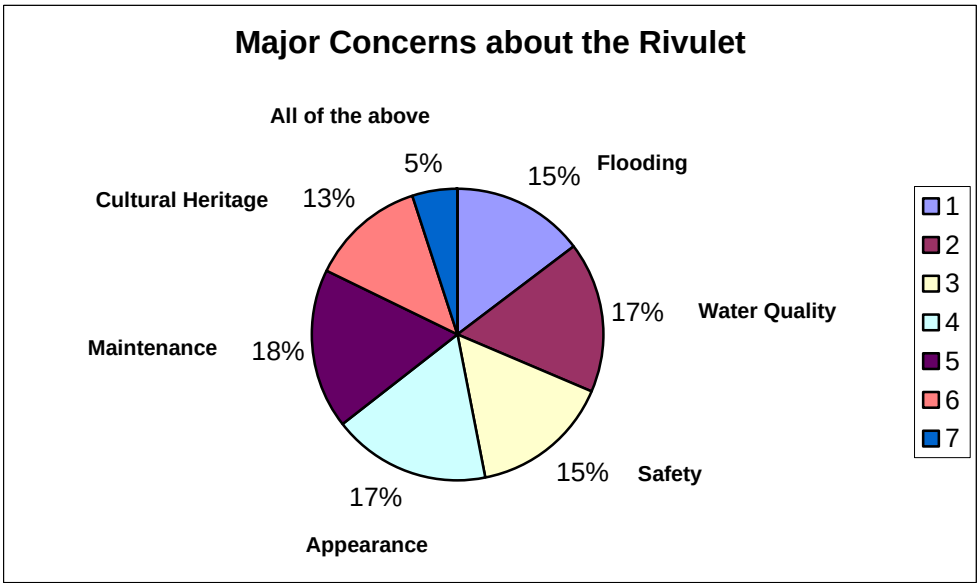
Question 1:
Do you or any member of your family use/value the Sandy Bay Rivulet?



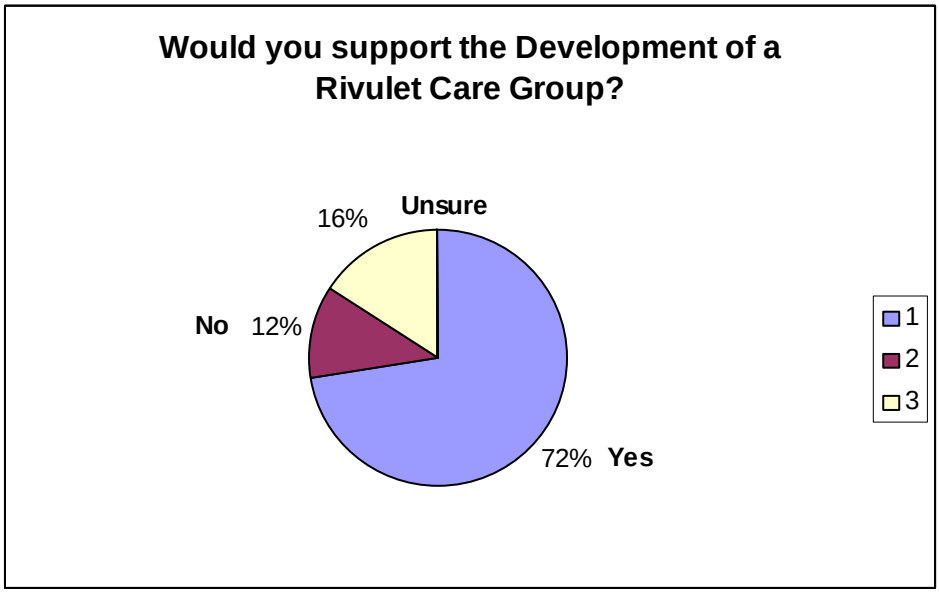
Question 2:
If yes, for what purpose do you most value the Sandy Bay Rivulet?



Question 3:
Please indicate the issues that concern you about the Sandy Bay Rivulet.

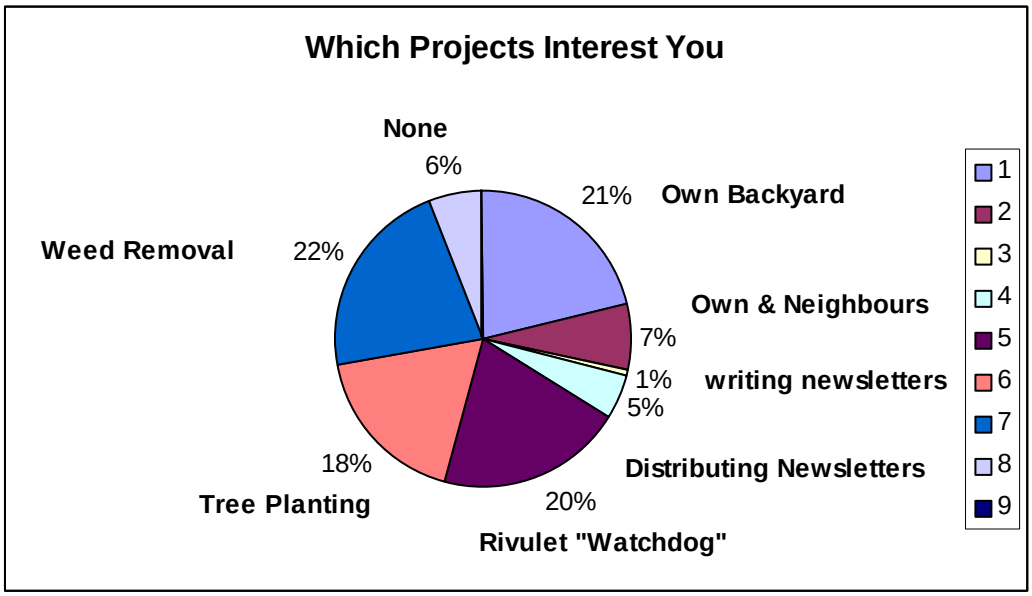


Question 4:
As a community member would you support the development of a 'Rivulet Care Group'?



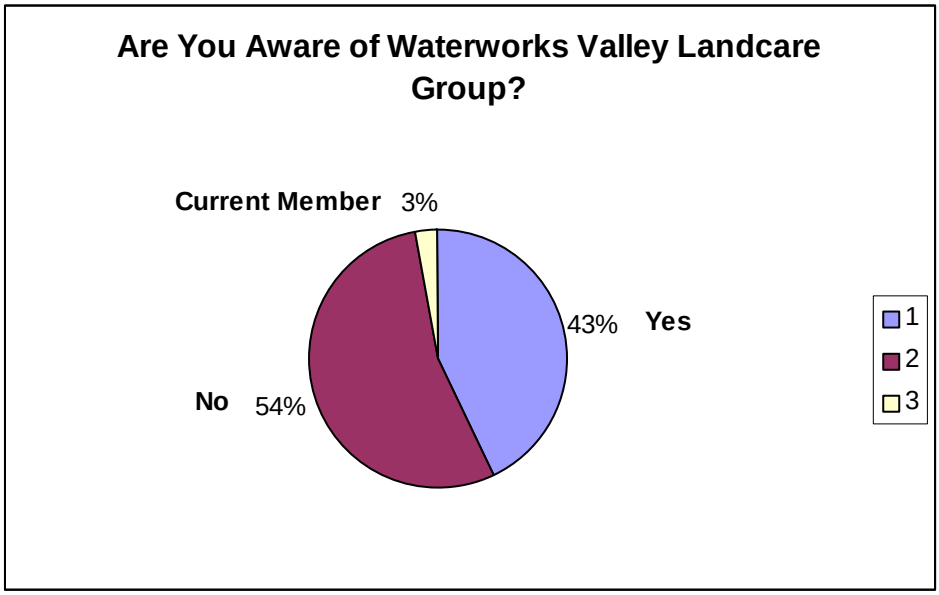
Question 5:

5. If a 'Rivulet Care Group' were established, which of the following projects would you be interested in?



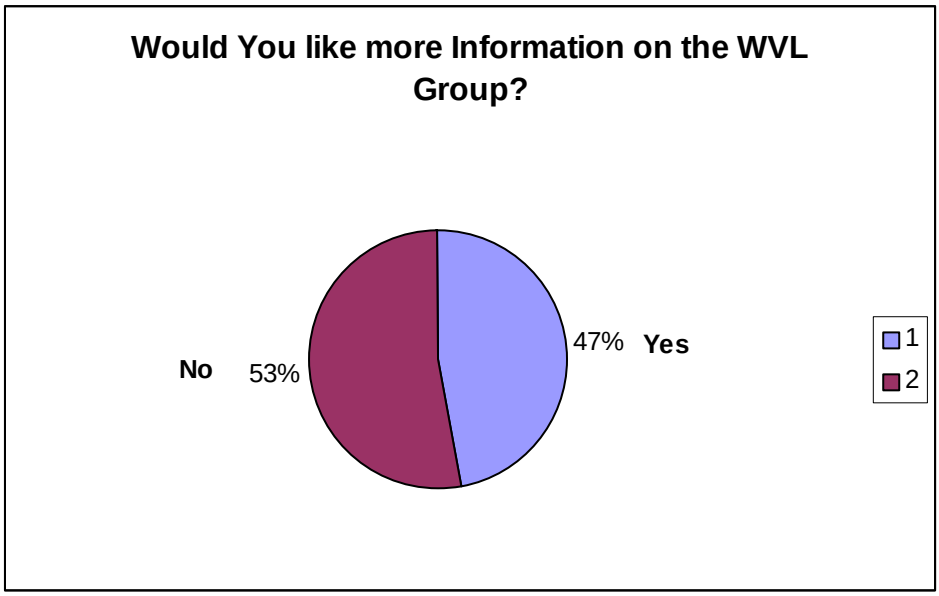
Question 6:

6. Are you aware of the Waterworks Valley Landcare Group?



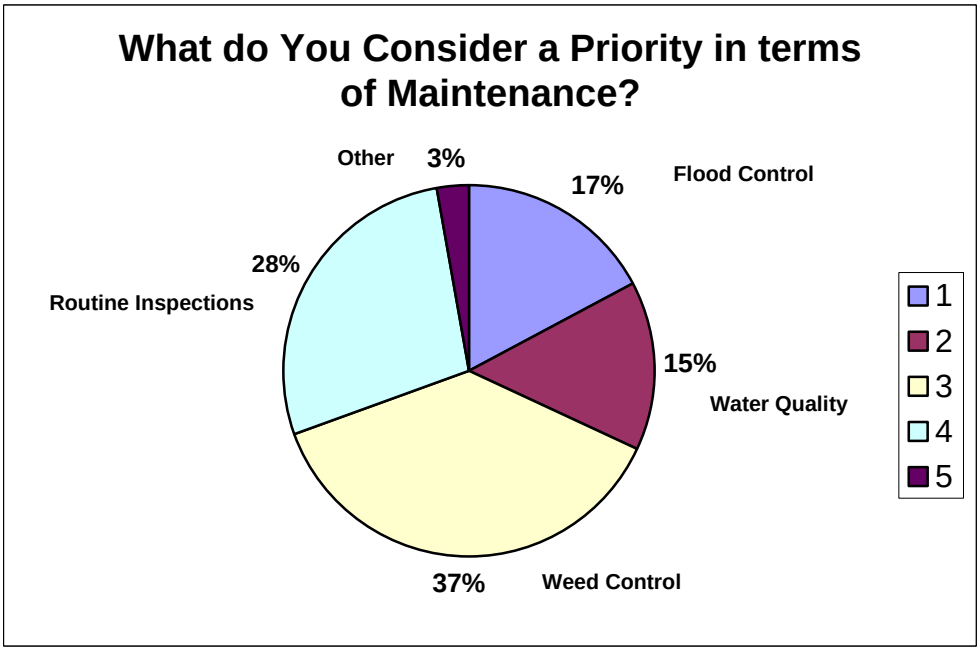
Question 7:

7. Would you like to receive more information about the Waterworks Valley Landcare Group?

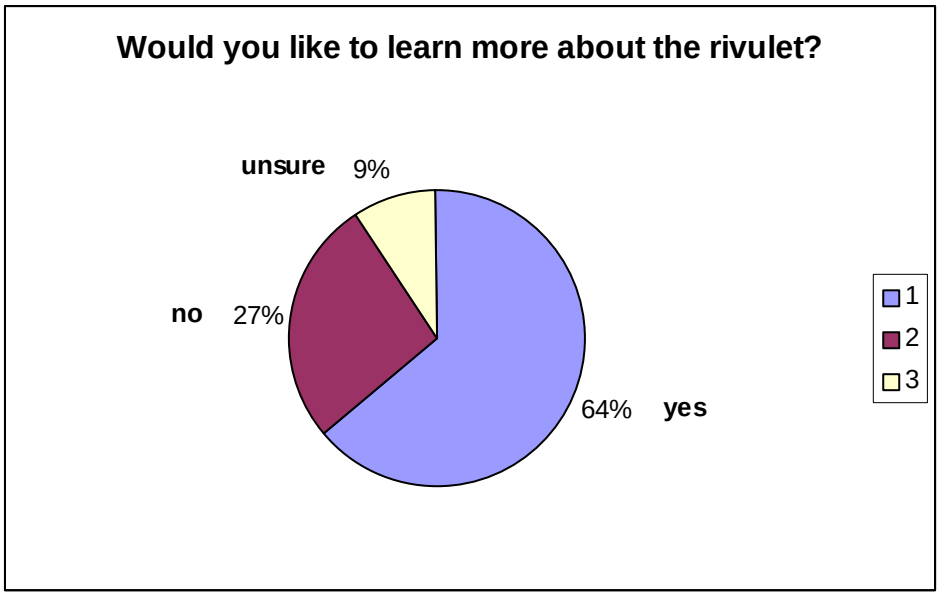


Question 8:

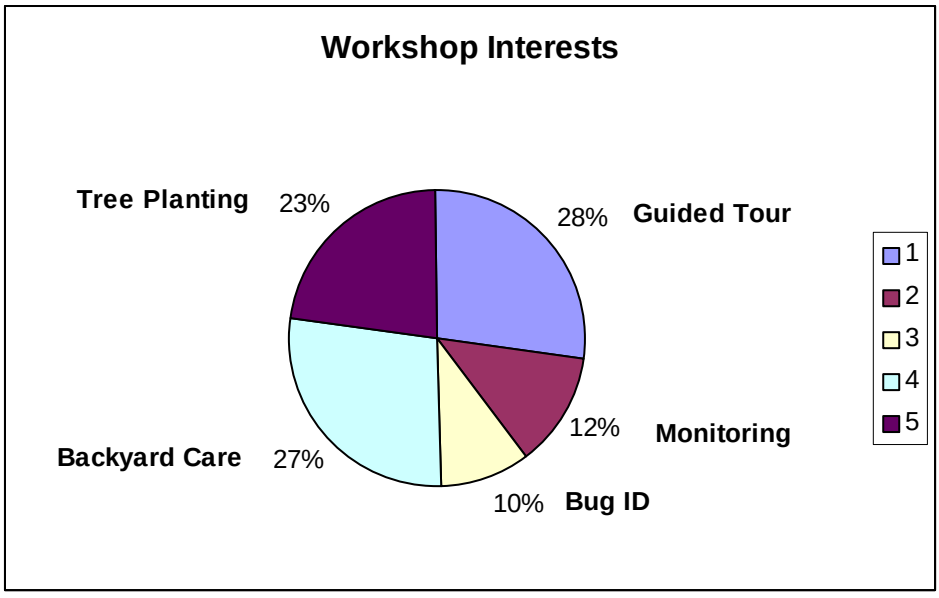
In your opinion, what do you consider to be a major priority in terms of the maintenance of Sandy Bay Rivulet?



Question 9:
Would you be interested in learning more about the Sandy Bay Rivulet environment?



Question 10:
If yes, which of the following workshop types would you be interested in attending?



Appendix 4 Project Data Sheets

HOBART
CITY COUNCIL

PROJECT DATA SHEET 1

New Asset Project selection for 2002/2003 Budget

PROJECT TITLE **VALUE ENHANCEMENT AND PROTECTION OF SANDY BAY RIVULET**

PROJECT DETAILS

Description	To enhance and protect the existing natural values of the Sandy Bay Rivulet held by community members, working interest groups and schools in the rivulet area.
Background	A recent community survey conducted by Hobart City Council revealed that members of the community who use and live along the Sandy Bay Rivulet value the area in a number of ways. The highest value among residents was recorded for the aesthetics of the rivulet and natural value at 42%, followed by the value for recreation and play at 40%. From these results and further community consultation members of the community expressed interest in becoming further involved in the care and maintenance of their own backyard section of Sandy Bay Rivulet (21%).
Outcomes	To ensure the long-term sustainability of the Sandy Bay Rivulet, it is crucial to involve members of the immediate community in the rivulets long-term care and management. It is important to acknowledge the values held by the community and include those values in any long-term management planning. The involvement of community members in the rivulet's management can be organised on a large scale where volunteer groups are organised and implemented, or alternatively on a smaller scale where individuals can contribute to long-term management strategies by focusing rehabilitative efforts on their own backyard section of the rivulet. A "Backyard Rivulet Care Group" could be established for these people and guidance given on rehabilitative action by Council staff.
Organisational Impacts	Through the involvement of community members in the long-term management of Sandy Bay Rivulet, individuals have a better understanding of the natural values and adopt a stewardship ethic towards the rivulet environment. The community's assistance in backyard rivulet care provides the Council with an important asset for a transition towards a more sustainable future.
File	
First year listed	2002
Status	Awaiting approval

PROJECT RANKING	4
Justification	To work towards a more environmentally sustainable future

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
$			
Other funding			

Future funding	[redacted]
External funding	
Possible staging	
Budget function	
Position in programme	

STRATEGIC PLAN

Key Area	Key Area 6 - Environmental Management
Strategy	To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues
Priority Action	To be decided by Project Manager

HOBART
CITY COUNCIL

PROJECT DATA SHEET 2

New Asset Project selection for 2003/2004 Budget

PROJECT TITLE **LITTER REDUCTION AND CONTROL IN THE SANDY BAY RIVULET**

PROJECT DETAILS

Description	To reduce and control litter and associated pollutants entering the Sandy Bay Rivulet via the stormwater system.
Background	Recent investigations by Hobart City Council into stormwater pollution control devices has led to the installation and trial of new litter treatment devices in the Hobart CBD area. Results from these trials have provided Hobart City Council with the necessary information and supporting evidence to recommend the installation of these devices in other problem areas within Hobart. Sandy Bay Rivulet is subject to high litter loads and pollutants due to the urban nature of the lower catchment and close proximity to the city area. Previous attempts to capture litter and sediment in Sandy Bay Rivulet have proved unsuccessful and is therefore a suitable location to trial products already known to effectively control and reduce litter pollution. Refer to attachments on available devices.
Outcomes	A reduction in litter pollution and contaminants entering Sandy Bay Rivulet ensures a healthier stream environment for aquatic stream fauna and marine life in the Derwent Estuary. The presence of litter treatment devices and accompanying signs will alert members of the public to stormwater issues and ways in which we can all help to minimise stormwater pollution.
Organisational Impacts	Through the installation of litter treatment devices, the concentration of pollutants entering the Sandy Bay Rivulet will be dramatically reduced resulting in a cleaner and healthier urban waterway. Council's involvement in the installation and promotion of these products will assist in the transition towards a more sustainable future.
File	
First year listed	2003
Status	Awaiting aproval

PROJECT RANKING	2
Justification	Is consistent with Hobart City Council's Strategic Plan 2001-2005

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
	[redacted]		
Other funding			
Future funding			
External funding			
Possible staging			

Budget function	Hydraulic Infrastructure
Position in programme	Awaiting to commence

STRATEGIC PLAN

Key Area	Key Area 2 – City Infrastructure Management Key Area 6 – Environmental Management
Strategy	Key Area 2 – To provide and maintain a high standard of infrastructure for the community including water supply, sewerage, stormwater drainage, roadways, parks, public spaces and recreational and sporting facilities. Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manager

Project Data Sheet 2 (a): ECOSOL FILTER

Ecosol Litter Trap: Suitable for small catchment areas with low leaf litter

Project Data Sheet attachment (b): FLOATING BOOMS

Examples of Floating Booms to be used in lower Sandy Bay Rivulet

Project Data Sheet attachment (C): ENVIROPOD LITTER TRAP DEVICE

Enviropod basket frame during installation

Enviropod installed and capturing litter

HOBART
CITY COUNCIL

PROJECT DATA SHEET 3

New Asset Project selection for 2002/2003 Budget

PROJECT TITLE **DEVELOP AND MAINTAIN A REGULAR WATER QUALITY MONITORING PROGRAM FOR THE SANDY BAY RIVULET**

PROJECT DETAILS

Description	Establish a strategic water quality monitoring program with local schools, residents, Waterwatch and Landcare groups in the Sandy Bay Rivulet area. Information obtained through monitoring will be included in a database that is accessible to the public.
Background	Recent investigations into Sandy Bay Rivulet reveal that there are a number of continuous and spontaneous monitoring events that take place in the rivulet by various groups. The data obtained from such monitoring events is usually used for individual purposes and is not generally made available for public use.
Outcomes	The collation of water quality monitoring data from various groups or individuals will allow for the development of a water quality monitoring database specific to Sandy Bay Rivulet. This information will be made available for public use, including schools, university, Waterwatch, Landcare groups and Hobart City Council. As a result the interested community will be better informed about water quality issues and will have an overview of the water quality status of the rivulet throughout the catchment area. Individuals and groups who become involved in the monitoring process will develop a better understanding about water quality issues, the associated causes of poor water quality and ways in which the community can respond in order to improve water quality.
Organisational Impacts	A water quality monitoring program will need to be developed and can be a program that can be applied to other rivulets and watercourses throughout Hobart. The initial development of the program will require the assistance of existing water quality monitoring groups to ensure that sampling methods and locations are standardised.
File	
First year listed	2002
Status	Awaiting approval

PROJECT RANKING	4
Justification	To improve and maintain water quality in the Sandy Bay Rivulet and inform members of the public about ways in which we can all contribute to improved water quality.

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
	[redacted]	[redacted]	[redacted]
Other funding	[redacted]		
Future funding	[redacted]		
External funding	[redacted]		

Possible staging	1st year 2002-2003 for initial establishment of monitoring program, then ongoing
Budget function	Hydraulic Engineering
Position in programme	1st year – awaiting initial set up and available resources

STRATEGIC PLAN

Key Area	Key Area 6 – Environmental Management
Strategy	Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manger

HOBART
CITY COUNCIL

PROJECT DATA SHEET 4

New Asset Project selection for 2004/2005 Budget

PROJECT TITLE **TO CONTROL AND MANAGE NON-NATIVE VEGETATION IN NATURAL AREAS OF THE SANDY BAY RIVULET CATCHMENT**

PROJECT DETAILS

Description	To control and manage non-native species within the Sandy Bay Rivulet Catchment to prevent the spread of exotic garden species into natural areas through a weed management strategy.
Background	Numerous weed species exist in the catchment area as a result of seed dispersion via animals, wind and disturbance. These weed species thrive and tend to displace native plant communities. As a result, native bird species are seen to disappear from areas where non-native species dominate, thus changing the dynamics of the ecosystem. Sandy Bay Rivulet residents value the rivulet and surrounds for its native flora and fauna and have expressed concerns over the disappearance of numerous plant and animal species from the area. The dumping of garden refuse on the banks of the rivulet is problematic in many locations along the length of the rivulet, and is often the catalyst for excessive weed growth in otherwise natural areas.
Outcomes	The development of a weed management strategy for Sandy Bay Rivulet will promote awareness among members of the community about garden escapees and their impact on the natural environment. With an increased awareness and active participation in rehabilitation the community will see the return of native plant and animal species to the area resulting in a more ecologically balanced environment. The weed management strategy will address important issues such as backyard dumping of garden refuse and effective weed control techniques. The Strategy will be made available for the general community and will include a weed map of the rivulet area highlighting weed affected zones and the priorities for management.
Organisational Impacts	A weed survey will be conducted in the first stages of the project from which a map is generated outlining the distribution of weed species in the rivulet catchment area. Once the map is finalised a strategy will be developed to control and manage problem areas. Extensive community consultation will be required in order to ascertain any existing management plans that may exist for vegetation within the catchmnet. The community will play an important role in the development of the strategy.
File	
First year listed	2004
Status	Awaiting approval

PROJECT RANKING	4
Justification	To increase biodiversity along the banks of the rivulet and to effectively control and manage weed species within the catchment to prevent the displacement of native plant communities.

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
Other funding			
Future funding			
External funding			
Possible staging	1st year – The development of a weed distribution map for the rivulet catchment area and Weed Management Strategy ongoing consultation and monitoring with community groups		
Budget function	Hydraulic Engineering and Parks & Landscape		
Position in programme	Not yet commenced		

STRATEGIC PLAN

Key Area	Key Area 5 – Land Use Planning and Development Key Area 6 – Environmental Management
Strategy	Key Area 5 - To develop and implement a sustainable development model that promotes a balance between investment, development and the use of land through integrated urban planning, resource management and recognition of the economic, environmental and social values of the city. Natural Resource Management Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manager