WATERSHED Torbay

Watershed Torbay Catchment Restoration Plan

APRIL 2005

PREFACE

The Watershed Torbay Catchment Restoration Plan is prepared following community concern about the deteriorating health of the Torbay catchment located on the South Coast of Western Australia. The Torbay Catchment Group, in partnership with the Department of Environment, was successful in application for funding through the National Rivers Consortium as one of two demonstration catchments in Australia. The key expected demonstration value of the Watershed Torbay project was to develop an understanding of catchment processes through research and community consultation leading to preparation of a whole of catchment management plan for restoration or environmental health values, particularly for waterways and wetlands.

The Restoration Plan is based on a partnership approach linking community interest with government, industry and research organisations. Documentation of the plan that follows here is presented in a strategic format that is intended to be used by the partner organisations to set priorities, attract funding and implement the actions of the plan.

Section A provides background information about the catchment, the community and the range of issues to be addressed to improve the health of the catchment.

Section B provides the strategic framework for targeted investment in resource condition change. Analysis of relevant research information links the aspirational goals and objectives identified by the community with Resource Condition Targets for seven Management Themes. The RCT's provide a measure of what may reasonable be expected to be achieved within approximately 20 years through investment into the proposed actions.

Section C identified the actions required. These are listed in order to achieve Management Action Targets. The MAT's are set for approximately 5 years and are intended to focus the proposed actions on achievement of resource condition change.

Section D provides a framework and set of indicators for monitoring and evaluation of the Restoration Plan. The framework is focused on processes of adaptive management.

The Torbay Catchment Group will lead in implementation of the Watershed Torbay Catchment Management Plan through arrangements with its partner organisations.

FOREWORD

We all love living in the Torbay area with its temperate climate, safe environment, wonderful coastline and relaxed rural lifestyle. Torbay has the advantages of being close to services in both Albany and Denmark while not being threatened by any large scale development. Our clean, fresh air is regarded as amongst the best in the world, free of industrial pollution and full of goodness from the Southern Ocean air flows. Many of us enjoy the close contact with nature, being able to grow some of our own food, having safe space around us and for our children to grow up in, as well as the caring friendliness of neighbours and the local community.

We must recognise that some of our past and current practices are impacting on the quality of the environment. There are problems with poor water quality in our creeks, wetlands, lakes and inlets leading to increasing algal blooms; damage from recreational use especially on the fragile coastal hills, erosion in drains and creeks, acidity and water logging of soils and salinity in the upper catchment.

There are additional pressures likely in the near future. The Marbelup Brook has been identified as the preferred next major source of public water supply for the City of Albany. The Albany irrigated tree farm, located in the upper catchment, is reaching its capacity to treat the City of Albany's waste water. Increasing numbers of people are moving into the area putting more pressure on resources which demands good planning. As well, there are increasing sources of nutrients from agriculture and urban development.

It is important to recognize the valuable assets in the catchment, the resources we use, the aspects we treasure and our historical links. If we truly value the assets, we need to work out how to protect them and to urgently start to repair the often unforeseen damage that has occurred in the past and before things get any worse.

This Watershed Torbay Catchment Restoration Plan is an attempt to do just that. It has been the result of the work of a dedicated group of local residents and agency representatives working together over the past four years with significant input from many of you. Thanks go to the Watershed Torbay Steering Committee, the Technical Advisory Group, the Drainage Management Group, the Torbay Catchment Group and the support team who had to carry out most of the tasks.

A plan is good: implementing the plan is far better! Now is the time for each one of us to start to make things happen. This plan is for everyone and I really encourage all in the community to come on board and help restore the catchment to a healthier condition. We can then be really proud of where we live combined with the satisfaction of the knowledge that we are passing on a better environment to future generations. After all, commitment from each one of us and just an hour or so out of our often hectic lifestyle, would all mount up to making a huge difference!

Andrew Marshall Chair, Torbay Catchment Group Chair, Watershed Torbay Community Steering Committee

ACKNOWLEDGEMENTS

The Watershed Torbay project had its genesis in mid 2000, when one of the officers in the South Coast Region of the Water and Rivers Commission, Jody Oates, returned from attending a national conference. Jody excitedly came into my office reporting the opportunity being provided by the National Rivers Consortium to establish waterways restoration demonstration catchments throughout Australia, and its desire to have one in WA.

After many conversations, competition from other catchments, and almost a year of planning, Torbay was eventually nominated by the Water and Rivers Commission to the Consortium.

The Commission had been working with the Torbay Catchment Group for several years trying to help facilitate resolution of communication issues about the Torbay bar management and algal blooms. The Group enthusiastically welcomed the opportunity to participate in the project, and this was confirmed through an early visit by Phil Price, former CEO of Land and Water Australia, and myself to the Torbay Catchment Group.

The formal project submission was prepared by Julie Pech, Luke Pen and myself, and eventually the project was signed off and formalised through a contract agreement in Mid 2001.

The entire Watershed Torbay Project owes its success to very many people, not least of which is David Weaver from the Department of Agriculture who suggested the great name for the project.

The project was undertaken through extensive discussion and consultation with community members and agencies. A Steering Committee comprising community members, representatives of the Torbay Catchment Group, and State and Local government agencies, was the key overseeing group. The Torbay Catchment Group was the major driver of on-ground works and community consultation. Without the motivation and commitment of these groups, the project would not have been successful.

I sincerely thank all members of the Torbay Catchment Group, members of the Watershed Torbay project steering committee, members of the drainage management group, and other community participants who have been involved in all aspects of the project over the past 4 years. A particularly thank you to John Simpson, first Chairman of the Steering Committee, and Andrew Marshall, Chairman of the Torbay Catchment Group, who also Chaired the Steering Committee after John resigned due to ill health.

There are two amazing people who have contributed strongly to the ethic, approach and outcomes of the project, Julie Pech and Louise Duxbury. Julie provided the project and catchment support role, and her supreme organisational skills, knowledge of the catchment and community links were vital to the project. Louise was the community participation and communications coordinator, studying her PhD while working part time in this role. Louise's insights on best practice community change and her wonderful open and participatory approach were very welcomed by the community, scientists and project team.

There has been strong input from a range of agency personnel, science and research staff throughout the project, both through the Technical Advisory Group and individual project components. Their cooperative and partnership style and support was essentially in achieving

good outcomes for the project and catchment, and I really appreciate the good advice and guidance given. In particular, Andrew Maughan had on ongoing and pivotal role in establishing monitoring, supporting a range of research projects, and modelling drainage scenarios. The project contribution, cooperation, and advice from both the Department of Agriculture and Water Corporation staff was very important.

Finally a thank you to Viv Read, our patient and very competent consultant who prepared both the drainage report and the final draft of the restoration plan.

Naomi Arrowsmith, Principle Investigator and Project Manager, Watershed Torbay

EXECUTIVE SUMMARY

The Torbay Catchment is located on the south coast of Western Australia between the towns of Albany and Denmark where land use change has led to community concern about deteriorating health of the catchment. The Torbay Catchment Group formed in response to these concerns. The group has developed a vision for their preferred future of the catchment:

> **".. to have an environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways"**

This vision provides the lead for research and management planning in the catchment.

'Watershed Torbay' was initiated in June 2001 as an integrated whole of catchment waterways restoration project. The project aimed to undertake research, community and stakeholder consultation, and preparation of a restoration plan order to achieve a balance of environmental, social and economic outcomes for the catchment. The National Rivers Consortium invested in research and planning for catchment restoration through Land and Water Australia (LWA) with State funding contributions from the Department of Environment (DoE), Department of Agriculture (WADA) and the Water Corporation (WC).

The Watershed Torbay Catchment Restoration Plan provides strategic direction for long term resource condition change through targeted investment into prioritised actions set within a 3-year Implementation Program. The Restoration Plan provides a whole of catchment approach to management based on the integration of research information, local knowledge and the values held by the community. Community input has been critical in the decision making process, with the community as the 'driver' of restoration priorities and actions, with a strong science underpinning.

The key environmental issues in the catchment are related to the condition of the waterways and wetlands. The natural drainage system has been significantly altered and is now dependent upon manual operation to control wetland water levels and the potential for flooding. Lake Manarup has been managed for flood mitigation purposes rather than as a wetland. Lake Powell and Torbay Inlet are now two wetlands with the highest occurrence of algal blooms in Western Australia. Nutrients from a small number of point sources are a part of the cause, but the extensive sandy soils indicate that diffuse sources of nutrient are the most significant cause. There is recent concern about the extent of impacts caused by acid sulphate soils.

While farming is the dominant land use in the catchment, almost 80% of landholders earn most of their income off-farm. Many properties are small with non-viable farming enterprises. There are some commercial tree plantations although the community is resistant to an increase in this land use. Treated waste water sourced from Albany is discharged to one tree farm in the catchment. Water resources for public supply are sought from the Marbelup Brook sub-catchment. Nature conservation values are significant in wetland, bush and coastal habitats.

Through processes of community consultation, seven Management Themes were identified:

1. Algal Blooms and Water Quality
2. Water Quantity
3. Drainage Management
4. Habitat and Biodiversity Management
5. Farming Systems
6. Land Use Planning
7. Education and Communication

These themes provide the basis to development of the Restoration Plan. Broad goals and objectives are identified for each Management Theme.

Natural assets in the catchment are identified for land, water resources, biodiversity and infrastructure and well as cultural and heritage values. These provide a specific focus for targeted investment in catchment management.

The primary expected outcome from the Restoration Plan is improvement in the condition of natural resources. Targets for Resource Condition Change are set for the Management themes considering a period of approximately 20 years.

To achieve resource condition change, targeted actions are proposed for a shorter time period. Management Action Targets are set for medium term achievement.

The Restoration Plan has 16 targets for resource condition change and 33 Management Action Targets. The 3-Year Action Plan (Section C) provides the actions, priorities, estimated costs and role and responsibilities for achieving these targets. While partner organisation contributions are to be arranged through an Investment Plan, the estimate of external funding required for implementation of the 3-year Implementation Plan actions is approximately $1.6m.

The community recognises that full restoration of environmental values in the catchment may not be possible without considerable loss of social and economic values. It is also understood that significant change may take a long time. There is good understanding that management of the natural systems of the catchment involves considerable uncertainty and that many factors may change with time. An Adaptive Management framework is significant to the Restoration Plan to ensure that decisions are based on monitoring and evaluation results. Section D outlines the processes linking M&E to adaptive decision-making and provides a set of indicators to measure change.

Review of the Restoration Plan is required within 3 years for re-investment through a second-phase 3-year Implementation Program.

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Section A

Abbreviations

ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
CALM	Department of Conservation and Land Management
CENRM	Centre of Excellence for Natural Resource Management
CoA	City of Albany
DoE	Department of Environment (formerly Waters and Rivers Commission)
DPI	Department of Planning and Infrastructure
DRF	Declared Rare Flora
FPC	Forest Products Commission
MAT	Management Action Target
N	Nitrogen
NRM	Natural Resource Management
P	Phosphorus
RCT	Resource Condition Target
SCRIPT	South Coast Regional Initiative Planning Team
TAG	Watershed Torbay Technical Advisory Group
TCG	Torbay Catchment Group
TN	Total Nitrogen
TP	Total Phosphorus
TPS	Town Planning Scheme
WADA	Western Australian Department of Agriculture
WALIS	West Australian Land Information System
WRC	Waters and Rivers Commission
WC	Water Corporation

WATERSHED Torbay

Watershed Torbay
Catchment Restoration Plan

SECTION A

PROJECT DESCRIPTION

A1.0 Introduction

A1.1 A National Case Study of Community-based Catchment Management

The Torbay Catchment is located on the south coast of Western Australia between the towns of Albany and Denmark. It is the catchment area to the Torbay Inlet within which there are several small waterways inter-connected through a series of wetlands. The low-lying wetlands were naturally influenced by marine inflow and tidal sequences which are now controlled by a system of drains and constructed flow regulators to reduce flooding of land used for horticulture and associated infrastructure. However, the community and agencies responsible for land and water management have increasing concern about the health of the wetlands and have sought a coordinated catchment-scale approach to manage their landscapes.

'Watershed Torbay' was initiated in June, 2001 to undertake the science, consultation, planning and implementation of a restoration plan program balancing environmental, social and economic outcomes for the future of the catchment. A partnership approach to engaging community, government and others with interest in the wellbeing of the catchment was adopted. The project proposal developed by the lead agency, the West Australian Department of Environment, in conjunction with the Torbay Catchment Group, gained the support of the National Rivers Consortium as a case study in developing community-based approaches to catchment restoration. It is one of several case studies in Australia. Previously, planning for restoration of waterways has focused on sections of streams rather than taking a whole of catchment approach, Watershed Torbay is working across the whole catchment.

The National Rivers Consortium invested in research and planning for catchment restoration through Land and Water Australia (LWA) with State funding contributions from the Department of Environment (DoE), and in-kind contributions from the Department of Agriculture (WADA) and the Water Corporation (WC). The expected outcomes were:

- to show the benefits of stream restoration at the catchment scale with a research
- component to project activities;
- to demonstrate community participation as an essential component;
- to incorporate monitoring and evaluation within ongoing adaptive management processes: and
- to achieve an action oriented learning environment through the collective work of researchers, agencies and community groups.

The project outcomes rest on an approach that values community participation, is committed to forming long term partnerships, uses a civic science approach to research and is committed to adaptive management. The 'Watershed Torbay' project made it possible to develop a Restoration Plan based on research and management for the whole catchment with the community as the 'driver' of restoration priorities and actions. This has occurred through the Torbay Catchment Group in cooperation with agencies responsible for land and water management in the catchment. As part of the commitment to adaptive management a Communication Learning Log has been progressively written during the project to record major steps taken during the four year

Watershed Torbay project. Direct quotes from key leaders from the community and partner agencies are included. The Learning Log is available on the website www.torbay.scric.org and will be available on the CD compiling the information on the Watershed Torbay project.

A1.2 Approach to Restoration Planning

The framework for the Torbay river restoration plan, shown is Figure A1, was adapted from Koehn et al., 2001.

The framework has been important in making the roles of the stakeholders and the research team clear. The key stakeholders - through community workshops, a catchment wide survey and the Watershed Torbay project steering committee and sub committees - have been the major drivers in developing the vision and objectives for the restoration plan.

The technical assistance group and contract researchers have provided information on possible actions to meet the objectives, adding to those suggested by the community and the steering committee. The technical assistance group has provided information about the current state of the catchment and provided a better understanding of how the catchment works. The key role of the technical team has been to give their assessment of how effective the proposed actions would be in working on the desired objectives.

The steering committee, with an emphasis on the community representatives, has then made judgments about how practical the proposed actions would be to implement, and how acceptable they are, that is, how willing landholders would be to undertake proposed actions. The integration of research information, local knowledge and the values held by the community has been critical in the decision making process.

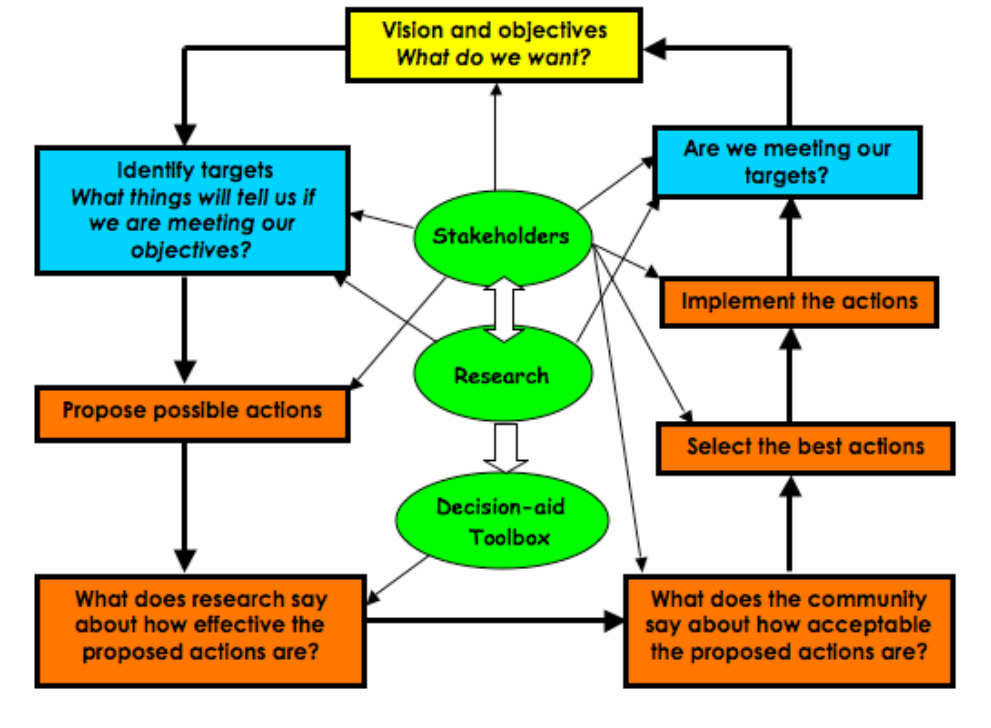


Figure A1 The Torbay Catchment Restoration Plan Framework

Through the project it has been recognised that work on a range of elements of change is needed to support the planning process. Communication work to build pressure for change and develop a shared vision has been undertaken throughout the project. The building of local skills through field days workshops, presentations by researchers and development of trials has been important in developing capacity to change and is a strong element in the Restoration Plan. While the Watershed Torbay project has focused on the preparation of the Restoration Plan, the Torbay Catchment Group has continued to gain financial support to undertake on the ground works. This has been important for maintaining local enthusiasm for catchment repair work. The Restoration Plan is based on the need to keep working on all key elements of change:

- Pressure for Change
- Clear Shared Vision
- Capacity to Change
- Actionable First Steps

The Restoration Plan includes an action plan and monitoring and evaluation framework.

A1.3 Vision for the Future

The vision for the future of the catchment is to have:

".. an environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways" .

The vision represents the aspirations of the community. It recognises differing and changing values within the community where some people are deriving their living through agriculture, horticulture and tourism while others as seeking improved semi-rural lifestyle values. The vision also reflects the importance of ecological systems for life support.

In 1990, the Torbay Waterways Protection Committee was formed in response to concern about outfall of primary treated effluent from Albany's Timewell Road Wastewater Treatment Plant, discharged into Five Mile Creek and Lake Powell. Presentation of a report on the environmental status of the Torbay Catchment was attended by 80 people at a community meeting in 1999 indicating the level of community concern. Following this meeting the Torbay Catchment Group was formed.

The 'Watershed Torbay' project was initiated in 2001 response to community growing concern about declining environmental health within the catchment. The project was formed to demonstrate an integrated approach to land use and natural resource management at a catchment scale.

Commencement of the project was on the basis that it would recognise changing land use and community values and aim to meet community expectations for environmental restoration combined with economic and social benefits.

Three community forums were held within the catchment (at Elleker, Torbay and Redmond) during 2002. The purpose of these was to identify the environmental, social and economic issues for the catchment, to suggest possible solutions and to provide input on visions for the future of the catchment. Following the forums a postal survey of catchment landholders was distributed. A third of households responded and provided further input to guide the development of the restoration plan.

Most people within the catchment consider that action is required particularly in relation to:

- The increased incidence of algal blooms in wetlands and watercourses in the lower catchment,
- Management of drainage,
- Loss of lifestyle quality for residents over several months of the year during blooms, degradation of streams, and
- Meeting Albany's drinking water requirements.

The community priorities for issues raised during the community forums and survey have been the basis for development of seven themes for management in the restoration plan. They are:

1. Algal Blooms and Water Quality

2. Water Quantity
3. Drainage Management
4. Habitat and Biodiversity Management
5. Farming Systems
6. Land Use Planning
7. Education and Communication

The detailed outcomes from the community forums are available at www.torbay.scric.org. The goals set by the community for the 'Watershed Torbay' project reflect changing values towards catchment management for sustainable use of natural resources. They also show strong interest by community for involvement in planning and willingness to participate in integrated catchment management.

A1.4 Restoration Planning Team

The Torbay Catchment Group (TCG) members have experience with many environmental restoration actions including weed management, waterways fencing and revegetation, foreshore condition surveys, macro-invertebrate monitoring, managing a major artificial wetland construction project, and stream restoration projects (including revegetation, pool and riffle construction; stock and vehicle crossings and off stream watering points.

Following a decision by the group to participate in the Watershed Torbay project, the Watershed Torbay Steering Committee was established to oversee the project, ensure a participative approach, and to broker arrangements.

The Watershed Torbay Steering Committee has responsibility for preparation of the Watershed Torbay Restoration Plan. The catchment group will have on-going responsibility for implementation and monitoring of the river restoration plan.

The 'Watershed Torbay' Community Steering Committee provided direction for the demonstration program and reported back to the Torbay Catchment Group. Members on the Watershed Torbay Steering Committee are people who represented the interests, uses and values of the catchment and who share a personal commitment to better management.

The specific requirement to 'develop a plan to improve drainage management' in the catchment has been addressed by the Drainage Steering Group of the 'Watershed Torbay' project. Members represented a range of community, industry and government organisations.

The 'Watershed Torbay' Technical Advisory Group (TAG) provided direction for research requirements of the demonstration program. The TAG provided direction for research to develop an understanding of the biophysical processes in the catchment and identification of effective and practical management responses to issues.

The following is the full list of people who contributed through one of these groups to the success of the project:

Andrew Marshall, Chair John Simpson, Former Chair

Phil Mellon, community
Chris Westacott, community
Terri Harwood, community
Diane Evers, local government
Danny Burkett, Water Corporation
Sarah Comer, CALM
Peter Collins , CALM
Louise Duxbury, Green Skills
Melissa Vernon, community
David Weaver, Department of Agriculture
Des Wolfe, local government
John Blaney-Murphy, community
Maurice McCormick, community
Mark Taylor, community,
Bill North, community
Noel Bignell, community
Paul Close, CENRM
Naomi Arrowsmith, Department of Environment
Julie Pech, Department of Environment
Prof Peter Davies, CENRM
Phillip Marshall, community
Ron Masters, Department of Agriculture
Andrew Maughan, Department of Environment
Phil Shephard, City of Albany
Chris Gunby, Department of Environment
Monty Walker, community
Graeme Wright, Water Corporation
Dale Holley, community
Lionel Downes, community
Graeme Heighton, community
Malclom Robb, Department of Environment
Brad Degens, Department of Environment
Kristina Fleming, SCRIPT
Steve Janicke, Department of Environment

Preparation of the Restoration Plan was undertaken through the 'Watershed Torbay' Community Steering Committee assisted through a Support Team coordinated through the Department of Environment. The Support Team was managed by Naomi Arrowsmith (Project Manager) and included Andrew Marshall (Chair of the Watershed Torbay Steering Committee), the Project Officer (Julie Pech), and the Communications Coordinator (Louise Duxbury).

A1.5 Research Approach

The Watershed Torbay project had a very strong focus on science to underpin and inform appropriate management actions for the catchment. Some 15 individual research projects were chosen to be conducted, grouped into five broad theme areas:

- Environmental flows
- Algal blooms: processes and drivers
- Managing the lower drainage system
- Catchment nutrient sources
- Social and economic issues.

Consistent with the project commitment to a civic science approach to research, researchers contracted to undertake work for Watershed Torbay were required to respond to a set of criteria based on a civic science approach:

What is the capacity of the research to answer the key community questions?

Will the research provide information to influence the selection and implementation of actions?

How transportable is the research to other catchments throughout Australia?

How urgent is the research in terms of influencing actions (this is the priority), or is it addressing a long-term issue?

What is the likelihood of obtaining other potential funding sources instead of National Rivers Consortium funding under the Watershed Torbay project?

What is the direct cost of the proposal and the extent to which there is matching funds for it?

What is the research proposal's potential to give results that lead to low cost land-use management change that is behavioural change?

A summary of relevant research projects coordinated through the TAG is provided in the supporting documentation.

A1.6 Structure of the Restoration Plan

The Watershed Torbay Catchment Restoration Plan consists of four sections (Figure A2). The Plan incorporates all relevant information leading to the actions to be taken. It also provides a framework for monitoring and evaluation linked through adaptive management to the implementation processes. The Plan outlines resource and capacity requirements for efficient implementation of the actions and effective communication of the results.

The **Project Description** section provides:

An outline of the demonstration program and the restoration planning team;
A vision for the future of the catchment;
A description of the catchment and communities; and
An assessment of the land use and natural resource management issues.

The **Assets, Goals and Targets** section provides:

Identification of valued catchment assets and community values;
Goals and objectives identified through community processes; and
Targets for resource condition change.

The **Action Plan** provides:

Management Action Targets and proposed actions;
Estimated costs allocation for a 3-year implementation program;
Identification of key roles and lead responsibilities; and
Feasibility assessment for achievement of targets.

The **Monitoring and Evaluation Plan** provides:

Current monitoring, analysis and trends;
An "Adaptive Management' framework; and
Indicators of change for goals, objectives and targets.

Figure A3 – Sections of the Restoration Plan.

The Restoration Plan is supported by a resource kit, and which all supporting information is compiled, and associated information is available on the 'Watershed Torbay' website (www.torbay.scric.org).

A2.0 Catchment Description

A2.1 Location and Overview

The Torbay catchment is located 26km west of Albany on the south coast of Western Australia (Figure A3). It is within the South Coast natural resource management (NRM) region.

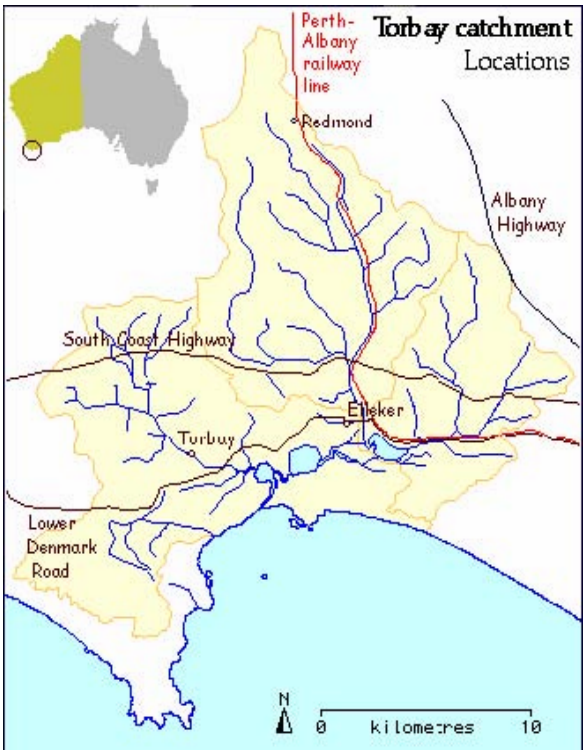


Figure A3 – Location of the Torbay Catchment

The area of the catchment is 330km^2 of which 33% remains as natural vegetation, 51% is used for grazing, 5% has commercial timber plantations and 1.6% is occupied by waterways and wetlands.

Other land uses in the catchment include horticulture (irrigated and non-irrigated), intensive animal industries (including piggeries), seasonal commercial fishing (in the Torbay Bay) and a growing tourism industry. A waste-water treatment plant for the town of Albany previously discharged effluent into the Torbay catchment. This followed secondary treatment managed by the Water Corporation under a licence issued by the Department of Environmental Protection license arrangements. This is now irrigated to a commercial timber plantation within the catchment.

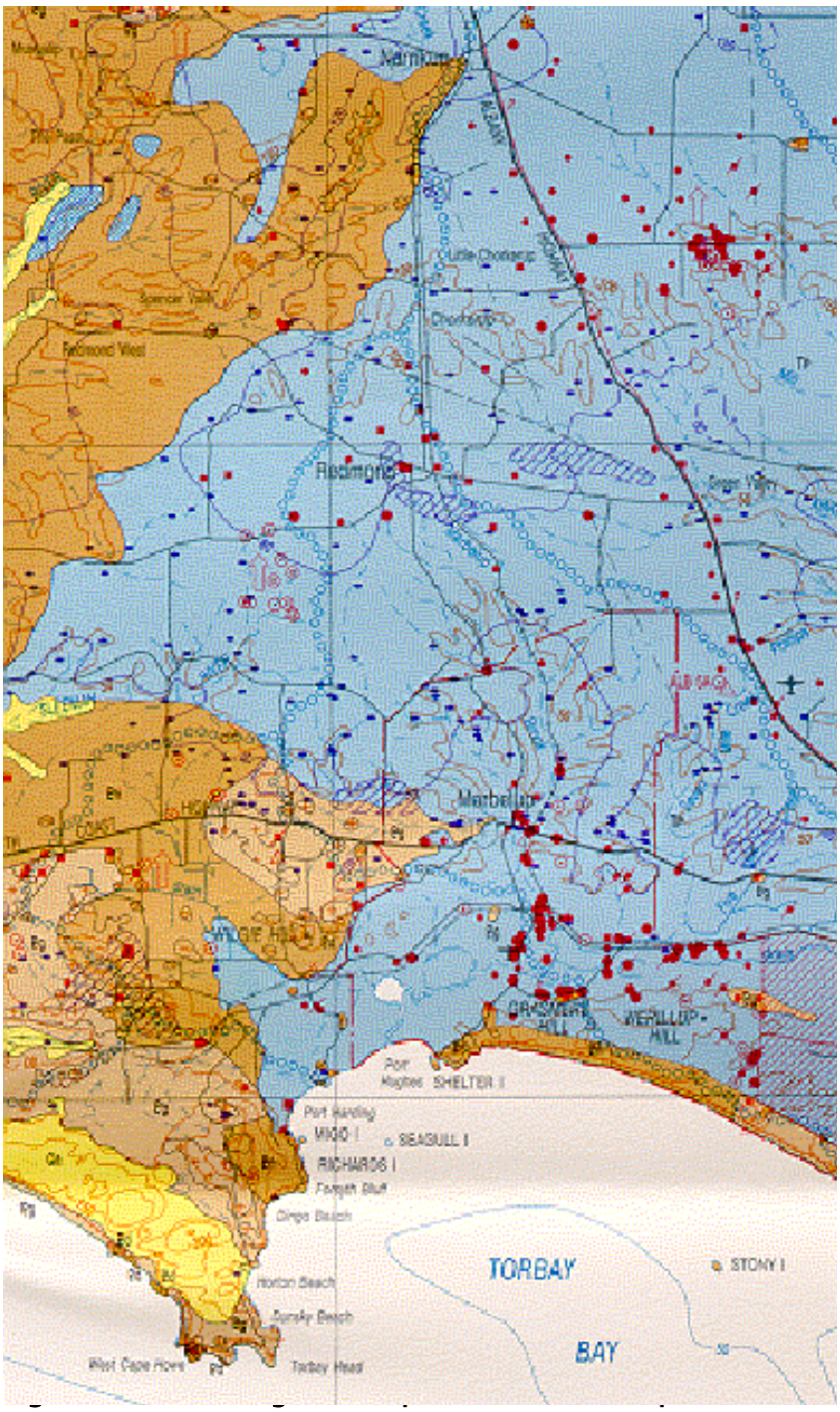
Climate is a Mediterranean type with cool, wet winters and warm to hot summers, with significant summer rainfall. Most of the rain comes from fronts associated with low-pressure systems passing over, or to the south of the area. The annual average rainfall for the area ranges from 1000mm to 800mm away from the coast. Variability of rainfall is low for WA. Pan evaporation rate is about 1200 mm. per annum, and is less than rainfall in 4 to 5 months of the year. The growing season generally exceed 10 months. Average monthly minimum and maximum temperatures range between 14°C and 26°C in summer and 7°C and 16°C in winter.

The small communities of Cuthbert, Elleker, Redmond and Torbay are located within the catchment. There are 563 rural properties with an average size of 100 - 150ha which suggests that there are many rural residents who may have off-farm interests. The West Cape Howe National Park is significant. The district is serviced by major and minor roads and the Perth-Albany freight railway.

A2.2 Geology, Landforms and Soils

The valley floor of the Torbay catchment is underlain by granitic, gneissic and doleritic rocks of Proterozoic age that form impermeable bedrock in the area. These rocks largely constrain the depth to which groundwater can infiltrate below the land surface. Bedrock outcrops to the north of the wetlands in the lower part of the catchment and in coastal cliffs (Figure A4).

The catchment valley floor (sometimes referred to as Grassmere Valley) is of deep (up to 150 meters) alluvial, colluvial and marine sediments. There is some suggestion of it being a previous marine strait (a seaway) during an earlier era (Hodgkin and Clark, 1990). Crystalline bedrock is overlain by sediments of Tertiary to recent age (Gozzard, 1989; Smith, 1997). The most permeable sediments in the area are calcareous sands in coastal dunes which have been patchily cemented to form a sandy limestone, and it is likely that most of the groundwater flow in the lower part of the Torbay catchment takes place within these materials. These sediments contain fresh groundwater of a suitable quality for potable use.



Torbay catchment (adapted from CALM, 1995)

Low-lying areas in near-coastal parts of the Torbay catchment are underlain by estuarine and shallow marine silty and sandy sediments of Holocene age (i.e. sediments that formed since the last ice age within the last 10,000 years). These sediments contain significant amounts of the iron sulfide mineral pyrite and they are highly reactive when exposed to air. Excavation of these

materials can created acid sulfate soils and the risk of discharging acidity and metals into the drainage system. Acid sulfate soils were first identified at Ewarts Swamp where a horticultural scheme failed because drainage had exposed pyrite to the air causing acidified soil and groundwater (Woodward, 1917). The potential occurrence of acid sulfate soils is shown in Figure A5.

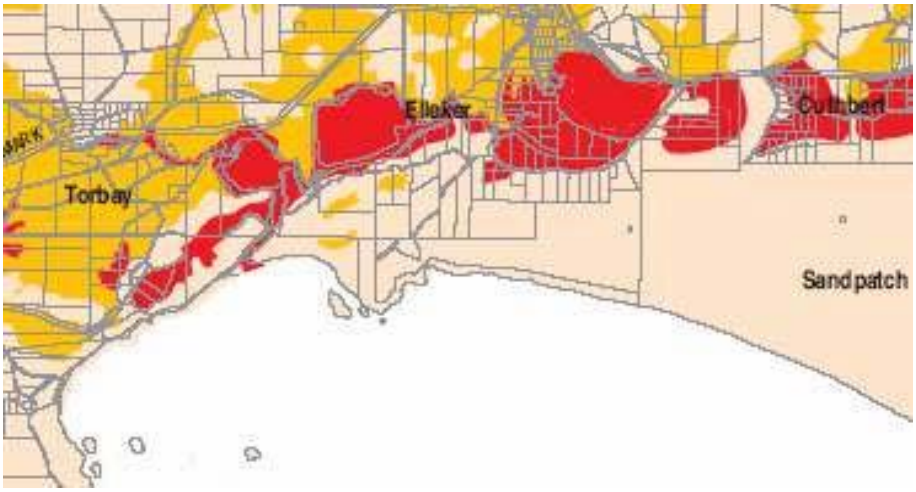


Figure A5, Distribution of Acid Sulphate Soils in the Lower Torbay Catchment

A2.3 Wetlands and waterways

The location of wetlands and waterways in the catchment in shown in Figure A6.

The wetlands of the Torbay catchment are distinctive within the region as being a small associated set of water bodies influenced by both riverine and coastal processes. The waterways that contribute to the wetlands are relatively small and some are now significantly altered by drainage. Prior to alteration of the natural drainage system, the wetlands functioned hydrologically as one system – the water level for all components were the same and were influenced simultaneously by rising floodwaters behind the naturally formed sand bar. The valley floor was also simultaneously influenced by saline water intrusion under tidal influence when the sand bar was open. The sand bar breached as a natural occurrence when water levels rose to about 1.1 meters AHD (Australian Height Datum) behind the bar.

Marbelup Brook, Five-mile Creek and Seven-mile Creek previously discharged into Lake Powell. The lake was originally of greater area (bounded by the approximate location of the Grassmere/Elleker Road) and discharged through an outlet that is now know as North Creek. Overflow from the lake was direct into Lake Manarup (also previously known as Red Hill Lagoon) which discharged to Torbay bay when the sand bar was breached and water levels in Torbay Inlet were lowered.

Marbelup Brook is the only natural river that flows into Lake Manarup and then Torbay Inlet. The lake is less than 1km^2 in area and is shallow but has a wide margin of fringing vegetation including paperbark trees and sedges.

The hydraulic gradient of the natural wetland system is very low. The amplitude of tides within the Torbay Bay ranges from 40 cm to 130 cm. Larger tidal sequences caused salt water to intrude upstream of the Lower Denmark Road along Marbelup Brook and through Lake Powell to the current Cuthbert horticultural area when the bar was open. Conversely, the wetlands and adjacent valley floors were probably well drained with low tide sequences. With evaporation, the wetlands were probably dry for periods of quite variable length. These factors suggest that the wetlands would have had considerable variation in hydro-period (including a drying sequence) and in salt concentration under natural conditions. It can be expected that the wetlands were well flushed on a seasonal basis.

Local information sources suggest Lake Powell to have been quite deep (estimates of over 4 meters) and with white sand beaches however Hodgkin and Clark (1990) note that the original depth was probably about 1 meter and is now about half that depth.

The lake extended to an area that is approximately bounded by the Elleker-Grassmere Road, an area significantly greater than the current water body. Remnants of the original foreshore can be seen in aerial photographs, and the lake bed topographic relief is evident along Woodides Road near Elleker. The lake was previously used for swimming, and occasionally the dry lake bed was suitable for bike-riding and horse-training. Lake Powell in now an 'A-Class' Reserve managed by the Department of Conservation and Land Management (CALM). It is recognised for high numbers of waterbirds (resident and migratory).

The Torbay catchment is now the most significantly altered wetland system on the south coast. The swamp valley between Torbay Inlet and Princess Royal Harbour has a fertile soil and was developed for agriculture in the late 19th century when drains were dug in Seven Mile Swamp (now known as Ewarts Swamp) to the east of Lake Powell discharging into Lake Manarup. Exposure of the soil to air by drainage and cultivation caused oxidation of iron pyrite in the soil leading to acidification of the land which is now not suitable for use.

There are 180km of waterways within the catchment. Foreshore surveys show some to remain in good ecological condition (see resource kit, and www.torbay.scric.org). The major waterways (listed from east to west) are Five-mile Creek, Seven-mile Creek and Marbelup Brook that previously drained naturally into Ewart Swamp and Lake Powell, and Unndiup Creek that drains into Torbay Inlet (Figure A6).

Figure A6, Waterways of Torbay Catchment

The sub-catchments defined for use within the program area are shown in Figure A7.

Figure A7, Torbay Sub-Catchments

A2.4 Torbay Catchment Estuary

Like most other estuaries of the south west of Western Australia, tidal exchange into Torbay Inlet is obstructed by sand bars and the water changes seasonally from nearly fresh to marine.

Torbay Inlet is now only a small part, (about 1 km^2) of what was formerly a larger estuarine system that included Lake Manarup which is now a compensating basin alongside the drain from Marbellup Brook and Lake Powell. Floodgates prevent estuary water entering the two lakes or backing up into cultivated land in swamps to the east.

Estuaries on the South Coast are of very recent origin, they are only about 6000 years old. In the last ice age sea level was more than 100 m lower than it is now, the coastline was 30-40 km further south near the edge of the continental shelf, and there were valleys and perhaps lakes where the estuaries are now. When the polar ice began to melt 20 000 years ago, the sea level rose rapidly and by about 6000 years ago had reached its present level; sea water flooded the valleys and they became the estuaries and coastal lagoons of today.

At first the estuaries were always open to the sea and sea water mixed freely with fresh water from the rivers, but subsequently sand eroded from the sea bed and eroded from the dunes has narrowed the mouths of most south west estuaries. Now exchange with the sea is restricted to periods when the bars are open, they are poorly flushed and the salinity regime is totally different from that of 6000 years ago.

When first formed, the Torbay catchment estuary was probably much deeper than it is now, perhaps even with a valley to hard rock. The sea level may also have been up to 2 metres higher than it is now. Sediments eroded from the catchment and sand from the beach has progressively filled the estuary. Coarse sediment brought by floods has built a large river delta. Waves have smoothed the sandy shoreline and built beach ridges that the vegetation has stabilised. Marram grass and other salt tolerant plants have trapped sediment. These same processes are continually reshaping the Torbay Inlet estuary today.

A2.5 Water Resources

Most of the catchment is within the Albany Groundwater Area although no groundwater bores are currently used for public supply. Allocation of groundwater for private bores is under license arrangements with the Department of Environment. The Marbelup Water Reserve was formed in 1986 as a Priority 3 area for public water supply. Consideration is being given to allocation of 6 gigalitres (GL) of the total 16Gl of annual stream flow in Marbelup Brook for public water supply in Albany. An estimation of Environmental Water Requirements is an important part of this consideration under the ‘Watershed Torbay’ project.

A2.6 Spatial Information and Management

Spatial information describing the catchment is available on a site within the Western Australian Land Information System (WALIS) website : (**http://atlas.walis.wa.gov.au/**

atlaswa/index.cfm?topic=south_coast&infoproduct=south_coast&region=regions&region_code=20). Table A1 lists the information that is available.

Table A1. Spatial information for the Torbay catchment. Information layer	Scale	Custodian
Infrastructure		
WA Base Map	1:100 000	Geoscience Australia
Cities and Towns	1:250 000	Geoscience Australia
Railways	1:250 000	Geoscience Australia
Roads and tracks	1:250 000	Geoscience Australia
Environment		
Landform classification	1:25 000	Agriculture WA
Soil classification	1:50 000	Agriculture WA
Strahler stream network	n.a.	Agriculture WA
Catchments	n.a.	Agriculture WA
Subcatchments	n.a.	Agriculture WA
Environmental Management Units	n.a.	Agriculture WA
Riparian Zone Risk Areas	n.a.	Agriculture WA
Major waterbodies	1:250 000	Geoscience Australia
Minor water bodies	1:250 000	Geoscience Australia
Water Quality evaluation sites	1:50 000	Agriculture WA
Loadsite water quality catchments	n.a.	Agriculture WA
Snapshot water quality catchments	n.a.	Agriculture WA
Landform Classification	1:25 000	Agriculture WA
Torbay Catchment	1:25 000	Water and Rivers Commission
Torbay Subcatchment	1:25 000	Water and Rivers Commission
Marbelup Brook Foreshore Conditions	n.a.	Water and Rivers Commission
5 Mile and 7 Mile Cks Foreshore Conditions	1:25 000	Water and Rivers Commission
Agriculture		
Existing landuse capability rating	n.a.	Agriculture WA
Low existing landuse Capability Areas	n.a.	Agriculture WA
Annual horticulture capability	n.a.	Agriculture WA
Cropping capability	n.a.	Agriculture WA
Grazing capability	n.a.	Agriculture WA
Perennial horticulture capability	n.a.	Agriculture WA
Integrated Land Use	n.a.	Agriculture WA

A3.0 Community Characteristics

A3.1 Land Use and Community History

Aborigines inhabited the Torbay Catchment for thousands of years, but there is now very little direct evidence of how they lived and how their society was organised. Several sites are on the register of the Department of Indigenous Affairs Aboriginal Sites of Significance. The coast provided access to marine food sources and a corridor for travel between the areas around Princess Royal Harbour to the east and Wilson Inlet to the west.

A number of British and French explorers and whalers sailed along the south coast from the late 16th century onwards, but the area was not settled or the hinterland explored by Europeans until the British settlement was established at Albany in 1826.

Initially whaling, sealing and timber-cutting were the main activities in the Torbay area, but the construction in 1889 of the Perth to Albany railway, which enters the northern boundary of the catchment through Redmond, runs south to Torbay and then turns east to Albany, opened up the region for settlement and farming. The WA Land Company built the railway in return for grants of land, which it then tried, with limited success, to sell to immigrants as smallholdings. In 1896 the government took over the land and the railway.

The railway was also important in the life of all the settlers: it brought supplies and mail, and until cars became common, it was the fastest way to get to Albany, with the only alternatives being horses or walking. Even in the 1930s the 20 kilometre trip by motor vehicle from Redmond, near the northern catchment boundary, to Albany, would take five hours due to the poor state of the roads as the following excerpt from the local newspaper at the time indicates: "..they have their troubles, and it is hardly necessary to say that their chief trouble comes from the state of the roads in winter. They are called roads, though they are mere bush tracks….in my trip to and through Grassmere, I passed along mere rugged tracks which in winter must be veritable Sloughs of Despond (Albany Advertiser, 1899). "

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When the catchment was first settled the main farming activity was market gardening, which was quite successful since the recently discovered goldfields around Kalgoorlie encouraged a huge influx of people and thus a strong demand for fresh vegetables. Much of the land used was only 0.5 to 1 metre above sea level, even up to 10 km from the sea, and it was subject to flooding, sometimes with salt water.

A barrage with floodgates half a kilometre from the bar was completed in 1912 in an unsuccessful attempt to prevent salt water backing up onto the farm land. It was built of Californian redwood and worked fairly well until about 1920. However sand built up against the downstream side, shallowing it from 5m on the upstream side to 60 cm on the downstream side. Gaps between the timbers allowed sea water to flow back into the Inlet and attempts to block these with sheets of iron obstructed outflow so that water did not get away fast enough and flooding continued. The decking was first burnt about 1928 and repaired and subsequently burnt several times before the barrage was blown up by the army in 1985 as a demolition exercise and became derelict. Some of the piles still stand.

A drainage scheme was operating during the 1930's when potatoes were grown in Seven Mile Swamp (now Ewart Swamp). The drainage infrastructure was also installed to protect the road and rail infrastructure from localised flooding. The peat-based lake bed caught fire during this period. Fire is considered locally to be the initiator of processes of oxidising iron pyrites resulting in significant acidification of the soils, however Hodgkin and Clark (1990) attribute the cause to drainage and cultivation. They quote an early observation by Woodward (1917): The poisonous mineral solutions in the soil of the "Seven Mile Swamp" are due to the oxidation of the iron pyrites in the soil itself owing to the mineral being brought in contact with the air by drainage and cultivation. Ewart Swamp is not suitable for horticulture and is considered to be a potential source of acidic effluent water to the wetland system.

Fish flourished for a time throughout the drainage system, probably until the water became too acid (pH 3.5 from the 1910s to 1940s). Lake Manarup is now also shallow. It is managed as a compensation basin and often dries out in summer.

During the 20th century cattle and sheep farming largely replaced vegetable growing as the main farming activity. More recently, tree plantations and tourism have grown in importance.
The Timewell Road waste-water treatment plant for Albany previously discharged effluent into Five-mile Creek following secondary treatment, or when detention capacity at the plant was exceeded. Organised community re-action to these arrangements in response to nutrient enrichment and mal-odour problems in Lake Powell resulted in new arrangements with improved treatment and effluent discharge to a commercial timber plantation within the catchment.

With flooding under control and the area of Lake Powell inundation significantly reduced as a result of the drainage controls, residential development in the former lake bed commenced. There are now many households in this landscape position. Their protection from flooding is currently dependent upon operation of the drainage system which was inadequate to control the significant localised flooding that occurred in 1992.

There have been recent housing development approvals for sites located within the bed of Ewart Swamp, an area also dependent upon operation of the drainage scheme for flood control.

A3.2 Community Statistics

Information from the Australian Bureau of Statistics (ABS) for two areas of the 2001 census is relevant to the upper and lower parts of the Torbay catchment. These show the community characteristics to be similar throughout the catchment although there are a greater number of older people living in the lower parts (Table A2). Income is medium to low compared on a State basis.

Table A2 Socio-economic attributes of Torbay catchment residents (a) Age structure; (b) Ancestry; and (c) Income.

Table A2 (a) Age structure of Torbay catchment residents People	Lower Catchment	Upper Catchment	Total
Aged 0-14 years	138 (24%)	91 (32%)	229 (26%)
Aged 15-29 years	93 (16%)	47 (17%)	140 (16%)
Aged 30-44 years	142 (24%)	71 (25%)	213 (25%)
Aged 45-64 years	167 (29%)	55 (20%)	222 (26%)
Aged = 65 years	44 (7%)	18 (6%)	62 (7%)
Total	584 (67%)	282 (33%)	866

Table A2(b) Ancestry of Torbay catchment residents

	Lower Catchment	Upper Catchment	Total
Australian & NZ	234 (30%)	125 (35%)	359 (32%)
English	298 (38%)	109 (31%)	407 (35%)
N West European	153 (20%)	71 (20%)	224 (20%)
S&E European	40 (5%)	16 (5%)	56 (5%)
Asian	9 (1%)	5 (1%)	14 (1%)
Other	9 (1%)	0 (0%)	9 (1%)
Not stated	35 (5%)	30 (8%)	65 (6%)
Total	778	356	1134

Table A2(c) Annual income for people aged > 15 years in the upper and lower catchment

Annual Income	15-19 yrs	20-24 yrs	25-34 yrs	35-44 yrs	45-54 yrs	55-64 yrs	65-74 yrs	= 75 yrs	Total
Negative /nil	26	0	6	6	8	12	0	0	58
$0-$26K	40	12	54	81	61	73	44	12	377
$26K-$52K	0	3	25	50	40	18	15	3	154
>$52K	3	0	3	12	3	3	0	3	27
Not stated	16	3	3	7	3	6	6	3	47
Total	85	18	91	156	115	112	65	21	449

A survey sent to the 580 landholders in the Torbay catchment resulted in 173 responses (Duxbury, 2003). The results from the survey are indicative only, as the survey was not random and respondents were skewed to the older age brackets and those with higher education levels. The information provided indicates that over 70% of landholdings are small (<100 Ha) and 38%

are less than 10 Ha. The most common land use is for cattle and sheep production although a high proportion of landholders use their land mainly for residential purpose. There are 4 aquaculture enterprises, 2 dairies and 2 piggeries. Almost 80% of respondents indicated that less than half of their income was generated from their property and almost 50% indicated that none of their income was from the land.

A4.0 Land Use and Natural Resource Management

A4.1 Introduction

Land in the Torbay catchment was originally settled and cleared for agricultural and horticultural use. Agriculture remains the dominant industry however the use of land is changing in response to increasing numbers of residents attracted to the area for lifestyle reasons. The 'Restoration Plan' project recognises the processes of change and aims to provide an integrated framework for linking the range of land uses that occur with management of natural resources.

A4.2 Agriculture

Conventional agriculture within the Torbay catchment is based on annual pasture-based grazing systems for cattle and sheep. The area used for grazing (17,000 Ha) is 51% of the catchment. There are limited areas cropped for cereal production. There are two dairies and two piggeries within the catchment. There are many small land holdings with landholder generating off-farm income.

A relatively recent change in land use is to commercial timber production. There is now approximately 5% (1700 Ha) of the catchment established to tree plantations. Most of this area is planted with Blue Gums (Eucalyptus globulus) in 10-12 year rotations under share-farm contract arrangements.

The existence of Cuthbert, Torbay, Elleker and Redmond owes much to the historical success of local farming enterprises. There is a strong feeling within the community that farming should remain a major land use as a driver of the local economy and as a key attraction of the local landscape. However, farming practices will need to become economically and environmentally sustainable in order to meet community expectations regarding the protection of environmental values.

A4.3 Horticulture

The Torbay and Cuthbert areas are well recognised as traditional potato growing areas particularly for seed potato production. While some pumpkins are grown and the area is suitable for cauliflower production, potatoes are the major horticultural crop. The area currently produces about 50% of WA's requirements for seed potato production.

Two separate locations are identified as associated with the Torbay Drainage System. The first is on land serviced by the Cuthbert Drain where there is an estimated 100Ha of land suitable and potentially available for horticulture. The second location is south of Lake Powell where there is an estimated 80Ha of land is suitable and previously used for horticulture. There are currently three growers in the Cuthbert area using approximately 60 Ha annually and four growers in the Lake Powell area using approximately 32Ha annually.
The suitability of land for annual horticulture in the Lake Powell area is dependent upon control of flooding and inundation and upon high groundwater levels to maintain suitable soil moisture status during the growing period. Current management of the Torbay Drainage system reduces the risk of floods, waterlogging and crop drought although some risk of these events remains. For a viable industry to continue, there is limited opportunity to alter production practices. The growing season is not flexible without supplementary irrigation. There are no obvious alternative horticultural crops tolerant of waterlogging and inundations that would be economically comparable.

A4.4 Commercial Fishing

The commercial fishing industry that occurs within Torbay Bay is based on catches of herring and salmon during the February-April period annually. Licensed operations are at two locations, one at Cosy Corner on the west end and the other near Mutton Bird Island at the east end. The industry is based on relatively low-value product but may generate approximately $0.25m from the bay each year.

A4.5 Residential use

The town community of Elleker is located adjacent to Lake Powell. Residential blocks of land within the townsite are small but more recent residential development is on larger blocks of land in surrounding areas. There is a number of relatively small ‘hobby farms’ (4-10Ha) adjacent to the drainage system or that overlooks the wetlands.

Residential development within the bed of former lakes is a significant issue. There are houses within the former bed of Lake Powell and some are within the former bed of Ewart Swamp. These areas are at risk of flooding both by surface water inundation and by groundwater rise. Groundwater levels in these low-lying areas seem to be highly connected with water levels in Lake Powell based on local information about water levels in dams rising and falling consistently with water levels in the lake.

Most residential properties within the former lake-bed areas have on-site sewage treatment by conventional septic tanks and leach drains. More recent housing approvals have required installation of nutrient retaining treatment systems. There are risks to public health from waste treatment in flood-prone areas.

Many residents are concerned about the water quality in the wetlands and waterways. Mal-odours from Marbelup Brook immediately downstream from the Marbelup Plug are the main cause for concern. This location coincides with a former rubbish tip (not used since the mid-1970’s) and with a depression in the streambed. Other complaints are about mal-odours from Lake Powell at some times of the year.

Those who live adjacent to North Creek consider that poor water quality and algal blooms diminish their lifestyle. Residents adjacent to Lake Manarup are concerned about the health of the wetland ecosystem due to artificially low water levels and are concerned about wind blown sediment within the lake when dry. Residents in these areas are generally concerned about the potential impact of environmental degradation on aesthetics and their property values.

A4.6 Nature Conservation

Lake Powell is an 'A-Class' reserve managed by the Department of Conservation and Land Management (CALM). It is well known for species richness, diversity and population size of water birds. It is regionally significant wetland. One reason for its high value as a wetland for water birds is that it has continuous water and reasonable depth. The high nutrient levels and prolonged algal blooms seem to not negatively affect bird breeding and use of the wetland. Higher bird numbers are partly due to the raised nutrient status of the water which has encouraged the growth of the Typha providing nesting areas and high levels of macro-invertebrate activity outside of the periods of algal blooms.

Lake Manarup and Torbay Inlet are identified as Vacant Crown Land administered by the Department of Land Administration. They are currently without dedicated management responsibility or effort. Both water bodies are considered locally to be of high conservation value but also at high risk. Lake Manarup does not reach full conservation value because of artificially controlled water levels for flood mitigation purposes. Torbay Inlet has decreasing water depth due to sedimentation, has poor water quality and experiences intense algal blooms.

A4.7 Recreation Opportunities

Local memories of the wetlands are often about swimming in fresh water, sailing up the lagoon to Torbay inlet and catching marron easily or fish that were 'worth eating'. Current residents would like to have increased recreational opportunities because it is significant to the lifestyle that they have sought by living there. Swimming, fishing and canoeing are the most popular water-based recreation. Windsurfing and sailing small craft is an interest. Potentially toxic algal blooms are of concern especially as young people either don't read warning signs or ignore them, and also for animals.

An increasing number of people are attracted to the tranquillity of the valley. Many enjoy the Grassmere-Elleker Road drive and appreciate the opportunities for casual contemplation along the way. There are also an increasing number of people camping near Torbay Inlet since improvements were made to access roads. These long-stay campers are generally interested in passive recreation and appreciate a healthy and diverse environment.

The potential for local tourism is recognised. The attractive landscape, environmental values and close proximity to Albany are significant. Further deterioration of environmental values is a deterrent to development of a tourism industry. There is recognition of the advantages of strong regional identification based on local conservation values.

A4.8 Land Use Planning

Land use change in the Torbay catchment is regulated under the Town Planning and Development Act (1945) through the Local Planning Strategy (LPS) and the Town Planning Schemes (TPS) operated by the City of Albany. The TPS provides guidelines and controls for subdivision and use and development of the land.

The LPS and TPS are currently under review as required under the Act. The new scheme will:

- Identify land within proposed rural zones (eg. general, priority, rural townsite and rural residential zones) in accordance with the State Planning Policies, the State Planning Strategy and the Lower Great Southern Region Strategy.
- Place controls on land use and development within the zones to achieve the stated objectives of the zones.
- Identify areas that require additional controls (e.g. areas subject to flooding, land use conflict, other non-agricultural use).

The revised scheme will provide for growth of Elleker subject to the preparation of a detailed townsite plan. Figure A8 illustrates the current residential areas of Elleker.

Some more intensive forms of rural land use will require land capability assessment to be prepared by the proponent to support the application (eg. intensive agricultural industries).

Figure A8. Residential development in Elleker and south of Lake Powell.

At a regional scale, the Department of Planning and Infrastructure is preparing the Lower Great Southern Planning Strategy. This provides direction for sustainable regional development.
In some parts of the catchment, a lack of detailed land use planning has resulted in community conflict and environmental problems. In working towards the achievement of a community vision, there is a need for the Local and State Governments to understand the particular and special needs of the Torbay catchment, and coordinate planning strategies to address environmental problems or reduce environmental degradation.

A5.0 Surface Water Drainage System

A5.1 Natural Surface Water Drainage

Prior to alteration of the natural drainage system, the wetlands of the valley floor functioned hydrologically as one system – the water level for all components were the same and were influenced simultaneously by rising floodwaters behind the naturally formed sand bar. The valley floor was also simultaneously influenced by saline water intrusion under tidal influence with the sand bar was open. The sand bar breached as a natural occurrence when water levels rose to about 1.1 meters AHD (Australian Height Datum) behind the bar.

Marbellup Brook, Five-mile Creek and Seven-mile Creek previously discharged into Lake Powell. The lake was originally of greater area (bounded by the approximate location of the Grassmere/Elleker Road) and discharged through an outlet that is now know as North Creek. Overflow from the lake was direct into Lake Manipur. (Note: this water body is sometimes referred to as a lagoon although it is not a true lagoon landform. A lagoon is the water body that occurs behind a sand bar and is influenced by saline intrusions. While it may be argued that this occurs now, the water body was filled by fresh inflow from Lake Powell overflow under natural drainage system.) Lake Manipur previously discharged to Torbay bay when the sand bar was breached and water levels in Torbay Inlet were lowered.

The hydraulic gradient of the natural wetland system is very low. The amplitude of tides within the Torbay Bay ranges from 40 cm to 130 cm. Larger tidal sequences caused salt water to intrude upstream of the Lower Denmark Road along Marcels Brook and through Lake Powell to the current Cuthbert horticultural area when the bar was open. Conversely, the wetlands and adjacent valley floors were probably well drained with low tide sequences. With evaporation, the wetlands were probably dry for periods of quite variable length. These factors suggest that the wetlands would have had considerable variation in hydro-period (including a drying sequence) and in salt concentration under natural conditions. It can be expected that the wetlands were well flushed on a seasonal basis.

A5.2 Sub-catchment Drainage

Soon after European settlement, land associated with wetlands within the Torbay catchment was recognised as being suitable for horticulture except for the risk of flooding. Drainage schemes were variously implemented until the current drainage system was constructed during the 1950's. The Torbay drainage system is a part of the Albany Drainage District, one of six districts established for agricultural land drainage of flood control in WA.

The natural sequence of surface water run-off has been altered considerably by drainage to control flooding and waterlogging in the six sub-catchments in the Watershed Torbay project area. Two of the sub-catchments (Torbay and Torbay West) discharge directly to the ocean or the inlet. Drainage in the other four sub-catchments is part of an integrated 3-level surface water control system. Drainage within the sub-catchments is listed below:

Seven Mile (upper) with 1.58 km of drains in the Seven Mile creek discharging into the Grassmere Drain.

Seven-mile (lower) with 9.74 km of drains from the Five Mile Creek and Cuthbert horticultural area (the Grassmere Drain) discharging into Lake Powell (the 'Middle Level' system).

Marbelup Brook with 4.32 km of drains discharging directly into the Torbay Inlet (the 'High Level' system) – a total annual flow of 16GL.

East Torbay with 16.78 km of drains (via North Creek) discharging directly into Lake Manarup (the 'Low Level' system).

Torbay East with 33.22 km of drains that discharge directly into the western side of the Torbay Inlet.

Torbay West with 3.88 km of drains that have direct ocean outfall.

Table A3. Drainage within sub-catchments	
7 Mile Lower Sub-catchment	9.74 km
7 Mile Upper Sub-catchment	1.58 km
East Torbay Sub-catchment	16.78 km
Marbelup Sub-catchment	4.32 km
West Torbay Sub-catchment	3.88 km
Torbay East Sub-catchment	33.22 km
TOTAL	**69.52 km**

In total there are approximately 70 km of excavated drains in the Watershed Torbay project area excluding feeder drains constructed on individual properties (Table A3). There are 180km of waterways within the project area.

The main areas of community concern about the drainage system are:

- Low water levels in Lake Manarup (unsuitable for water birds and wind mobilised sediments within the lake when dry)
- Acidic discharge water from the Low Level system into Lake Manarup.
- Mal-odours from Marbelup Brook below the Plug, and on occasions from Lake Powell.
- Water quality in North Creek for water-based recreation.
- Algal blooms in Lake Powell and Torbay Inlet.

With an increasing number of smaller landholdings and changing land use in the project area there are changing expectations for water resource management towards improved wetland health. This is significant for operation of the 3-level drainage system.

A6.0 Purpose of Restoration Plan

The Watershed Torbay Catchment Restoration Plan combines the expectations of community, as expressed through their Vision for the catchment, with science-based information. It provides a framework for implementation of priority actions through targeted investment under partnership arrangements. Partners to the project include many private landholders within the community as well as government and other public organisations. The Restoration Plan aims to achieve this vision through practical targets, strategies and actions.

The Restoration Plan also provides a 'blueprint' for change management. A key demonstration value of the project is recognition of the need for change in management practices. The goals, targets and actions of the Restoration Plan are focused on the changes that are feasible and acceptable.

WATERSHED Torbay

Watershed Torbay
Catchment Restoration Plan:

SECTION B

ASSETS, GOALS & TARGETS

B1.0 A Strategic Approach

The vision for the Torbay catchment was developed by the Torbay Catchment Group.

VISION for *'Watershed Torbay'*

> ***"An environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways".***

Community forums held during 2002 as part of the Watershed Torbay Project identified environmental, social and economic characteristics of a preferred future for the Torbay catchment (Appendix 3).

The *'Watershed Torbay'* Steering Committee has endorsed the Vision Statement. The demonstration project is based on a strategic approach to catchment management to achieve the vision.

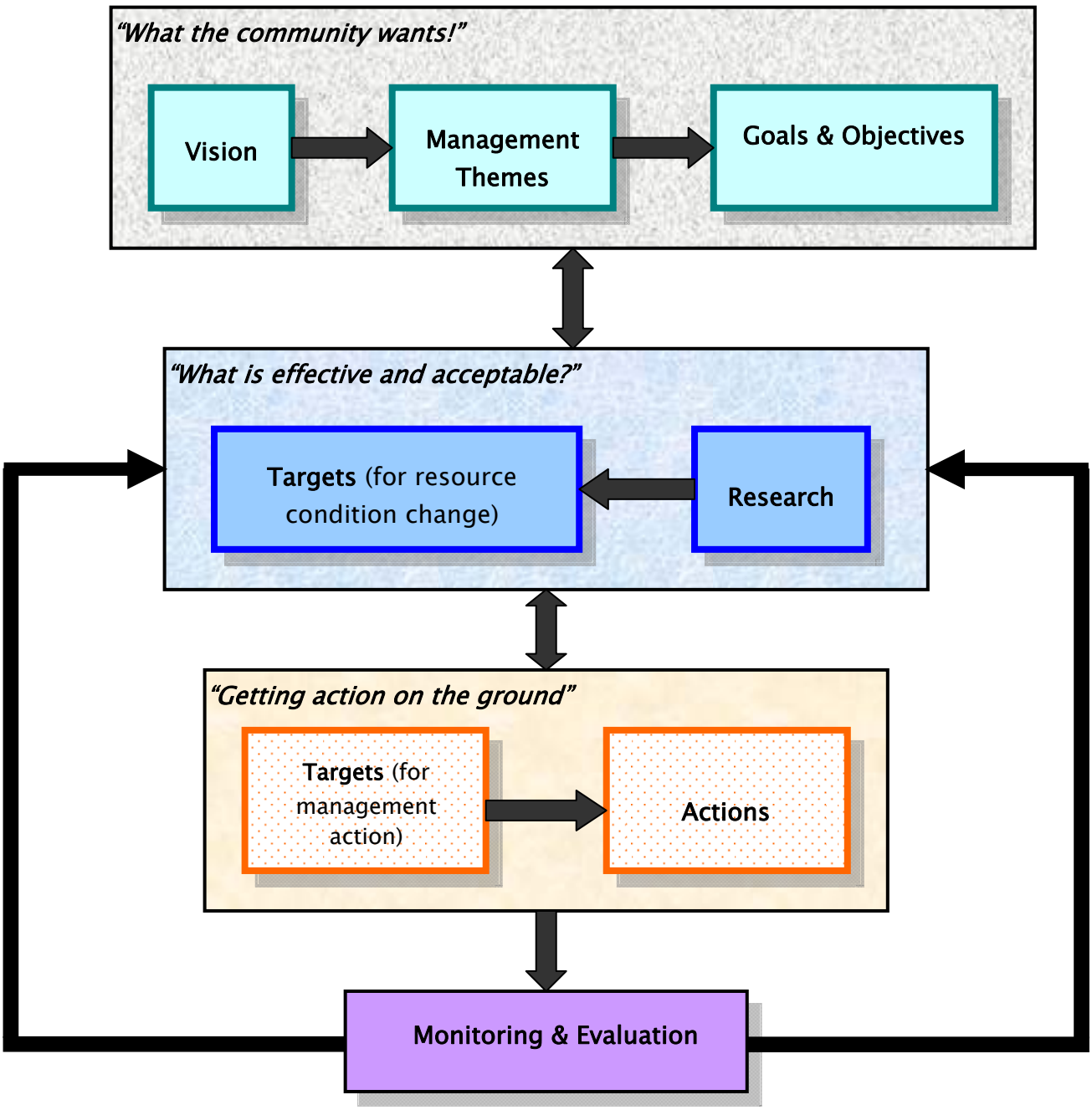
The strategic process for integrated catchment management planning adopted for the project is represented in Figure B1. **Goals** are identified in relation to each of the seven **Management Themes**. These set the level of community expectations about outcomes from the demonstration project.

Specific **objectives** with **targets** are set to achieve the goals. These are derived from science-based information and are Specific, Measurable, Achievable, Relevant and Time-bound (SMART). **Targets for resource condition change** are identified for each of the Management Themes, for example there are targets for the quality of water in wetlands. These are derived from science-based information and are set at levels that are considered to be achievable over a 20-25 year period. While these targets may not always meet community expectations, they are an assessment of what can realistically be achieved based on current research findings. New information could lead to decisions for change in the targets for resource condition. This may be for a higher level of resource protection or improvement, or lower to a more achievable level.

Targets for management action with sets of **Actions** are listed in Section C (the Action Plan). These are also derived from science-based information to ensure that the proposed actions will result in the targeted resource condition change. The reasons for taking the proposed actions are provided in this section (Section B). The reasoning provides the linkage between the goals, targets and actions. This is important because it may be a long time before results are measurable for resource condition change (e.g. water quality) but we need to be assured that the actions taken will eventually lead to the targeted change.

It is also important to measure the level of management actions in association with **Monitoring and Evaluation** (Section D) for resource condition change. Measures for implementation of management actions and indicators or resource condition change are identified in Section D. Figure B1 shows how monitoring will continue to influence priorities for actions through 'adaptive management' processes.

For the *Vision* of the 'Watershed Torbay' Catchment Restoration Plan to have lasting relevance, there is a need for ongoing sharing of ideas, values and information. Knowledge, understanding and communication involve the whole community - including government agencies, industry interest groups, community groups and individuals. There needs to be commitment to understanding the range of opinions, values or responsibilities in order to gain respect for the legitimate needs of others who live or have interests within the catchment.



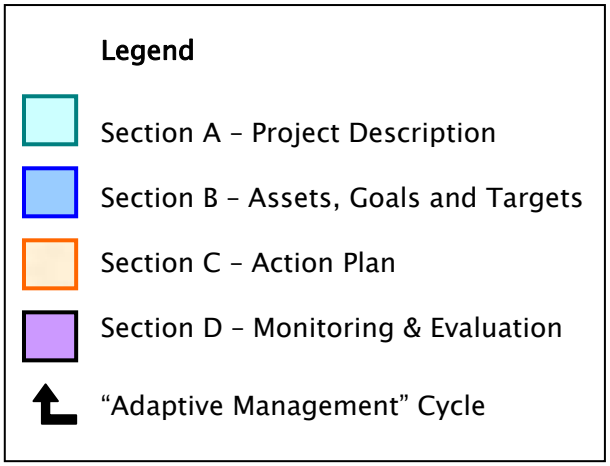


Figure B1 Strategic processes for integrated catchment management planning.

B1.1 Identifying Priority Assets and Values

The community has expressed concern about a range of issues that are affecting the natural resource, infrastructure and heritage assets, values or specific features. The high priority assets and values that are considered to be at risk are listed below:

Land

- Current Land Use (assuming that it is appropriate)
- Soils and soil/water management opportunities (specific to land use e.g. seed potato production)
- Existing residential development.

Water Resources

- Torbay Inlet
- Lake Powell (an A-Class Reserve which maintains a high conservation value because of bird richness and numbers, some of which are rare or endangered species. The lake is listed on the Register of the National Estate, Australian Heritage Commission).
- Lake Manarup
- Marbelup Brook, primarily for existing private water supplies and future supply options.
- North Creek (although this is now primarily an excavated drain)
- Potable quality water (both surface and ground)
- Beach-inlet (and associated marine-estuary dynamics).

Biodiversity

- 'Unique South Coast wetlands system' – a small association of 'tannin stained' wetlands.
- Lake Powell – a listed wetland of national significance (register)
- Waterways and remnant pristine riparian vegetation
- Reserves (coastal and catchment) – National conservation estate, road and rail reserves
- Natural vegetation associations (including those associated with wetlands)
- Fish stocks
- Birds associated with wetlands
- Threatened/endangered species and ecological communities
- Declared Rare Flora (DRF)
- Native revegetation on public and private land.

Infrastructure, Culture and Heritage

- All constructed drains and wetlands
- Fencing for landscape management
- Flood control mechanisms
- Road, rail and access tracks
- Locally characteristic infrastructure heritage (e.g. distinctive bridges)
- Aboriginal sites of significance
- Community facilities, including local halls
- Recreational use opportunities, especially within waterways and constructed drain systems and coastal areas.
- Tourism opportunities (e.g. with the Bibbulmum Track).

The proposed actions of the 'Watershed Torbay' Catchment Restoration Plan are for the purpose of protecting or enhancing the assets and values of the landscape and community.

B2.0 Goals, Objectives and Targets for Management Themes

There are seven Management Themes. These encompass the range of issues and expectations expressed by the community about managing natural resources to protect or enhance community and landscape assets and values within the Torbay catchment. The Goals and Objectives for these themes are listed below followed by development of a strategic approach to management actions in order to achieve targeted outcomes. Two themes, those related to planning and communication, do not have Resource Conditions Targets set as they are not seeking to achieve specific environmental outcomes.

B2.1 Theme One: Water Quality and Algal Blooms

The availability of good quality water is a fundamental requirement to sustaining communities and environment. Since settlement, there has been a gradual decline in the catchment's water quality. Algal blooms are the most obvious sign that waterways are unhealthy. As well as being a health risk, algal blooms smell bad and look ugly, resulting in an unpleasant living environment for nearby residents and detract from a growing tourism industry.

Managing water quality and algal blooms was a key driver in establishing the Watershed Torbay project, and is therefore a principal focus.

➢ **Goal (2025):**	Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals and algal blooms are minimal. Water in Marbelup Brook remains suitable for drinking. Other waterways and waterbodies are suitable for recreation, domestic and agricultural use.
➢ **Objectives:**	The source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and managed so that: • There are no fish kills due to poor water quality, • The incidence of algal blooms is reduced, • The transport of nutrients, sediments and contaminants into waterways and wetlands in minimised, • Management practices are adopted that minimise public health and environmental risks for drinking water from Marbelup Brook.

Torbay Inlet and Lake Powell are recognised as being two of the most nutrient enriched wetlands in Western Australia (WRC, 2004a). Both wetlands have frequent algal blooms, which are sometimes toxic, and have occasional fish kills as a result of high nutrient loads. Algal blooms also occur in waterways, including Marbellup Brook. Compared with other wetlands internationally, the poor health of the Torbay catchment water bodies is unexpected because use of land for farming is relatively recent and fertiliser applications for agriculture are relatively low (Weaver, Neville & Deeley, 2003). Recent wor4k (AGSO, 2005) has shown that the release of nutrient from sediments in both lake Powell and Torbay inlet are much higher than any other sites measured in Australia.

Nutrient enrichment, shallow depths and high light conditions provides conditions suitable for algal blooms which includes the potential for toxic species of blue-green phytoplankton (e.g. *Nodularia spumigena*, *Microcystis* and *Anabaena*).

The frequency of algal bloom occurrence is estimated to be:

Name of lake	Toxic blooms	All blooms
Lake Powell	6 months/year	6 months/year
Torbay Inlet	2 months/year	3 months/year
Marbellup Brook	3 months/year	5 months/year

The nutrients causing algal bloom are phosphorus (P) and nitrogen (N) both in various forms. Silica is also a significant determinant of algal blooms, particularly in Torbay Inlet (WRC, 2004a). The key aquatic systems 'driver' of algal blooms varies according to conditions and is not always well understood.

The high level of nutrients in Torbay Inlet and Lake Powell are likely to be from a range of sources including:

External Diffuse Source

- Leaching of nutrients from sandy profile soils and to a lesser degree erosion of nutrient enriched soil used for extensive agriculture
- Discharge of nutrients in groundwater to wetlands
- Release of nutrients due to oxidation of acid sulphate soils

External Point Source

- Discharge of nutrients from intensive industries (including wastewater treatment plants, dairies, piggeries and annual horticulture)
- Leaching from residential septic systems
- Release of nutrients from lakebed sediments
- Water bird faecal contamination.

Internal Point Source

- Release of nutrients from lakebed sediments.

The proportional contribution of nutrient load provided by different sources through different transport pathways and processes is not fully known. Current research initiatives will provide increased understanding of nutrient sources, particularly from oxidation of acid sulphate soils.

The pathways for nutrients from the source to the water bodies are also significant for management decisions. The pathways considered are:

- Soil-water processes (considered further in the 'Farming Systems' theme)
- Surface water flow (nutrient transport in solute and particulate form)
- Sediment transport
- Groundwater movement
- Lakebed sediment processes.

The sources and pathways of nutrients in the Torbay catchment are described below.

B2.1.1 Nutrients from surface water flows

Water quality and stream flow has been continuously measured at six gauging stations within the Torbay catchment since January 1997 (Figure B2).

Figure B2 Location of stream gauging stations within the Torbay catchment.

Surface flows into Torbay Inlet are from two major tributaries: the Torbay Drain west of the inlet and from Marbelup Brook. Flow rates vary seasonally with highest flows in winter (Torbay Drain median winter flow of 78 ML (megalitres)/day; Marbelup Brook median winter flow of 72 ML/day) and lowest flows in summer (Torbay Drain median summer flow of 0.3 ML/day; Marbelup Brook median winter flow of 16 ML/day). Marbelup Brook provides significant surface flows to the estuary all year round.

Both major tributaries to Torbay Inlet contributed highest nutrient concentrations (e.g. 7.6 mg/L TN; 0.82 mg/L TP) and loads in autumn/winter.

There are four tributaries to Lake Powell - Seven Mile Creek, Cuthbert Drain, Grasmere Creek and Five Mile Creek.

Seven Mile Creek provides the highest surface flows (median summer flow of 5 ML/day; median winter flow: 18 ML/day). Seven Mile Creek currently receives water excess from the tree farm where the Water Corporation wastewater treatment plant secondary treated effluent is discharged.

Flows are substantially lower for Cuthbert Drain, Grassmere Creek and Five Mile Creek (1-6, 1-2 and 1-8 ML/day respectively). All tributaries are seasonally variable.

Nutrient loads delivered to Torbay Inlet and Lake Powell by their major tributaries have been calculated from continuous flow data and fortnightly water quality data from 1997 to 2002 (Table B1). The significance of Torbay Drain and Marbellup Brook to the nutrient load in Torbay Inlet is demonstrated by the high N and P annual loads from stream flow.

Table B1. Nutrient load for Torbay catchment tributaries. (Source: WRC, 2004a)

Tributary	**Nitrogen load Tonnes/ann.**	**Phosphorus load Tonnes/ann.**	**Catchment Area (ha)**
Torbay Drain	30.4	2.4	5300
Marbellup Brook	18.8	2.2	13100
Seven Mile Creek	5.7	0.8	2850
Five Mile Creek	3.6	1.0	1350
Cuthbert Drain	4.0	0.3	1250
Grassmere Creek	1.1	0.1	520

The relative proportional contribution of nutrient load varies with catchment size. Five Mile Creek has a small percentage of total stream flow but a relatively high proportion of total P load (Table B2).

Table B2. Proportion of flow and loads by sampling point (1997–2000 data).

	% flow	**% Total N load**	**% Total P load**	**% Total area**
Torbay Main Drain	38	**49**	38	53.8
Marbellup Brook	41	31	31	21.8
Seven Mile Creek	11	8	11	11.7
Five Mile Creek	5	6	**16**	5.5
Cuthbert Drain	3	4	2	5.1
Grassmere Creek	2	2	2	2.1

(Note: Bold figures highlight particularly high nutrient proportions relative to flow.)

Analysis of surface water nutrients over a 5-year period (1997-2002) for the six tributaries shows no significant trend except for Total Nitrogen in Seven Mile Creek which has a slightly declining trend (WRC, unpublished data) thought to be due to the ceasing of direct discharge of treated wastewater to the creek. .

B2.1.2 Land use as a source of nutrients

The relative proportion of nutrients derived from a range of land uses within the Torbay catchment is shown in Table B3. The high contribution from point sources is confirmed by analysis of Case Studies for a piggery, a dairy and an annual horticultural enterprise (Neville, 2003). The distribution of these land uses within the Torbay catchment is shown in Figure B3.

Table B3 Proportional contribution of different land uses to total nitrogen and phosphorus generated at source for the whole catchment.

Land use	Phosphorus (%)	Nitrogen (%)
Dairy	46	32
Grazing	34	45
Annual Horticulture	13	15
Peri-urban	2	3
Piggery	2	1
Plantation	2	3
Remnant vegetation	<1	1
Cropping	<1	<1
Un-sewered urban	<1	<1
Wetland	<1	<1
Sewered urban	<1	<1

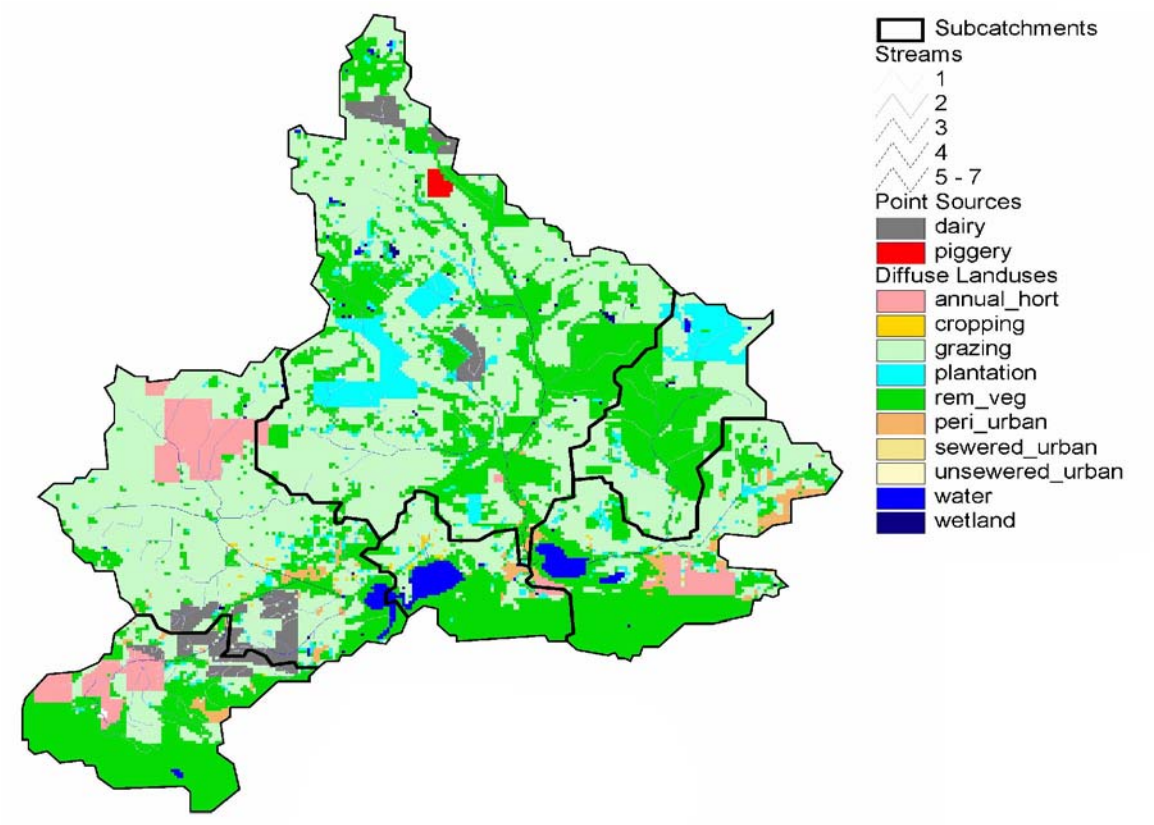


Figure B3 Distribution of land uses within the Torbay catchment.

Figure B4 shows the potential for nutrient generation from these land uses. The analysis is based on an assessment of land use nutrient generation rates and other catchment features. The results of a water quality 'snapshot' survey undertaken 4th December, 1998 are shown as a visual comparison between one off measurements of water quality and perceived contributions of those nutrients.

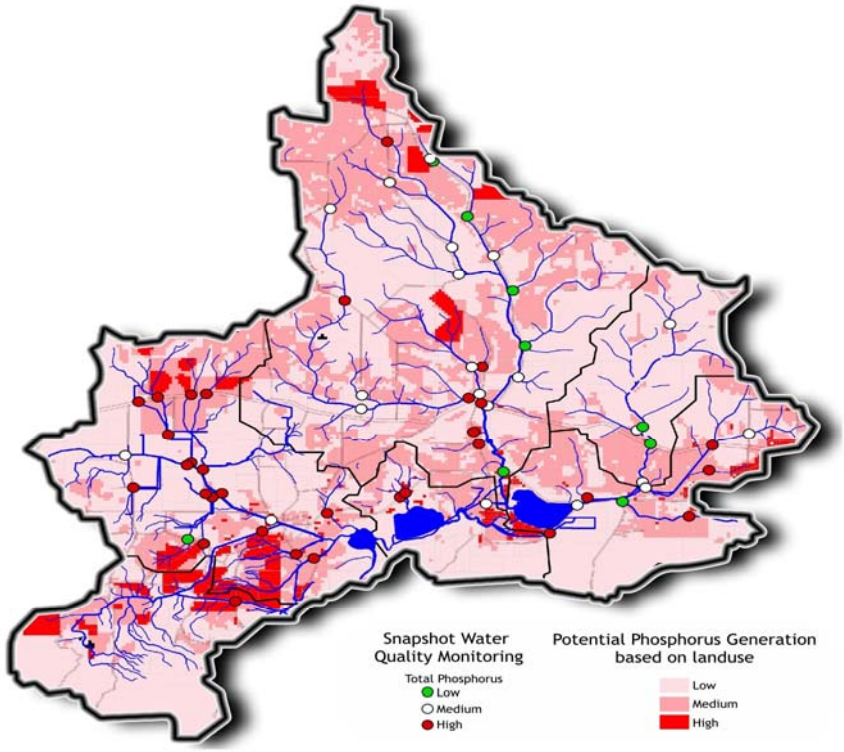


Figure B4 The potential for nutrient phosphorus and nitrogen generation in the Torbay catchment compared to snapshot water quality measurements.

B2.1.3 Point sources of nutrients

Albany Wastewater Treatment

Wastewater from Albany is piped to the treatment plant located within the Five Mile Creek sub-catchment. Secondary treatment effluent is used to irrigate a tree farm within the Seven Mile Creek sub-catchment. The quality of effluent used is approximately 23 mg/L TN and 8–10 mg/L TP.

Water and nutrient excess from this site is discharged into Seven Mile Creek and eventually into Lake Powell. The concentration of total nitrogen discharged from the tree farm is less than 2 mg/L and total phosphorus is less that 0.1mg/L (measured at the Gunn Road gauging station). The volume of run-off is approximately 0.5–1.5 ML/d. The contribution of nutrients from the waste water treatment plant delivered to Lake Powell via Seven Mile Creek is shown in Table B4. The total nitrogen load is generally maintained at about 500kg/a (8.7% of total Seven Mile Creek N load) and total phosphorus is maintained at about 50 kg/a (6.25%of total Seven Mile Creek P load).

Table B4 Annual total nitrogen and total phosphorus loads from the waste water treatment plant delivered to Seven Mile Creek

Year	Estimated TN in Surface runoff (kg/year)	Overall TN load[4] (kg/year)	Estimated TP in surface runoff (kg/year)	Overall TP load[4] (kg/year)
1997[1]	339	530	30	43
1998[1]	312	533	26	42
1999[1]	368	573	26	41
2000[1]	318	623	14	48
2001[2]	225[3]	373	10.9[3]	28.9
2002[2]	146[3]	302	8.3[3]	26.3
2003[2]	482[3]	644	45.5[3]	63.5

1 - Data from Brown & Root (2001) independent review
2 - Data from CYMOD (2004) independent review, TP groundwater data is estimated average over three year period.
3 - Calculated from HYDSYS hydrological analysis of actual flows and weekly analysis results.
4 – Overall load includes the estimates of surface flow contributions derived from water quality sampling and modelled estimates of groundwater contributions of nutrients.

The volume of wastewater from Albany is forecast to double within 20 years. The treatment facilities are expected to have reached their hydraulic capacity by somewhere between 2006-9. Under current license conditions, the tree farm has reached the total nitrogen application limit, however there are indications that the nitrogen assimilation capacity of the tree farm may be higher (Water Corporation, 2003). There are several preferred options being considered to accommodate the increased wastewater in the short term. These include establishing additional tree farms, increasing discharge to Seven Mile Creek ('indirect disposal') and compensate the increase with investment in nutrient management within the Marbelup Brook catchment (the Environmental Improvement Initiative), and reuse of treated wastewater. The second option is preferred by the Water Corporation.

Wastewater from Elleker

There are 104 septic tanks in the town of Elleker (2005 information). The nutrient load from the septic tanks to Lake Powell has not been established.

Since the 1991 flood, new residential development on properties lower than 1.5m AHD require an 'alternative' effluent disposal system that minimises nutrient loss. The April 2005 floods further illustrate the need to prevent residential development in the floodplain.

Intensive agricultural industries

Nutrient balance analysis of a dairy, a piggery and annual horticulture within the Torbay catchment shows that intensive industries have potential for very high exports of nutrients from the enterprise site as these industries have high levels of nutrient surplus, or unutilised nutrients in their production systems (Neville, 2003). Site conditions, particularly soil structure and the phosphorus retention capacity of soils, can influence the rate at which any phosphorus surplus is exported from a site. The analysis provides Input:Output ratios for phosphorus and nitrogen.

Figure B5 shows the components of ratio calculations. For example, a 5.5 kg phosphorus input into a farming system resulting in 1 kg leaving the property in produce gives a ration of 5.5:1. In this

situation, the remaining 4.5 kg of P either increases soil storage or is discharged from the property, potentially adding to waterway nutrient loads. Figure B5 also shows that Nutrient Surplus can also be calculated from information about inputs and outputs.

The Input:Output ratios calculated for intensive industries in the Torbay catchment (Neville, 2003) shows the P ratio for the dairy was 5.5:1, the piggery was 3.7:1 and annual horticulture was 5.8:1. The N ratios were considered a less reliable index of nutrient use efficiency due to nitrogen fixing by legume based pastures and nitrogen loss by volatilisation.

Attaining a P Input:Output ratio of 1:1 is desirable however a ratio of 1.5:1 is suggested in the international literature as acceptable. These measures provide a useful basis for intensive industries to target but may not be easily applied to individual properties. The nutrient surplus per hectare may provide a better way of determining nutrient loss for an individual enterprise.

Recent soil testing was undertaken in the catchment as part of a Watershed Torbay initiative to improve fertiliser management practices in the catchment. ……

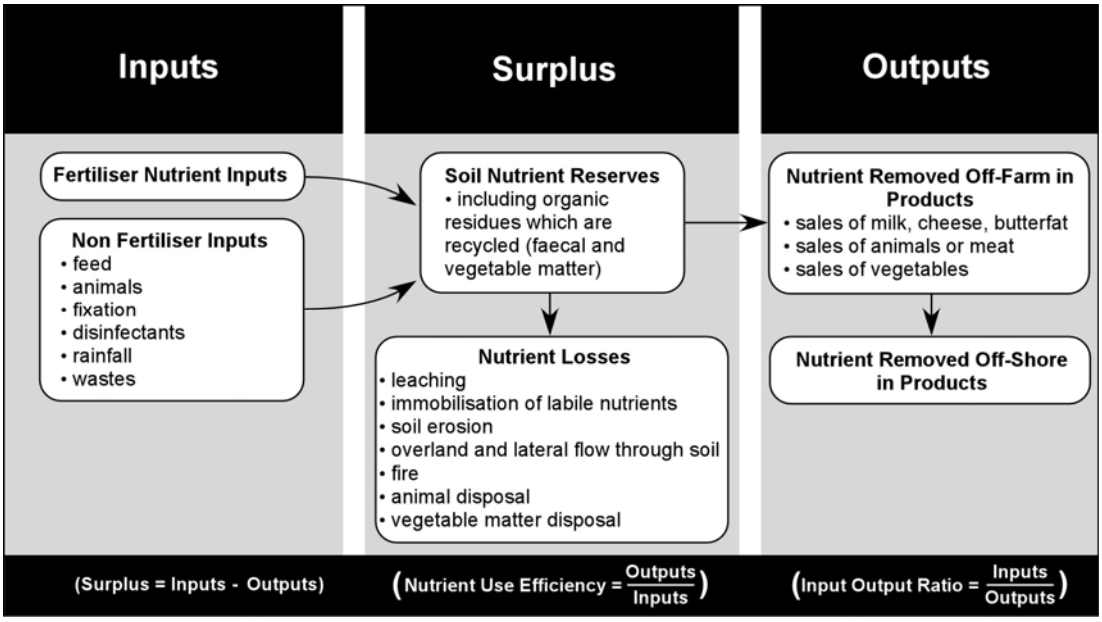


Figure B5 Component of Nutrient Ratio and Nutrient Surplus calculations.

B2.1.4 Acid sulphate soils as a source of nutrients

A potentially significant source of nutrients to water bodies in the Torbay catchment is due to oxidation and progressive degradation of organic matter in soils (WRC, 2004b). Conceptual assessment of geochemical processes suggests that up to 50% of the total nitrogen load and up to 80% of the total phosphorus load in wetlands could be sourced from acid sulphate soils however this estimate requires field verification.

B2.1.5 Groundwater as a source of nutrients

Groundwater has been monitored at 24 locations in the lower catchment since June 2003 (Figure B6). Water level is measured in all bores monthly. Nitrogen and phosphorus concentrations are measured for 12 of the bores every three months.

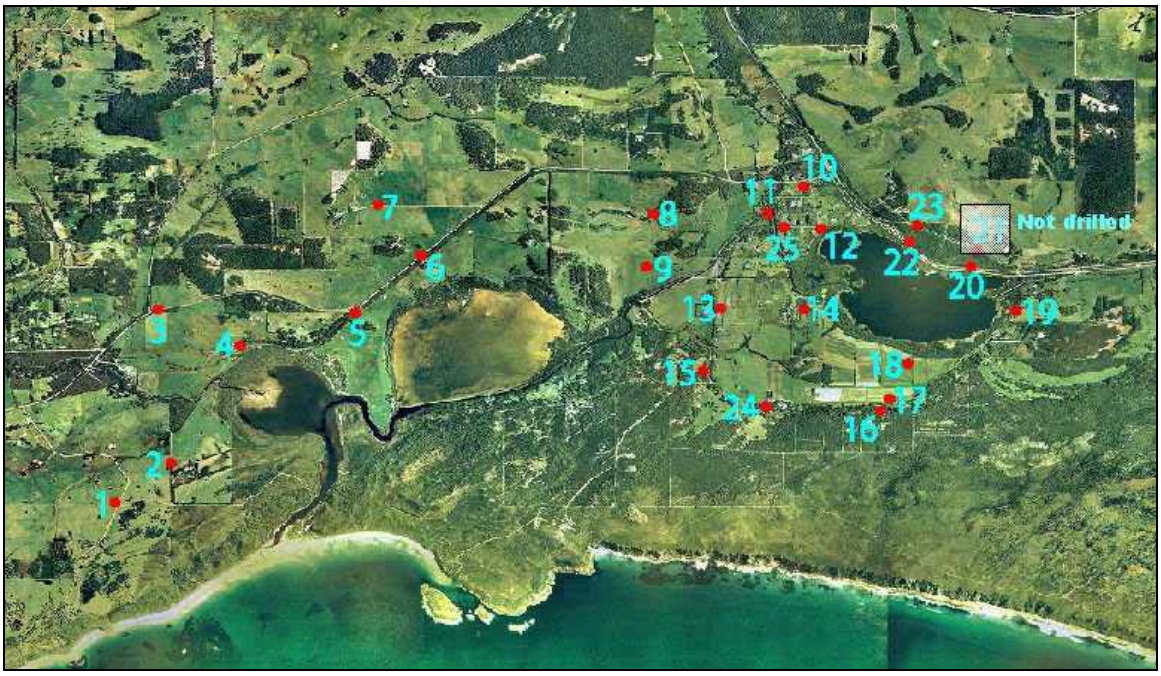


Figure B6 Location of groundwater monitoring wells in the Torbay catchment.

Contoured water-table elevations (Figure B7) indicate that groundwater flows from the north, west and east to surface water bodies in the lower part of the Torbay catchment.

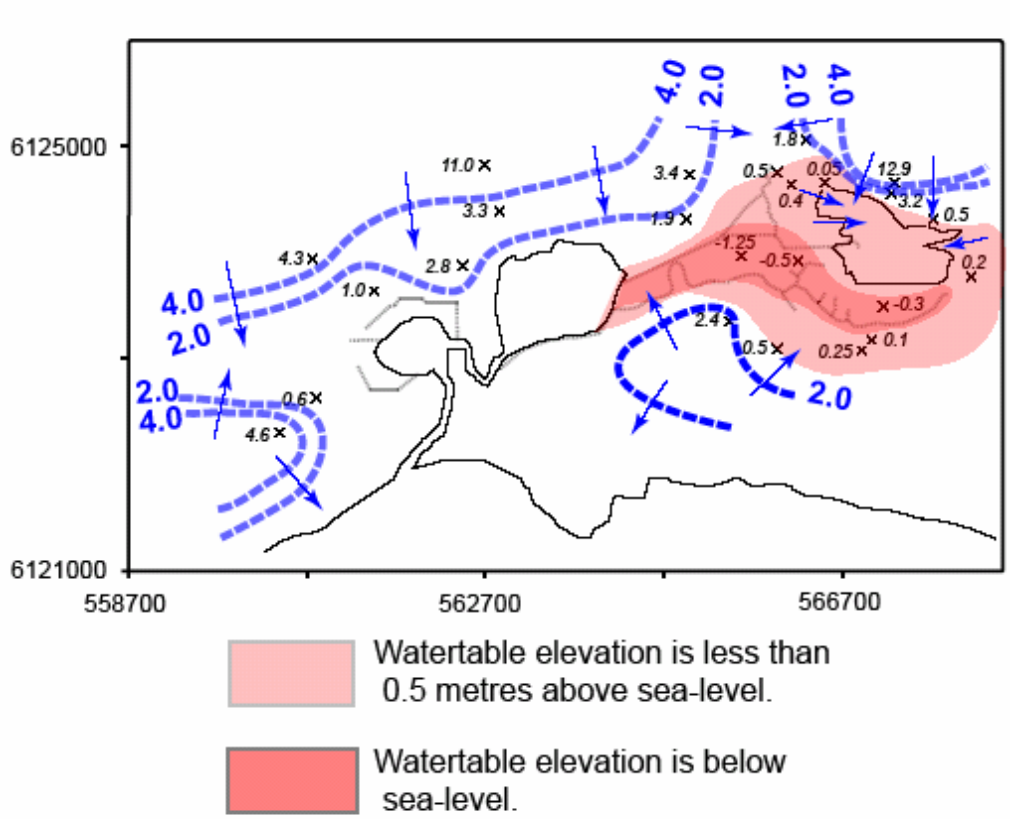


Figure B7 Groundwater elevation (m AHD) and direction of groundwater flow when the water-table is low due to the sandbar at the mouth of Torbay Inlet being open (Source: WRC, 2004b).

The existing drainage management scheme (described in Section A5.0) is the most important factor controlling groundwater flow within the lower part of the Torbay catchment. This particularly affects water levels in Lake Manarup and Torbay Inlet when the sandbar across the mouth of the estuary is closed. The water-table difference contours (Figure B8) show that there is a large area of seasonal groundwater mounding beneath Torbay Inlet when the sandbar is closed.

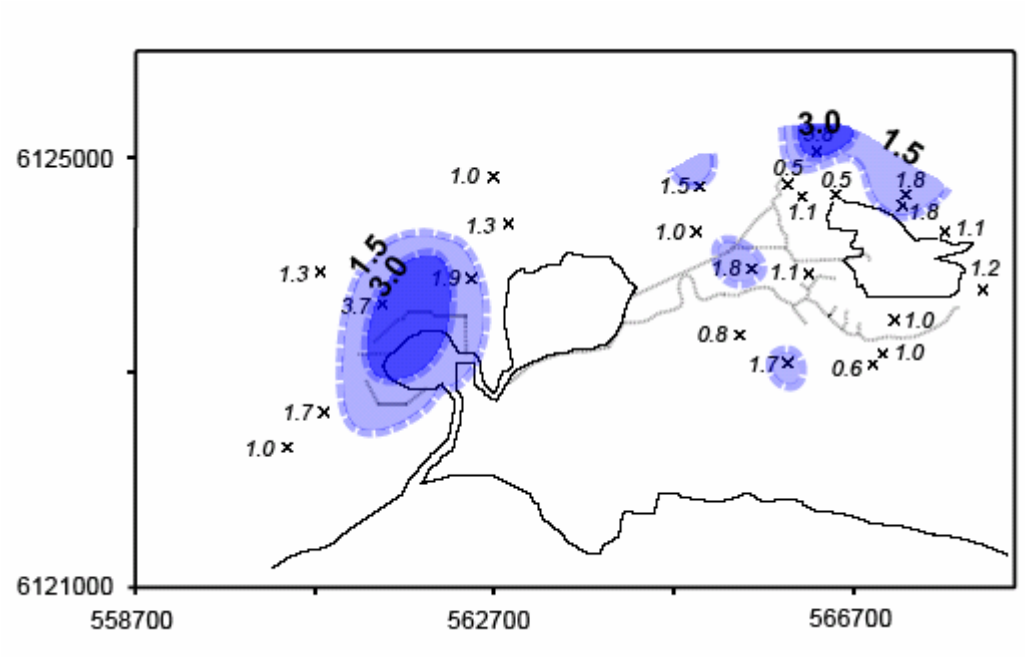


Figure B8 Area of potential groundwater mounding due to recharge when the sandbar at the mouth of the Inlet is closed (Source: WRC, 2004b).

Initial indications from groundwater analysis suggest that transmission of nutrients in groundwater to water bodies is a relatively low proportion of total nutrient loads.

Groundwater was found to be acidic where disturbed acid sulfate soils occur. These soils could also be the cause of potentially toxic metals and other contaminants to be leached into drains and groundwater, including aluminium, cadmium, selenium, mercury, copper and zinc.

Sulfuric acid is formed from oxidizing acid sulfate soils. The potential for leaching acid from soils at risk where there are fluctuating water tables is considered to be high (WRC, 2004b).

B2.1.6 Lakebed sediments as a source of nutrients

Given the shallow nature of both Torbay Inlet and Lake Powell (average depths 0.5 m), the status of sediment nutrients is likely to be an important factor influencing water quality and primary productivity. Measurement of sediment pore water nutrients found ammonia and orthophosphate concentrations were very high, indicating sediment-water fluxes are highly likely in these water bodies (WRC, 2004a).

Investigations of sediment-water nutrient fluxes in Torbay Inlet or Lake Powell have just been completed by Geosciences Australia, and this work found extremely high flux rates in both waterbodies.

B2.1.7 Nutrient Processes with Torbay Inlet and Lake Powell

Water quality monitoring in both Torbay Inlet and Lake Powell has been undertaken at a fortnightly/monthly frequency since October 1999 at sites shown in Figure B9.

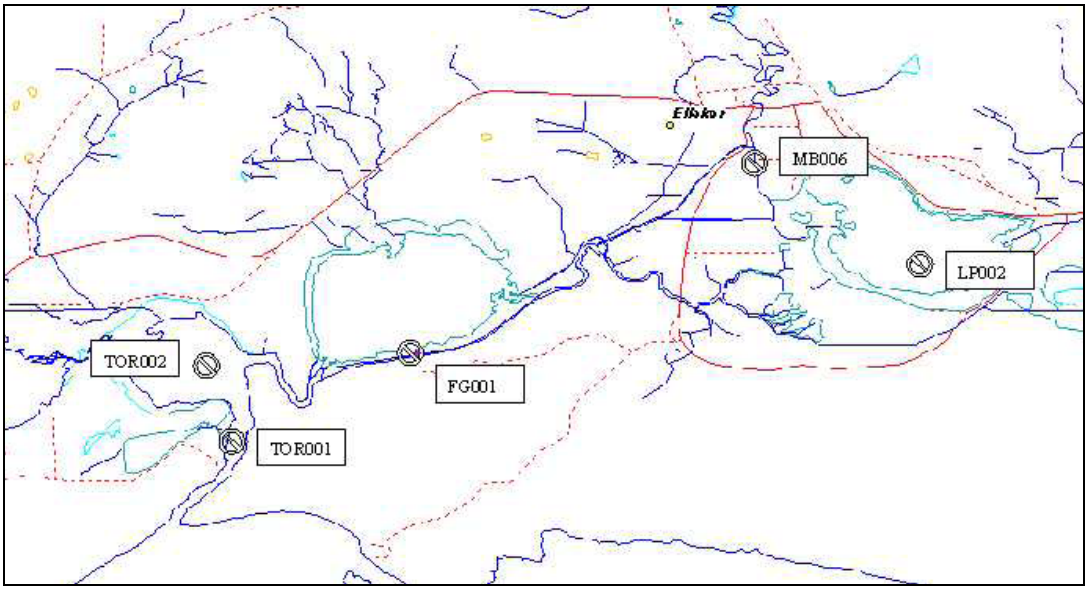


Figure B9 Location of water quality monitoring sites for Torbay Inlet and Lake Powell (Source: WRC, 2004a)

Torbay Inlet

Prior to winter 2002, phytoplankton assemblages in Torbay Inlet were dominated by a combination of cyanophytes (the blue-green algal species, including *Nodularia*), chlorophytes and diatoms. Since winter 2002, phytoplankton assemblages in Torbay Inlet have been dominated by diatoms throughout the year. This change in phytoplankton assemblages in Torbay Inlet is likely to be due to a combination of environmental factors, including bar status/frequency of marine connectivity and salinity. High salinity in Torbay Inlet favours the presence of diatoms. Vertical stratification (i.e. layers of fresher water near the surface and saline water near the bed) was evident in Torbay Inlet.

Figure B10 shows a model of summer nutrient processes, including the marine influence, favouring the strong presence of diatoms within the phytoplankton assemblage. The main nutrient sources are from Torbay Main Drain and Marbelup Brook. The growth of summer phytoplankton assemblages is limited by water column silica concentrations (WRC, 2004a).

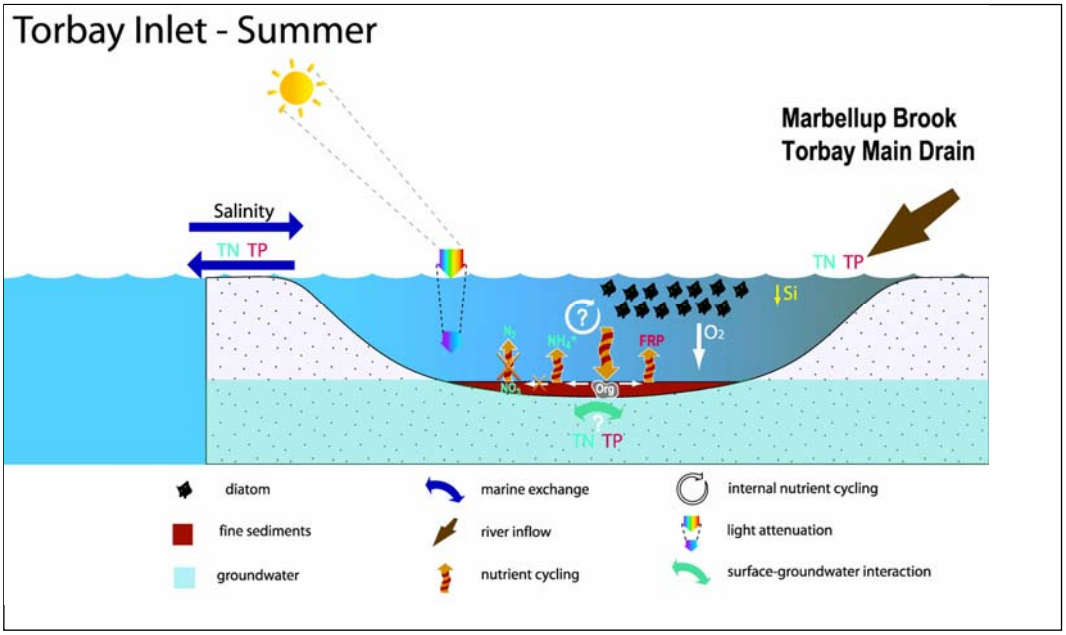


Figure B10 Conceptual model of water quality processes in Torbay Inlet during summer (Source: WRC, 2004a).

Lake Powell

Phytoplankton assemblages in Lake Powell were dominated by cyanophytes during summer/autumn, and by a mix of cyanophytes, chlorophytes and diatoms during winter and spring throughout the monitoring period (1999–2004). Ammonia and orthophosphate concentrations were consistently lower in Lake Powell than in Torbay Inlet. Salinity was also lower in Lake Powell but dissolved oxygen concentrations were higher.

Phytoplankton growth in Lake Powell is limited by nitrogen and silica, with partial phosphorus limitation.

Figure B11 shows a model of summer nutrient processes in Lake Powell.

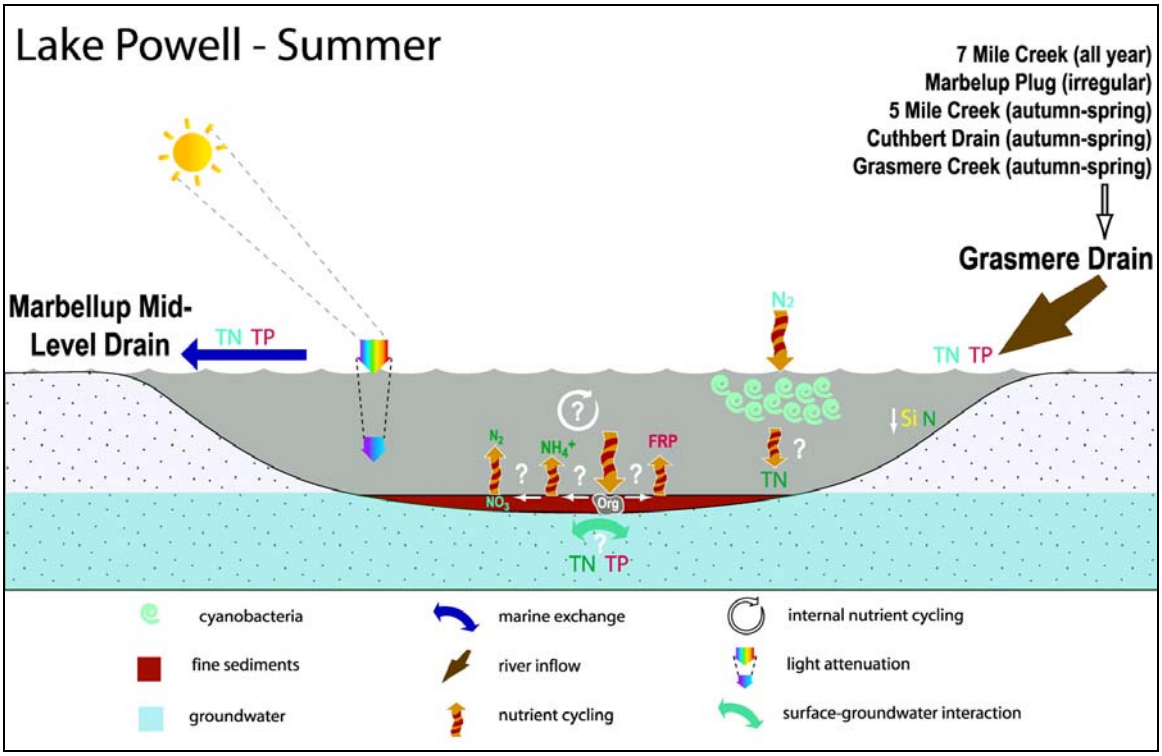


Figure B11 Conceptual model of water quality processes in Lake Powell during summer (Source: WRC, 2004a).

B2.1.8 Marbelup Brook Stream Flow Quality

The suitability of Marbelup Brook for public drinking water is dependent upon it meeting quality and health standards. There is concern about incompatible land uses within the Marbelup Brook catchment, including residential development and intensive animal industries. The risk is to public health standards by the potential for water-borne pathogens. The Marbelup Brook sub-catchment was declared the Marbelup Water Reserve in 1986 under the Country Areas Water Supply Act 1947.

An analysis of the management options to reduce this risk suggests that adoption of Best Management Practices through voluntary support schemes is favoured (McGuire, 2002). Other options include:

1. Restricting land use through altering classification for land use controls from Priority 3 to Priority 2 for Public Drinking Water Source Areas (WA Planning Commission, 2003), or
2. Post-contamination water treatment.

The first of these is considered too onerous on landholders, the second too expensive for government (McGuire, 2002). However, protection planning currently underway is likely to recommend greater land use controls. A risk evaluation undertaken by the Water Corporation (Water Corporation, unpublished) show much of the existing catchment is consistent with priority 2 classification.

The opportunity exists to undertake Best Management Practice actions within the Marbelup Brook catchment that reduce nutrient flows to water receiving bodies (Lake Powell and Torbay Inlet) and provide ecosystem services through increased public health standards for future public water supplies.

B2.1.9 Water Quality and Algal Blooms: Targets for change

The most significant water quality issues within the Torbay catchment are the high nutrient loads in streamflow and the very high occurrence of algal blooms in wetlands and waterways. The community and partners of the '*Watershed Torbay*' project expect to reduce the incidence of algal blooms so that water is suitable for maintenance of healthy aquatic ecosystems, and in some situations, for human use. The cause of algal blooms is the high nutrient load within wetlands and waterways. Reduction in the incidence of conditions suitable for blooms will require a reduction in nutrients however the extent to which a reduction can be achieved through nutrient management remains uncertain. A target is set for the preferred reduction in algal bloom incidence in order to provide guidelines for research and management.

As further information is gathered, particularly on the impacts of nutrients from acid sulphate soils, further targets for water quality improvement for groundwater may be set.

A short rationale on how targets have been set for each of the waterways is given below.

Torbay Main Drain

Torbay main drain contributes 38% of the flow of the catchment, but 49% of the Total N load and 38% of the Total P load. Both Total N and Total P concentrations are high. However, most nutrient is in organic or particulate form, and intervention by way of streamlining is considered to be reasonable achievable. Given the large loads from this catchment, ambitious targets have been set, with TN proposed to meet water quality guideline values.

Marbelup Brook

Marbelup Brook is the other significant contributor of flow, comprising 41%. However, water quality is relatively good, with low Total N (below guidelines) and moderate Total P concentrations. However, given the high flow, loads are very large. While much of the riparian zone is intact, there is considerable potential to improve 1st and 2nd order stream quality. Several point sources occur in this catchment, and there are opportunities to improve water quality from these, and broadacre agriculture through fertiliser management. Current TN concentrations are considered to provide a benchmark for other streams in the catchment. TP reduction target is to guideline values.

Seven Mile Creek

Seven Mile Creek has been showing a reducing trend for Total N over the past 8 years. Total N concentrations are low, but Total P concentrations remain high, and the proportion of soluble phosphorus is also higher than for Marbelup Brook. However, loads are low given that this system contributes only 5% of the flow for the catchment (but 25% of the flow to Lake Powell). Moderate reductions targets have been set, recognising the relatively good riparian zone conditions but room for improvement in fertiliser management to reduce soluble phosphorus.

Five Mile Creek

Five Mile Creek contributes only 5% of total catchment flow, but 16% of Total P (and 50% of Total P to Lake Powell). To concentrations are extremely high, and about 60% of the phosphorus is in soluble form, which is not consistent with other streams in the catchment. . Nitrogen concentrations are also high. An ambitious TN reduction target has been set, to a target below water quality guidelines. However, this is considered achievable given the comparison with the local benchmark set by Marbelup Creek, and the current downward trend in TN concentrations.

Given the very high TP concentrations, it is considered important to better understand the sources of P, and whether they are related to the legacy of the wastewater treatment plan discharges to the creek, prior to setting targets. This work forms an action in this plan.

Cuthbert Drain

Cuthbert drain contributes 3% of the flow, 4% of the TN, and2% of the TP. Concentrations of Total N are high, but TP meets ANZECC water quality criteria. TN concentrations are likely to be related to acid sulphate soil processes. No reduction in TP concentration has been proposed given it currently meets guideline values, but an ambitious TN reduction is proposed.

Grassmere Drain

This drain contributes 2% of the flow, and proportional load of both TN and TP. However, both TN and TP concentrations are high, although there has been a very small downward trend in TN over the 8 year period 1997 – 2005. The TN target has been set at guideline value, and an ambitious TP reduction target has been set. Soluble phosphorus concentrations are a relatively high component of TP for this catchment.

The **Targets** for resource condition change for **Theme One: Water Quality and Algal Blooms** are:

1. ***Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbellup Brook by 2025***
2. ***Median nutrient concentrations discharge from the sub-catchments meet the following targets by 2020:***

Sub-catchment	Current Median Nutrient Concentration (mg/L)		Target Median Nutrient Concentration (mg/L)	
	TN	TP	TN	TP
Torbay Drain:	**1.80**	**0.110**	**1.20**	**0.090**
Marbelup Brook:	**0.68**	**0.077**	**0.60**	**0.065**
Seven Mile Creek:	**1.00**	**0.130**	**0.68**	**0.100**
Five Mile Creek:	**1.35**	**0.460**	**1.00**	**To be set**
Cuthbert Drain:	**2.45**	**0.059**	**2.00**	**0.059**
Grassmere Creek:	**1.40**	**0.200**	**1.20**	**0.150**

3. ***The quality of water in Marbles Brook meets national criteria for public drinking water supply (NHMRC & ARMCANZ, 1996) by 2015.***

Note: Guideline values use for this catchment are for the SW Streams, TN of 1.2 mg/L, and TP of 0.065 mg/L.

B2.2 Theme Two: Water Quantity

Water quantity in the Torbay catchment is significant for three reasons:

1. The potential allocation of drinking quality water for the Lower Great Southern Water Supply Scheme,
2. Ongoing adequate self supply for catchment land holders, and
3. Ensure adequate water quantity to maintain ecological functions in waterways and wetlands (environmental water provision).
4.

➢ **Goal (2025):**	Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.
➢ **Objectives:**	• Flow in Marbelup Brook is adequate to maintain ecological requirements, • Water regimes in Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals, • The drainage district is managed to meet the needs of current land uses, future land uses, and the environment, and • Those who benefit from the use of the catchment to provide environmental services contribute to the costs of restoration.

The stream flow of creeks within each sub-catchment is measured at gauging stations (as shown in Figure B2). The Marbelup Brook has the greatest average annual flow of 16 gigalitres (GL).

Water consumption in the City of Albany is increasing and total demand is expected to double from the current consumption of 5 GL within the next 25 years (Water Corporation, 2000). The current primary source area is the Werillup Hill aquifer which is now at full sustainable use levels. Additional water sources are required. One favoured proposal is to allocate up to 6GL from Marbelup Brook for direct supply to Albany, or to recharge the Werillup Hill aquifer.

The function of aquatic ecosystems is determined primarily by the quality of water as well as the period and duration of stream flow. Modification to stream flow can substantially impact on basic river ecological health. Ecological Water Requirements (EWRs) are defined as "*the water regimes needed to maintain ecological values of water dependent ecosystems at a low level of risk*". Determination of EWRs for Marbelup Brook will be important for stream flow allocation for public water supply.

With proposals to allocate water for public use and with possible alterations to the current operating strategy of the drainage system, there is a need to ensure sufficient stream flow is available for environmental requirements. This as important for Lake Powell, Torbay Inlet and Lake Manarup. It is also significant for in-stream ecologic functions of waterways.

B2.2.1 Water Quantity: Targets for change

The requirement for allocation of water from Marbelup Brook for public water supply is expected to occur within 10 years. The targets for resource condition change are set for this time period and apply to both water allocation and environmental water provision.

1. ***Major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions by 2015.***

2. ***Use of surface and groundwater resources for private and public benefit is maximised within identified sustainable yield.***

B2.3 Theme Three: Drainage Management

The Albany Drainage District was established to provide benefits for agriculture and horticulture through reduced flood risk. It now provides additional benefits for urban residential development and public infrastructure protection. The drainage district is proclaimed under the State Governments *Land Drainage Act (1925).*

A description of the functions of the drainage system in the Torbay catchment is provided in Section A. A full description of the drainage system, community expectations, industry benefits and flexibility of management is provided in the Source Document for the '*Watershed Torbay'*) Drainage Steering Committee (Viv Read &Assoc., 2003).

➢ **Goal (2025):**	Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.
➢ **Objectives:**	• The impact of flooding on horticulture is minimised, • Flooding in residential areas is minimised, • The potential adverse effects of drainage management on fisheries is minimised (including commercial fisheries and native fish species), • The impact of drainage management on algal blooms is minimised, and • The drainage system is managed to prevent or minimise sedimentation of receiving water bodies.

The current drainage infrastructure systems in the Manarup, Seven Mile (upper), Seven Mile (lower) and East Torbay sub-catchments has converted the natural single level hydraulic system into three separate levels as shown in Figure B12.

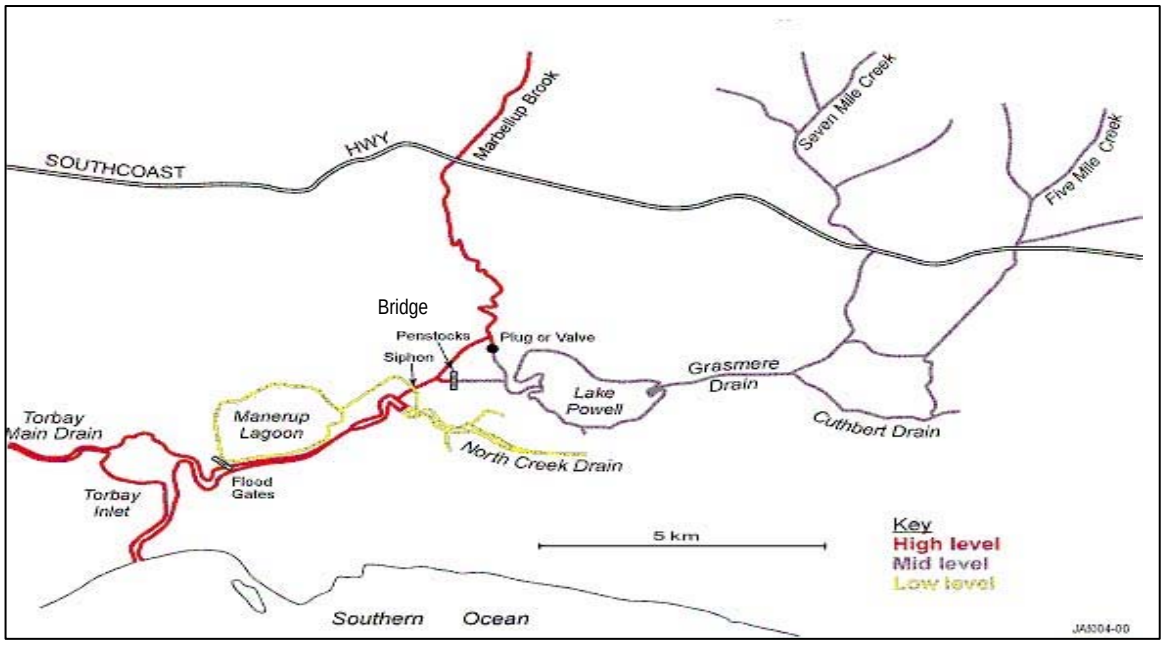


Figure B12 The three-level Torbay drainage system (adapted from Adeney, 2001).

The original purpose was to increase the suitability of land within the valley floor for horticulture and to protect rail and road infrastructure from occasional flooding and saltwater intrusion. Floodwaters were reduced during the growing season. In addition, groundwater levels were controlled to ensure optimal soil moisture for horticulture during the growing season for the land south of the current Lake Powell water body and in the Cuthbert horticultural area.

The drainage system was initially operated by farmers within the district following installation during the 1950's. With further clearing of natural vegetation for agriculture, surface water run-off rates increased causing additional flooding. In 1969, the waterway between the Torbay Inlet and the sand bar was excavated to increase its flow capacity and reduce the risk of flooding. Since then, the drainage infrastructure has been managed by state government water management agencies.

The three systems are:

1. **The High-level System –** Marbelup Brook is diverted away from Lake Powell by installation of an earth wall (the Marbelup Plug) via an excavated drain that by-passes Lake Manarup and discharges into Torbay Inlet.

   A small volume of Marbelup Brook stream flow is discharged through a control valve built into the Marbelup Plug to Lake Powell via the original Marbelup Brook waterway.

   Under this system, the water level of the lower reaches of Marbelup Brook (up-stream to the weir near the Lower Denmark Road), the Marbelup constructed drain and Torbay Inlet has the same water level. It is only these areas that are now under uncontrolled estuarine influence when the sand bar is open.

2. **The Mid-level System –** constructed drains in the Five-mile Creek and the Seven-mile Creek are confluent with the Cuthbert Drain to form the Grassmere Drain that discharges directly into Lake Powell. Check structures in the main drains and drains on private land are used to control groundwater levels for horticulture.

   The water level in Lake Powell is controlled by penstocks and floodgates located at Bridge 45 on the Grassmere-Elleker Road along the excavated drain from the lake. The penstocks restrict the inflow to the lake from the High Level system when the water level is high and possibly saline, and to restrict outflow from the lake when water levels in the lake are to be controlled for soil moisture maintenance of adjacent horticultural land. The penstocks are operated manually.

   The floodgates at Bridge 45 open automatically when the water level in Lake Powell exceeds 0.8 meters AHD and the penstocks are opened to allow outflow to the High Level system.

3. **The Low-level System –** a constructed drain from Ewart Swamp discharges into North Creek which flows to Lake Manarup via an un-controlled siphon. This arrangement allows excess surface water from horticultural land near the Grassmere-Elleker Road south of Lake Powell to drain into Lake Manarup. For this to operate, the water levels in Lake Manarup need to be maintained at a low level (less than 0.2 meters AHD). As Lake Manarup is of similar level to Torbay Inlet and subject to tidal influence or high water level inflow, penstocks and floodgates are installed at the lake outlet. The penstocks are manually operated to maintain low water levels in the lake but also to allow inflow to the lake as required.

The drainage reserves extend for 35 km throughout the lower Torbay Catchment. Private drains feed into the public arterial drains. The drains within the catchment are generally in need of maintenance

to control bank erosion and slumping, and sediment transport. This may require some new management practices, including strategically designed revegetation. Sediment transport, particularly in response to some maintenance actions, has caused a high level of deposition in the receiving water bodies causing loss of water body depth. A sediment delta is conspicuous in Torbay Inlet caused by high sediment loads from the Torbay Drain.

B2.3.1 Drainage System Control Mechanisms

The 3-level drainage system has four main control points:

1. **The 'Marbelup Plug' Valve –** that allows a small proportion of Marbelup Brook stream flow to enter Lake Powell as environmental flow. The valve can be closed as required.

2. **The Bridge 45 Penstocks and Floodgates –** that are the main control mechanism between the High Level and Medium Level systems. They are used to:
    - maintain water levels in Lake Powell as required for horticulture
    - restrict saltwater intrusions into Lake Powell when the High Level system is under tidal influence
    - enable flood flow discharge from Lake Powell when the level exceeds 0.8 meters.

3. **The Lake Manarup Penstocks and Floodgate** – that control inflow from the Torbay Inlet up to 0.8m AHD (level for minimum flood risk) when low water levels in the lake are required.

4. **The 'Bar' –** which is the sand bar that forms naturally across the Torbay Inlet channel on the beach due to wave action sediment processes. The Bar breaches naturally 5-10 times each year when water levels are at approximately 1.1 meters AHD. The period for which the Bar stays open varies from a few days to several months. Many factors affect this period, including rainfall, wind and sea swell.

    There are several seasonal periods when the Bar is artificially breached if it has not occurred naturally. This is done to reduce existing flood-waters from adjacent land up-stream, or to lower water storage levels (for example, in Lake Manarup) to provide future flood detention capacity. The control of the Bar openings is a critical operating decision.

B2.3.1.1 Seasonal Operating Options

The current operation is based on the requirement to manage water levels for horticulture, however other factors are considered in operating systems decisions including:

- Minimise risk of flooding in residential areas, particularly the area near Woodides Road.
- Restrict the occurrence of fresh 'black water' outflow to the Torbay Bay during the commercial fishing season (February-April).
- Increasing the depth of water in Lake Manarup according to local community requests.
- Reducing mal-odours from Marbelup Brook downstream of the Marbelup Plug.

There are two seasonal strategies for operation:

1. **The 'Summer Operating Strategy'**

   The aim is to maintain water levels in Lake Powell at approximately 0.8 meters AHD. The control mechanism is the 'Bridge 45' penstock.

   The water level in Lake Manarup is maintained at a low level during the potato-growing period so the Low-level system will function if a rainfall event occurs that may cause flooding.

   Artificial breaching of the bar is avoided during the February-March period as is preferred by the commercial industry in the Torbay Bay.

   The Marbelup Plug valve usually remains open during summer to allow some stream flow in Marbelup Brook in response to local community complaints about mal-odours.

2. **The 'Winter Operating Strategy'**

   The aim in winter is to avoid flooding and to minimise water detention in Lake Manarup and Torbay Inlet. To achieve this, the Bar is artificially opened normally during May and is kept open until the end of October. This may require the Bar to be artificially breached 5-10 times during this period.

   Lake Manarup is kept as low as possible for as long as possible during this winter period so that it has adequate capacity to hold run-off from the Low Level system during the potato growing season.

   The 'Bridge 45' penstocks are also kept open all winter to drain excess water from Lake Powell.

   The Marbelup Plug valve generally remains open throughout winter.

B2.3.1.2 Drainage System Operation Criteria

Operating decisions for the 3-level system are based on a range of factors. Criteria for these are described.

1. **Inundation due to Rainfall and Preceding Events**

   Late winter rains or summer rains following a wet winter may cause increasing floodwaters in Torbay Inlet and Lake Manarup that may increase the risk of flooding horticultural crops and residential areas. This may require a decision to release water from the system by breaching the Bar. There is now an expectation by horticulturalists that land used for horticulture is not inundated for a period of more than 72 hours during the potato-growing season. This relates to inundation of the Cuthbert horticultural area, land south of Lake Powell and land in the North Creek catchment.

2. **Horticultural Soil Water Requirements**

   Horticulturalists adjacent to Lake Powell observe the soil moisture status of their land during the growing period. If the water levels in Lake Powell are low and there is a risk of plant wilt, the Bridge 45 penstocks will be raised to contain inflow from the Grassmere Drain.

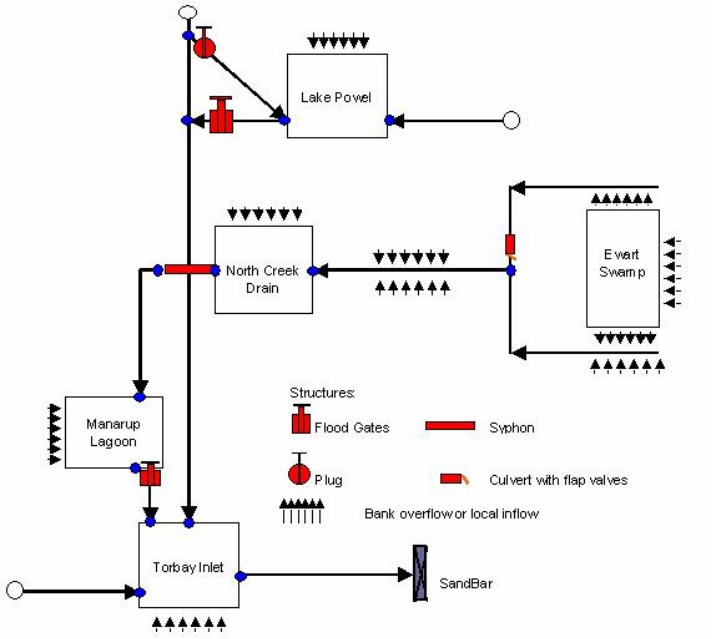
3. Critical Flood Levels

Critical levels are the levels above which flooding will occur. They are known for a range of locations within the drainage system: - 1.4 meters AHD at Torbay Inlet, 0.2 meters for Lake Manarup and 1.0 meter for Lake Powell.

4. Bar Breaching conditions

Tides in Torbay Bay range from 0.4 – 1.3 meters in amplitude. While the oceanic conditions in the bay vary considerably, the preferred conditions for breaching the Bar are with a receding high tide and low swell.

The complexity of the system and proposed changes lead to development of a computer-based water balance model by the Department of Environment (Aditya Jha, *pers. comm.*.), as shown in the conceptual diagram below. The model simulates the three levels of the drainage system and allows estimation of the effects of transfer of water from one level to another as may occur due to change in the drainage operating system. It accounts for water level, stored volume and surface area of each water body separately or connected hydraulic structures (i.e. the control mechanisms described in Section A5.0). The model does not account for nutrient loads or other water quality measures in its current form.



Conceptual Flow Diagram of Torbay Drainage Network

The water balance model has provided a visual image of how the drainage system can be operated differently under a range of operational strategies.

Detailed bathometric and land survey information undertaken during 2002-3 for the wetlands and drainage system has enabled calculation of the volume of the wetlands. Lake Powell has a total volume (at 1.4m AHD) and so with known inflow the frequency of filling is 2.3 times annually. For Torbay inlet, the total volume in similar ($1.44x10^6$ m^3) but the frequency of filling is 16 times annually. The bathymetry for the High, Medium and Low level systems is shown in Figure B13 a, b and c.

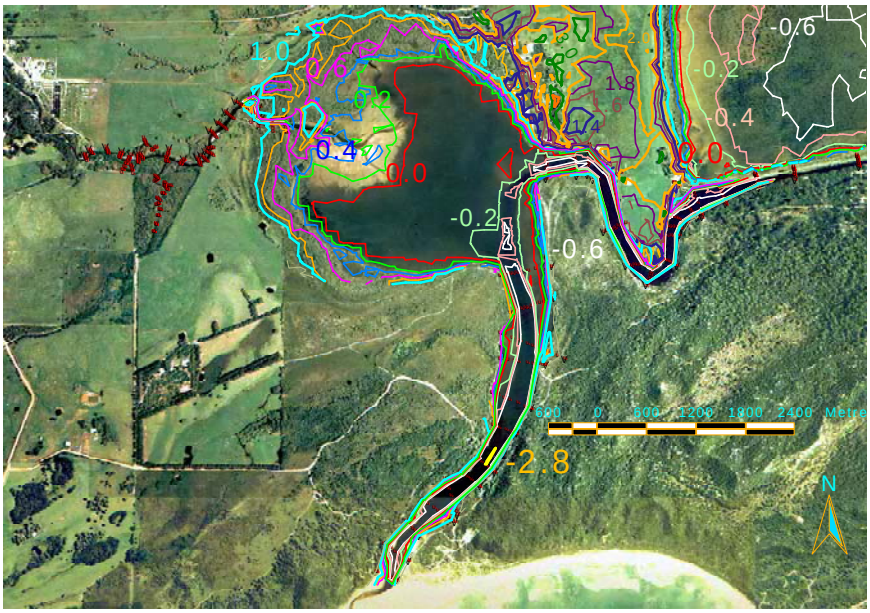


Figure B13(a). Bathymetric levels (meters AHD) for Torbay Inlet (the High-level drainage system)

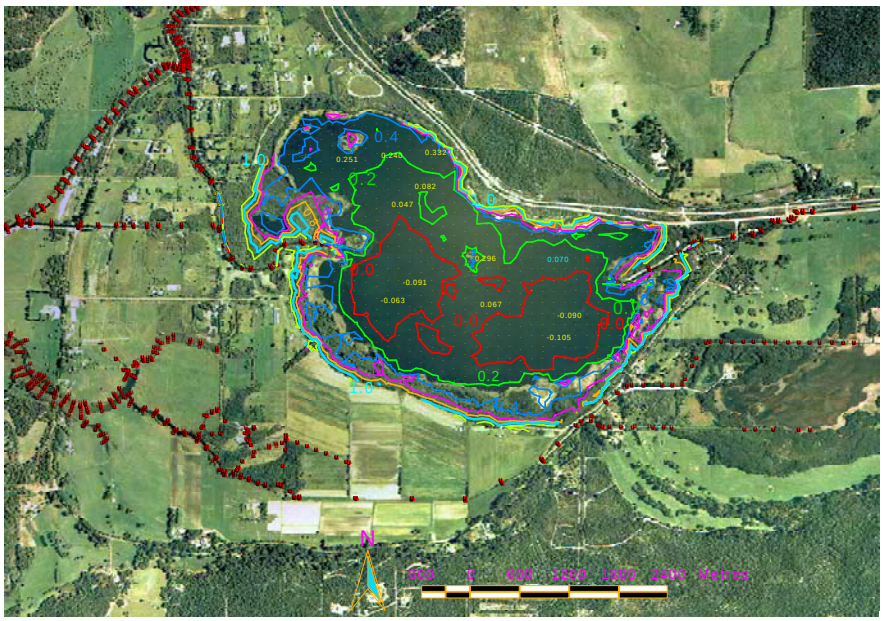


Figure B13(b). Bathymetric levels (meters AHD) for Lake Powell (the Medium-level drainage system)

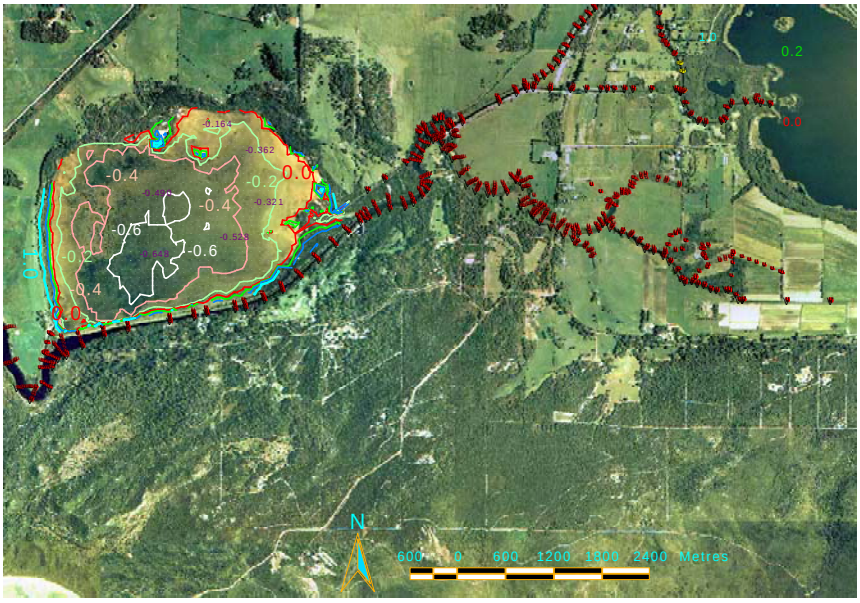


Figure B13(c). Bathymetric levels (meters AHD) for Lake Manarup (the Low-level drainage system)

The water balance model has used the bathometric and land survey information to calculate the volume of the water bodies at a range of water levels. Figure B14 provides an example for the High-level drainage system.

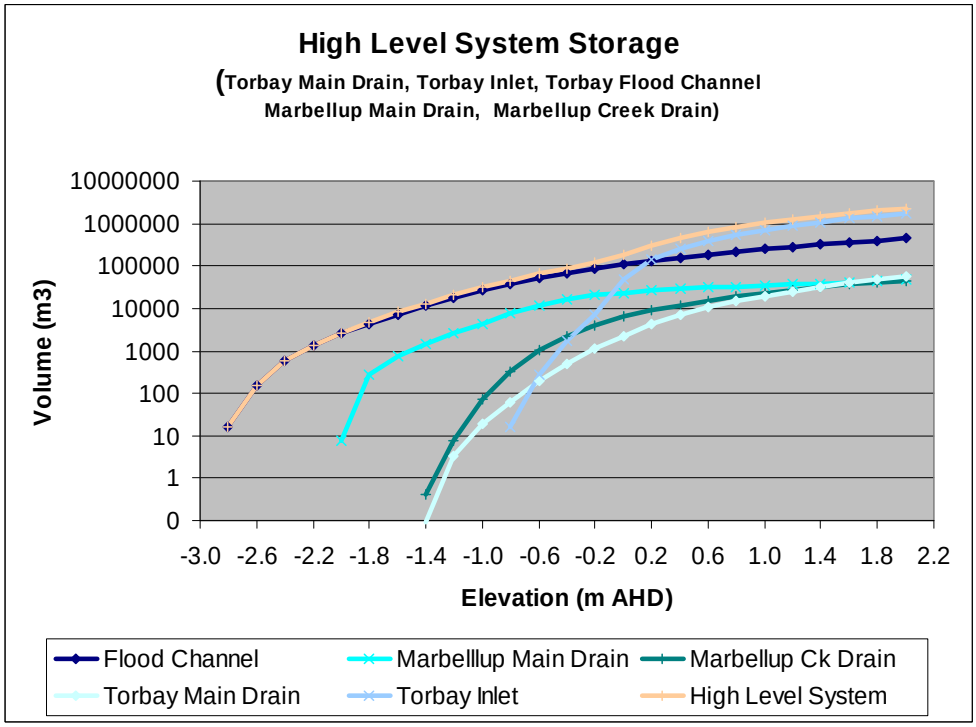


Figure B14. Water body volumes in the High-level drainage system.

B2.3.2 Management scenarios for the drainage operating system

The community has expressed concern about the effect of the drainage system on environmental and public amenity values. A Drainage Sub-committee established as part of the '*Watershed Torbay*' project recognised opportunities for possible changes to operation of the drainage system to provide multiple benefits to the community. The scenarios for management change to the current operating system are:

1. **(a) Current Operating Strategy -** the current drainage operating system continues. While this option does not address community concerns, it does provide flood protection for the potato industry and residential areas.

   (b) Current Operating Strategy with Bar Open during Commercial Fishing Season – this option assumes greater flexibility of bar opening periods than has previously occurred based on negotiated arrangement with commercial fishing licensee's.

2. **Remove all controls** – reverting to a single hydraulic system by removal of all floodgates, penstock, plugs and siphons. While this may appear to have appeal for enhancing the wetland systems, it is recognised as being unacceptable due to the flood risk to agricultural and residential areas. The land currently used for potato growing would no longer be suitable for production.

3. **(a) Pump North Creek to Marbelup Creek Drain (High System)** – mechanical pumping North Creek stream flow (either total stream flow or peak flow volumes) to by-pass the Siphon and discharge flow into the High-level system (i.e. into Torbay Inlet) instead of Lake Manarup. The lake would then not be required for flood mitigation purposes and could be filled through Lake Manarup Gates.

   (3ai) Continuous Sandbar Opening – installation of culverts or other structures to allow continuous stream outflow or ocean inflow. The cost of installation and maintenance would be relatively high for this option.

   (3aii) 1-way (out) sandbar opening– this addition option is to restrict ocean inflow to Torbay Inlet. This would be unacceptable as the frequency of blue-green algal blooms would increase without the current level of saline inflow.

   (3aiii) Remove Lake Manerup Gates - if North Creek is pumped to the High-level system, then the Manarup Gates could be removed so that the lake is continuously connected to Torbay Inlet. Alternatively, the gates could remain but be left open. This would provide management flexibility if there is a future need to prolong water detention in the lake, or to prevent ocean inflow.

3. **(b) North Creek Bridge Gates & Pump (Low-level System)** – this option is based on North Creek flowing into Lake Manarup (the Low-level system) while water levels in the lake are low. When the lake water levels rise, the gates would be shut and North Creek stream flow is pumped over the gate into Lake Manarup. This option allows Lake Manarup to be managed as a wetland ecosystem without the risk of flooding to horticultural and residential areas.

4. **Open Marbelup Plug Valve** – removal of the Marbelup Plug would return Marbelup Brook stream flow to Lake Powell as a part of the Mid-level system. This would reduce the incidence of mal-odours downstream of the Plug.

5. Connect Lake Powell to the "High-level system" (Via Gate 45)

5. (a) Remove Marbelup Plug, Remove 'Gate 45' and install Lake Powell Flood Gates – this option has the benefits of Option 4 plus adds the potential for flushing Lake Powell with Marbelup Brook stream flow. Control of water levels in Lake Powell (to benefit potato production and ecosystem management within the Lake Powell Reserve) is provided by construction of the Flood Gates at the outflow point on Lake Powell. The Flood Gates and Penstocks on Bridge 45 would no longer be required.

5. (b) Replace Marbelup Plug with Control Gates - with option 5a, stream flow from Marbelup Brook would be diverted from Lake Powell when the proposed gates are closed. This could increase the risk of flooding to residential areas (e.g. near Woodides Road) unless a substantial levee is maintained to contain the diversion flows. This risk could be reduced by installation of additional Control Gates at the current location of the Marbelup Plug. With these gates closed, Marbelup Brook stream flow would be diverted to the High-level system so reducing the risk of flooding in residential areas.

5. (c) Install Weir Downstream of Marbelup Plug (on Marbelup Creek Drain) – installation of a permanent weir would provide a mechanism to prevent saline (tidal) inflow to Lake Powell if Marbelup Plug is removed. This required height of this structure could significantly reduce the function of the High-level system if this is required (i.e. with Option 5b). The suggested weir may affect native fish migration.

6. Connect the "Mid-level System" with the "Low-level System"

6. (a) Install Gates to Lake Powell – Flood Gates could be installed at the inflow to Lake Powell and a diversion drain be constructed to take this inflow to North Creek. This would provide the option to divert flows with high nutrient levels away from the lake but would increase the flood potential for North Creek.

6. (b) Increase North Creek Flow Capacity – with Option 6a, the flood risk could be reduced by increasing the North Creek channel capacity.

6. (c) Construct a drain south-west from Lake Powell to North Creek – this option is proposed to increase the potential for flushing nutrients from Lake Powell. The proportion of the water body that would flush with this option is not known. The potential for flooding the horticultural and residential areas could increase.

7. Construct levees to increase the water retention capacity of the water bodies

7. (a) Lake Powell – increasing the volume of Lake Powell could increase the flushing potential of the water body although the effectiveness of this is uncertain. High water levels would assist in the control of the introduced *Typha* (Bullrush) but may threaten the native sedges. Construction of the proposed levees would cause significant disturbance within the Reserve, and would increase the difficulty of managing soil moisture conditions for the horticultural land.

7. (b) Lake Manarup – increasing the volume of Lake Manarup could assist in restoring the water body as a functioning wetland ecosystem. Initially, the ecosystem functions could be restored by increasing inflow to the lake with its current capacity. This could prove adequate and levees to increase the lake volume may not be required.

7. **(c) Existing drains entering Lake Powell and Torbay Inlet** – the existing levees of these drains could be increased to reduce the potential for flooding of adjacent land.

   The water balance model is able to show the relative benefits to be derived from increasing the water body capacity with construction of levees.

B2.3.2.1 Criteria to consider for change to operation of the drainage system

The current operating system for the drainage considers a range of biophysical and social factors for decisions of control or regulation of water levels. If the objectives of the operating strategy are to alter, consideration needs to be given to these and other factors may influence the decision or be affected by it.

1. Inundation due to Rainfall and Preceding Events

Late winter rains or summer rains following a wet winter may cause increasing floodwaters in Torbay Inlet and Lake Manarup that may increase the risk of flooding horticultural crops and residential areas. This may require a decision to release water from the system by breaching the Bar. There is an expectation by horticulturalists that land used for horticulture is not inundated for a period of more than 72 hours during the potato-growing season. This relates to inundation of the Cuthbert horticultural area, land south of Lake Powell and land in the North Creek catchment.

2. Horticultural Soil Water Requirements

Horticulturalists adjacent to Lake Powell observe the soil moisture status of their land during the growing period. If the water levels in Lake Powell are low and there is a risk of plant wilt, the Bridge 45 penstocks will be raised to contain inflow from the Grasmere Drain.

3. Critical Flood Levels

Critical levels are the levels above which flooding will occur. They are known for a range of locations within the drainage system: - 1.4 meters AHD at Torbay Inlet, 0.2 meters for Lake Manarup and 1.0 meter for Lake Powell.

4. Bar Breaching conditions

Tides in Torbay Bay range from 0.4 – 1.3 meters in amplitude. While the oceanic conditions in the bay vary considerably, the preferred conditions for breaching the Bar are with a receding high tide and low swell.

5. Local Community Concerns

The main areas of community concern are:

- Algal blooms in Lake Powell and Torbay Inlet.
- Low water levels in Lake Manarup (unsuitable for fish stocks, water birds and wind mobilised sediments within the lake when it is dry.
- Mal-odours from Marbellup Brook below the Plug, and on occasions from Lake Powell.
- Acidic discharge water from the Low Level system into Lake Manarup.
- Poor quality of water for public recreation in drains and some waterways.

6. Acid Sulphate Soils

Since the September drainage options workshop, the Department of Environment has documented the extent of acid sulphate soils and the connection of these to the release of nitrates and phosphates when disturbed (DoE, 2004b). Previously, Ewart's Swamp was considered the main source of acidic stream flow however the document notes that all soils derived from estuarine deposits (i.e. those soils from Torbay to Princess Royal Harbour) are potential acid sulphate soils. It is not yet clear how this may impact on decisions about the drainage operating systems, but it is likely to be significant.

Table B5 provides a list of the community services or landscape features associates with the three levels of the drainage system. It also provides an estimate of the preferred water level range to maintain these services or features. This information provides objective criteria for evaluation of proposed changes to the drainage operating system.

B2.3.3 Assessment of options for management of the drainage operating system

Information based on water balance modelling and workshop processes allowed an assessment of the management options for the drainage operating system to be assessed according to a set of criteria. Table B6 shows the outcomes of this assessment. The options to be further considered are:

- 3(a) Pump North Creek to Marbellup Creek Drain (High System)
- 3(aiii) Remove Lake Manarup Gates
- 3(b) North Creek Bridge Gates & Pump (Low System)
- 4. Open Marbellup Plug
- 5(a) Remove Marbellup Plug, Remove "Gate 45" and install Lake Powell Flood Gates

Construction of levees remains an option although was not assessed. The water balance model will assist in assessment of the benefit of levees in association with other preferred options.

Table B5 Criteria for assessment of the options for management of the drainage operating system within the Torbay catchment.

DRAINAGE SYSTEM	COMMUNITY SERVICE/ LANDSCAPE FEATURE	PREFERRED WATER LEVEL RANGE	COMMENTS
Low Level System	Lake Manarup– Maintain water to prevent dry blow of lake bed.	Minimum = -0.2 – 0.0 m AHD	Most of the lake has water coverage with - 0.2 m. of lake bed. 0.0m gives coverage of all of lake bed.
	Lake Manarup – Maintain good water levels suitable for wading bird habitat.	Minimum = -0.2 m AHD would provide minimum depth over 50% of the lake bed. Minimum = 0.0 m AHD would provide minimum depth over 80%+ of lake bed.	Assume 0.2 m water depth is ideal for wading birds (needs to be confirmed). Depth required for other water birds to be established.
	Maximise environmental values of Lake Manarup		Environmental Water Requirements to be developed.
	Maximise environment values of Ewarts Swamp		Environmental Water Requirements to be developed.
	Farmland flooding between Torbay Inlet and Lake Manarup	Maximum = 1.2 m AHD would provide for 0.2 m depth to groundwater.	
	Prevent groundwater flooding of spuds in south Lake Powell	Maximum = 0.2 AHD would provide for 0.2 m depth to groundwater.	Confirmation required that that this level is suitable flood protection for potato production.
	Avoid surface flooding of potato crops in summer	Maximum = -0.4 to -0.2 AHD would ensure some flood retention capacity, but ideally –0.6 to –0.4 AHD	
	Prevent summer salt water ingress to Lake Manarup during bar opening times.		Penstocks closed in summer to prevent salt water intrusion.
	Prevent flooding of Woodides Road residences		
	Prevent flooding of houses in Ewarts Swamp		

SYSTEM	*FEATURE*	PREFERRED WATER LEVEL RANGE	COMMENTS
Medium Level System	Ensure sufficient groundwater moisture for potatoes in summer	Range 0.6 – 0.8 m AHD in summer.	Confirmation required that that this level is suitable soil moisture control for potato production.
	Lake Powell – maintain water depths suitable for wading birds during summer period.	Minimum 0.4 m AHD would provide minimum depth over 70-80% of lake bed. Minimum 0.6 m AHD would provide minimum depth over 100% of lake bed.	Assume 0.2 m water depth is ideal for wading birds (needs to be confirmed). Depth required for other water birds to be established.
	Lake Powell – maintain water depths to maximise environmental values of wetland including management of typha spread		Environmental Water Requirements to be developed. Water regimes to be considered to maximise *Baumea articulata*..
	Lake Powell – Lake bed drying to aid denitrification and minimise algal blooms	Achieve minimum water level of 0.0m AHD would provide for 60-70% lake bed drying.	
	Prevent flooding of surrounding properties, especially houses.	Maximum of 1.0 m AHD	Confirmation required that that this level is suitable flood protection for potato production and residential areas.
	Maintain water regime in Marbellup Plug to minimise algal booms		Need to establish the level of flow through the Marbellup Plug to minimise algal blooms and mal-odours.
High Level System	Torbay Inlet - maximise salt water regime to Inlet over summer to avoid algal blooms		Maximise bar openings through late winter and early-mid summer. Maximise water levels prior to bar opening to lengthen bar open period.
	Prevent flooding of surrounding land.	Maximum of 0.8 m AHD for Torbay main drain maximum of 1.4 m AHD for area between Manarup and Torbay Inlet.	Need to confirm areas of agricultural land prone to flooding.
	Minimise bar openings during February March	Achieve minimum of –0.3 m AHD is possible in mid-late summer so that bar closes and sufficient flood retention capacity in case of summer rainfall	A level of -0.3 m AHD was achieved in 2003 at end of summer causing substantial bed drying of Torbay Inlet. The consequences of this are not clear.
	Torbay Inlet – maintain water levels to minimise algal bloom potential		
	Torbay Inlet – maintain water levels to maximise environmental values of Inlet		Environmental Water Requirements to be developed.

Table B6. Evaluation of management options for the drainage operating system within the Torbay catchment.

Code to Assessment Criteria

1. Lake Powell ecosystem health
2. Torbay Inlet ecosystem health
3. Lake Manerup ecosystem health
4. Grassmere potato farm flooding & soil moisture
5. Residential flooding
6. Commercial fishing
7. Marbellup "midges & mal-odours"
8. Waterway recreation (recreational fishing, suitable for use by kids (water quality criteria) and paddling).
9. Fish migration
10. Flooding of agricultural land (other than land used for horticulture)
11. Cost and ease of operation

Options	**Assessment Criteria (see above)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	***Decision*** **(Out, Unsure, OK)**
1 Do nothing new	X	X	X	√	√	√	X	X	√ ?	√	-	Remains an option
2 Remove all controls	√	√	√	X	X	√	√	√	√	X	-	Not being considered further due to impact on horticultural industry and residential flooding.
3 North Creek options												
3a Pump North Creek to Marbellup Creek Drain (High System)	X	?	X	-	-	√	-	-	-	-	X	To be modelled
3ai Continuous Sandbar Opening	-	X	X	-	-	-	-	√	√	X	X	Out due to difficulties in maintaining the sandbar open.
3aii 1-way (out) sandbar opening	-	X	X	-	-	-	-	X	XX	X	X	Out – as above
3aiii Remove Lake Manarup Gates	-	√	√	-	-	-	-	√	√	X	√	To be included in modelling.
3b North Creek Bridge Gates & Pump (Low System)	X	X	√	√	√	√	X	√	X	X	X	To be further considered and modelled
4 Open Marbellup Plug	√	-	-	X	X	-	√	√	√	-	-	Keep it in and model it to get sense of proportion and volume of water

5. Connecting Lake Powell to the 'High Level' system.												
5a Remove Marbellup Plug, Remove "Gate 45" and install Lake Powell Flood Gates	-	-	-	-	X	-	√	√	√	-	-	To be modelled. Risk of increased flooding (may require levees to be constructed).
5b. Replace Marbellup Plug with Control Gates												Not to be considered further (reasons are not clear).
5c. Install Weir Downstream of Marbellup Plug (on Marbellup Creek Drain).												Not to be considered further (reasons are not clear).
6. Connect 'Mid System' to 'High System"	X	X	X	X	X	-	X	X	-	-	X	Not to be considered further (unless specifically proposed and assessed by external proponent).
7. Construct levees												
7a Lake Powell												
7b Lake Manarup												
7c Drains entering Lake Powell and Torbay Inlet.												

Code: X =bad, √ =good, - =neutral ? = uncertain

B2.3.4 Drainage Management: Targets for change

The three level drainage system in the lower Torbay catchment has been operating since the 1950's providing benefits to horticulture and for flood protection. Ceasing operation and removal of the drainage infrastructure is not considered as an option because of the advantages that the current operating system currently provides. Changes that are made to the infrastructure or operating system should to also consider the impact on the condition of all natural resource and heritage values.

The targets for resource condition change to be achieved by adopting alternative drainage practices to the current system are set with the understanding that:

- The health of the receiving water bodies is not worse,
- The current benefits to primary producers remain as long as required,
- Residential and infrastructure flood protection remains,
- Marine and inland fish passage and spawning is not restricted,
- Social values, including lifestyle and recreation values, are improved, not diminished, and
- The cost and difficulty of operation is not significantly greater. (Note: additional costs for construction of new works, changed operation or increased maintenance will require an additional allocation of funding from the State Government).

The frequency with which Torbay Inlet is connected to the ocean depends upon breaching of the sandbar. Phytoplankton assemblages in Torbay Inlet change from a mix of cyanophytes, chlorophytes and diatoms to an assemblage dominated by diatoms when there is increased salinity. This is preferred from an amenity perspective. Maintenance of high salinities (e.g. >15,000–20,000 mg/L) within the estuary is preferred. This requirement will affect decisions about changes to the frequency with which the sandbar is opened.

Considering these factors, changes in the drainage infrastructure and operating system would be expected to achieve the following resource condition targets:

The **Targets** for resource condition change for **Theme Three: Drainage Management** are:

1. ***Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds) by 2025.***

2. ***Sediment transport in drains and sediment deposition in Torbay Inlet and Lake Powell and is reduced by 50% by 2010.***

3. ***The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025.***

B2.4 Theme Four: Habitat and Biodiversity Management

The South Coast region of Western Australia is recognised for high nature conservation values. Biological diversity (or 'Biodiversity') is a term that represents all natural living things across the landscape. It includes genetic diversity, species diversity, structural diversity (the variety of physical growth forms, especially for vegetation) and the diversity of living assemblages (the variety of biotic communities). The regional context for biodiversity on the south coast is described in *Southern Prospects 2004-9*, a regional strategy for natural resource management (SCRIPT, 2004). This identifies the importance of natural vegetation, wetlands, waterways and coastal ecosystems within the region. An analysis of vegetation types for the region lists those that are least represented in reserves or private remnant patches. The strategy also identifies threatened species and ecological communities within the region and the key threatening processes of habitat fragmentation and weed invasion. A range of targets and associated actions are proposed, many of which are relevant to the '*Watershed Torbay*' Catchment Restoration Plan.

➢ **Goal (2025):**	Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.
➢ **Objectives:**	• Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained, • The condition of foreshore vegetation and in-stream habitat is maintained or improved, • The habitat value and habitat connectivity for native fauna is improved and increased, • Population sizes and diversity of native freshwater fish and crustacean are maintained, • Requirements for fish passage and spawning in waterways are maintained, • Representative and adequate areas of pre-European vegetation types are retained, • The impact of exotic pest animal species on native fauna is reduced, and • The impact of weeds on native vegetation and aquatic ecosystems is reduced.

B2.4.1 Natural vegetation types

The Torbay catchment has 36% of the total area of 32,000 Ha remaining as natural vegetation. Table B7 shows the extent of 10 vegetation types in the catchment and compares the proportion that remains with original occurrence for each type. This shows a significant reduction in the area of freshwater lakes (due to reduction in the area of Lake Powell for horticultural use) but that some terrestrial vegetation types are little altered.

Sedge lands are of particular importance with 27% of the total original area in WA now occurring within the South Coast region. Total area of sedge lands in the state is only 59% of the original distribution area (SCRIPT, 2004). Table B7 shows that only 25% (2074 Ha) of the sedge land vegetation type in the Torbay catchment currently remains. Drainage of land for agriculture has affected substantial areas of sedge land.

Table B7. Remnant natural vegetation in the Torbay catchment (source: SCRIPT, 2004)

Vegetation Type	Pre-European Extent (Ha)	Vegetation Removed Ha (%)	Vegetation Present (Ha)	Vegetation within 50km of the catchment (Ha)
Bare areas; freshwater lakes	319	257 (80%)	62	236
Low forest; jarrah	652	112 (17%)	540	13705
Low forest; jarrah, *Eucalyptus staeri* & *Allocasuarina fraseriana*	12932	8665 (67%)	4267	16961
Medium forest; jarrah-marri	4442	3158 (71%)	1284	66911
Mosaic: Medium forest; jarrah-marri / Low forest; jarrah	2065	1753 (85%)	312	3846
Sedgeland; reed swamps, occasionally with heath	8177	6103 (75%)	2074	3371
Shrublands; Acacia scrub-heath unknown spp	2750	332 (12%)	2418	12104
Shrublands; mixed heath	384	1 (0%)	382	5678
Shrublands; tallerack mallee-heath	0.2	0.2 (100%)	0	262
Tall forest; karri (*Eucalyptus diversicolor*)	334	173 (52%)	162	7254
TOTAL	**32,056**	**20,556 (64%)**	**11,500**	**130,328**

B2.4.2 Species at risk

The State's Threatened Fauna database (managed by CALM) shows species at risk in the Torbay catchment to be:

- Australasian Bittern (Vulnerable)
- Baudin's Cockatoo (Vulnerable)
- Carnaby's Cockatoo (Endangered)
- Western Ringtail Possum (Vulnerable)
- Western Whipbird (Vulnerable)

The 'Endangered' Western Ground Parrot was recorded near Cosy Corner in 1983.

Other Priority species are the Black Bittern, the Forest Red-tailed Black Cockatoo, the Western Bandicoot and the Western Brush Wallaby.

Threatened flora species within the catchment include:

- *Caladenia plicata*
- *Synaphea incurva*
- *Lysinema lasianthum*
- *Chorizema reticulatum*
- *Microtis pulchella*
- *Schizaea rupestris*
- *Rhodanthe pyrethrum*
- *Laxmannia jamesii*

B2.4.3 Regional Reserves and Macro-corridors

Conservation reserves within the Torbay catchment are shown in Figure B15. Reserves within the region are managed according to the *South Coast Management Plan* (CALM, 1991) with specific management plans prepared for each reserve as required. Management guidelines are currently being prepared for Lake Powell. (CALM, in prep.) A management plan for coastal reserves has been initiated.

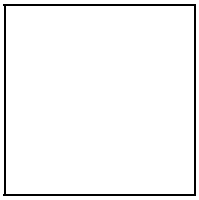


Figure B15. Conservation reserves in the Torbay catchment

The regional priorities for conservation identified by both CALM and the City of Albany are for connectivity of remnant vegetation particularly as habitat value for wildlife. The opportunities for strategic corridors within the region are well recognised (SCRIPT, 2004). Strategic zonation based on spatial analysis of remnant woody vegetation for the Torbay catchment is shown in Figure B16. Classification of zones was developed as a part of the (draft) South Coast macro-Corridors Project (Watson and Wilkins, 1999, Sanders & Watson, in prep). The zones are:

Strategic Zone A: Contains areas of woody vegetation where patches greater than 30 hectares in size are spaced no greater than one kilometre apart and potentially form the most strategic link between major protected areas.

Strategic Zone B: Contains areas of woody vegetation where patches greater than 30 hectares in size are spaced no greater than one kilometre apart and potentially provide good nodes of habitat which are in close proximity (<1km) to Strategic Zone A.

Strategic Zone C: Contains areas of woody vegetation where patches greater than 30 hectares in size are greater than one kilometre from the woody vegetation in Strategic Zones A & B. The vegetation within Zone C potentially provides habitat value for wildlife at the local scale but requires closer assessment to determine potential values for a regional scale macro-corridor network (Sanders and Watson, in prep.).

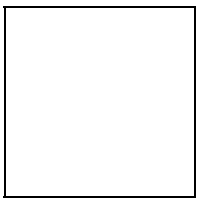


Figure B16. Strategic zones for macro-corridor development within the Torbay catchment.

This analysis shows the high potential for adding to biodiversity and habitat value through bio-geographic planning for corridors. The connectivity in the Marbellup Sub-catchments and in the coastal areas suggests these to be preferred for consideration. This is a significant management strategy to address the key regional threatening process for biodiversity – fragmentation of habitat. This threat may be due to clearing for agriculture or the many other causes of vegetation decline, including fire, weed dominance, salinity and pathogens.

B2.4.4 Wetland Ecosystems

Although considerably altered from natural conditions, the lakes, inlet and other wetlands in the Torbay catchment are recognised for high biodiversity and habitat values. Targets and actions for retention or enhancement of these values through water quality and quantity management are outlined for Theme 1 (Algal Blooms and Water Quality) and Theme 2 (Water Quantity). Theme 3 (Drainage Management) includes actions to return Lake Manarup to a functioning ecological system.

Lake Powell is of particular interest as it occurs within an 'A-Class' Nature Conservation Reserve and is recognised as a wetland of regional significance (Environment Australia, 2001). Lake Powell is listed on the Register of the National Estate in Australia's inventory of natural heritage places of significance. The lake currently has very high water bird species diversity and abundance despite the high incidence of toxic algal blooms within the water body.

A potentially significant threat to Lake Powell is through the spread of the introduced Bullrush (*Typha orientalis*) which currently is well established around the margin of the lake. Lower water levels and high nutrient levels have favoured establishment of *Typha* although it currently coexists with the native macrophyte *Baumea articulate*. *B. articulata* appears to have a stable distribution in fringing vegetation at higher elevations. *T. orientalis* is not considered detrimental to lake ecology at present as it utilises nutrients within the lake and provides valuable habitat, however it could further dominate to the detriment of the lake ecosystem. Monitoring the extension of *Typha* at 5-year intervals is suggested (Bourne, 2002). Management options include physical removal of *Typha* from the system followed by safe herbicide use. Manipulation of water levels is probably ineffective as a control option as the water body is now quite shallow. A reduction in nutrient inputs may assist, however lake bed sediments probably have very high residual nutrient loads. Typha management will be a key issue considered in management planning for the Lake.

B2.4.5 Waterways and Artificial Drains

The condition of foreshore vegetation for waterways and artificial drains in the Torbay catchment has been assessed according to standard criteria (Pen and Scott, 1995). There are 128 km of waterways in the Marbelup Brook catchment. The assessment shows that 30% are considered 'pristine' and 36% are 'good' (WRC, 2001). It is significant to note that 100% of 4th- order stream and 70% of 3rd – order stream are of 'pristine' or 'good' classification. These classes were also identified for 71% of 2nd – order and 59% of 1st – order streams. The survey shows the very high value of foreshore vegetation within this sub-catchment and notes that 103km of waterways are a priority for fencing.

The Torbay Inlet Sub-catchment has extensive artificial drainage over 35% of the catchment area. There are 74km of drains and 92km of natural waterways. Only 1% of waterways are considered 'pristine' as shown in Table B8. Four separate areas are proposed for foreshore management within the sub-catchment. The survey report provides detailed recommendations for management within each of these areas (Green Skills, 2003), including the importance of weed management and the requirement to fence 63km of waterway. Figure B17 provides summary information from the survey foreshore survey.

Table B8 Foreshore condition for waterways of the Torbay Inlet Sub-Catchment.

Assessed Grade of Waterway	Total Length (kilometres)	Total length %	Fenced length %
A- Grade foreshore - Pristine to Slightly Disturbed	1.2 km	1 %	100 %
B grade foreshore - Degraded - weed infested to weed dominated	4.6 km	3 %	72 %
C grade foreshore - Erosion prone to eroded	21.2 km	13 %	41 %
D grade foreshore - Actively eroding	15.8 km	10 %	2 %
DR - Artificial drain	24.1 km	15 %	16 %
DRWC - Water Corporation drain	37.1 km	23 %	50 %
SW - Pasture swale	47.3 km	31.3 %	1.2%
DRSW - Artificial swale	7.5 km	4.7 %	0 %
TOTALS	**158.8** km	**100 %**	**23.2 %**

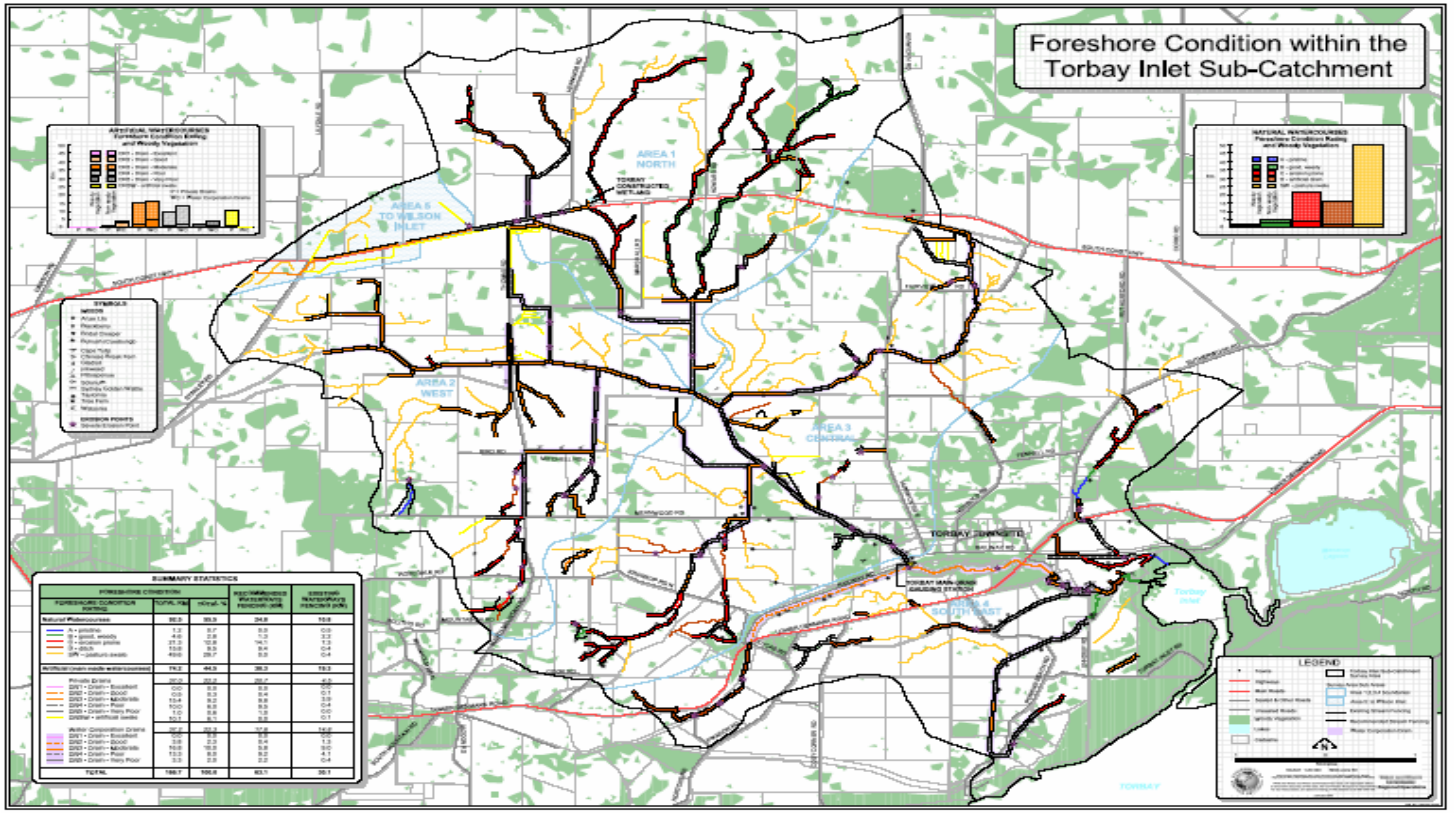


Figure B17. **Summary foreshore condition information for the Torbay Inlet Sub-catchment.**

The foreshore condition of waterways and drains in the Five-mile Creek, Seven-mile Creek and Cuthbert Drain Sub-catchments has also been assessed (Green Skills, 2000). Five-mile Creek has only 5% of waterways identified as 'pristine' compared with 43%of waterways in the Seven-mile Creek. Table B9 provides summary information from the survey. The report provides detailed management recommendations for each set of waterways.

Table B9 Recommended fencing and revegetation for waterways in the Five-mile and Seven-mile creek catchments (adapted from Green Skills, 2000).

Waterway	Length (km)	Existing Fencing (km)	Recommended Fencing (km)	Sites requiring revegetation.
Grassmere Drain	3.7	0.3	Nil	2 (1.2 Ha)
Five-mile Creek	25.4	6.3	11.6	10 (13.8 Ha)
Seven-mile Creek	47.9	6.3	16.6	7 (13.6 Ha)
Total waterways	77.0	12.8	28.2	19 (28.7 Ha)

Best management practice information is included in the Foreshore Survey reports (Green Skills 2000, 2003). This includes fencing for existing valuable foreshore vegetation and 'streamlining' (fencing, revegetation and stabilisation of bank erosion) for degraded drains and waterways.

Environmental weeds are a priority issue of the Torbay Catchment Group. The *Environmental Weeds Strategy for City of Albany Reserves* (City of Albany, 2001) provides guidelines for best practice actions that are relevant to the Torbay catchment. Control of *Typha* (Cambungi) is a priority in the Torbay Catchment Group' *2004 Weed Action Plan*.

B2.4.6 Habitat and Biodiversity: Targets for Change

The biodiversity and habitat values and assets, as identified in Section B2.4, includes the wetlands systems, pristine riparian vegetation, the reserves and private remnant vegetation, water birds, fish stocks and threatened or endangered species. The Department of Conservation and Land Management (CALM) has lead responsibility for management of nature conservation reserves and recovery of threatened or endangered species and ecosystems. A key focus for biodiversity and habitat management for the '*Watershed Torbay'* Catchment Restoration Plan is on wetland and waterway ecosystems.

The **Targets** for resource condition change for **Theme Four: Habitat and Biodiversity Management** are:

1. ***Major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions by 2025.***
   (NOTE: actions for this target are included in Themes 1, 2, 3 & 5).

2. ***All 'pristine' foreshore vegetation (Class A) is permanently maintained and all 'good' foreshore vegetation (Class B) is returned to 'pristine' condition by 2025.***

3. ***All 3rd and 4th – order waterways have established permanent foreshore vegetation by 2010.***

4. ***Identified waterway corridors are established for wildlife habitat as a part of a regional 'macro-corridor' by 2015.***

5. ***Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.***

6. ***All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.***

7. ***Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.***

B2.5 Theme Five: Farming Systems

Farming is now an established feature of landscapes within the Torbay catchment and the community wants it to remain that way. The dominant agricultural use is grazing for cattle. There are relatively small areas used for annual horticulture, and approximately 5% of the catchment is used for commercial tree crops.

Viability of the agricultural industry within the catchment is important for private investment capacity in natural resource management, however more than 70% of landholdings are less than 100Ha and the majority (about 80%) of residents derive most of their income off-farm. Requirements for change in farming systems towards industry sustainability and improved environment outcomes should take into account the high level of non-viable agricultural land use.

➢ **Goal (2025):**	The farming communities have adopted 'best practice' systems for sustainable land use resulting in measurable agricultural and environmental benefits.
➢ **Objectives:**	• Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy, • Farm nutrient loss is reduced, • Soil loss from farms is reduced, and • The impact of weeds on agricultural production is reduced.

The Water Quality and Algal Blooms management theme identified the use of land for grazing as a significant diffuse source of nutrients contributing an estimated 34% of total phosphorus and 45% of total nitrogen load from the catchment.

Intensive animal industries and annual horticulture are a part of landscapes with extensive agricultural land use. These industries are point sources and are estimated to make a high contribution to total catchment nutrient load.

Developing sustainable farming systems that provide net environmental benefits requires integration of intensive and extensive agriculture with other land uses, particularly the increasing requirements for tourism, recreation and lifestyle residential use. Figure B18 shows the nutrient input and outputs associated with a range of land uses integrated within the Torbay catchment.

The Torbay Catchment Group has a strong interest in coordinated weed management as a part of farming systems, including the impact of weeds on both productivity and the environment. The Weed Action Plan developed by the catchment group in 2004 identifies actions for control of Watsonia as a priority agricultural weed.

B2.5.1 Options for Managing Nutrients within Farming Systems

Nutrient management within farming systems considers input and output control as well as pathways for nutrient movement and loss from the farming system. There are also opportunities for nutrient retention (eg in tree crops) and assimilation (eg. by soil modification) within farming systems.

Figure B18. Nutrient inputs and exports for land uses within the Torbay catchment.

Table B10 provides a preliminary analysis of the effectiveness and cost benefit for broad categories of management practices. This shows that adoption of perennial pastures and effective use of fertilisers are preferred management options for farmers.

Table B10. Effectiveness and cost benefit of practices for nutrient management.

Management Practice	Phosphorus Removal %	trogen moval %	Productivity (Net Ongoing Cost)	Combined Cost Benefit
Perennial Pastures	High	Moderate	High Benefit	High
Effective Fertiliser use	Moderate	Low	High Benefit	High
Riparian Fencing & Revegetation	Low	High	High Cost	Low
Stock control/ water management in streams	Moderate	Low	Low Cost	Low-Moderate
Point source effluent management	High	Low	Low Cost	Moderate

(Source: adapted from Neville, 2003).

An estimate of the current levels of implementation of best practice actions for nutrient reduction is provided in Table B11. This current level of implementation is estimated to result in a 10%reduction of total nutrient load (Weaver *et al.*, 2003).

Table B11. An estimate of the current level of adoption of practices for nutrient reduction in the Torbay catchment.

		% Implementation
Perennial pasture in grazing	500-750 mm	10%
	>750 mm	50%
Effective fertiliser use	Grazing	30%
	Annual horticulture	25%
Stock control/ water management (Grazing)	2nd order stream	10%
	3rd order+ stream	40%
Veg buffer/ filter strips	1st order streams	5%
	2nd order streams	10%
	3rd order + streams	50%

(Source: Neville, 2003)

Computer modelling for a range of management scenarios show that even with the highest adoption rates for best practice actions, the expected nutrient load reduction over the current effort would be 20-30%(Weaver, *et al.*, 2003). From this analysis, a target nutrient load reduction of 38% for phosphorus and 24% for nitrogen is proposed. The estimated investment required for these actions is $1.5m but that an annual net benefit over 10 years to the landholders of $0.26m could be expected. Table B12 shows the respective nutrient load reductions, costs and net benefits for a range of management actions.

Table B12. Estimated nutrient reduction for management actions proposed in the Torbay catchment.

BMP	**% reduction**	
	N	**P**
1st order Vegetated Stream Buffers	40	5
2nd order Vegetated Stream Buffers	40	5
3rd order+ Vegetated Stream Buffers	40	5
Perennial pastures	20	20-30
Effective fertiliser use	5	5-10
1st order stock control, water management	10	5
2nd order stock control, water management	10	5
3rd order stock control, water management	10	5
Dairy effluent management	75	75
Piggery effluent management	75	75
Alkaloam soil amendment ($5 – 20$ tonnes ha^{-1})	ND	30-60

(Source: Adapted from Weaver, 2003)

Based on the analysis, the focus for nutrient reduction management strategies should be on:

1. Effluent management for reduction from point-sources, for both N and P,
2. Perennial pastures and effective fertiliser use for phosphorus and nitrogen reduction, and
3. Vegetated stream buffers for further nitrogen reduction.

Vegetated stream buffers are shown to be effective for nitrogen reduction but of only limited benefit for phosphorus reduction (McKergow *et al.*, 2003). This indicates the importance of information about the extent to which algal blooms in the wetland systems are driven by N rather than P. If nitrogen is the key determinant of algal blooms, then a high priority should be attributed to establishment of vegetated stream buffers. If not, then the management emphasis should be on paddock management of pastures and fertilisers. For both lake Powell and Torbay Inlet, both N and P are limiting nutrients. Therefore, strategies to reduce both are considered in this them.

B2.5.2 Farming Systems: Target for Change

The Resource Condition Target for Theme One is for a reduction of algal blooms in Torbay Inlet, Lake Powell and Marbelup Brook by 2025. The extent to which farming system change will contribute to this change in resource condition remains uncertain however, nutrient balance modelling indicates that significant reductions in nutrient export from point and diffuse sources within the Torbay catchment can be achieved.

The **Target** for resource condition change for **Theme Five: Farming Systems** is:

1. ***The total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus by 2025.***

The management action target and actions for reduction in point source nutrient loss are provided in Theme One (Water Quality and Algal Blooms).

B2.6 Theme Six: Land Use Planning

Land in the Torbay catchment is used mainly for primary production (agriculture and horticulture), however land use trends suggest more diversified use in the future, including farm forestry, public water supply, tourism, recreation and lifestyle residential use. Development of land use in the catchment is outlined in Section A3.1. The community is keen to retain a predominantly agriculture landscape character and has expressed concern about unplanned change within the Torbay catchment. The Torbay Catchment Group is seeking opportunities to participate in land use planning at all levels to ensure that landscape change is compatible with the *Vision for the Future*.

➢ **Goal (2025):**	Regional and local planning provides the policies and mechanisms to implement new actions that are beneficial for natural resource condition, ensure that land is used according to its capability and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.
➢ **Objectives:**	• Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current land use, • Land use intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines, • Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands, • Priority water resources are protected for beneficial use now and into the future, • Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained, • Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands,

➢ **Objectives:**	• The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations, • The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit, • The current landscape mosaic characterised by agriculture and natural vegetation is maintained, and • Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.

B2.6.1 Planning and Policy Mechanisms

There is a range of planning and policy mechanisms currently available. This includes statutory options through state and local government, and non-statutory planning. The land use changes required to meet the resource condition change targets of the *Watershed Torbay Catchment Restoration Plan* may require institutional processes that exceed the capacity of current planning and policy mechanisms. Where this occurs, changes to institutional arrangements are proposed.

B2.6.1.1 Lower Great Southern Regional Planning Strategy

A draft document is being prepared by the Department of Planning and Infrastructure (DPI) to provide strategic direction for planning to meet future social, economic and environmental management requirements within the region. The regional planning strategy provides the basis for development of statutory land use planning by state and local government. A formal period of public comment on the draft regional planning strategy will occur during 2005.

The regional planning strategy will provide guidance for more specific local planning outcomes and provide capacity for broad land use change. For the Torbay catchment, there may be opportunities to define requirements for Regional Open Space (on public and private land where the priority for 'open space' is identified), priority agricultural use areas and increased public access, and to provide guidance for inclusion of measures in the City of Albany Local Planning Strategy and Town Planning Scheme to address land use and management, and rehabilitation issues affecting the catchment.

While the regional planning strategy is not able to affect specific local planning outcomes, it does provide capacity for broad land use change. For the Torbay catchment, there may be opportunities to define requirements for Regional Open Space (on public and private land where the priority for 'open space' is identified), priority agricultural use areas and increased public access.

B2.6.1.2 Local Planning Strategy and Town Planning Scheme

Local Government Authorities are required to develop a Local Planning Strategy under the *Town Planning and Development Act (1945)* (Section A4). The City of Albany is currently preparing a Local Planning Strategy which is consistent with the direction of the Lower Great Southern Regional Planning Strategy.

The Local Planning Strategy will be implemented through non-statutory policies contained in the LPS and through statutory planning mechanisms in the Town Planning Scheme (TPS). The current TPS applicable to the majority of the rural areas of the Shire including the Torbay catchment was prepared in 1981, and incorporates only very limited measures for influencing land use and management in the catchment. The City's current Local Rural Strategy contains general and site specific policies and has been used to guide rural development, especially for Special Rural/Rural Residential developments.
Specific mechanisms of the current Local Rural Strategy include:

- Policies protecting natural resources (including options for revegetation, rehabilitation, fencing or ceding land) through re-zonings, subdivisions and development application processes,

- Planning consent for intensive agricultural industry proposals require detailed assessment, based on soil types, fertiliser use, waste management practices. Nutrient management is a major policy area (Ref. GP4-GP7),

- Referral to DoE for assessment of impacts of proposals on water-bodies,

- Specific rural residential policy relevant to the Torbay catchment,

- Policy provision for protection of potato growing in an area adjacent to Lake Powell.

In formulating its new LPS and TPS the City of Albany will retain or improve the mechanisms of the current Local Rural Strategy. Formal public consultation and final documentation is expected to occur during 2005.

The LPS and TPS will contain two key land evaluation processes:

1. *Land capability assessment* – identification of land characteristics (requirements and limitations) for a range of land uses mapped on the basis of soil/landscape units, and

2. *Land Use Class/Planning Zone matrix* – an assessment of suitability and compatibility of land uses within planning zones.

The TPS has capacity through the use class - zoning matrix to prohibit a particular land use class from a zone. Other land uses may be permitted at the discretion of the Council subject to meeting certain performance criteria and/or trade offs (e.g. regarding flood risk, nutrient loss potential, retention and planting of vegetation, etc) which can be prescribed in a scheme provision. Scheme provisions outline controls and development requirements within a specified area, and may include (for example) implementation of stormwater management or revegetation plans. Statutory land use assessment and land evaluation processes also provide opportunities to promote water resource protection, including some aspects of drainage management.

B2.6.2 Referral of Development Applications

Under the TPS, proposals to establish certain land uses must be submitted to the City of Albany for approval. Certain proposals are referred to delegated authorities (e.g. the Department of Environment) for advice. Their advice is provided according to policies or

management guidelines of the respective referral organisation. The CoA considers the advice provided and approves (with or without conditions) or rejects the proposal (with reasons for rejection provided). Approval conditions may include a range of requirements being met (e.g. compliance with Codes of Practice, natural vegetation protection orders, preparation of a Nutrient and Irrigation Management Plan, ceding Foreshore reserves and others).

The Development Application process provides an opportunity for there to be a presumption against a particular land use in one or more planning zones unless prescribed performance standards are met. In this situation, the proponent would be required to provide the information that shows how the proposal will be acceptable (i.e. the onus is on the proponent rather than the authorising agencies to nominate the actions that will be taken to avoid identified environmental risks).

B2.6.3 Town Planning Scheme Amendments

Changes to the TPS can occur during the period of it being effective via the Scheme Amendment process. Proposed changes are referred to delegated agencies (e.g. DoE, EPA) for advice. This function provides an opportunity to alter planning conditions based on additional information or improved understanding. This is particularly important for environmental management within the Torbay catchment where there is ongoing research and the recommended management from the research outcomes may require statutory processes for effective implementation.

This function also provides an opportunity to improve the level of information used for assessment. In the Torbay catchment, information available for land capability assessment is more detailed that for other areas in the region. The TPS Amendment processes allow for revision of the land capability assessment.

B2.6.4 Land Subdivision Proposals

Proposals for land sub-division are made to the Western Australian Planning Commission (WAPC). The Commission sets the policy and guidelines under the *Town Planning and Develop Act (1928)* that are incorporated by local government authorities into Town Planning Schemes, strategies and policies and in providing comments of advice on sub-division proposals. Proposals are referred to relevant government authorities, including local government, for advice. The advice provided is based on policies and management guidelines of the respective organisations. For the CoA, the TPS provides the basis for advice.

Decisions for sub-division of rural land are guided by the WA Planning Commissions Statement of Planning Policy (SPP) 11 – Agriculture and Rural Land Use Planning. This is to be considered in conjunction with guidelines provided in Policy No DC 3.4 for specific sub-division circumstances (e.g. for conservation).

The major policy objectives are to protect agricultural land, provide for rural settlement, minimise land use conflict and carefully manage natural resources.
Through local government Town Planning Schemes (TPS), 'Priority Agriculture Zones' are identified. Sub-division is not encouraged in these areas but could occur in the 'General Agriculture Zone'.

Policy No DC 3.4 identifies that there is a general presumption against sub-division of rural land but provides criteria for specific Conservation purposes, including sub-division of natural vegetation from agricultural land for conservation purposes. This policy applies more specifically to the Wheatbelt Agricultural Policy Area, which includes the City of Albany and could be considered in formulating special planning provisions for stream and wetland foreshore management within the Torbay catchment. Such arrangements would provide opportunities for Conservation Covenants to be applied to priority areas of natural vegetation.

B2.6.5 Statements of Planning Policy

Statements of Planning Policy (SPP) are developed by the WAPC under Section 5AA of the *Town Planning and Development Act (1928)* to provide guidelines for land use planning in WA. Decision making authorities, including local government, are required to have due regard to these policies when preparing local planning strategies and determining applications. There are four that are directly relevant to the *Watershed Torbay Catchment Restoration Plan*.

SPP 2 – Environment and Natural Resources

The key features of this planning policy are:

- General policies on water resources protection, air quality, soil quality and contamination, biodiversity, mineral resources, landscape protection promoting environmental protection and positive environmental outcomes,
- Guidelines to consider environmental, economic and social effects and land use change,
- Includes support protection of biodiversity, remnant vegetation protection and consideration of 'greenhouse' gas emissions.
- Requires consideration of catchment management strategies that are prepared by groups and are endorsed by State Government agencies,

A Guideline for the implementation of SPP 2 is currently being developed by the Department for Planning and Infrastructure for the WA Planning Commission.

SPP 2.5 – Agricultural and Rural Land Use Planning

The key features of this planning policy are:

- Priority Agricultural Areas are mapped in the TPS and there is a presumption against non-agricultural use in these areas. An Agricultural Impact Assessment is required for non-agricultural uses,

- Development approval for intensive agricultural industries may be required in Priority Agricultural Areas but is always required in other zones,

- Rural-Residential and Rural Smallholdings zonings are to be planned to cater for settlement growth,

- Public Drinking Water Source Areas are identified and protected,

- Revegetation/remediation can be required, and

- Flood risk areas are to be mapped (by DoE) as part of the TPS. Special Control Areas can be designated where planning approval is required for construction of dwellings, sheds, landfill, clearing and other proposed land use changes in this area.

SPP2.7 – Public Drinking Water Source Policy

The key features of this planning policy are:

- Provides a focus on protection of declared Public Drinking Water Source Areas (PDWSA's) for water quality and public health issues (declaration of the Marbelup Brook catchment is expected within 2 years),

- Requires use of a land use compatibility table prepared by DoE, and

- Special Control Areas can be identified for some for PDWSA's.

SPP 2.9 – Water Resources

The key features of this planning policy are:

- Provides broad policy protection of water resources, both quality and quantity considering the processes of erosion, sedimentation, nutrient enrichment, pollution and the requirements for foreshore vegetation. The policy promotes environmental repair and can require specific site rehabilitation (e.g. for foreshore vegetation or sedge lands) as a part of development applications,

- Requires planning to recognise Natural Resource Management strategies, catchment strategies that are prepared by groups and endorsed by state agencies,

- Ensure proposed land uses are compatible with available water resources.

- Wetlands and waterways, and their associated values (as mapped by DoE) are to be protected and enhanced,

- Water quality is not to deteriorate as a result of a development proposal, and
- Guidance for conservation planning including buffer areas and distances to protect priority areas.

B2.6.6 Water Resource Protection Plans

A Water Resource Protection Plan is to the prepared for the Marbelup Brook catchment within 2 years. The catchment and water resources are declared under the *Country Areas Water Supply Act (1914).*

Public Drinking Water Source Areas have three levels of water quality protection called priority classification areas:

Priority 1 (P1) - defined to ensure there is no degradation of the water resource. They cover land normally owned by the State where the provision of the highest quality drinking water is the prime land use value. P1 areas are managed with the principle of risk avoidance.

Priority 2 (P2) - defined to ensure that there is no increase in risk of pollution to the water source. P2 areas are declared over land where low intensity development (such as rural) already exists. Protection of public water supply sources is a high priority in these areas. P2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines.

Priority 3 (P3) - defined to limit the risk of pollution to the water source. P3 areas are declared over land where water supply sources need to co-exist with other land uses such as residential, commercial and light industrial developments. Protection of P3 areas is achieved through management guidelines rather than restrictions on land use. If the water source does become contaminated, then water supplies may need to be treated or an alternative water source found.

B2.6.7 Policies of State Government Agency and Authorities

The Department of Environment and the Environmental Protection Authority have a range of relevant policies that are effective through provision of advice for statutory referral processes. . The Draft Country Sewerage Policy recently developed by many agencies including the Department of Environment and the Department of Health contains guidance on the environmental requirements for on site wastewater disposal. These requirements are more restrictive within environmentally sensitive areas, defined as those areas within the capture zones of wetlands and watercourses. Such a definition could be applied to the Torbay area, and the policy will have application for further urban development within the Torbay catchment.

B2.6.8 Management Plans

Management Plans are prepared for nature conservation reserves and other public areas as required under various legislation (e.g. the *Conservation and Land Management Act 1985*).

B2.6.9 Non-statutory Planning

Farm and catchment plans are an effective way for individual landholders to identify opportunities and threats to their properties as well as providing a structured approach for decisions about implementation of industry ‘best practice’ actions.

B2.7 Theme Seven: Community Education and Information

The '*Watershed Torbay*' project is based on community-lead partnership arrangements that include local, state and federal governments and a range of organisations for a national demonstration of achieving a vision of a healthy environment with sustainable production. It is not an approach based on statutory regulation and control.

Success of a partnership-based approach depends significantly upon three key strategies:

- Developing a 'shared Vision' for the future,
- Engaging community and partners, and
- Communications and information management

These are to be applied across the management Themes.

➢ **Goal (2025):**	The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the shared vision for the catchment.
➢ **Objectives:**	• All key stakeholders are willingly involved in implementing the restoration plan. • A high level of community awareness about the values of the catchment and about the best practices for sustainable management. • Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes. • There is a significant level of community involvement in reviewing the restoration plan on a five yearly basis.

B2.7.1 Developing a 'Shared Vision'

The Torbay Catchment group has a vision for the future (Section A1.3). It is to have:

> ***".. an environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways"***

The vision reflects many community values and represents requirements for change in attitudes and land use practices. The Restoration Plan provides direction for change towards the vision for the future through management targets and actions. Achieving the vision will require most people in the catchment and project partners understanding and 'owning' the change processes that it represents. This is required at a high level to ensure that the community commits to the processes and is proud of the achievements.

A social and economic 'benchmark' survey sent to the 580 landholders in the Torbay catchment during 2002-3 provides a robust basis for community understanding and commitment to components of the vision during early stages of the '*Watershed Torbay*' project (Unpublished report, Survey of Landholder land use and attitudes in the Torbay catchment, Aug 2003; Duxbury). The 30% survey response indicated a relatively high level of interest in the key issues of the project but also a relatively low level of previous involvement (72% of respondents have not previously volunteered community Landcare effort). This suggests an opportunity to build on the interest to gain greater involvement through engagement with the vision for the future.

B2.7.2 Engaging Community and Partners

The social benchmark survey (Duxbury, 2002) indicates there to be relatively strong interest by those who responded to the survey although 70% of landholders in the catchment did not respond so the steps for engagement of most of the community will require specific awareness and extension actions that are suitable for the range of interest groups. The survey shows that large proportions of the 580 land owners have small properties for residential use and earn most income off-farm. It also shows that the general level of education is relatively high but the key deterrents to involvement are available time and finances.

The diversity of cultures and interests of people living within the catchment needs to be recognised. Many enjoy a rural lifestyle and adopt principles of environmental heath and sustainable living but may know little about commercial farming. While some targeted information is required for commercial agriculture and horticulture, other information is required for those not commercially involved in primary production. Landcare is characterised by being focused on farmers. The '*Watershed Torbay*' project is an opportunity to broaden engagement for the whole community.

With significant public investment within the Torbay catchment expected for implementation of actions, there is a requirement to develop formal arrangements with partner organisations. This includes partners providing funds directly (investors) and those who provide information or services. Formal arrangements are to include commitments to funding and services during the implementation period of the project.

B2.7.3 Communications and Information Management

Engagement of interest and involvement by community and partner organisations is also dependent upon effective communications and efficient information management. Communicating information, knowledge and experience is often most effective by direct dialogue through field tours, local demonstrations, participatory research initiatives and other co-operative actions that facilitate informal experience development and information sharing.

Semi-structured communication processes have been developed during the '*Watershed Torbay*' project. An important part of these processes is maintaining a 'Communications Learning Log' in which group events are recorded and 'new group learning' is identified. This also provides a 'track record' of group development. Additional 'social learning' processes are required particularly for skills development, for example in soil testing, drain restoration works and other actions of the Restoration Plan.

Efficient information management is important for project effectiveness and for continued engagement of community and stakeholders. Information from previous research or trials should be readily accessible in a form suitable for adoption by management. A pre-requisite of future research and development (R&D) should be for science-based information to be related to local management based requirements. Researchers should also be encouraged to engage local community members within projects to increase the level of engagement and understanding and to ensure that local knowledge is contributed.

Spatial information should also be easily accessible in both hardcopy (map) and digital formats.

WATERSHED Torbay

Watershed Torbay
Catchment Restoration Plan:

SECTION C

ACTION PLAN

C1.0 Planning for Action

Section B provides the strategic framework for setting targets for 'resource condition' change to achieve the goals and objectives of the *Watershed Torbay Restoration Plan*. The Resource Condition Targets are based on current information and understanding of catchment-scale processes, including those for water and nutrient management. The targets for resource condition change are set for approximately 20 years into the future.

The Action Plan (Section C) is based on targets for management action. The options for management are considered and targets are set implementation to achieve resource condition change within 5-10 years. The specific actions for each of the Management Action Targets (MATs) are listed (Section C2.0). The actions are proposed within a **3-year implementation program** with the expectation that the *Watershed Torbay Restoration Plan* will be reviewed at the end of this period. The extent to which the MATs can be achieved within the 3-year period is estimated and a preliminary feasibility assessment provided.

The priority for implementation of each of the actions has been set (Section C3.0). These are derived from review comments provided by partner organisations, from a series of three community workshops held during February, 2005, and by the Watershed Torbay Steering Committee. These review processes have also provided direction on the commencement date for each of the proposed actions. Responsibilities for implementation are identified and an estimate of total cost allocation required for each action within the 3-year implementation program is provided.

Section C4.0 provides a framework for building the capacity to implement the actions and to achieve the required change management practice. It outlines the financial and human resources required through an investment planning approach.

The *Watershed Torbay Catchment Restoration Plan* provides direction for implementation of actions to achieve resource condition change. A review of the plan is proposed at the end of the first 3-year period. The extent to which the actions have contributed towards the targets is to be evaluated. Some revision of the targets may be required. The proposed review will also incorporate new information and knowledge.

C2.0 Targets for Management Action

The Goals, Objectives and Targets for Resource Condition Change are developed for each of the seven Management Themes in Section B.

C2.1 Targets and Actions for Theme One: Water Quality and Algal Blooms

Improved water quality and reduced algal blooms requires extensive changes to management practice, particularly for:

- point sources of nutrients,
- restoration of waterways, and
- planning to control nutrient loss.

Further actions in other Management Themes will also contribute significantly to the resource condition change targets for this theme, particularly those for farming systems management.

➢ **Goal (2025):**	Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals, and algal blooms are minimal. Water in Marbellup Brook remains suitable for drinking. Other waterways and waterbodies are suitable for recreation, domestic and agricultural use.
➢ **Objectives:**	The source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and managed so that: • There are no fish kills due to poor water quality, • The incidence of algal blooms is reduced, • The transport of nutrients, sediments and contaminants into waterways and wetlands in minimised, • Management practices are adopted that minimise public health and environmental risks for drinking water from Marbellup Brook.

➢ Targets:	Resource Condition Change
1.1	Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbellup Brook by 2025.
1.2	Median nutrient concentrations discharged from the sub-catchments meet the following targets by 2020: Sub Catchment — Current Load TN / TP — Load Reduction TN / TP Torbay Drain 1.80 0.110 1.20 0.090 Marbelup Brk 0.68 0.077 0.60 0.065 Seven Mile Crk 1.00 0.130 0.68 0.100 Five Mile Crk 1.35 0.460 1.00 to be set Cuthbert Drain 2.45 0.059 2.00 0.059 Grassmere Crk 1.40 0.200 1.20 0.150
	The quality of water in Marbellup Brook meets national criteria for public drinking water supply (NHMRC & ARMCANZ, 1996) by 2015.

A significant reduction in nutrient inputs to wetlands and waterways is required to achieve the significant reduction in algal blooms. This can be achieved by control of the source of nutrients or management of nutrients within streams or in lakebed sediments.

T1MAT1: Discharge of nutrients to the Torbay catchment from the disposal of wastewater does not increase beyond current levels. (Note current levels are below those approved through Ministerial conditions).

Actions:

1. Review future options for wastewater disposal in Torbay catchment and provide information to the community.

2. Continue monitoring water quality in stream flow for Seven Mile Creek with evaluation and reporting annually.

3. Encourage source reduction of wastewater flows from the City of Albany through prevention of stormwater entering sewers, and public awareness program for wastewater reuse,

4. Assess options for City of Albany and other waste water producers to pay for 'ecosystem services' as a contribution to catchment management.

T1MAT2(a): All third and fourth-order waterways in Marbellup Brook have permanent vegetated stream buffers established by 2010.

T1MAT2(b): By 2015, 70% of all first and second order streams have permanent perennial vegetation.

Actions:

1. Prepare maps and tables to show the extent of stream 'orders' in the Marbellup Brook sub-catchment and the width of stream buffers provided by natural riparian vegetation.

2. Prepare a nutrient and pathogen 'risk map' for the Marbellup Brook sub-catchment based on soil-type and existing pollution hazards.

3. Prioritise streams within the Marbellup Brook sub-catchment for vegetated stream buffering.

4. Investigate the use of agroforestry to enhance stream restoration and provide an economic benefit.

5. Develop 'best practice' guidelines and other options for the required stream buffering for nutrient and pathogen control.

6. Coordinate cost sharing arrangements for landholders through the Torbay catchment group (including consideration of a trial an 'auction-based' approach) to implement the vegetated stream buffers according to 'best practice' guidelines.

7. Voluntary cost sharing arrangements are reviewed annually and finally reviewed and reported in 2010 to determine their effectiveness compared with regulatory approaches.

Diffuse sources of nutrients are also significant to total nutrient load in wetlands. There are opportunities for nutrient loss reduction by change practice in farming systems. An estimated 30% reduction is considered feasible over a 20 year period (Weaver *et al.*, 2003). The targets for nutrient reduction within each sub-catchment are based on this assumption.

T1MAT3: **Three trial demonstrations of nutrient reduction from stream flow and sediments implemented by 2007.**

There is significant transport of nutrient within stream flow either in solution or by sediment transport. There are two options to reduce nutrient transport through these pathways.

1. *Application of Phoslock™ (or similar product)*
   Phoslock™ is a product that may be applied occasionally or continuously for reduced in-stream free reactive phosphorus concentrations. Effective applications require low salinity. The need for repeat or continuous applications may be expensive (e.g. >$100,000/year) and nutrient reduction benefits are only experienced while applications continue. A trial application is being considered.

2. *In-stream nutrient stripping (artifical wetlands)*
   Nutrient stripping within Marbellup Brook and/or Torbay Main Drain may be effective however the potential benefits when considered as a part of the whole system of nutrient transport within the Torbay catchment is difficult to quantify. The costs of nutrient stripping formations may be potentially costly due to the cost of earthworks, planting and maintenance (e.g. >$100,000 for capital cost and $5-30,000 ongoing maintenance costs).

Surface flow to Lake Powell from all tributaries is delivered through the Grasmere Drain. This drain may be well suited to install a nutrient stripping feature such as an artificial wetland for reducing nutrient concentrations in surface waters entering Lake Powell.

Actions:

1. Investigate and assess the application of slurry injected Phoslock™ (or other nutrient binding substance) to one of the tributaries to Lake Powell (e.g. Seven Mile Creek). Implement a trial if appropriate.

2. After 5 years operation (2007), assess the effectiveness of the existing Torbay artificial wetland basin as a nutrient reduction option for the catchment. Arrange installation of further trials of in-stream nutrient stripping techniques on one of the tributaries to Lake Powell (e.g. Grasmere Drain).

3. Review 'best practice' options to manage sediments in waterways, drains and the lakebed.

T1MAT4: Future land use development in the Marbellup Brook catchment complies with public water supply objectives for the catchment.

Actions:

1. Develop an appropriate land use classification that identifies potential threats to the quality of public water supply and identifies water quality criteria relevant to the Marbellup Sub-catchment.

C2.1.1 Water Quality and Algal Blooms - Filling Information Gaps

Actions:

1. Developing a clear understanding of the relative contribution of nutrient loads from the range of sources to Torbay inlet and Lake Powell, and the relative importance of N and P in control of algal blooms in both wetlands.

2. Estimate the nutrient load contribution to Lake Powell from residential septic systems in the town of Elleker.

3. Investigate the potential for nutrient release from acid sulphate soils where there are fluctuating water tables and estimate the relative proportion of this source to the total nutrient load in wetlands based on field investigations.

4. Identify the extent to which a 30% reduction in diffuse source nutrient loss will reduce the incidence of algal blooms in Torbay Inlet and Lake Powell.

5. Quantify the effectiveness of periodic or continuous applications of Phoslock™ as a significant contribution to nutrient load reduction.

C2.2 Targets and Actions for Theme Two: Water Quantity

Water is a finite resource for which there is increasing demand for use. The high quality water from the Marbelup Brook catchment is identified as a suitable source for public supply in the near future, and for further self-supply use in the catchment. Restoration of wetlands is also dependant upon there being adequate water quantity for ecological functions. The actions for this theme are focused on identifying environmental water requirements and providing statutory conditions for resource protection and allocation.

Provision of water for public supply is considered to be an 'ecosystem service'. Actions within the catchment for water supply management are generally consistent with the actions required for nutrient loss reduction, especially for nitrogen management within waterways. The actions for this Management Theme are considered to be providing resource supply and restoration services.

➢ **Goal (2025):**	Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.
➢ **Objectives:**	• Flow in Marbellup Brook is adequate to maintain ecological requirements, • Water Regimes for Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals, • The drainage district is managed to meet the needs of current land uses, future land uses, and the environment, and • Those who benefit from the use of the catchment to provide environmental services contribute to the costs of restoration.
➢ **Target**	**Resource Condition Change** **2.1**: Major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions by 2015 **2.2**: Maximise use of surface water and groundwater resources for private and public benefit within identified sustainable yield.

T2MAT1: **Environmental Water Requirements are determined for Marbellup Brook, Lake Powell, Lake Manarup and Torbay Inlet by 2007**

Actions:

1. Prepare 'Environmental Water Requirement' assessments for Marbellup Brook, Lake Powell, Lake Manarup and Torbay Inlet.

2. Use monitoring information to establish the extent to which the environmental water requirements are met under current flow regimes and the current operating strategy for the drainage system.

3. If necessary, develop strategies to meet environmental water requirements, or determine the impact and acceptability of reduced flows.

T2MAT2: **Water resources in the Marbellup Brook Catchment are proclaimed under the Rights in Water and Irrigation Act (1914) and a Water Resource Allocation Plan is prepared, including an assessment of changing land use and climate change, by 2007.**

Actions:

1. Develop an allocation plan for the Torbay Catchment to ensure water is available for private and public users on a sustainable use basis, and meets environmental water requirements.

2. The Marbellup Sub-catchment is proclaimed under the *Rights in water and Irrigation Act (1929)* so that water use allocation is controlled by licensing.

3. Investigate the impacts of commercial plantations (e.g. blue gums) and farm forestry on water supply availability in Marbellup Brook, and determine an area limit for blue gums to maximise water availability and water quality.

4. Assess the potential impact of climate change on water resources in the Marbellup Brook Catchment.

C2.3 Targets and Actions for Theme Three: Drainage Management

The options for change to the drainage operating system are listed in Section B. These are considered the most suitable options to meet the criteria and targets for resource condition change (Section B). There is a further requirement to apply the water balance model to these three options. This analysis will assist in further development of the actions required for the management action targets over the next 3-5 years.

➢ **Goal (2025):**	Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.
➢ **Objectives:**	• The impact of flooding on horticulture is minimised, • Flooding in residential areas is minimised, • The potential adverse effects of drainage management on fisheries in minimised (including commercial fisheries and native fish species), The impact of drainage management on algal blooms is minimised, and • The drainage system is managed to prevent or minimize sedimentation of receiving water bodies.
➢ **Targets**	**Resource Condition Change** **3.1**: Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds) by 2025. **3.2**: Sediment transport in drains, and sediment deposition in Torbay Inlet and Lake Powell, is reduced by 50% by 2015. **3.3**: The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025

T3MAT1: Options for change to drainage management to maximise water quality and public amenity in Marbellup Brook (including the section downstream of the Marbellup Plug) and Lake Powell are fully assessed by 2006.

The proposed operating system changes in Option 5a (to remove Marbellup Plug, remove "Gate 45" and install Lake Powell Flood Gates) are intended to provide the opportunity to flush water in Lake Powell by diversion of stream flow from Marbellup Brook. These changes would also add significant environmental flow to the section of Marbellup Brook currently truncated by the Marbellup Plug.

The water balance model shows that the levels are suitable for this to occur (i.e. flushing from the High-level system to the Mid-level system), however the extent to which this flow to Lake Powell would be effective in flushing nutrients from the water body and reduce the occurrence of toxic algal blooms remains uncertain. Implementation of Option 5a (Section BXX) needs also to consider the potential for increased flood hazards to land for residential and horticultural use.

Actions:

1. Finalise the modelling of drainage management Option 5a to assess social and environmental outcomes, and the expected costs.

2. Undertake flood risk assessment for Option 5a.

T3MAT2: The required regime for salt water flushing and maintenance of adequate water depth to improve environmental values in Torbay Inlet is identified, and is being implemented through management of sand bar openings by 2007.

The proposal for changes to the drainage operating system in Option 3a (pump North Creek to Marbellup Creek Drain – the High-level system) and 3b (install floodgates on North Creek and pump to Lake Manarup as required – the Low-level system) are intended to provide greater flexibility in management of the bar openings for environmental benefit to Torbay Inlet and Lake Manarup. Option 3a would require all stream flow from North Creek to be pumped to the high-level system. The feasibility of doing so is limited due to the flood risk (due to surface water and groundwater) by the required channel blockage.

Option 3b would require pumping over the proposed floodgates on North Creek only when the level in Lake Manarup is higher than stream flow in North Creek and when it is required to minimise flood risk to residential and horticultural areas. With this option, maintenance of relatively low water levels in Lake Manarup controlled by the Manarup Gates will be required. It is currently uncertain if the low water level required for flood water management under Option 3b will provide adequate depth of water for rehabilitation of Lake Manarup as a functioning wetland ecosystem.

Actions:

1. Review current scientific research to determine the preferred salt water flushing regime for Torbay Inlet.

2. Model the potential effect on the preferred salt water flushing regime for Torbay Inlet if drainage management were to adopt Option 1b or Option 3b (see drainage scenario descriptions in Section B).

3. Negotiate appropriate operating arrangements (e.g. with the Water Corporation) for opening the sandbar to achieve the preferred salt water flushing regime for Torbay Inlet.

T3MAT3: Lake Manarup is being maintained with adequate water for functions of the wetland ecosystem (without disadvantage to Lake Powell and Torbay inlet) by 2007.

There is potential for Lake Manarup to be maintained as a functioning wetland ecosystem with drainage management Option 3b. Under this option, the frequency and period of inundation of the lake (the 'hydroperiod'), and the depth of water is influenced by the sandbar opening regime if the Manarup Flood Gates are kept open (or removed). Otherwise, the hydroperiod and water depth of the lake can be managed by inflow from North Creek (streamflow or pumped as proposed under Option 3b), and by closure of Manarup Flood Gates.

Actions:

1. Determine preferred hydrological regime (hydroperiod and water depth) for Lake Manarup to maximise environmental values.

2. Apply the hydrological model to Options 3a, 3aiii and 3b to assess the water levels and period of inundation for Lake Manarup particularly in relation to opening of the sandbar and other factors of drainage systems management.

3. Estimate the volume of water to be pumped and the period of pumping required for Option 3b,

4. Assess the potential flood risk associated with Option 3b,

5. Prepare design and plans for closure of the 'siphon' between North Creek (the lower-level system) and Lake Manarup, construction of floodgates and detention pondage (near or in association with the North Creek bridge), and the pumping infrastructure and services required for Option 3b.

T3MAT4: Public and private drains identified with high erosion risk or sediment transport are permanently stabilised by 2010.

In the longer-term, the depth of water in Torbay Inlet and Lake Powell may be further reduced by sediment infill without appropriate catchment and drain management. This will probably increase the risk of algal blooms due to shallower water depth

(higher temperatures) and nutrients contained within the sediments. Management of sediment loss and transport within the catchment is required to meet the management action target.

Foreshore Condition surveys has identified sections of waterways and private drains that were eroding (Green Skills, 2000). . The management requirements of public drains (managed by the Water Corporation) were assessed and guidelines for best management practice (BMP) developed (Regeneration Technology Pty Ltd and Jim Davies and Associates, 1999). These BMP guidelines were developed based on spot site assessment of the major public drains. There is a further requirement to survey the public drains to identify priorities for implementation of works.

Actions:

1. Review the 'sediment risk' of public and major private drains, including further ground survey for management needs assessment,

2. Revise Best Management Practice guidelines for public and private drain maintenance including:

    a. Revegetation techniques to stabilise banks,
    b. Improving channel roughness to reduce sediment transport capacity of flowing water,
    c. Earth works to re-contour drains to reduce sediment loss.

3. Restore private drains at risk of erosion according to management needs assessment priorities.

4. Provide information and advice to ensure that new drains include appropriate design to minimise risk of nutrient, sediment and acid transport.

5. Rehabilitated and maintain public drains for multiple benefits but with the primary function remaining as flood control.

T3MAT5: The processes and extent to which sulphuric acid, nutrients and other potential pollutants are released from acid sulphate soils due to the current operating strategy of the drainage systems is known by 2006.

The community is keen to have waterways and wetlands suitable for recreation, including catching fish 'worth eating'. The quality of water is a key determinant of this expectation. Management of nutrients in the catchment is important for water quality improvement (Management Themes 1 and 5), however change to the operating strategy for the drainage system may also be significant.

The current operating strategy for the drainage system causes the groundwater level to fluctuate. These processes cause oxidation of acid sulphate soils and the release of sulphuric acid. It may also cause significant release of nutrient from organic soils (DoE, 2004b). The extent to which the current operating strategy increases the risk of acid and nutrient release compared with the natural sequence of flooding and bar openings is not clear. There is a requirement to better understand the contribution to poor water quality in water ways and water bodies due to controlled fluctuations of groundwater levels in acid sulphate soils.

Actions:

1. Determine the distribution and level of acidity (actual and potential) in soils of the Lower Torbay catchment;

2. Undertake sampling and analysis of drainage water, groundwater, aquatic sediments and biota to determine the environmental impacts of acid drainage on the Lower Torbay waterways;

3. Evaluate the most appropriate drainage design to minimize mobilization of acid and nutrients from soil profiles;
4. Develop and implement training programs for on-farm land management practices that minimise the disturbance of acid sulfate soils.

C2.3.1 Drainage Management - Filling information Gaps

The current operating strategy for the drainage system provides benefits particularly through flood protection and management of water levels for horticulture. Changes to the system could be two forms:

1. changes to the current operating system without change in infrastructure (i.e. by changes to timing and frequency control actions or the level at which water is managed;

2. changes to infrastructure and significantly different operating strategies.

The first of these is relatively low risk but may not meet the high expectations of community for environmental benefits. The second has the potential risk of increased flooding, but there is also uncertainty about the environmental benefits that can be derived by changes to drainage operation alone. Further information is required about these issues.

The required reduction in the incidence of toxic algal blooms in Lake Powell may require:

- flushing of the lake through operation of the drainage system (Option 5a),
- reduction of nutrient input by catchment and 'in-stream' management, or
- treatment of lakebed sediments to reduce *in situ* nutrient release.

The relative contribution of lake flushing through changes to the operating strategy for the drainage system is not currently well understood. There is a requirement to model the potential benefits from drainage management Option 5a.

C2.4 Targets and Actions for Theme Four: Habitat and Biodiversity Management

Many management actions for Theme Four (Habitat and Biodiversity Management) will be compatible with actions for other management themes, especially those for wetland, waterway and drainage management.

➢ Goal (2025):	Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.
➢ Objectives:	• Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained, • The condition of foreshore vegetation and in-stream habitat is maintained or improved, • The habitat value and habitat connectivity for native fauna is improve and increased, • Population sizes and diversity of native freshwater fish and crustacean are maintained, • Requirements for fish passage and spawning in waterways are maintained, • Representative and adequate areas of pre-European vegetation types are retained, • The impact of exotic pest animal species on native fauna is reduced, and • The impact of weeds on native vegetation and aquatic ecosystems is reduced.

➢ Targets	Resource Condition Change
	4.1: Major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions by 2025. *NOTE: actions for this target are included in Themes 1, 2, 3 & 5.*
	4.2: All 'pristine' foreshore vegetation (Class A) is permanently maintained and all 'good' foreshore vegetation (Class B) is returned to 'pristine' condition by 2025.
	4.3: All 3rd and 4th – order waterways have established permanent foreshore vegetation by 2015.
	4.4: Identified waterway and terrestrial vegetation corridors are established for wildlife habitat as a part of a regional 'macro-corridor' by 2015.
	4.5: Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.
	4.6: All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.
	4.7: Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.

Fencing waterways to restrict stock access and enable revegetation of the riparian zone is important to reduce soil loss by channel erosion and to provide nutrient filtering (mainly nitrogen) by in-stream vegetation. A buffer of permanent vegetation adjacent to waterways also creates a (temporary) nutrient sink within the nutrient transport pathway and provides biodiversity and habitat benefits.

The extent of stream restoration in the Torbay catchment as measured by field survey is shown in Table C1. This shows a total length of 218km is required to meet the nutrient reduction target. A survey of management practices undertaken for the *Watershed Torbay* project (undertaken during April, 2003) shows that 84km (38.4%) currently have fencing and revegetation. A further 102 km of stream restoration is required to meet the target for nutrient reduction.

Table C1 Area of fencing and revegetation needed to meet the target

	Stream length
Total length of lower order streams*	169.9 km
Total length of higher order streams**	48.3 km
Sum	**218.2 km**
Length of lower order streams fenced as at April 2003	60.9 km
Length of higher order streams fenced as at April 2003	23.0 km
Sum	**83.9 km**
Length of lower order streams to be fenced in future to meet target	76.3 km
Length of higher order streams to be fenced in future to meet target	25.3 km
Sum	**101.6 km**

* lower order streams are defined here to be 1st and 2nd order streams

** higher order streams are defined here to be 3rd and 4th order streams

Figure C1 shows the priorities for fencing based on:

- A high priority for streams in the Torbay West sub-catchment because of high nutrient loads (relative to flow) in Torbay Drain,
- A high priority also for the Marbellup Brook sub-catchment to maintain high quality stream flow for future allocated use,
- Streams with reaches close to receiving water bodies, including Lake Manerup, Lake Powell and the Hortin's Drain system (which discharges directly into the ocean).

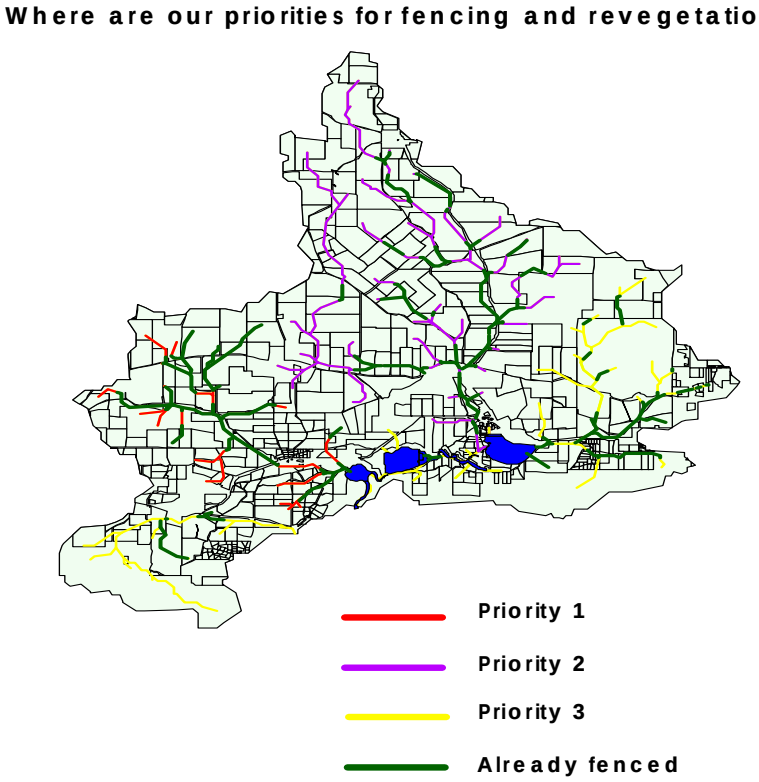


Figure C1 Priorities for establishment of vegetated stream buffers in the Torbay catchment.

T4MAT1a.	**More than 150km of priority waterways within the Torbay catchment currently unfenced are fenced and revegetated according to local 'best practice' for permanent management of foreshore vegetation by 2010.**

T4MAT1b.	**A further 100km of vegetated stream buffers are established according to priority areas by 2010.**

Actions:

1. Combine all foreshore survey information for the Torbay catchment onto one map base. Show Stream 'ordering' on the map. Establish priorities for fencing and revegetation based on criteria of:
   - 'pristine' and 'good' (classes A and B) foreshore vegetation,
   - 3rd and 4th order streams,
   - Channel erosion risk, and
   - Regional connectivity.

2. Prepare information sheets of local 'best practice' for riparian zone rehabilitation and management ('Stream-lining').

3. Develop cost-sharing arrangements for vegetated stream buffering, including trial of an 'auction-based' system, considering regional and catchment priorities as well as public and private benefits.

4. Organise and provide on-ground support services to ensure that information is available to priority areas.

T4MAT2: More than 50% of sedge lands within the Torbay catchment are managed to maintain or restore ecological values by 2010.

Actions:

1. Undertake detailed mapping of the sedge land vegetation type within the Torbay catchments and identify threats (e.g. invasion by *Typha orientalis*) and management requirements for permanent protection.

2. Identify areas that may be suitable for restoration of sedge land vegetation (some areas of land contaminated with chemicals is suggested).

3. Prepare information sheets of local 'best practice' for sedge land management.

4. Arrange funding and cost-sharing arrangements for management of sedge lands in priority areas within the catchment.

5. Initiative a public awareness and involvement program for sedge land management.

T4MAT3: All viable remnant vegetation patches of regionally inadequate vegetation types greater than 1 Ha are fenced and management according to local 'best practice' by 2010.

Actions:

1. Prepare a catchment map/database of vegetation types that identifies:
   - Areas that are inadequately represented,
   - Areas greater than 1 ha in size,
   - Fencing status, and
   - Priorities for protection.

2. Prepare information sheets of local 'best practice' for remnant vegetation management.

3. Arrange funding and cost-sharing arrangements for management of priority remnant vegetation within the catchment.

4. Initiative a public awareness strategy on the value of remnant vegetation.

T4MAT4: More than 75% of the length of foreshore of Lake Powell, Lake Manarup and Torbay Inlet have a minimum 20 meter foreshore vegetation margin by 2015.

Actions:

1. Undertake foreshore vegetation surveys for the 3 major wetlands assessing also threatening processes (including weeds), management requirements and practical suitability for rehabilitation or extension of wetland foreshore vegetation.

2. Clarify landowner boundaries and other cadastral information to ensure clear understanding of land ownership status.

3. Review options for increased vegetation buffers through land purchase, increased reserve status, covenants, management agreements and others.

4. Prepare information sheets of local 'best practice' for wetland vegetation management.

5. Arrange funding and cost-sharing arrangements for rehabilitation and management of priority wetland vegetation within the catchment.

T4MAT5: Priority environmental weeds are mapped and have management programs for control to achieve 10% per annum reduction with total control by 2015.

Actions:

1. Undertake catchment-scale environmental weed mapping program.

2. Prepare environmental weed control programs for priority species.

3. Prepare information sheets of local 'best practice' for weed management.

4. Arrange funding and cost-sharing arrangements for implementation of annual environmental weed management program.

T4MAT6: *The environmental requirements of freshwater and marine fish and crustacea in waterways and wetlands of the Torbay catchment are understood and being managed by 2010.*

Actions:

1. Undertake surveys as required to establish the species of fish and crustacea that utilize the waterways and wetlands for the catchment as habitat or passage, and the environmental requirements for their use.

2. Prioritize stream reaches and wetlands for in-stream habitat enhance programs.

3. Trial stream habitat enhancement (revegetation for temperature control, organic matter and food sources, and woody debris for shelter).

4. Prepare information sheets of local 'best practice' for stream habitat enhancement specific to the Torbay catchment.

C2.5 Targets and Actions for Theme Five: Farming Systems

Management actions for farming systems are focussed on developing and adopting 'best management practice' at a catchment scale particularly for reduction in point and diffuse sources for nutrients.

Management change requirements need to account for the mix of viable agricultural enterprises with non-viable farms (due either to off-farm income or lifestyle residential use). It is proposed that assessment of resource condition change (such as a nutrient loss reduction) is arranged on a sub-catchment basis.

➢ **Goal (2025):**	The farming communities have adopted 'best practice' systems for sustainable land use resulting in measurable agricultural and environmental benefits.
➢ **Objectives:**	• Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy, • Farm nutrient loss is reduced, • Soil loss from farms is reduced, and • The impact of weeds on agricultural production is reduced.
➢ **Target**	**Resource Condition Change** **5.1**: The total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus by 2025.

C2.5.1 Intensive Animal Industries

T5MAT1: Intensive animal industries and annual horticulture located in high or medium risk sites have adopted management practices that result in a reduction of the current industry nutrient surplus by 40% by 2010.

Actions:

1. Calculate the current nutrient surplus from intensive animal or horticultural enterprises.

2. Review management practices for nutrient reduction adopted for similar industries in other coastal rural areas (e.g. Busselton, Peel-Harvey catchment) and determine practices applicable to Torbay.

3. Prepare and implement nutrient management plans for intensive animal and horticultural industries.

4. Evaluate and implement cost-sharing options and other policy instruments that provide incentives for adoption of 'best practice' management.

5. Provide information and support for adoption of environmental management systems in the catchment.

C2.5.2 Nutrient Surplus Reduction Targets

T5MAT2: More than half of the landholders in the Torbay catchment who derive more than 50% of their income from farming their properties have prepared a 'farm nutrient surplus' calculation and response plan by 2010.

Actions:

1. Develop appropriate methods for farm nutrient balance and management audit based on currently available information and research.

2. Conduct an initial farm nutrient balance and management audit for voluntary involvement by landholders within the catchment.

3. Based on information from the initial farm nutrient balance and management audit, review the nutrient surplus reduction targets set for each sub-catchment (Theme One – Water Quality and Algal Blooms). The revised targets are to be achievable (i.e. by acceptable levels of change within farming systems) and remain relevant to nutrient reduction levels for waterway and wetland restoration.

4. Prepare demonstration property plans for one large and one small property within the Torbay catchment to show 'best practice' management for nutrient loss reduction.

5. Initiate a program for 'continuous improvement' of best management practices to achieve sub-catchment nutrient surplus reduction targets through review and evaluation of updated information by the catchment group, industry and the community.

6. Identify incentives (financial and others) for voluntary engagement in the nutrient reduction program.

7. Arrange state, national and international 'farming systems' study tours for innovative landholders (eg. through a Churchill Fellowship).

8. Establish visible community indicators (eg a nutrient reduction "barometer" at Elleker community store and other locations) and regular updates in newsletters and newspapers to show the level to which the targets are being achieved.

A regional survey of agricultural soils in the South Coast region has shown that the level phosphorus (P) and potassium (K) in soils are now at levels greater than plant requirements due to annual fertiliser applications and that sulphur (S) is the commonly deficient nutrient (Weaver and Reed, 1998). High fertilizer application levels including P are often used to address the deficiency in S.

The pathways for transport of P in sandy duplex profile soils include:

- Leaching in deep sand soils with low P retention capacity,
- Transmissive zone leaching including sand-filled alluvial channels, macropores, relic root channels and other transmissive cracks or fissures,
- Sub-surface flow above the clay layer n duplex soils
- Surface flow without soil loss (nutrient transport in solution)
- Surface flow with soil loss (nutrient transport in solution and in soil particles)

Nitrogen (N) transport pathways are more complex. Some of N that is excess to plant requirements is lost in solution through leaching however it is also lost through volatilisation.

The proposed management strategies for effective fertiliser use include:

1. **Soil testing and analysis** – so as to recommend fertiliser applications that are required to meet plant requirements,
2. **Fertiliser use and management** – e.g. fertiliser types, time of application, buffer areas with reduced fertiliser applications (including firebreaks),
3. **Increase nutrient use through increased productivity** – by extending the period of production and increasing the depth of root zone use, particularly on deep leaching sandy soils, and
4. **Surface and subsurface water management** – to reduce soil erosion and water logging.

Viable agricultural enterprises for grazing and horticulture are where substantial amounts of fertiliser are applied. Responses from surveys undertaken for the *watershed* Torbay project (April, 2003) suggest that 30% of the area under grazing and 25% of the area used for horticulture is fertilised using best practice principles. Table C2 shows that 'best practice' fertiliser use should be applied to an additional 10,500 Ha of grazing or horticultural land to achieve the resource condition change target for nutrient loss reduction.

Table C2 The area of land required to adopt effective fertiliser management to meet the resource condition change target.

	Area
Total area of catchment where grazing is the dominant land use	170 km^2
Estimated area of grazing fertiliser BMP as at April 2003	51 km^2
Total area of catchment where horticulture is the dominant land use	19 km^2
Estimated area of horticulture fertiliser BMP as at April 2003	5 km^2
Total area of fertiliser BMP needed to meet 85% target	161 km^2
Post-April 2003 area of grazing or horticulture fertiliser BMP needed to meet target	105 km^2

The priority areas for further adoption of 'best practice' fertiliser management within the Torbay catchment are shown in Figure C2.

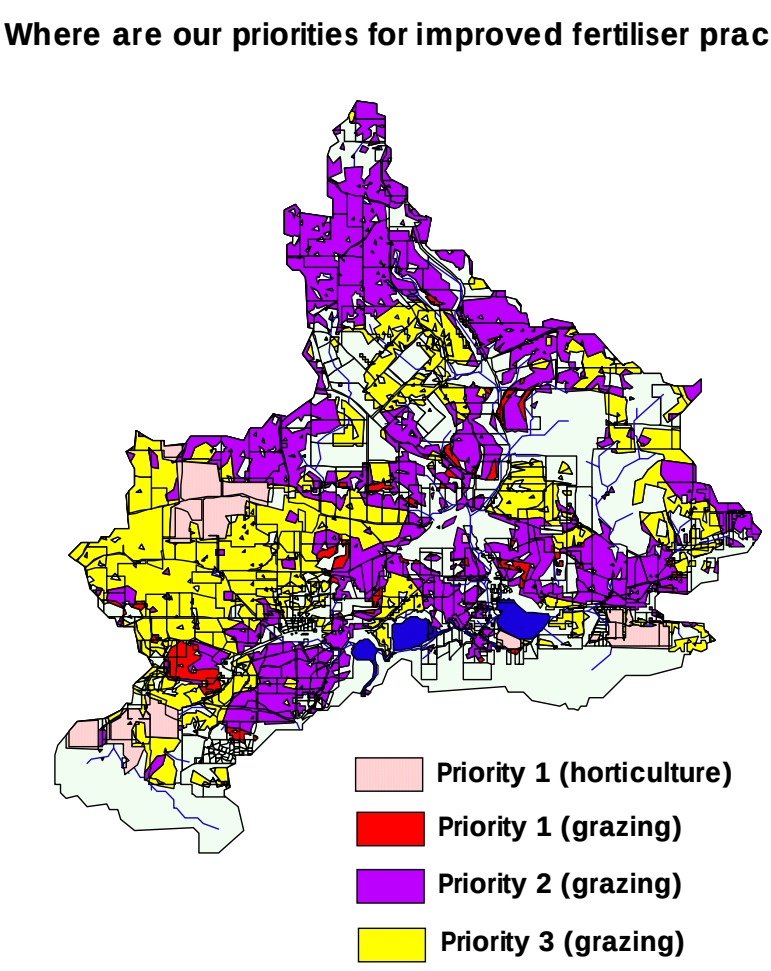


Figure C2. Priority areas for adoption of 'best practice' fertilizer management in the Torbay catchment.

In addition to on-farm fertiliser management, there is a requirement to reduce nutrient loss that occurs with soil loss (erosion) and waterlogging. Identification of priority areas for surface water and soil erosion control is based on classification of the iron content and erosion potential of soils (i.e. erosive soils with high nutrient content are highest priority). Figure C3 shows the location of priority areas for surface water and soil erosion management in the Torbay catchment.

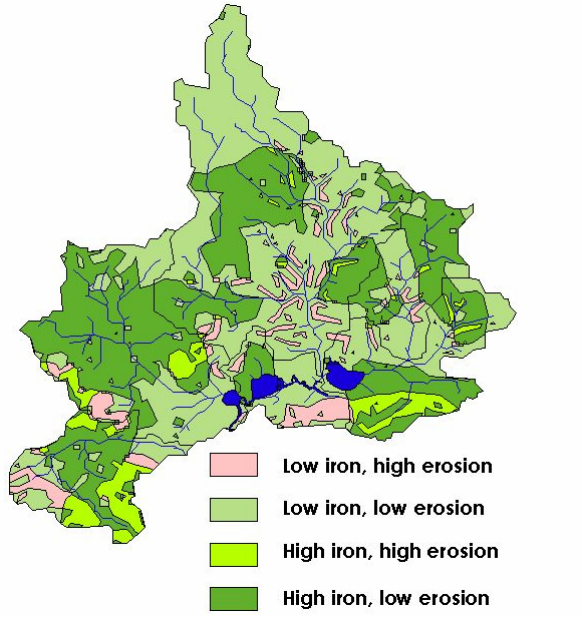


Figure C3. Priority areas for surface water and soil erosion control in the Torbay catchment.

The targets for management of fertiliser use, surface water and soil erosion to reduce nutrient loss from farming systems are:

T5MAT3:	**More than 30 viable farming enterprises are adopting 'best management' practices according to nutrient management plans and are demonstrating achievements of defined nutrient surplus target reductions without production loss by 2010.**

Actions:

1. Promote and encourage adoption of soil and plant testing and analysis to guide appropriate fertiliser application according to production requirements,

2. Develop a *proforma* and tool for farm nutrient audit and budgets, and promote adoption of a nutrient budget approach for all priority area properties,

3. Increase community understanding of efficient fertiliser use, particularly the efficient use of sulphur sources and trace elements,

4. Develop a "Nutrient Management" information series, including developing 'best practice' notes for a range of farming systems and interest groups,

5. Promote and support research and development with fertiliser manufacturers to develop, trial and produce a slow-release fertiliser suitable for use in the Torbay catchment (eg 'Redcoat' fertiliser)

6. Improve community awareness of efficient fertiliser use by:
   - paddock-scale demonstrations and associated field-days
   - a bus tour for members of the Torbay Catchment Group to the Peel Harvey Catchment
   - disseminate information about productivity and environmental benefits associated with soil ameliorants fertiliser options (including the use of lime and 'Alkaloam')

7. Evaluate the potential for delivery of bulk 'Alkaloam' supplies to the Torbay catchment,

8. Demonstrate and promote the adoption of surface water control and interception drainage structures in priority areas with high surface water run-off and potential soil loss, and

9. Arrange integrated surface water management plans on a sub-catchment basis for priority areas with high surface water run-off and potential soil loss.

C2.5.3 Establishment of Perennial Pastures, Shrubs and Trees

Perennial pastures, shrubs and trees are considered to have significantly higher nutrient assimilation capacity than annual pastures within the Torbay catchment. The extent to which it is greater needs to be established for the catchment.

Current adoption of perennial pastures within the Torbay catchment is mapped based on information from survey responses (April, 2003) and local knowledge (as shown in Figure C4). This shows that approximately 50% of the area under grazing in the high rainfall part of the catchment (>750mm) is established with perennial pasture but only 10% in the lower rainfall area (<750 mm) is established with perennial pastures. It is estimated that 85% of land used for grazing needs to be established to perennial plants to achieve the required resource condition change.

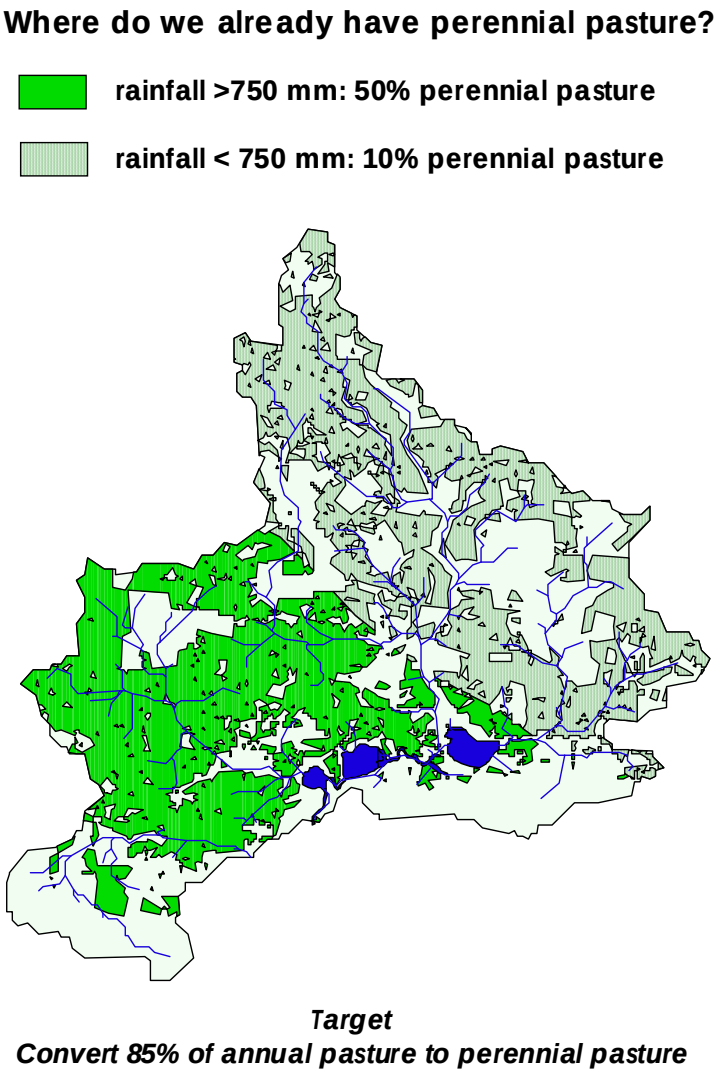


Figure C4. **An estimate of the current extent of perennial pastures in farming systems within the Torbay catchment.**

Considering that the area currently established to perennial pastures is 33% of all land used for grazing in the catchment, a further 8,900 Ha is required to be established to meet the target (Table C3).

Table C3. The area of land required to be established with perennials to meet the resource condition change target.

	Area
Total area of catchment where grazing is the dominant land use	170 km²
Estimated area of grazing under perennial pasture as at April 2003	56 km²
Estimated proportion of grazing area under perennial pasture as at April 2003	33%
Area of perennial pasture required to meet 85% target	145 km²
Post-April 2003 area of annual pasture requiring conversion to meet target	89 km²

The priority areas for further establishment of perennial pastures shrubs or trees based on nutrient loss risk is shown in Figure C5.

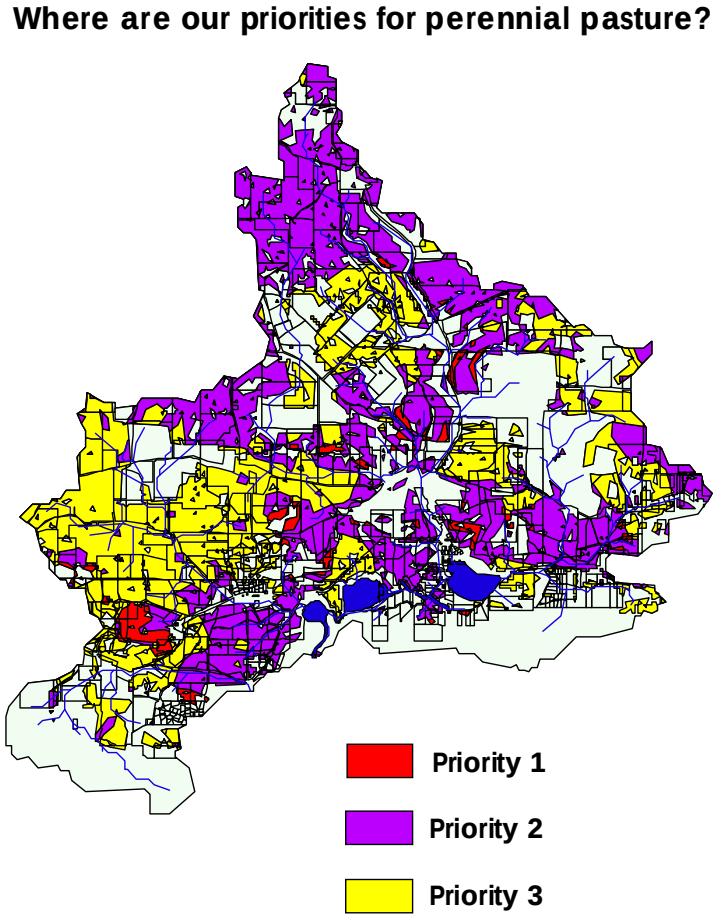


Figure C5. **Priority areas for establishment of perennial plants in the Torbay catchment.**

T5MAT4:	**A total of 75% of land used for grazing is established with perennial plants (trees, shrubs or pastures) by 2015.**

Actions:

1. Undertake map analysis with field verification survey to identify the area of soils in each sub-catchment that have high nutrient leaching capacity and are suitable for establishment of perennial pastures, shrubs or trees.
2. Develop a Perennial Pastures support and extension program suitable for both larger and smaller farm enterprises within the Torbay catchment (could be linked to or based on the existing 'Prograze' program).

3. Initiate large-scale demonstrations of a range of perennial pastures, shrubs and trees options.

4. Develop a series of "Pastures Management" field days and information notes with support from industry organisations (e.g. the WA Lucerne Growers Association) for both perennials and annual pastures (focussing on both production and environmental benefits).

5. Undertake a catchment-scale program with cost-sharing arrangements establish perennial grasses and legumes in priority areas within the catchment.

6. Establish a trial of *Agonis juniperina* as a perennial shrub with potential commercial and nutrient loss reduction benefits.

7. Develop agroforestry as an alternative land use:
   - Implement 50 ha of wide-spaced commercial saw log agroforestry to in the catchment by 2008
   - Develop an Agroforestry Information Series
   - Develop a Master Tree-Growers Course
   - Undertake research into the production and water quality benefits of perennial pastures (current postgraduate studies initiated).

8. Undertake research into the farm production and the benefits to water quality by nutrient loss reduction through the adoption of perennial pastures, shrubs and trees.

C2.5.4 Information gaps

There is further requirement to better understand the significance of farming systems management for benefits to resource condition within the Torbay catchment. Some points to be addressed are:

- The relative nutrient surplus use by perennials and annual pastures,
- A comparison of nutrient surplus reduction for a range of perennials (e.g. kikuyu, phalaris),
- The extent to which P in soil (i.e. nutrient surplus) is actually available for uptake by pastures,
- The potential for soil ameliorants to reduce nutrient loss from farming systems,
- Development of slow release fertilisers that are suitable for use in the Torbay catchment.

C2.6 Targets and Actions for Theme Six: Land Use Planning

The policy and planning mechanisms that relate to implementation of the *Watershed Torbay Catchment Restoration Plan* are described in Section B2.6.1. There is also consideration of additional planning mechanisms that may be required for effective implementation of the plan.

Incentives may be required for individual landholders to engage in planning practices and to implement 'best practice' actions for net environmental benefit. Ensuring that information is relevant and easily available is a first step in encouraging engagement in planning. Incentives for adoption of actions for change management in order to deliver public benefits (e.g. improved water quality) can be provided through cost-sharing arrangements.

Improved understanding of the policy and institutional change framework relevant to the Torbay catchment especially in relation to regulatory instruments will also provide incentives for industry self-regulation through planning.

The Management Action Targets and actions required to achieve the goals and objectives for the Land Use Planning theme are outlined below.

➢ **Goal (2025):**	Regional and local planning provides the policies and mechanisms to implement new actions that are beneficial for natural resource condition, ensure that land is used according to its capability and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.
➢ **Objectives:**	• Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current land use, • Land use intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines, • Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands,

	• Priority water resources are protected for beneficial use now and into the future, • Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained, • Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands, • The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations, • The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit, • The current landscape mosaic characterised by agriculture and natural vegetation is maintained, and • Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.

C2.6.1 Adopting 'Land Capability' and 'Net Nutrient Reduction' Principles

Land capability analysis is a process for systematic assessment of land attributes with respect to its use. Sustainable land use is based on the land resource being used within it's capability. If use exceeds the capability of land, then resource degradation is expected. Acid sulphate soils require additional consideration in land capability assessment.

The principles of land capability should prevail through planning and management. The current Town Planning Scheme (TPS) for the City of Albany, and the revised TPS adopt land capability principles. However, the effectiveness of land capability analysis is limited by the level of information about the land that is available. Information for land in the Torbay catchment is generally at a higher level that in other catchments in the region as a result of the *Watershed Torbay* project. Planning processes should be adjusted to make best use of the information that is available.

There is further potential through policy and planning mechanisms to arrange 'net nutrient reduction' to result from land use change proposals. Nutrient management plans can be required for some proposed developments that there is zero nutrient loss from the proposed development and that there is additional nutrient reduction strategies. Opportunities for 'environmental off-sets' to reduce nutrients can also be considered. For example, proposals that may result in increased nutrient discharge compared to the pre-development can undertake addition works within a sub-catchment (e.g. revegetation using local native species) that result in a net nutrient reduction for that area.

T6MAT1: Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information and adopt 'Net Nutrient Reduction' principles for planning proposals by 2007.

Actions:

- Review current land capability assessment processes to identify limitations and opportunities for improvement (i.e. with additional information),
- Prepare a revised land capability framework for the Torbay catchment that makes best use of current information and is suitable for management and planning purposes,
- Develop additional information sets to enable assessment of development proposals within areas identified with acid sulphate soils,
- Ensure the revised land capability processes are adopted within the Local Planning Strategy and Town Planning Scheme for the City of Albany (this may require a TPS Amendment)
- Ensure that the requirement for Nutrient Management Plans is prescribed in the LPS and TPS for significant Development Applications,
- Develop guiding principles for inclusion in the LPS and TPS for application of 'environmental off-sets' within the Torbay catchment, and
- Promote revised 'land capability' and 'net nutrient reduction' principles to landholders within the catchment for management through existing communication processes and to development proponents through planning processes.

C2.6.2 Land Use Intensification

Planning can be applied to ensure that further land use intensification and residential development adjacent to Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled to minimise nutrient, flood and other environmental risks.

T6MAT2: Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information by 2007.

Actions:

1. Map priority areas within the Torbay catchment where further development may increase the risk to environmental values for consideration within the (draft) Lower Great Southern Regional Planning Strategy and the (draft) Local Planning Strategy and Town Planning Scheme for the City of Albany,
2. Map the 'Floodplain' and 'Buffers' for the lower Torbay catchment as define spatial areas to have conditional requirements for development applications,
3. Prepare provisions for proposed development within the mapped priority areas for consideration within the LPS and TPS,
4. Identify the mapped priority areas that may be suitable for Regional Open Space or additional public access for consideration within the (draft) Lower Great Southern Regional Planning Strategy.

C2.6.3 Development and Maintenance of Drains

Construction of additional drains and maintenance of existing drains with the Torbay catchment has potential to increase the acidification of wetlands where they occur in acid sulphate soils, sedimentation in soils with unconsolidated sands and increased flooding. There are opportunities within policy and planning mechanisms to control the potential impacts of drains.

T6MAT3: All proposals for additional deep drainage and significant maintenance works within the Torbay catchment are assessed as Development Applications and on the basis of a presumption against drainage in areas identified at risk by 2007.

Actions:

1. Prepare provisions to define deep drainage construction and maintenance as development for planning purposes and provide an additional 'Land Use Class' for drainage within the TPS and associated planning processes,

2. Undertake a risk analysis due to additional deep drainage construction and maintenance in the Torbay catchment and apply this to assessment of land use planning zones for deep drainage within the Town Planing Scheme for the City of Albany,

3. Include a presumption of no additional drainage construction within identified risk areas and prepare a set of approval conditions for inclusion in the LPS and TPS for proposed drainage construction and maintenance within these areas,

4. Prepare policies and management guidelines for inclusion in the LPS and TPS to provide direction for planning approval processes and to promote 'best practice' drainage construction and maintenance,

5. Arrange for drainage development applications to be referred to the appropriate agencies and authorities (including the Department of Environment as a key agency and a partner of the Torbay Catchment Group), and

6. Communicate the risk of drainage construction and maintenance within the identified risk areas to landholders and responsible authorities within the catchment and promote 'best practice' management through catchment group communications and through planning processes.

C2.6.3 Water Resource Protection

Stream flow in Marbellup Brook is identified as a potential public water drinking source. A Water Resource Protection Plan under the *Country Areas Water Supply Act 1914* is to be prepared before 2007. There are opportunities to add value to the proposed water resource planning within the Marbelup Brook sub-catchment through other policy and planning mechanisms.

T6MAT4: The Water Resource Protection Plan for the Marbelup Brook sub-catchment is recognised as a priority area within the Lower Great Southern Regional Planning Strategy and the Town Planning Scheme for the City of Albany by 2007.

Actions:

1. Arrange for the Water Resource Protection Plan for the Marbelup Brook sub-catchment to be prepared in a way that is compatible with regional and local government planning processes, including adoption of land use planning processes,

2. Define the Marbelup Brook sub-catchment as a priority area to be considered in the Lower Great Southern Regional Planning Strategy and the LPS and TPS for the City of Albany.,

3. Investigate measures for private funding of catchment rehabilitation works (eg as a trade-off for subdivision rights)

C2.6.3 Commercial Tree Plantations

The community has expressed concern about the effect of uncontrolled expansion of commercial tree plantations within the Torbay catchment. The concerns are particularly in relation to social and environmental impacts, including the potential loss of groundwater resources. Planning provides some opportunity to control the undesirable development of extensive tree plantations through the land capability processes and planning zones although this will require additional information about the potential impact of plantations on the catchment water balance.

T6MAT5: Proposals for commercial tree plantations within identified priority areas of the Torbay catchment are assessed as Development Applications through the TPS for the City of Albany with the presumption against this development in these areas by 2007.

Actions:

1. Prepare a catchment water balance model to show the potential impacts of commercial tree plantations on surface and groundwater resources for the Marbelup Brook sub-catchment,

2. Provide definitions for 'commercial tree plantations' and 'farm forestry' or 'agro-forestry' for planning purposes,

3. Ensure that consideration of 'commercial tree plantations within identified priority areas' as Development Applications is continued in the revised TPS for the City of Albany,

4. Prepare guidelines for management conditions to planning approval of commercial tree plantations within identified priority areas for potential inclusion in the LPS and TPS, including a requirement by the development proponent to assess the potential impact of the proposal on sustainable groundwater yield,

5. Identify areas in the Torbay catchment where potential tree plantations may reduce the visual amenity of the catchment and include these areas in a submission from the Torbay Catchment Group for comment on the (draft) Lower Great Southern Regional Planning Strategy and the (draft) TPS for the City of Albany.

C2.6.4 Urban Growth

While the urban communities within the Torbay catchment are currently quite small, there is potential for increased growth. Policy and planning can ensure that additional urban development does not result in increased nutrient input to waterways and wetlands. The potential for this to occur is greatest for the town of Elleker.

T6MAT6: *Urban growth in the town of Elleker is planned to ensure no additional risk to waterways and wetlands and that the potential for flooding of residential development is minimal by 2007.*

Actions:

1. Identify and evaluate the on-site and environmental risk due to further urban development in the Elleker town site, including potential for increased nutrients to waterways and wetlands, impacts of acid sulphate soils, flooding and mal-odours,

2. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) LPS and TPS for the City of Albany to ensure the environmental risk of further urban development within the Torbay catchment is recognised.

C2.6.5 Increasing Biodiversity Values

Nature conservation or biodiversity values within the Torbay catchment can be secured or enhanced through application of policy and planning mechanisms, in addition to those that currently exist for reserves management by CALM. The area in reserves can be increased by ceding Foreshore Reserves as a condition on significant sub-division proposals. These processes may be appropriate to increase riparian vegetation in reserves for waterways and wetlands, or for rehabilitation requirements associated with development proposals.

Remnants of natural vegetation on private properties can protected through planning arrangements. Proposals for sub-division can require rehabilitation of specific areas and imposition of Conservation Covenants. There are opportunities to link these initiatives to catchment or larger scale bio-geographic planning as outlined in Section B2.4.3.

T6MAT7: Priority areas for conservation protection or enhancement are identified and linked to local government and regional planning processes by 2007.

Actions:

1. Map areas of high conservation priority showing potential to add to existing biodiversity values by increased area or site rehabilitation,

2. Map priority areas for foreshore vegetation buffers adjacent to the major wetlands within the Torbay catchment

3. Develop catchment-scale macro-corridor initiatives for consideration by future planning proposals,

4. Ensure sub-division proposals are referred to the appropriate agencies for consideration of ceding Foreshore Reserves within mapped priority areas, and

5. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) TPS for the City of Albany.

C2.6.6 Recognising Environmental Services

Ecosystem services are the benefits that society gains from the environment, including clean water supply and waste disposal to the environment. These services are generally not valued or are under-valued. Both of these services are provided to the residents and businesses of the City of Albany from the Torbay catchment. Opportunities to recognise these values and compensate for their use can be developed through policy and planning mechanisms. For example, a 'conservation rate' could be initiated through local government so that the beneficiary pays for the ecosystem services. Revenue collected could be returned to the catchment for natural resource management.

T6MAT8: The value of ecosystem services is understood and a trial system for compensation under a 'beneficiary pays' principle within the City of Albany is established by 2008.

Actions:

1. Prepare a Discussion Paper to develop a broader understanding of 'ecosystem services' in relation to the Torbay catchment,

2. Review payment systems for 'ecosystem services' from national and international examples,

3. Prepare a proposed schedule of expenditure for revenue gained from 'ecosystem service' payments, and

4. Design a trial application of a 'conservation rate' to assess the net benefits of long term adoption.

C2.6.7 Maintaining the Character of Agricultural Landscapes

The community has expressed concern about the loss of the current agricultural character of landscapes within the Torbay catchment. Agriculture is effectively preserved in Priority Agricultural Areas as described by the Statement of Planning Policy for Agriculture and Rural Land Use Planning.

T6MAT9: Priority Agricultural Areas in the Torbay catchment are revised and a preferred landscape description prepared for consideration by regional and planning processes by 2005.

Actions:

1. Revise current areas classified of Priority Agricultural Area and General Agriculture within the Torbay catchment to ensure that these meet the expectations of the community,

2. Prepare a description of preferred agricultural landscapes for the two planning classes based on community aspirations and goals for goals for the Torbay catchment, and

3. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) LPS and TPS for the City of Albany.

C2.6.8 Social Values and Recreational Opportunities

Opportunities for social and recreational values can be increased through planning processes. Proposals can be made through current regional and local government planning.

T6MAT10: Opportunities for increased social and recreational values within the Torbay catchment have been reviewed through regional and local government planning processes by 2007.

Actions:

1. Prepare a map and associated documentation that outlines opportunities for increase social and recreational amenity within the Torbay catchment,

2. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) LPS and TPS for the City of Albany.

C2.7 Targets and Actions for Theme Seven: Community Education and Information

➢ **Goal (2025):**	The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the shared vision for the catchment.
➢ **Objectives:**	• All key stakeholders are willingly involved in implementing the restoration plan. • A high level of community awareness about the values of the catchment and about the best practices for sustainable management. • Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes. • There is a significant level of community involvement in reviewing the restoration plan on a five yearly basis.

C2.7.1 Developing a 'Shared Vision'

T7MAT1: More than half of landholders and residents in the Torbay catchment are able to express clear understanding and support for the catchment Vision and Restoration Plan by 2010.

Actions:

1. Appoint a full-time TCG Coordinator (3 year contract)

2. Conduct community forums and catchment tours to recommit to the vision, report on restoration plan implementation progress to date and provide opportunities for community involvement in reviewing priority actions.

3. Report on achievements of Targets and Actions in an annual 'Report Card' format.

4. Prepare a summary version of the Restoration Plan targeting specific interest groups and further engage community in reviews and amendments to the plan.

5. Prepared a set of maps (for management Themes) with clearly identified locations and tasks for local involvement.

6. Arrange clear and localised 'best practice' information that is relevant and achievable.

7. Identify key 'barriers to change' and develop incentives or other measures to overcome these barriers.

8. Initiate information and skills development opportunities for 'special interest' groups (e.g. small-scale landholders).

9. Identify and support community leaders into specific roles for which they are well recognised.

10. Provide public recognition for individual and community actions undertaken according to the Restoration Plan.

11. Engage the community through involvement with schools and other related interest groups.

12. Initiate community projects that have achievable outcomes and contribute to the targets of the Restoration Plan.

13. Organise cost-sharing arrangements and publicise these in ways that ensure that they are considered available to all in the catchment, including both small and large-scale landholders.

14. Show that key partners (e.g. government agencies) are committed to the project and are contributing within the partnership framework.

15. Provide a clear statement of 'roles and responsibilities' for actions and information in the form of 'partner profiles' about the expected roles for involvement.

16. Develop and update a local skills audit and where ever possible use local people to undertake contract catchment restoration works.

C2.7.2 Communications and Information Management

T7MAT2: More than 40% of landholders are attending at least one group event annually and have copies of or direct access to current research and information relevant to actions for implementation of the Restoration Plan by 2010.

Actions:

1. Survey all landholders and residents biennially to monitor support for vision as well as review key issues or actions, and gauge attitudes to changing land management.

2. Review the social benchmark survey information to identify key 'drivers' or 'barriers' for communication and information management for differing landholder interests and cultural or age groups.

3. Maintain the 'Communications Learning Log' and ensure that a short summary of new group learning is widely distributed.

C3.0 Achievement of Management Action Targets, Priorities, Responsibilities and Estimated Costs

An estimate has been made of the extent to which each of the Management Action Targets can be achieved within the first 3 year period of implementation. Some actions will fully achieve the MAT within that time while for other targets, only initial actions may be taken within that time. For example, change management that is dependent upon demonstrations to develop 'best practice' and understanding by landholders may take longer time. An assessment of the feasibility for achievement of the MAT's is also included in Table C4.

The priority for implementation of each of the actions has been derived from review comments provided by partner organisations and from community workshops held during February, 2005. The proposed commencement year during the 3-year Implementation program is shown for each project. Some are ongoing processes expected to continue beyond the 3-year period.

Responsibilities for implementation are identified and an estimate of total cost allo cation required for each action within the 3-year implementation program is provided in Table C4. The costs are provided as budget estimates within a 3-year period. The organisations identified to adopt lead responsibility for implementation of the action area also identified in the table. Information provided by Weaver (2003) has provided a guide for some cost estimates (Table C5).

Table C4 Priorities, Responsibilities and Estimated Costs For Proposed Actions In The Torbay Catchment.

Note 1: All actions relating to how changes to farming systems will contribute to improved water quality are contained in section 5 – Farming Systems.
Note 2: Abbreviations are explained in full at the end of Table C4.

Theme 1 – Water Quality and Algal Blooms

Goal

Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals, and algal blooms are minimal. Water in Marbelup Brook remains suitable for recreation, domestic and agricultural use.

Objective

The Source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and management so that:
There are no fish kills due to poor water quality;
The incidence of algal blooms is reduced;
The transport of nutrients, sediments and contaminants into waterways and wetlands is minimised; and
Management practices are adopted that minimise public health and environmental risks for drinking water from Marbelup Brook.

Targets for Resource Condition Change

1.1 Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbelup Brook by 2025
1.2 Median nutrient concentrations from the sub-catchments meet the set reduction targets.
1.3 The quality of water in Marbelup Brook meets national criteria for public water supply by 2015.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T1MAT1: Discharge of nutrients to the Torbay catchment from the disposal of wastewater does not increase beyond current levels. (Note, current levels are well below Ministerial approval).	1. Review future options for wastewater disposal in Torbay catchment and provide information to the community.	H (ongoing)	90		WC	Water corporation is currently assessing options, including on-site and off-site water reuse.
	2. Continue monitoring water quality in stream flow for Seven Mile Creek with evaluation and reporting annually.	H (ongoing)			WC	Ongoing under Ministerial conditions
	3. Encourage source reduction of wastewater flows from the City of Albany through prevention of stormwater entering sewers, and public awareness program for wastewater reuse,	H (06 and ongoing)		20 WC	WC, CoA	Include in urban land development design, and longer-term initiatives to be built into infrastructure maintenance and replacement program. WC is suggested funding source
	4. Assess options for City of Albany and other waste water producers to pay for ‘ecosystem services’ as a contribution to catchment management.	M (06)		25 NAP	WC, CoA	Feasibility study to assess application of “ecosystem service” costs in this situation.
T1MAT2(a): All third and fourth-order waterways in Marbelup Brook have permanent vegetated stream buffers established by 2010. **T1MAT2(b): By 2015, 70% of all first and second order streams have permanent perennial vegetation.**	1. Prepare maps and tables to show the extent for stream ‘orders’ in the Marbelup Brook sub-catchment and the width of stream buffers provided by natural riparian vegetation.	H (05)	60 25	1 DoE	DoE	Small task that would show the extent of works required
	2. Prepare a nutrient and pathogen ‘risk map’ for the Marbelup Brook sub-catchment based on soil-type and existing pollution hazards.	H (05)		2 DoE and WADA	DoE, WADA	Map compilation from existing information
	3. Prioritise streams within the Marbelup Brook sub-	H (05)			DoE, WADA	Essentially achieve, but broaden to

	catchment for vegetated stream buffering.					include criteria related to nutrient assimilation.
	4. Investigate the use of agroforestry to enhance stream restoration and provide an economic benefit.	M (06)			FPC, WADA	Link to farming systems theme. Included here as a potentially profitable option for stream buffering for nutrient reduction with some habitat and biodiversity benefit.
	5. Develop 'best practice' guidelines and other options for the required stream buffering for nutrient and pathogen control.	H (06)		10 NAP	DoE, TCG, WC	To be linked with preparation of the Water "Source Protection Plan for Marbelup Brook. Service provider to prepare guidelines in close association with TCG.
	6. Cost sharing arrangements for landholders to be coordinated through the Torbay catchment group (including consideration of a trial an 'auction-based' approach) to implement the vegetated stream buffers according to 'best practice' guidelines.	H (05)		450 (150 per annum over 3 years), NAP	TCG	Costs based on $5000/km for stream buffers (estimated from Weaver, 2003) and restoration of 30 km each year for 3 years. Initial cost sharing of 80:20+labour suggested although trial of an auction based system is recommended. Preparation of a detailed cost-sharing schedule is required.
	7. Voluntary cost sharing arrangements are reviewed annually and finally reviewed and reported in 2010 to determine their effectiveness compared with regulatory approaches.	H (ongoing and annually)		100 (?) NAP, NWF	TCG, DoE	On-going review and assessment of cost-sharing arrangements is essential to ensure efficient use of public and private investment funding.
T1MAT3: **Three trial demonstrations of nutrient reduction from stream flow and sediments implemented by 2007.**	1. Investigate and assess the application of slurry injected Phoslock™ (or other nutrient binding substance) to one of the tributaries to Lake Powell (e.g. Seven Mile Creek). Implement a trial if appropriate.	M (06)	60	DoE	DoE	Need to fully assess the benefits, risks and cost-effectiveness of this trial before consideration of long term application.
	2. After 5 years operation (2007), assess the effectiveness of the existing Torbay artificial wetland basin as a nutrient reduction option for the catchment. Arrange installation of further trials of in-stream nutrient stripping techniques on one of the tributaries to Lake Powell (e.g. Grasmere Drain).	M (07)			DoE, TCG	Ongoing monitoring of existing artificial wetland is essential.
	3. Review 'best practice' options to manage sediments in waterways, drains and the lakebed.	M (05)		20 NAP	DoE, WC	Review existing best practice guidelines for public drains (Regeneration Technology and JDA, 1999). Link with current lake bed sediment research. Contract services to provide a preliminary assessment of sediment removal options, including dredging, from drains and lake beds.
T1MAT4: Future land use development in the Marbelup Brook catchment complies with public water supply objectives for the catchment.	1. Develop an appropriate land use classification that identifies potential threats to the quality of public water supply and identifies water quality criteria relevant to the Marbelup Sub-catchment.	H (05)	85	CoA, DoE	CoA, DoE, TCG	Implement through land use planning actions. Link to water source protection plan.

Theme 2 – Water Quantity

Goal

Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.

Objectives

- Flow in Marbelup Brook is adequate to maintain ecological requirements,
- Water Regimes for Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals,
- The drainage district is managed to meet the needs of current land uses, future land uses, and the environment, and
- Those who benefit from the use of the catchment to provide environmental services contribute to the costs of restoration.

Targets for Resource Condition Change

2.1: Major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions by 2015
2.2: Maximum use of surface water and groundwater resources for private and public benefit within identified sustainable yield.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T2MAT1: Environmental Water Requirements are determined for Marbelup Brook, Lake Powell, Lake Manarup and Torbay Inlet by 2007	1. Prepare 'Environmental Water Requirement' assessments for Marbelup Brook, Lake Powell, Lake Manarup and Torbay Inlet.	H (05)	100	25 NAP	DoE	Contract services to be arranged for assessment of each wetland. Water Corporation would be expected to undertake for Marbelup, as part of approval process for water supply abstraction.
	2. Use monitoring information to establish the extent to which the environmental water requirements are met under current flow regimes and the current operating strategy for the drainage system..	H (ongoing)			DoE	Assessment to be based initially on current stream flow monitoring with recommendations for additional measures if required.
	3. If necessary, develop strategies to meet environmental water requirements, or determine the impact and acceptability of reduced flows.	H (07)			DoE	Linked to water allocation planning for Marbelup Brook and also to land use impact assessments, including the effect of commercial tree plantations on ground and surface water resources.
T2MAT2: Water resources in the Marbelup Brook Catchment are proclaimed under the Rights in Water and Irrigation Act (1914) and a Water Resource Allocation Plan is prepared, including an assessment of changing land use and climate change, by 2007.	1.Develop an allocation plan for the Torbay Catchment to ensure water is available for private and public users on a sustainable use basis, and meets environmental water requirements.	H (06)	100	50 NAP and DoE	DoE	According to requirements under Rights in Water and Irrigation Act
	2. The Marbelup Sub-catchment is proclaimed under the *Rights in water and Irrigation Act (1929)* so that water use allocation is controlled by licensing.	H (07)			DoE	Subject to approval by Water and Rivers Commission Board.
	3. Investigate the impacts of commercial plantations (e.g. blue gums) and farm forestry on water supply availability in Marbelup Brook, and determine an area limit for blue gums to maximise water availability and water quality.	H (06)		20 OWP, DoE, NAP	OWP, WADA, FPC, DoE	Contract for services for water balance model to show impact of land use and climate change on water resources.
	4. Assess the potential impact of climate change on water resources in the Marbelup Brook Catchment.	H (06)			DoE, WADA	Include in water balance model for previous action.

Theme 3 – Drainage Management

Goal

Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.

Objectives

- The impact of flooding on horticulture is minimised,
- Flooding in residential areas is minimised,
- The potential adverse effects of drainage management on fisheries in minimised (including commercial fisheries and native fish species), The impact of drainage management on algal blooms is minimised, and
- The drainage system is managed to prevent or minimize sedimentation of receiving water bodies.

Targets for Resource Condition Change

3.1 Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds) by 2025.
3.2 Sediment transport in drains, and sediment deposition in Torbay Inlet and Lake Powell, is reduced by 50% by 2015.
3.3 The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T3MAT1: Options for change to drainage management to maximise water quality and public amenity in Marbellup Brook (including the section downstream of the Marbellup Plug) and Lake Powell are fully assessed by 2006.	1. Finalise the modelling of drainage management Option 5a to assess social and environmental outcomes, and the expected costs.	H (05)	80	20 DoE, NAP	DoE	Existing model can be applied to all components of Option 5a and linked to the flood risk assessment.
	2. Undertake flood risk assessment for Option 5a.	H (05)		30	DoE	Use of existing bathymetry and land survey information with internal planning or contract for services to prepare flood risk assessment.
T3MAT2: The required regime for salt water flushing and maintenance of adequate water depth to improve environmental values in Torbay Inlet is identified and between key stakeholders, and is being implemented through management of sand bar openings by 2007.	1. Review current scientific research to determine the preferred salt water flushing regime for Torbay Inlet.	H (05)	100		DoE	Linking to information provided in the recent review of water quality in Torbay Inlet (WRC, 2004a)
	2. Model the potential effect on the preferred salt water flushing regime for Torbay Inlet if drainage management were to adopt Option 1b or Option 3b (see drainage scenario descriptions in Section B).	M-H (06)		15 NAP	DoE	
	3. Negotiate appropriate operating arrangements for opening the sandbar to achieve the preferred salt water flushing regime for Torbay Inlet.	H (06)			DoE, WC, TCG	Negotiations required by the Water Corporation with commercial fishing licensees and community adjacent to Torbay Inlet. Consideration of potential effects on potato industry also to be considered.
T3MAT3: Lake Manarup is being maintained with adequate water for functions of the wetland ecosystem (without disadvantage to Lake Powell and Torbay inlet)	1. Determine preferred hydrological regime (hydroperiod and water depth) for Lake Manarup to maximise environmental values.	H (05)	80		DoE, TCG	Links to action in T2MAT1. TCG to clarify the preferred environmental values expected

by 2007.						by managing the lake hydrology.
	2. Apply the hydrological model to Options 3a, 3aiii and 3b to assess the water levels and period of inundation for Lake Manarup particularly in relation to opening of the sandbar and other factors of drainage systems management.	H (05)			DoE	See T3MAT2 Action 2
	3. Estimate the volume of water to be pumped and the period of pumping required for Option 3b,	H (05)			WC, DoE	Streamflow monitoring and hydrological modelling should be adequate to estimate pump volume under a range of rainfall event probabilities.
	4. Assess the potential flood risk associated with Option 3b,	H (05)			DoE, WC	As above
	5. Prepare design and plans for closure of the 'siphon' between North Creek (the lower-level system) and Lake Manarup, construction of floodgates and detention pondage (near or in association with the North Creek bridge), and the pumping infrastructure and services required for Option 3b.	M (06)				Priority for action depends on preliminary feasibility assessment deviede from Actions 1,2,3 and 4 above. Options for public funding to be assessed.
T3MAT4: Public and private drains identified with high erosion risk or sediment transport are permanently stabilised by 2010.	1. Review the 'sediment risk' of public and major private drains, including further ground survey for management needs assessment,	H (05)	30	15 NAP	WC, TCG	Link to T1MAT3 Action 3. That action related to existing sediments, this action related to reducing sediment sources based on restoration and management. All related actions to be integrated.
	2. Revise Best Management Practice guidelines for public and private drain maintenance including: Revegetation techniques to stabilise banks, Improving channel roughness to reduce sediment transport capacity of flowing water, Earth works to re-contour drains to reduce sediment loss.	H (05)		5 NAP	WC, TCG	
	3. Restore private drains at risk of erosion according to management needs assessment priorities.	H (06)		300 (100 per annum over 3 years) NAP	WC, TCG	Resources required are estimate only. Action 1 will improve cost estimates. Details for itemised coasts are provided by Regeneration Technology and JDA, 1999.
	4. Provide information and advice to ensure that new drains include appropriate design to minimise risk of nutrient, sediment and acid transport.	H (07)			WC	
	5. Rehabilitated and maintain public drains for multiple benefits but with the primary function remaining as flood control.	M (ongoing)			WC	
T3MAT5: The processes and extent to which sulphuric acid, nutrients and other potential pollutants are released from acid sulphate soils due to the current operating strategy of the drainage systems is known by	1. Determine the distribution and level of acidity (actual and potential) in soils of the Lower Torbay catchment;	H (05)	50		DoE, WADA	

2006.						
	2. Undertake sampling and analysis of drainage water, groundwater, aquatic sediments and biota to determine the environmental impacts of acid drainage on the Lower Torbay waterways;	H (05 and ongoing)		10 (5 per annum over 2 years) NAP	DoE	
	3. Evaluate the most appropriate drainage design to minimize mobilization of acid and nutrients from soil profiles;	H (07)			WA, WADA, Potato Industry	
	4. Develop and implement training programs for on-farm land management practices that minimise the disturbance of acid sulfate soils.	H (07)		20 NAP	TCG	Potato industry to contribute to design to minimise on-site and off-site impacts by drainage in acid sulphate soils.

Theme 4 – Habitat and Biodiversity Management

Goal

Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.

Objectives

- Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained,
- The condition of foreshore vegetation and in-stream habitat is maintained or improved,
- The habitat value and habitat connectivity for native fauna is improve and increased,
- Population sizes and diversity of native freshwater fish and crustacean are maintained,
- Requirements for fish passage and spawning in waterways are maintained,
- Representative and adequate areas of pre-European vegetation types are retained,
- The impact of exotic pest animal species on native fauna is reduced, and
- The impact of weeds on native vegetation and aquatic ecosystems is reduced.

Targets for Resource Condition Change

4.1 Major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions by 2025.
4.2 All 'pristine' foreshore vegetation (Class A) is permanently maintained and all 'good' foreshore vegetation (Class B) is returned to 'pristine' condition by 2025.
4.3 All 3rd and 4th – order waterways have established permanent foreshore vegetation by 2015.
4.4 Identified waterway and terrestrial vegetation corridors are established for wildlife habitat as a part of a regional 'macro-corridor' by 2015.
4.5 Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.
4.6 All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.
4.7 Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T4MAT1a More than 150km of priority waterways within the Torbay catchment currently unfenced are fenced and revegetated according to local 'best practice' for permanent management of foreshore vegetation by 2010. **T4MAT1b A further 100km of vegetated stream buffers are established according to priority areas by 2010.**	1. Combine all foreshore survey information for the Torbay catchment onto one map base. Show Stream 'ordering on the map. Establish priorities for fencing and revegetation based on criteria of: • 'pristine' and 'good' (classes A and B) foreshore vegetation, • 3rd and 4th order streams, • Channel erosion risk, and • Regional connectivity.	H (05)	80 20		DoE, TCG	Linked with T1MAT2 Action 1 Include stream monitoring information in format suitable for community interpretation.
	2. Prepare information sheets of local 'best practice' for riparian zone rehabilitation and management ('Stream-lining').	M (06)			DoE, TCG	Link to T1MAT2 Action4
	3. Develop cost-sharing arrangements for vegetated stream buffering, including trial of an 'auction-based' system, considering regional and catchment priorities as well as public and private benefits.	H (06)			TCG	Link to T1MAT2 Action 5 (a basis for cost-sharing is proposed)
	4. Organise and provide on-ground support services to ensure that information is available to priority areas.	H (05)				Include services for advice on species selection, establishment of an arboretum (to show species suitable for multi-purpose corridors).
T4MAT2 More than 50% of sedge lands within the Torbay catchment are managed to maintain or restore ecological values by 2010.	1. Undertake detailed mapping of the sedge land vegetation type within the Torbay catchments and identify threats (e.g. invasion by *Typha orientalis*) and	H (05)	50	10 NHT	DoE, CALM	Mapping to show distribution, current 'resource condition' and areas that could be restored a sedge

	management requirements for permanent protection.					lands.
	2. Prepare information sheets of local 'best practice' for sedge land management.	M (06)			DoE, CALM	Include options for re-establishment of sedge-lands (e.g. on land with chemical residues)
	3. Identify areas that may be suitable for restoration of sedge land vegetation	M (06)			DoE, CALM	Some areas of land contaminated with chemicals is suggested.
	4. Arrange funding and cost-sharing arrangements for management of sedge lands in priority areas within the catchment.	M (06)			TCG, DoE, CALM	TAFE (Albany) have a nursery that could be available to grow species suitable for restoration.
	5. Initiate a public awareness and involvement program for sedge land management.	M (06)			TCG	
T4MAT3 All viable remnant vegetation patches of regionally inadequate vegetation types greater than 1 Ha are fenced and managed according to local 'best practice' by 2010.	1. Prepare a catchment map/data base of vegetation types that identifies: • areas that are inadequately represented • areas greater than 1 ha in size • fencing status • priorities for protection.	H (05)	60	4 NHT	CALM, WADA	Map to be developed from existing information.
	2. Prepare information sheets of local 'best practice' for remnant vegetation management.	H (05)			TCG, CALM, WADA	Based on existing management information with review for local relevance by TCG.
	3. Arrange funding and cost-sharing arrangements for management of priority remnant vegetation within the catchment.	M (06)		150 (50 pa , 3 year program) NHT	TCG	Cost sharing to be consistent with regional arrangements (e.g. for the Kent River Recovery Catchment)
	4. Initiative a public awareness strategy on the value of remnant vegetation.	M (06)			TCG, CALM	Link with other public awareness for habitat and biodiversity management.
T4MAT4. More than 75% of the length of foreshore for Lake Powell, Lake Manarup and Torbay Inlet have a minimum 20 meter foreshore vegetation margin by 2015.	1. Undertake foreshore vegetation surveys for the 3 major wetlands, assessing threats, management requirements, and suitability for rehabilitation or extension of wetland foreshore vegetation	M (05)	20	15 NAP	DoE	A review of the appropriate buffer width for each of the wetlands should be undertaken following the survey. It is recognised that Lake Powell may have limited options for buffer width extension. Lake Manarup may have most to gain so is likely to be a higher priority.
	2. Review land owner boundaries and other cadastral information.	M (05)			COA, TCG	Combine review with clarification of land ownership associated with public drains.
	3. Review options for increased vegetation buffers through land purchase, increased reserve status, covenants, management agreements and others.	M (06)			DPI, CoA, DoE	Links with Land Use Planning theme.
	4. Prepare information sheets of local 'best practice' for wetland vegetation management on private.	M (06)		5 NHT	DoE, TCG	Link with a program of field involvement with group projects.
	5. Source funding and arrange cost-sharing for rehabilitation and management of priority wetland vegetation.	M (06)		60 (20 pa, 3 years) NHT	TCG	Include community-based projects.
T4MAT5. Priority environmental weeds are mapped	1. Undertake catchment - scale environmental weed	M (06)	80	10 NHT	TCG	Note that priorities for weeds have

and have management programs for control to achieve 10% per annum reduction, with total control by 2015.	mapping program					been previously established by the City of Albany and DoE, and that the TCG has a current weed eradication program for Watsonia.
	2. Prepare environmental weed decimation programs for priority species.	M (06)			TCG	Include review of options for Typha in Lake Powell and consider potential for community involvement, including progressive manual removal.
	3. Prepare information sheets of local 'best practice' for weed management.	M (06)		5 NHT	TCG, DoE	Adapt existing information (many sources) for local application. Seek advice from networks
	4. Arrange funding and cost-sharing arrangements for implementation of annual environmental weed management program.	M (06)		30 (10 pa, 3 year program) NHT	TCG	Funding to be available for individual landholder, but especially for community group initiative focused on environmental weed eradication.
T4MAT6. The environmental requirements of freshwater and marine fish and crustacea in waterways and wetlands of the Torbay catchment are understood and being managed by 2010.	1. Undertake surveys as required to establish the species of fish and crustaceans that utilise the waterways and wetlands as habitat or passage, and the environmental requirements for their use.	M (current research)	25		DoE	Include 'historical survey' to indicate what was there originally. Additional field survey may be required.
	2. Prioritize stream reaches and wetlands for in-stream habitat enhancement programs.	M (05)			DoE, TCG	Link with prioritisation of waterways for protection or restoration.
	3. Trial stream habitat enhancement (revegetation for temperature control, organic matter and food sources, and woody debris for shelter).	M (06)		30 (15pa, 2 year program) Research funding	TCG, DoE	Include assessment of options for re-introduction of native fish.
	4. Prepare information sheets of local 'best practice' for stream habitat enhancement specific to the Torbay catchment.	M (06)		5 NAP	DoE	Link to field activities and community involvement.

Theme 5 – Farming Systems

Goal

The farming communities have adopted bet practice systems for sustainable land use resulting in measurable agricultural and environmental benefits.

Objectives

- Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy;
- Farm nutrient loss is reduced;
- Soil loss from farms is reduced; and
- The impact of weeds on agricultural production is reduced.

Targets for Resource Condition Change

5.1 The total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus by 2025.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T5MAT1. **Intensive animal industries and annual horticulture located in high or medium risk sites have adopted management practices that result in a reduction of the current industry nutrient surplus by 40% by 2010.**	1. Calculate the current nutrient surplus from intensive animal or horticultural enterprises.	H (06)	25		WADA	Need to develop a clear and easy to use process that is not too time-consuming for landholders. The process should be clear about the purpose and provide information to support the need for nutrient control, and possible incentive arrangements.
	2. Review management practices for nutrient reduction adopted for similar industries in other coastal rural areas (e.g. Busselton, Peel-Harvey catchment) and determine practices applicable to Torbay	H (05)			WADA	Provide an indication of differing capacity within farm management to change (i.e. some may be near 'best practices', others not)
	3. Prepare and implement nutrient management plans for intensive animal and horticultural industries.	H (06)			WADA, landholders	Seek opportunities to link these plans to industry accreditation (e.g. quality assured production programs).
	4. Evaluate and implement cost-sharing options and other policy instruments that provide incentives for adoption of 'best practice' management.	M (06)			WADA, TCG	Link to current policy development for intensive animal industries. Compare with other similar areas in WA. Consider options for non-cooperation. Some cost sharing could be linked with Environment Investment Initiative as 'nutrient off-set' investment (through Water Corporation).
	5. Provide information and support for adoption of environmental management systems in the catchment.	M (06)			WADA, landholders	Need to be clear about benefits to the industry to gain adoption.
T5MAT2. **More than half of the landholders in the Torbay catchment, who derive more than 50% of their income from farming their properties, have prepared a 'farm nutrient surplus' calculation and response plan by 2010.**	1. Develop appropriate methods for farm nutrient balance and management audit based on currently available information and research.	H (05)	50	15 NAP	WADA, TCG	Need to develop a clear and easy to use process that is not too time-consuming for landholders. The process should be clear about the purpose and provide information to support the need for nutrient

						control, and possible incentive arrangements.
	2. Conduct an initial farm nutrient balance and management audit for voluntary involvement by landholders within the catchment.	H (05)			TCG, WADA	Role for proposed TCG projects coordinator.
	3. Based on information from the initial farm nutrient balance and management audit, review the nutrient surplus reduction targets set for each sub-catchment (Theme One – Water Quality and Algal Blooms).	H (06)			WADA, DoE, TCG	The revised targets are to be achievable (i.e. by acceptable levels of change within farming systems) and remain relevant to nutrient reduction levels for waterway and wetland restoration.
	4. Prepare demonstration property plans for one large and one small property within the Torbay catchment to show 'best practice' management for nutrient loss reduction.	H (06)		10 (NAP)	TCG, WADA, DoE	Role for TCG Coordinator.
	5. Initiate a program for 'continuous improvement' of best management practices to achieve sub-catchment nutrient surplus reduction targets through review and evaluation of updated information by the catchment group, industry and the community.	H (06)			WADA, DoE, TCG	Link to Monitoring and Evaluation plan.
	6. Identify incentives (financial and others) for voluntary engagement in the nutrient reduction program.	H (05)			TCG, WADA, DoE	Build on experience from other areas (e.g. the Peel-Harvey catchment).
	7. Arrange state, national and international 'farming systems' study tours for innovative landholders (eg. through a Churchill Fellowship).	M (06)		10 NAP	TCG	National and international travel could attract a bursary or similar funding opportunity.
	8. Establish visible community indicators (eg a nutrient reduction "barometer" at Elleker community store and other locations) and regular updates in the Albany Advertiser to show the level to which the targets are being achieved.	H (06)		5 DoE or other agency	TCG	Will require considerable support and require appropriate information available. Could also be located at other sites, such as prominent wetlands or demonstration sites.
T5MAT3 (a). **More than 30 viable farming enterprises are adopting 'best management' practices according to nutrient management plans and are demonstrating achievement of defined nutrient surplus reduction targets without production loss by 2010.** **T5MAT3 (b)** **The use of slow release fertiliser or other appropriate fertiliser options for futrient reduction is adopted over 25% of the catchment by 2010.**	1. Promote and encourage adoption of soil and plant testing and analysis to guide appropriate fertiliser application according to production requirements.	H (05)	25 10		WADA	Costs of analysis are considered to be too high and inhibit routine soil and plant testing. While the production benefits of testing should justify the costs, there is a need to review financial options to encourage broader adoption. This needs to consider the high proportion of non-viable farm units.
	2. Develop a *proforma* and tool for farm nutrient audit and budgets, and promote adoption of a nutrient budget approach for all priority area properties,	H (05)		25 NAP	TCG, WADA	Key role for TCG Co-ordinator. Contract for services required to develop 'audit and budget' tools.
	3. Increase community understanding of efficient fertiliser use, particularly of sulphur sources and trace elements.	H (05)		15 (5 p.a., 3 year program) NAP, DAWA	TCG, WADA	TCG Coordinator to arrange. Specialist advice and support required.
	4. Develop a "Nutrient Management" information	H (05)		45 (15 p.a., 3 year program)	TCG, WADA	TCG Coordinator to arrange

	series, including developing 'best practice' notes for a range of farming systems and interest groups.			NAP		specialist advice and support.
	5. Promote and support research and development with fertiliser manufacturers to develop, trial and produce a slow-release fertiliser suitable for use in the Torbay catchment (eg 'Redcoat' fertiliser)	H (05)			WADA	
	6. Improve community awareness of efficient fertiliser use by: • paddock-scale demonstrations and associated field-days • a bus tour for members of the Torbay Catchment Group to the Peel Harvey Catchment • disseminate information about productivity and environmental benefits associated with soil ameliorants fertiliser options (including the use of lime and 'Alkaloam')	H (05)			TCG, WADA	TCG Coordinator to arrange.
	7. Evaluate the potential for delivery of bulk 'Alkaloam' supplies to the Torbay catchment.	H (05)			WADA	Considering rail and road transport opportunities.
	8. Demonstrate and promote the adoption of surface water control and interception drainage structures in priority areas with high surface water run-off and potential soil loss, and	M (06)		20 NAP	WADA	Design and implement a demonstration site with interception drainage in an area where high soil loss potential is related to nutrient loss. Review existing Torbay catchment and Wilson Inlet drainage works.
	9. Arrange integrated surface water management plans on a sub-catchment basis for priority areas with high surface water run-off and potential soil loss.	M (06)		20 NAP	TCG, WADA	Key role for TCG Coordinator.
T5MAT4. **A total of 75% of land used for grazing is established with perennial plants (trees, shrubs or pastures) by 2015.**	1. Undertake map analysis with field verification survey to identify the area of soils in each sub-catchment that have high nutrient leaching capacity and are suitable for establishment of perennial pastures, shrubs or trees.	H (05)	60	25 NAP, WADA	WADA	Base on existing soil/landscape mapping and soil sampling. Some field verification required for land capability assessment.
	2. Develop a Perennial Pastures support and extension program suitable for both larger and smaller farm enterprises within the Torbay catchment (could be linked to or based on the existing 'Prograze' program).	H (05)			TCG, WADA	Support group in a way that provides 1-on-1 farmer support (as occurs with WA Lucerne Growers Association).
	3. Initiate large-scale demonstrations of a range of perennial pastures, shrubs and trees options.	H (06)		50 (25 pa, 2 year program) NAP	TCG, WADA	Selection of suitable properties could occur during 2005. Include both large and small-scale properties. Set up economic 'benchmark' indices.
	4. Develop a series of "Pastures Management" field days and information notes with support from industry organisations (e.g. the WA Lucerne Growers	H (05)		5 WADA, WALGA	TCG	Key task for TCG Coordinator role.

	Association) for both perennials and annual pastures (focussing on both production and environmental benefits).					
	5. Undertake a catchment-scale 'roll-out' program with cost-sharing arrangements establish perennial grasses and legumes in priority areas within the catchment	H (07)		80 NAP	TCG	'Roll-out' program to follow demonstration projects (Action 3).
	6. Establish a trial of Agonis juniperina as a perennial shrub with potential commercial and nutrient loss reduction benefits.	M (06)		10 FPC, CALM, CENRM	TCG, FPC	Undertake in partnership with FPC. Link to CALM 'SEARCH' project. A 'trial plan' required to show expected site benefits (commercial, nutrient reduction) and risks (excess water use, invasive potential). Assume a trial of approximately 10 Ha.
	7. Develop agroforestry as an alternative land use: • Implement demonstration agro-forestry site (up to 50 Ha). • Develop an agro-forestry Information Series • Develop a Master Tree-Growers Course	M (06) L (06) L (06)				There is resistance within the community to plantation forestry due to concern about spray drift and lowering ground water tables. This has influenced attitudes against agro-forestry. A large-scale demonstration (50Ha) with a range of species is suggested by some community members with the expectation that increased knowledge about the options will increase opportunities for adoption.
	8. Undertake research into the farm production and the benefits to water quality by nutrient loss reduction through the adoption of perennial pastures, shrubs and trees.	H (05)				Undertake in partnership with WADA.

Theme 6 – Land Use Planning

Goal

Regional and local planning provides the policies and mechanisms to implement new actions that are beneficial for natural resource condition, ensure that land is used according to its capability, and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.

Objectives

- Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current land use,
- Land use intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines,
- Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands,
- Priority water resources are protected for beneficial use now and into the future,
- Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained,
- Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands,
- The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations,
- The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit,
- The current landscape mosaic characterised by agriculture and natural vegetation is maintained, and
- Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.

Targets for Resource Condition Change

None set.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T6MAT1. Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information and adopt 'Net Nutrient Reduction' principles for planning propos*als* by 2007.	1. Review current land capability assessment processes to identify limitations and opportunities for improvement (i.e. with additional information).	H (05)	100	20 CoA, NAP, DoE, WADA	WADA, CoA	Contract for service to review current information particularly in relation to soil nutrient status and acid sulphate soils.
	2. Prepare a revised land capability framework for the Torbay catchment that makes best use of current information and is suitable for management and planning purposes.	M (05)			CoA	Include as a part of service contract for Action 1.
	3. Develop additional information sets to enable assessment of development proposals within areas identified with acid sulphate soils.	H (06)			DoE, CoA	Based on existing information.
	4. Ensure the revised land capability processes are adopted within the Local Planning Strategy and Town Planning Scheme for the City of Albany (this may require a TPS Amendment)	H (06)			CoA	This should follow acceptance of revised land capability framework for the Torbay Catchment by the Implementation Steering Committee.
	5. Ensure that the requirement for Nutrient Management Plans is prescribed in the LPS and TPS for significant Development Applications.	H (05)			CoA, DoE	Ensure format for required plans are standardised (i.e. as required under Water Resource Protection Plans).
	6. Develop guiding principles for inclusion in the LPS and TPS application of 'environmental off-sets' within the Torbay catchment.	M (06)			DoE, WC	Internal discussion paper required initially to develop the principles appropriate to the Torbay Catchment.

	7. Promote revised 'land capability' and 'net nutrient reduction' principles to landholders within the catchment for management through existing communication processes and to development proponents through planning processes.	H (05)			TCG, DoE, CoA	Key role for TCG Coordinator
T6MAT2 **Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information by 2007.**	**1. Map priority areas within the Torbay catchment where further development may increase the risk to environmental values for consideration within the (draft) Lower Great Southern Regional Planning Strategy and the Local Planning Strategy and Town Planning Scheme for the City of Albany.**	H (05)	100	1	TCG, DoE, CoA, DPI	Consultation processes with community through TCG required. Contract required for GIS services.
	2. Map the 'Floodplain' and 'Buffers' for the lower Torbay catchment as define spatial areas to have conditional requirements for development applications,	H (05)			DoE	'Buffers' to be define in consultation with CoA and DPI
	3. Prepare provisions for proposed development within the mapped priority areas for consideration within the LPS and TPS	H (06)			CoA, DoE	
	4. Identify the mapped priority areas that may be suitable for Regional Open Space or additional public access for consideration within the (draft) Lower Great Southern Regional Planning Strategy.	M (05)			TCG, CALM, DoE	To be undertaken with Action 1.
T6MAT3 **All proposals for additional deep drainage and significant maintenance works within the Torbay catchment are assessed as Development Applications and on the basis of a presumption against drainage in areas identified at risk by 2007.**	1. Prepare provisions to define deep drainage construction and maintenance as development for planning purposes and provide an additional 'Land Use Class' for drainage within the TPS and associated planning processes.	H (05)	100		DoE, WC, CoA	Link with proposed actions for drainage maintenance.
	2. Undertake a risk analysis due to additional deep drainage construction and maintenance in the Torbay catchment and apply this to assessment of land use planning zones for deep drainage within the Town Planing Scheme for the City of Albany.	H (06)			DoE	Key risks are due to flooding, sedimentation and the effect of acid sulphate soils.
	3. Include a presumption of no additional drainage construction within identified risk areas and prepare a set of approval conditions for inclusion in the LPS and TPS for proposed drainage construction.	H (06)			CoA, DoE	
	4. Prepare policies and management guidelines for inclusion in the LPS and TPS to provide direction for planning approval processes and to promote 'best practice' drainage construction and maintenance.	H (06)			CoA, DoE	
	5. Arrange for drainage development applications to be referred to the appropriate agencies and authorities (including the Department of Environment as a key agency and a partner of the Torbay Catchment Group).	H (05)			CoA	
	6. Communicate the risk of drainage construction and maintenance within the identified risk areas to landholders and responsible authorities within the	H (06)			TCG	Role for TCG Coordinator in association with other

	catchment and promote 'best practice' management through catchment group communications					communication actions.
T6MAT4. **The Water Resource Protection Plan for the Marbelup Brook sub-catchment is recognised as a priority area within the Lower Great Southern Regional Planning Strategy and the Town Planning Scheme for the City of Albany by 2007.**	1. Arrange for the Water Resource Protection Plan for the Marbelup Brook sub-catchment to be prepared in a way that is compatible with regional and local government planning processes, including adoption of land use planning processes,	H (06)	100		DoE	Arrangement for preparation of the plan is in progress.
	2. Define the Marbelup Brook sub-catchment as a priority area to be considered in the Lower Great Southern Regional Planning Strategy and the LPS and TPS for the City of Albany.	H (05)			DoE	
	3. Investigate measures for private funding of catchment rehabilitation works (e.g. as a 'trade-off' for sub-division rights).	M (06)			DoE	
T6MAT5 **Proposals for commercial tree plantations within identified priority areas of the Torbay catchment are assessed as Development Applications through the TPS for the City of Albany with the presumption against this development in these areas by 2007.**	1. Prepare a catchment water balance model to show the potential impacts of commercial tree plantations on surface and groundwater resources for the Marbelup Brook sub-catchment,	M (06)	100	20 NAP	DoE	Model should be interactive for comparison of a range of land use change scenarios. Model should also show the maximum area of tree plantation that can be established without detrimental impact on surface and groundwater resources. The model should be suitable for application in all sub-catchments.
	2. Provide definitions for 'commercial tree plantations' and 'farm forestry' or 'agro-forestry' for planning purposes,	H (05)			FPC, CoA	
	3. Ensure that consideration of 'commercial tree plantations within identified priority areas' as Development Applications is continued in the revised TPS for the City of Albany,	M (05)			CoA	
	4. Prepare guidelines for management conditions to planning approval of commercial tree plantations within identified priority areas for potential inclusion in the LPS and TPS including a requirement by the development proponent to assess the potential impact of the proposal on sustainable groundwater yield,	M (06)			FPC, DoE	The information should show that the onus in on the proponent to assess the impact of commercial tree plantations on groundwater resources in defined priority areas. Guidelines to show that sustainable yield within catchments is not to be reduced by more than 5% as a result of commercial tree plantations.
	5. Identify areas in the Torbay catchment where potential tree plantations may reduce the visual amenity of the catchment and include these areas in a submission from the Torbay Catchment Group for comment on the (draft) Lower Great Southern Regional Planning Strategy and the (draft) TPS for the City of Albany.	M (05)			TCG, CoA, DPI	A short workshop open to community representation to be held to gain consensus outcomes about visual amenity values.
T6MAT6. **Urban growth in the town of Elleker is planned to ensure no additional risk to waterways and wetlands and that the potential for flooding of residential development is minimal by 2007.**	1. Identify and evaluate the on-site and environmental risk due to further urban development in the Elleker town site, including potential for increased nutrients to waterways and wetlands, impacts of acid sulphate soils, flooding and mal-odours,	M (06)	80		DoE, WC, CoA	Informed assessment of risk by representatives of responsible government authorities is required.
	2. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft)	M (05)			DoE	Written submission from DoE also representing TCG.

	LPS and TPS for the City of Albany to ensure the environmental risk of further urban development is recognised.					
T6MAT7. **Priority areas for conservation protection or enhancement are identified and linked to local government and regional planning processes by 2007.**	1. Map areas of high conservation priority showing potential to add to existing biodiversity values	M (06)	100		CALM, DPI, TCG	Link to T6MAT2 Action1
	2. Map priority areas for foreshore vegetation buffers adjacent to the major wetlands	M (06)			DoE, TCG	Link to T6MAT2 Action1
	3. Develop catchment-scale macro-corridor initiatives for consideration by future planning proposals,	M (06)			CALM, DPI	
	4. Ensure sub-division proposals are referred to the appropriate agencies for consideration of ceding Foreshore Reserves within mapped priority areas, and	H (05)			CoA	
	5. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) TPS for the City of Albany	H (05)			CALM, DoE	
T6MAT8. **The value of ecosystem services is understood and a trial system for compensation under a 'beneficiary pays' principle within the City of Albany is established by 2008.**	1. Prepare a Discussion Paper to develop a broader understanding of 'ecosystem services' in relation to the Torbay catchment,	M (06)	40		DoE, WC	
	2. Review payment systems for 'ecosystem services' from national and international examples,	M (06)			DoE, WC	Include with Action 1
	3. Prepare a proposed 'schedule of expenditure' for revenue gained from 'ecosystem service'	M (07)			TCG, DoE	Schedule to be guided by priority actions in the Restoration Plan.
	4. Design a trial application of a 'conservation rate' to assess the net benefits of long term adoption.	M (07)			DoE, WC, CoA	Some costs may be involved in setting up the trial but are difficult to estimate prior to undertaking the above actions.
T6MAT9. **Priority Agricultural Areas in the Torbay catchment are revised and a preferred landscape description prepared for consideration by regional and planning processes by 2005.**	1. Revise current areas classified of Priority Agricultural Area and General Agriculture within the Torbay catchment to ensure that these meet the expectations of the community,	M (05)	75		TCG, CoA, WADA	A short workshop open to community representation to be held to gain consensus outcomes about priority agricultural areas.
	2. Prepare a description of preferred agricultural landscapes for the two planning classes based on community aspirations and goals for goals for the Torbay catchment, and	M (05)			TCG	
	3. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) LPS and TPS for the City of Albany.	M (05)			TCG	
T6MAT10. **Opportunities for increased social and recreational values within the Torbay catchment have been reviewed through regional and local government planning processes by 2007.**	1. Prepare a map and associated documentation that outlines opportunities for increase social and recreational amenity within the Torbay catchment,	M (05)	100		TCG, CoA, DPI	A short workshop open to community representation to be held to gain consensus outcomes about recreation and social amenity values.
	2. Submit comments and information to the consultation processes for the (draft) Lower Great Southern Regional Planning Strategy and the (draft) LPS and TPS for the City of Albany.	M (05)			TCG	

Theme 7 – Community Education and Information

Goal

The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the share vision for the catchment.

Objectives

- All key stakeholders are willingly involved in implementing the restoration plan.
- A high level of community awareness about the values of the catchment and about the best practices for sustainable management.
- Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes.
- There is a significant level of community involvement in reviewing the restoration plan on a five yearly basis.

Targets for Resource Condition Change

None set.

Management Action Target	Actions	Priority (Start Year)	3-Year Program Achievement (%)	3-Year cost estimate ($,000) and funding source	Responsibility	Comments
T7MAT1. More than half of landholders and residents in the Torbay catchment are able to express clear understanding and support for the catchment Vision and restoration plan by 2010.	1. Appoint a full-time TCG Coordinator (3-year contract)	H (05)	75	225 (75 p.a. 3 year program) NAP	TCG	Cost estimate includes salary, vehicle and on-costs.
	2. Conduct community forums and catchment tours to recommit to the vision, report on restoration plan implementation progress to date and provide opportunities for community involvement in reviewing priority actions.	H (05)		6 (2 p.a.,3 year program) NAP	TCG	Awareness of the project in the catchment is generally quite low. Need to identify what it takes to get people involved: • Actions that get people involved, • Information days (including field trips) • Recognition of effort (building local pride in the project) • Provide incentives for community effort (benefits from group initiative) • Provide 'special interest' forums (e.g. for small landholders).
	3. Report on achievement of Targets and Actions in an annual 'Report Card' format	H (05)		15 (5 p.a., 3 year program) NAP	TCG, DoE	
	4. Prepare a summary version of the Restoration Plan targeting specific interest groups and further engage community in reviews and amendments to the plan.	M (07)			TCG, DoE	
	5. Prepared a set of maps (for management Themes) with clearly identified locations and tasks for local involvement.	H (05)		4 DoE	DoE	Link with other actions for map preparation.
	6. Arrange clear and localised 'best practice' information that is relevant and achievable.	H (05)			TCG	Link with other 'best practice' information actions.

	7. Identify key 'barriers to change' and develop incentives or other measures to overcome these barriers.	M (ongoing)			DoE, TCG	Ongoing processes with group development.
	8. Initiate information and skills development opportunities for 'special interest' groups (e.g. small-scale landholders).	M (06)			TCG	Key role for TCG Coordinator.
	9. Identify and support community leaders into specific roles for which they are well recognised.	H (ongoing)			TCG	Identify leadership in a range of forms, but particularly for the Management Themes.
	10. Provide public recognition for individual and community actions undertaken according to the Restoration Plan.	H (ongoing)			TCG	Ongoing processes but with specific forms of recognition (e.g. identifying people with successful projects).
	11. Engage the community through involvement with schools and other related interest groups.	H (ongoing)			TCG, DoE	Link with existing programs, including 'Ribbons of Blue'
	12. Initiate community projects that have achievable outcomes and contribute to the targets of the Restoration Plan.	H (ongoing)			TCG	
	13. Organise cost-sharing arrangements and publicise these in ways that ensure that they are considered available to all in the catchment, including both small and large-scale landholders.	H (05)			TCG	A key role for the TCG Committee
	14. Show that key partners (e.g. government agencies) are committed to the project and are contributing within the partnership framework.	H (ongoing)			TCG, agencies	Development of Partnership Agreements.
	15. Provide a clear statement of 'roles and responsibilities' for actions and information in the form of 'partner profiles' about the expected roles for involvement	H (05)			TCG, partner organisations	Informative brochures that clearly show the partnership arrangements.
	16. Develop and update a local skills audit and where ever possible use local people to undertake contract catchment restoration works.	M (ongoing)			TCG	Role for TCG Coordinator.
T7MAT2. **More than 40% of landholders are attending at least one group event annually and have copies of or direct access to current research and information relevant to actions for implementation of the Restoration Plan by 2010.**	1. Survey all landholders and residents biennially to monitor support for vision as well as review key issues or actions, and gauge attitudes to changing land management.	M (07)	75	5 NAP	TCG, DoE	The 2003 social survey provides benchmark information for comparative analysis. Indicator Repeat social surveys show that the level of community involvement has increased to over 50% by 2010.
	2. Review the social benchmark survey information to identify key 'drivers' or 'barriers' for communication and information management for differing landholder interests and cultural or age groups.	M (06)			TCG	
	3. Maintain the 'Communications Learning Log' and ensure that a short summary of new group learning is widely distributed	M (ongoing)			TCG	Role for TCG Coordinator.

ABBREVIATIONS USED IN TABLE C4.

CALM	Department of Conservation and Land Management
CENRM	Centre of Excellence for Natural Resource Management
CoA	City of Albany
DoE	Department of Environment
DPI	Department of Planning and Infrastructure
FPC	Forest Products Commission
SCRIPT	South Coast Regional Initiative Planning Team
TCC	Torbay Catchment Group
WADA	Western Australian Department of Agriculture
WC	Water Corporation

Table C5. Cost estimates for implementation of Best Management Practices in the Torbay Catchment (adapted from Weaver, 2003).

Best Management Practices (BMP)	Capital Cost of BMP Implementation	Net Cost or (Benefit) Year $^{-1}$
1st order Vegetated Stream Buffers	\$6,110 km^{-1}	\$475 km^{-1}
2nd order Vegetated Stream Buffers	\$5,030 km^{-1}	\$225 km^{-1}
3rd order + Vegetated Stream Buffers	\$3,975 km^{-1}	\$175 km^{-1}
Perennial pastures	\$135 ha^{-1}	(\$60) ha^{-1}
Effective fertiliser use	\$10.00ha^{-1}	(\$9.40)ha^{-1}
1st order stock control, water management	\$750 km^{-1}	\$50 km^{-1}
2nd order stock control, water management	\$1,250km^{-1}	\$50 km^{-1}
3rd order+ order stock control, water management	\$2,0000 km^{-1}	\$50 km^{-1}
Dairy effluent management	\$75 source^{-1}	(\$3) source^{-1}
Piggery effluent management	\$100 source $^{-1}$	(\$3) source^{-1}
Alkaloam soil amendment (5 – 20 tonnes ha^{-1})	\$70 – \$280 ha^{-1}	\$40) ha^{-1}

Broad costs estimates for the drainage options are provided in Table C7. The infrastructure of the Albany Drainage District drainage system includes:

	(% of total replacement value)
• Drains and channels	29.0
• Timber bridges	28.3
• Concrete bridges	10.8
• Pipe bridges and box culverts	15.0
• Concrete structures	5.6
• Timber checks	10.8

A financial analysis for the physical assets of the complete Albany Drainage System undertaken in 1991/2 shows the replacement costs to be \$6.74m (Water Corporation, 1996). With the assumption that approximately half the infrastructure is within the Torbay, Marbellup and Five-Mile/Seven-Mile Creek sub-systems then the Replacement costs are estimated to be \$3.35m Based on 5%rate of return, the Net Present Value (NPV) of the replacement costs is \$6.3m. The NPV for the write down value of infrastructure is estimated to be \$2.94m.

Table C6. Estimated Costs and Level Of Acceptance For Draining Options In The Lower Torbay Catchment

OPTION SUMMARY Options 1b, 3b and 4 considered most acceptable by the Drainage Management Sub-committee. • Option 1b provides better operating criteria for Lake Manarup, with the fishing industry constraint on bar openings removed. • Option 4 provides for better operating criteria at Marbellup Brook, which should result in improved water quality and aesthetic impacts. • Option 3b will have higher costs but does provide potato farmers with management flexibility while also providing benefit for Lake Manarup.		
DRAINAGE MANAGEMENT OPTION	**ESTIMATED COSTS**	**ACCEPTABILITY**
1(a). Current Operating Strategy:	• Continue with existing drainage management practices. • Current operating and maintenance costs estimated to be $50,000/annum. • Capital investment on an 'as needs basis' for upgrading or replacement of infrastructure. • Capital replacement costs are estimated to be $6.3M	• Current practice which has been in place for 50 years and serves some stakeholder interests adequately. • There has been some opposition to management decisions performed at specific times in the past (eg. bar openings during summer and commercial fishing season) from local residents and fishing licensees. • Environment not specifically considered as part of the drainage system operating criteria.
1(b). Current operating Strategy with Bar Open during Commercial Fishing Season: Operation of the drainage system as for 1(a) but with Torbay Inlet sandbar opened during salmon fishing season.	• No additional infrastructure or management costs. • Improved flexibility with drainage management for environmental outcomes and horticultural management..	• Requires written agreement between licensed fisherman and Water Corporation. • Lake Manarup is not required as a flood compensating basin under this option. • The community prefers Lake Manarup to attract aquatic and birdlife; and to reduce wind erosion of dry bed sediments (social benefit).

DRAINAGE MANAGEMENT OPTION	ESTIMATED COSTS	ACCEPTABILITY
3. NORTH CREEK OPTIONS: 3(a). Pump North Creek to Marbellup Creek Drain (High System)	• Estimated capital cost to build pump station of $300,000 (including survey costs, approvals etc.) • Annual operational and management costs estimated to be up to $50,000	• A Cost/Benefit Analysis is required to realise the effectiveness of investment in this option. • Inflow to Lake Manarup Lagoon will be reduced if all stream flow from North Creek is pumped to the High-level system. • Impact assessment of diverting acidic stream flow from North Creek to Torbay Inlet is required. • This option could improve the quality of water in North Creek.
3(b). North Creek Bridge Gates & Pump (Low-level System)	• Construct Check Structure (floodgates and penstocks) at narrow bridge - estimated to cost $500,000 (current condition of the bridge needs to be considered). • Pumping equipment estimated to cost $100,000. • Annual operational and management costs estimated to be up to $50,000.	• This option should provide improved ground water and surface water control in potato growing areas. • Will allow increased flexibility in water levels in Lake Manarup (i.e. Lake Manarup will not require specific bar openings to be filled). • Upstream flood protection will be dependent upon the reliability of the pump system.
4. Open Marbellup Plug Valve	• Cost to remove existing earth bund estimated to be $10,000 • Cost to build larger capacity control valve and operating platform at Marbellup plug, retaining existing earth bund estimated to be $50,000.	• This option should achieve improvements to water quality in the currently stagnant section of Marbellup Brook. • There is a need to develop operating criteria if a new control valve is installed.

DRAINAGE MANAGEMENT OPTION	ESTIMATED COSTS	ACCEPTABILITY
LINK LAKE POWELL TO HIGH-LEVEL SYSTEM: 5(a). Remove Marbellup Plug, Remove 'Gate 45' and install Lake Powell Flood Gates:	• Cost to remove existing earth bund estimated to be $10,000 • Remove floodgates and penstocks from Bridge 45 estimated to cost $50,000. • Build new structure [floodgates and penstocks] at Lake Powell estimated to cost $500,000. • Construction of a levee system to reduce flood risk estimated to cost $500,000. • Improve water channel capacity to accommodate significantly higher flows estimated to cost in excess of $500,000.	• Many unknown factors associated with this option (including suitability of soils, affect on the drainage system, the extent of area at risk to flooding, access to private land, stream flow velocities and volume). • In the event of failure of levees, there is potential for flooding of homes and properties. Who would be liable?

C4.0 Capacity for Implementation

Implementing the *Watershed Torbay Catchment Restoration Plan* is dependent upon the effectiveness of partnership arrangements between the community, government agencies, non-government organisations, research institutions and industry bodies. The Torbay Catchment Group provides the appropriate forum for development of partnership arrangements.

C4.1 Leadership through the Torbay Catchment Group

The Torbay Catchment Group (TCG) is the lead organisation for implementation of the *Watershed Torbay Catchment Restoration Plan*. The community-based group formed out of concern for the effect of changing land use within the catchment, with particular concern for the condition of waterways and wetlands. The TCG has provided the basis for development of the *Water Torbay* project with sub-committee structures contributing over a 4 year period to preparation of the restoration plan (Figure A2). The Executive Committee of the TCG is responsible for implementation of the actions according to the targets in the Restoration Plan.

For implementation of the plan, the TCG will require a revised structure with increased focus on project management, community engagement and communication. It is proposed that this occur through a single **Implementation Steering Committee** to provide skills-based support for implementation of the Restoration Plan. The Implementation Steering Committee should report to the TCG Executive Committee.

Membership to the Implementation Steering Committee should include people with the appropriate skills from community and partner organisations. The **key roles** of the proposed Implementation Steering Committee are to:

- Review priorities for implementation of actions,
- Prepare a 3-year Investment Plan,
- Arrange investment funding for implementation,
- Develop project management arrangements for implementing high priority actions,
- Arrange appropriate service providers for implementation of actions,
- Development of 'best practice' information,
- Develop processes for information sharing and management,
- Engagement of community and landholders, and
- Initiation of community involvement projects.

It is proposed that the roles of the Implementation Steering Committee are supported by a full-time employed Coordinator. This position would report to the

Implementation Steering Committee. A cost allocation for this position in included with Action 1 for T7MAT1.

C4.2 Partnership Arrangements

The key partner organisations required for effective implementation of the *Watershed Torbay Catchment Restoration Plan* are listed in Table C8. Formal arrangements for each of these organisations with the TCG are required. These arrangements are to clarify the roles and responsibilities and provide commitment for provision of resources for implementation. The resources required are to be identified in the proposed Investment Plan.

The lead roles for organisations are shown in Table C8. The table also shows the organisations that are recommended for member representation on the Implementation Steering Committee.

Table C8 Partner Organisations for implementation of the Restoration Plan

Partner Organisation	Key Roles
Department of Environment	• Water resource protection • Project management • Communications • Community engagement • Monitoring and evaluation
Western Australian Department of Agriculture	• Diffuse source nutrient management • Farming systems development
Water Corporation	• Operation of the drainage system
Department of Conservation and Land Management	• Management of conservation reserves • Developing opportunities for increased biodiversity values
City of Albany	• Development and application of appropriate policy and planning mechanisms
South Coast Regional Initiative Planning Team	• Provision of resources for regional priority actions • Monitoring resource condition change.
Centre of Excellence for Natural Resource Management	• Research and information support
Department of Planning and Infrastructure	• Regional policy and planning initiatives
Forest Products Commission	• Development of appropriate commercial farm forestry options.

Note: the partner organisations identified in bold are recommended for member representation on the Implementation Steering Committee.

C4.3 Investment Planning

The *Watershed Torbay Catchment Restoration Plan* provides a long term strategic direction with medium term targets for achievement of actions, and a 3-year Implementation Program of prioritised actions. An Investment Plan is required to arrange funding from partner organisations and external sources.

Table C2 provides budget estimates for external source funding for the proposed set of actions for the 3-year Implementation Program. The Investment Plan will identify

the respective partner organisation contributions to these actions (staff time and other resources).

The total budget estimates for external funding for all 3-Year Implementation Program actions are listed in Appendix 6.

		$ ('000)
Theme One:	Algal Blooms and Water Quality	478
Theme Two:	Water Quantity	95
Theme Three:	Drainage Management	315
Theme Four:	Habitation and Biodiversity Management	244
Theme Five:	Farming Systems	181
Theme Six:	Land Use Planning	41
Theme Seven:	Community Education and Information	255

TOTAL 3-Year External Fund Budget Estimate **$1,609,000**

C4.4 Direction for Research and Development

There are key areas where additional information is required for management decisions. The research requirements for these areas are outlined below.

1. **Groundwater interactions as a source of nutrients to Lake Powell, Lake Manarup and Torbay Inlet.**
   Analysis of groundwater from 26 piezometers around the three water bodies has identified the potential for fluctuating groundwater tables to be a source of nutrients within areas of acid sulphate soils. The extent to which this is a contributor to nutrient enrichment requires further investigation.

2. **Nutrient discharge from Potato Farms to Lake Powell via flooding and or surface drainage.**
   There is an ongoing requirement to determine the interaction between potato farms and Lake Powell to assess the potential source of nutrient through both inundation due to Lake flooding, or localised surface water drainage to the Lake.
   Surface water flows to Lake Powell, or flood water receding into Lake Powell could be potential nutrient pathways.

3. **Sources of N to Lake Powell and Torbay Inlet**
   Analysis of aquatic plants is required to determine if the most significant source of nutrients in plants (algae) is from sewage, agricultural fertilisers or through nitrogen fixation. The outcome from this research will also help clarify community perceptions about the impact of the WWTP on Lake Powell.

4. **Sediment – Water Interactions and Nutrient Release**

Understand the interaction between sediments and the water column in Lake Powell and Torbay Inlet is critical to understand the overall nutrient balance, and role of sediments in providing nutrients to support algal blooms in summer. Lake Powell does not become anoxic due to its shallow depth (there is limited stratification of the water body to mixing by wind). Some areas of Torbay Inlet do experience anoxic conditions on a seasonal basis.

There is a further requirement determine the N potential contained in the sediments within Lake Powell and Torbay Inlet. Sediments are to be collected, incubated under anaerobic conditions to release ammonia, and then analysed. This provides information on the potential for N release from sediments should anaerobic conditions prevail. While low oxygen is not an issue for Lake Powell at the water interface, anaerobic sediments may be contributing to high pore water values and may be contributing significantly to nutrient cycling in Lake Powell.

5. **Environmental Criteria for Lake Powell, Lake Manarup and Torbay Inlet.**

Research is required to enable further development of the decision criteria for assessment of drainage scheme options for management. This will require refinement of water level criteria to sustain viable aquatic ecosystems and to minimise algal bloom frequency and other impacts. Specific hydro-period and water level criteria required are to:

- protect and aid recruitment of fringing vegetation, provide water-bird habitat, and protect other values (fish, invertebrates etc).
- aid nutrient cycling (eg is bed drying required to aid denitrification?)
- manage *Typha spp.* invasion in Lake Powell.

WATERSHED Torbay

Watershed Torbay
Catchment Restoration Plan:

SECTION D

MONITORING AND EVALUATION

D1.0 A Framework for Monitoring and Evaluation

The effectiveness of the *Watershed Torbay Catchment Restoration Plan* is to be demonstrated through monitoring and evaluation (M&E) processes. These are to show:

1. Resource condition change
2. Rate of implementation
3. Effectiveness of implementation
4. Acceptance of change by community and partner organisations, and
5. Better understanding of the systems involved.

These measures then need to show **achievement of the aspirational goals and objectives** of the Torbay Catchment Group (TCG) for each of the seven Management Themes through improvement in **indicators of catchment health.**

The efficiency of an M&E program is in ensuring that the measures are adequately indicate the goal, objective or target that they represent. This requires that **representative indicators** are clearly identified. Some indicators for M&E are being measured currently. There will be other actions required.

The Restoration Plan is based on change management. A significant requirement of M&E is show that investment in practice change is resulting in resource condition improvement. However, brokering practice change according to a prepared Restoration Plan is undertaken within a continuously changing 'operating environment' (i.e. the social, economic and environmental factors that influence normal decision-making processes). An important component of change is through improved understanding and knowledge of the systems being managed.

The processes that allow adjustment of decisions in response to a changing operating environment are described as **adaptive management**. Figure D1 shows the adaptive management cycle that is based on planning, action, monitoring and review.

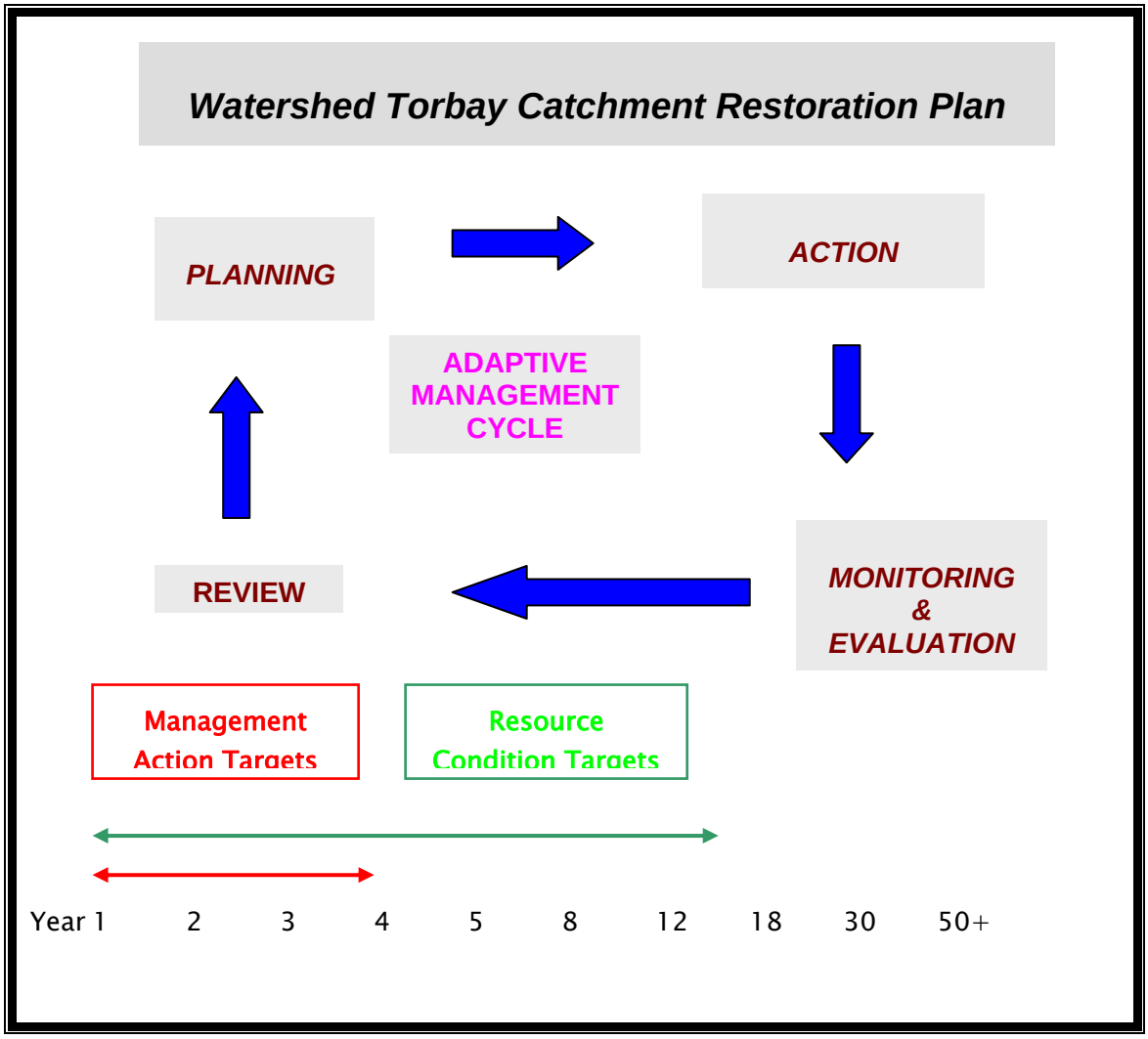


Figure D1 Monitoring and evaluation in the Adaptive Management cycle.

Evaluation of the measures of indicators for change should be delivered into the Adaptive Management Cycle. The performance of the implementation program is measured against the Management Action Targets over time. The effectiveness of the actions in achieving resource condition change is also measured over time.

The review processes are critical to the effectiveness of the adaptive management cycle. Monitoring information is to be evaluated in accordance with the implementation program to enable the Implementation Steering Committee to adjust priorities for investment. It is proposed that this is a specific set of tasks undertaken by the Implementation Steering Committee lead by the Department of Environment on a 6-month basis.

Section D2 with review current monitoring programs. These will be aligned where appropriate with representative indicators for resource condition and management action targets identified in Section D3. The recommended processes for evaluation and reporting are provided in Section D4.

D2.0 Current M&E Measurement

Monitoring within Torbay catchment is continuing to occur in three key areas:

- Surface water (quantity and quality)
- Groundwater (level and quality), and
- Catchment health indicators.

D2.1 Surface water monitoring

There are 6 gauging stations within the Torbay catchment with monitoring records since January, 1997. They are located to measure stream flow in:

- Five-mile Creek
- Seven-mile Creek
- Cuthbert Drain
- Grassmere Creek
- Marbelup Brook
- Torbay Drain

The location of these monitoring stations is shown in Figure B2.

The gauging stations provide measures of Total Nitrogen (TN), Total Phosphorus (TP) and turbidity (T – a measure of sediment load). Each of these are recorded as concentrations (both observed and flow-weighted) although can be converted to annual load measurement (as a product of average concentration and annual stream flow).

An analysis of the trends for TN, TP and T for the 1997-2002 period is provided in the resource kit.

D2.2 Groundwater Monitoring

Groundwater has been monitored at 24 locations in the lower catchment since June 2003. Water level is measured in all wells monthly. Nitrogen and phosphorus concentrations are measured for 12 of the bores every three months. The location of the monitoring wells is shown in Figure B6.

D2.3 Catchment Health Indicators

Catchment Health indicators show achievement of the communities' aspirational goals and targets. The selection of catchment health indicators for the Torbay catchment is described by Duxbury (2003). The environmental, economic and social characteristics for which indicators are proposed were derived from a social survey undertaken during 2002. They are:

- Quality of water in waterways and lakes
- Weed infestation in the catchment
- Level of protection and extent of native vegetation and fauna
- Level of rehabilitation of waterways and drains with vegetation and bank stabilising
- Status of fish stocks in the Inlet and waterways
- Income levels of people living in the catchment
- Level of community participation in local organizations
- Degree of satisfaction about living in the catchment area

The suggested indicators for each of these characteristics are given in the resource kit.

D3.0 Indicators of change

The effectiveness of monitoring is dependent upon having indicators that are representative of the resource condition or practice change that is expected through implementation of the planned actions. Selection of indicators depends on a range of criteria, described by the SMART acronym:

Simple	Easily interpreted, easily monitored, appropriate for community use, mappable.
Measurable	Statistically verifiable, reproducible and comparable, able to be combined with others to forms of indices, able to show trends over time.
Accessible	Regularly monitored, currently used by public and private managers, cost-effective.
Relevant	Indicative of resource condition change or practice change.
Time-bound	Measure that show change within time periods that relate to targets.

Catchment Health indicators are identified for the Goals and Objectives in Table D1. These are to reflect the characteristics for which community expects change (as proposed in Appendix 5). Measurement of these indicators is to be based on measures of community perception of change through periodic social surveys. These indicators are important to demonstrate to the community that their aspirations for a healthy catchment in the future is progressing according to the Vision statement. The indicators for community goals and objectives may not meet all SMART criteria.

Indicators are listed for Resource Condition Targets and Management Action Targets for the seven Management Themes in Table D1. These indicators are identified as measures to be taken that objectively indicate change. The significance of these measures is in providing information for decisions undertaken within the Adaptive Management Framework.

Table D1. Indicators of Change for Goals, Objectives and Targets.

THEME 1 – WATER QUALITY & ALGAL BLOOMS			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals and algal blooms are minimal. Water in Marbelup Brook remains suitable for drinking. Other waterways and waterbodies are suitable for recreation, domestic and agricultural use.	Observations of frequency and size of algal blooms. Complaints of mal-odours. Can you drink the water? Can you swim in the water?		
OBJECTIVES The source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and managed so that: • There are no fish kills due to poor water quality, • The incidence of algal blooms is reduced, • The transport of nutrients, sediments and contaminants into waterways and wetlands is minimised, • Management practices are adopted that minimise public health and environmental risks for drinking water from Marbelup Brook.	Records of fish kills. See T1RCT1 See T1MAT1 See T1RCT2	Increase public awareness to ensure fish kill are reported.	Signs about fish kills in the catchment are required

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET **T1RCT1** Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbelup Brook by 2025 **T1RCT2** Nutrient loads discharge from the sub-catchments are reduced by the following percentage by 2020: **Sub-catchment** **Current Load** **Load Reduction** **TN TP TN TP** **Torbay Drain:** **Marbelup Brook:** **Seven Mile Creek:**	Routine phytoplankton sampling. Annual flow-weighted measures at existing gauging stations.	Initiate sampling on a routine basis with a frequency that ensures all algal blooms are sampled. Existing monitoring.	The frequency of sampling may alter during the year according to seasonal risk of algal blooms.

Five Mile Creek: **Cuthbert Drain:** **Grassmere Creek:** **T1RCT3** The quality of water in Marbelup Brook meets national criteria for public drinking water supply (NHMRC & ARMCANZ, 1996) by 2015.	Routine sampling of salinity, nutrients and potential pathogens (eg *E. coli* counts).	Standard water quality monitoring procedures.	

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T1MAT1.** Discharge of nutrients to the Torbay catchment from the disposal of wastewater does not increase beyond current levels of x tonnes Nitrogen and x tonnes Phosphorus per annum (as approved through the Ministerial Conditions).	Measurement of TN and TP at Seven-mile Creek gauging station.	Continue with existing measurement.	
T1MAT2(a) All third and fourth-order waterways in Marbelup have permanent vegetated stream buffers established by 2010. **T1MAT2(b)** By 2015, 70% of all first and second order streams have permanent perennial vegetation.	The length (km) of waterways fenced annually. The length (km) of waterways with permanent revegetation established annually.	GIS map to show length of waterways currently fenced and the annual additional length of fencing	Communications should express this indicator as a percentage (%) of all 3rd and 4th –order waterways that are fenced on an annual basis. As above for 1st and 2nd –order waterways.
T1MAT3. Three trials demonstrations of nutrient reduction from stream flow and sediments implemented by 2007.	Implementation of three demonstration sites.		
T1MAT4. Future land use development in the Marbelup Brook catchment complies with public water supply objectives for the catchment.	Audit of compliance of conditions imposed on development approvals.	Initiate compliance assessment processes for the Marbelup Brook catchment as a part of the Public Drinking Water Source Protection Plan.	

THEME 2 – WATER QUANTITY			
	INDICATORS	ACTIONS	COMMENTS
GOALS (2025). Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.	Observations of bird populations, fish stock and fringing vegetation condition.	Long-term community-based monitoring of bird species richness and abundance is a valuable indicator of environmental values.	Opportunity for routine involvement by Birds Australia and affiliated organisations in systematic surveys and monitoring.
OBJECTIVES • Flow in Marbelup Brook is adequate to maintain ecological requirements.	Stream flow measurement downstream from future surface water extraction point for public water supply.	This measure to be assessed against objective Environmental Water Requirement criteria – yet to be determined.	
• Water regimes in Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals.	See T2RCT1 SeeT2RCT2		
• The drainage district is managed to meet the needs of current land uses, future land uses, and the environment.	Annual fees collected for ecosystem services.	See T6MAT8 for actions.	There is considerable social and administrative change required to meet this objective. The indicator is expected to remain zero for at least 3 years.
• Those who benefit from the use of the catchment to provide ecosystem services contribute to the costs of restoration.			

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET T2RCT1 Major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions by 2015.	Measures of depth and period of inundation in the respective water bodies.	These measures to be compared against minimum water criteria – yet to be determined.	
T2RCT2 **Maximum use of s**urface water and groundwater resources for private and public benefit within identified sustainable yield.	Estimates of water availability according to a water allocation plan.	Prepare a broad water allocation plan which includes Environmental Water Requirements.	
MANAGEMENT ACTION TARGETS **T2MAT1.** Environmental Water Requirements are determined for Marbelup Brook, Lake Powell, Lake Manarup and Torbay Inlet by 2007. **T2MAT2.** Water resources in the Marbelup Brook Catchment are proclaimed under the *Rights in Water and Irrigation Act (1914)* and a Water Resource Allocation Plan is prepared, including an assessment of changing land use and climate change, by 2007.	Peer-reviewed report prepared. Water Resource Allocation Plan is prepared for the proclaimed catchment.	Arrange standard format for assessment of Environmental Water Requirements.	

THEME 3 – DRAINAGE MANAGEMENT			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.	Community acceptance that drainage is well managed.		Complaints from community about mal-odours, risk of flooding, impacts on fishing etc. are a good measure of community acceptance.
OBJECTIVES • The impact of flooding on horticulture is minimised, • Flooding in residential areas is minimised, • The potential adverse effects of drainage management on fisheries in minimised (including commercial fisheries and native fish species), • The impact of drainage management on algal blooms is minimised, and • The drainage system is managed to prevent or minimize sedimentation of receiving water bodies.	Successful production of potatoes. Records of flood impacts. Reduced commercial fish harvest attributed to drainage management. See T1RCT1 See T3RCT2		

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET T3RCT1 Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds) by 2025.	See T2RCT1 and T2 RCT2		
T3RCT2 Sediment transport in drains and sediment deposition in Torbay Inlet and Lake Powell and is reduced by 50% by 2010.	The lake bed level (meters AHD)	Repeat surveys of lake bed bathymetry (standard monitoring transects only, not comprehensive survey).	The detailed bathometric survey provides a basis for measuring increase in sediment deposition in the lake beds.
T3RCT3 The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025.	Water quality measures in North Creek and Marbelup Drain.	Routine water quality monitoring sites to be initiated.	Tasks may be suitable for community involvement through 'Ribbons of Blue' program.
MANAGEMENT ACTION TARGETS T3MAT1. Options for change to drainage management to maximise water quality and public amenity in Marbelup Brook (including the section downstream of the Marbelup Plug) and Lake Powell are fully assessed by 2006	Reviewed documentation of the assessment of drainage options.	Actions are listed in Section C.	

	INDICATORS	ACTIONS	COMMENTS
T3MAT2. The required regime for salt water flushing and maintenance of adequate water depth to improve environmental values in Torbay Inlet is identified and agreed between key stakeholders, and is being implemented through management of sandbar openings by 2007.	Record of artificial sandbar openings in comparison with an agreed regime for salt water flushing.	Actions in Section C for developing the agreed sandbar opening regime.	
T3MAT3. Lake Manarup is being maintained with adequate water to ensure ecological function (without disadvantage to Lake Powell and Torbay Inlet) by 2007.	See T2RCT1 and T2 RCT2		
T3MAT4. Public and private drains identified with high risk of erosion or sediment transport are permanently stabilised by 2010.	Length of drain (km) stabilised.	Initial actions to identify the extent of drains at risk to erosion.	The indicator should be communicated as a percentage (%) of the total length of drainage at risk.
T3MAT5. The processes and extent to which sulphuric acid, nutrients and other potential pollutants are released from acid sulphate soils due to the current operating strategy of the drainage systems is known by 2006.	Peer-reviewed report based on field survey and measurement completed.		

THEME 4 – HABITAT & BIODIVERSITY MANAGEMENT			
	INDICATORS	**ACTIONS**	**COMMENTS**
GOAL (2025) Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.	Community perception of biodiversity enhancement.		
OBJECTIVES • Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained, • The condition of foreshore vegetation and in-stream habitat is maintained or improved, • The habitat value and habitat connectivity for native fauna is improve and increased, • Population sizes and diversity of native freshwater fish and crustacea are maintained, • Requirements for fish passage and spawning in waterways are maintained, • Representative and adequate areas of pre-European vegetation types are retained, • The impact of exotic pest animal species on native fauna is reduced, and • The impact of weeds on native vegetation and aquatic ecosystems is reduced.	See T2RCT1 and T2 RCT2 Foreshore conditions survey scores. The percentage (%) of tree cover in the catchment. See T4MAT7 See T4 MAT7 Percentage (%) of vegetation types in reserves and other protected areas. Relative abundance of exotic pest animals. Measure of relative extent (Ha) of priority weeds.		

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGETS **T4RCT1** Major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions by 2025. (NOTE: actions for this target are included in Themes 1, 2, 3 & 5).	See T2RCT1 and T2 RCT2		
T4RCT2 All 'pristine' foreshore vegetation (Class A) is permanently maintained and all 'good' foreshore vegetation (Class B) is returned to 'pristine' condition by 2025.	Foreshore vegetation survey scores (Pen and Scott, 1995)		
T4RCT3 All 3rd and 4th – order waterways have established permanent foreshore vegetation by 2010.	See T1MAT2(a)		
T4RCT4 Identified waterway corridors are established for wildlife habitat as a part of a regional 'macro-corridor' by 2015.	Length (km) of wildlife corridors established.	Macro-corridor plan for the catchment to be finalised. Note links to actions in T1MAT2(b).	Indicator should be communicated as a percentage (%) of the total length of wildlife corridor establishment proposed for the Torbay catchment.
T4RCT5 Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.	See T4 MAT2	Mapping required to establish the area that requires protection.	
T4RCT6 All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.	Foreshore vegetation survey score.	Need to establish the required width of foreshore vegetation for ecosystem functions.	

T4RCT7 Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.	Measures of aquatic species richness and abundance.		
MANAGEMENT ACTION TARGETS **T4MAT1a.** More than 150km of priority waterways within the Torbay catchment currently unfenced are fenced and revegetated according to local 'best practice' for permanent management of foreshore vegetation by 2010.	The length (km) of waterways fenced and revegetated.	Maps to be prepared to show the priority areas for waterway fencing and revegetation.	The indicator is best communicated as a percentage (%) of the total length of waterways on a sub-catchment basis.
T4MAT1b. A further 100km of vegetated stream buffers are established according to priority areas by 2010.	The length (km) of stream buffers established.		The indicator is best communicated as a percentage (%) of the total length of waterways on a sub-catchment basis.
T4MAT3. All viable remnant vegetation patches of regionally inadequate vegetation types greater than 1 Ha are fenced and managed according to local 'best practice' by 2010.	The area (Ha) of remnant vegetation fenced for each vegetation type.		The indicator is best communicated as a percentage (%) of the total area of each vegetation type within the Torbay catchment.
T4MAT4. More than 75% of the length of foreshore for Lake Powell, Lake Manarup and Torbay Inlet have a minimum 20 meter foreshore vegetation margin by 2015.	Length (km) of foreshore vegetation.	Mapping required to establish the current extent and priority areas for restoration.	
T4MAT5. Priority environmental weeds are mapped and have management programs for control to achieve 10% per annum reduction, with total control by 2015.	The percentage (%) annual reduction in the mapped area of priority environmental weeds.	Mapping required for the current extent of priority environmental weeds.	

T4MAT6. The environmental requirements of freshwater and marine fish and crustacea in waterways and wetlands of the Torbay catchment are understood and being managed by 2010.	Measures of aquatic species richness and abundance.		

THEME 5 – FARMING SYSTEMS			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) The farming communities have adopted 'best practice' systems for sustainable land use resulting in measurable agricultural and environmental benefits.	Number of farms adopting 'best management practices'	BMP for each industry needs to be defined. Surveys of BMP adoption required.	
OBJECTIVES • Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy, • Farm nutrient loss is reduced, • Soil loss from farms is reduced, and • The impact of weeds on agricultural production is reduced.	Locally acceptable 'Best Management Practice' information sheets are prepared. Percentage (%) nutrient load reduction shown by voluntary farm nutrient auditing. Turbidity measures at stream gauging stations The percentage (%) annual reduction in the mapped area of priority agricultural weeds.	Action for development of BMPs in Section C. Linked to actions for farm nutrient audits and nutrient budgets in Section C. Mapping required for the current extent of priority agricultural weeds.	Existing monitoring information.

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGETS **T5RCT1** The total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus by 2025.	Analysis of soil test results for Total Phosphorus at 5-year intervals. Analysis of farm nutrient audits for Total Nitrogen at 5-year intervals.	Link to actions for increased adoption of soils testing. Arrange for results to be coordinated on a catchment-scale. Link to actions for adoption of farm nutrient audits and budgets. Arrange for results to be coordinated on a catchment-scale.	See also T1RCT2 for nutrient reduction in stream flow.
MANAGEMENT ACTION TARGETS **T5MAT1**. Intensive animal industries and annual horticulture located in high or medium risk sites have adopted management practices that result in a reduction of the current industry nutrient surplus by 40% by 2010.	On-site monitoring of nutrients according to nutrient management plans.	Link to Action 3 (Section C)	
T5MAT2. More than half of the landholders in the Torbay catchment, who derive more than 50% of their income from farming their properties, have prepared a 'farm nutrient surplus' calculation and response plan by 2010.	Records of preparation of calculations and response plans.	Link to Actions 1-3 (Section C)	Key task for TCG Coordinator.
T5MAT3. More than 30 viable farming enterprises have nutrient management plans and are demonstrating achievement of defined nutrient surplus reduction targets without production loss by 2010.	Response to landholder survey undertaken at 5-year intervals.	Standardise baseline information to ensure surveys are undertaken in a consistent way.	Assessment of current level of adoption to be documented.
T5MAT4. A total of 75% of land used for grazing is established with perennial plants (trees, shrubs or pastures) by 2015.	Response to landholder survey undertaken at 5-year intervals.	As above.	Need to assess the extent of existing perennial plant cover. Proposed actions will assess the benefits for nutrient management by increasing the extent of cover.

THEME 6 – LAND USE PLANNING			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Regional and local planning provides the policies and mechanisms to implement new actions that are beneficial for natural resource condition, ensure that land is used according to its capability and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.	Survey of community perception of sustainable land use practice within the catchment.	Link to community survey processes.	An informed community will provide a clear perception about the extent to which sustainable practices are adopted.
OBJECTIVES • Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current land use, • Land use intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines, • Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands.	See T6MAT1. See T6MAT2 See T6MAT3		

• Priority water resources are protected for beneficial use now and into the future, • Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained, • Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands, • The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations, • The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit, • The current landscape mosaic characterised by agriculture and natural vegetation is maintained, and • Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.	See T6MAT4 See T6MAT5 See T6MAT6 See T6MAT7 See T6MAT8 Response to community survey about landscape values. Response to community survey about recreational opportunities.		

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T6MAT1** Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information and adopt 'Net Nutrient Reduction' principles for planning propo*sals* by 2007.	Compliance audits for conditions for environmental management listed for new develop	Prepare 'check-list' of conditions for compliance auditing.	Arrange for information about the *Watershed Torbay Catchment Restoration Plan* to be provided with all development approvals so that the proponents are informed about the purpose of the audit procedures and support this purpose.
T6MAT2 Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information by 2007.	Records of statutory application assessment processes.		Arrange with CoA to maintain records of adoption of land capability by proponents for development applications.
T6MAT3 All proposals for additional deep drainage and significant maintenance works within the Torbay catchment are assessed as Development Applications and on the basis of a presumption against drainage in areas identified at risk by 2007.	Records of statutory application assessment processes.		As above.
T6MAT4. The Water Resource Protection Plan for the Marbelup Brook sub-catchment is recognised as a priority area within the Lower Great Southern Regional Planning Strategy and the Local Planning Strategy and Town Planning Scheme for the City of Albany by 2007.	Adoption within the planning documents.		
T6MAT5 Proposals for commercial tree plantations within identified priority areas of the Torbay catchment are assessed as Development Applications through the TPS for the City of Albany with the presumption	Records of statutory application assessment processes.		Arrange with CoA to maintain records of adoption of land capability by proponents for development applications.

against this development in these areas by 2007.			
T6MAT6. Urban growth in the town of Elleker is planned to ensure no additional risk to waterways and wetlands and that the potential for flooding of residential development is minimal by 2007.	Records of statutory application assessment processes for residential development.		As above.
T6MAT7. Priority areas for conservation protection or enhancement are identified and linked to local government and regional planning processes by 2007.	Adoption of defined priority areas within planning documents.	Link to Actions 1-2 (Section C)	
T6MAT8. The value of ecosystem services is understood and a trial system for compensation under a 'beneficiary pays' principle within the City of Albany is established by 2008.	Survey of community attitude within the City of Albany.	Prepare information for community about 'ecosystem services', particularly with Case Studies and an outline of the proposed trial.	Liaison with the Water Corporation and the City of Albany require through all stages of this target area.
T6MAT9. Priority Agricultural Areas in the Torbay catchment are revised and a preferred landscape description prepared for consideration by regional and planning processes by 2005.	Adoption of revised areas within planning documents.		Development of a preferred landscape description to be undertaken by TCG with close cooperation of CoA and DPI.
T6MAT10. Opportunities for increased social and recreational values within the Torbay catchment have been reviewed through regional and local government planning processes by 2007.	Adoption of revised areas within planning documents.		TCG to propose opportunities for increased social and recreational values to CoA and DPI.

THEME 7 – COMMUNITY EDUCATION AND INFORMATION			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the shared vision for the catchment.	Survey of community perception of catchment values and the effectiveness of the Restoration Plan.		This will be a strong indication of the effectiveness of information and communication strategies.
OBJECTIVES • All key stakeholders are willingly involved in implementing the restoration plan.	Landholder survey to show level of adoption of proposed actions at 5-year intervals.		
• There is a high level of community awareness about the values of the catchment and about the best practices for sustainable management.	Survey of community perception of catchment values and the effectiveness of the Restoration Plan.		
• Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes.	Survey of community understanding of key environmental processes and priority issues.		Effective communication required for this objective.
• There is a significant level of community involvement in reviewing the restoration plan on a five yearly basis.	The attendance/number of responses to processes for reviewing the plan.		Workshop survey processes expected as a part of reviewing the Restoration Plan.

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T7MAT1** More than half of landholders and residents in the Torbay catchment are able to express clear understanding and support for the catchment Vision and restoration plan by 2010.	Response to a landholder and community survey held at 5-year intervals.	Clarify the criteria to measure 'understanding and support' for use in the survey.	Document current information about community understanding and support.
T7MAT2. More than 40% of landholders are attending at least one group event annually and have copies of or direct access to current research and information relevant to actions for implementation of the Restoration Plan by 2010.	Attendance at field days or other information dissemination events. Response to landholder and community survey about access to information.		

WATERSHED Torbay

Watershed Torbay
Catchment Restoration Plan:

SECTION D

MONITORING AND EVALUATION

D1.0 A Framework for Monitoring and Evaluation

The effectiveness of the *Watershed Torbay Catchment Restoration Plan* is to be demonstrated through monitoring and evaluation (M&E) processes. These are to show:

1. Resource condition change
2. Rate of implementation
3. Effectiveness of implementation
4. Acceptance of change by community and partner organisations, and
5. Better understanding of the systems involved.

These measures then need to show **achievement of the aspirational goals and objectives** of the Torbay Catchment Group (TCG) for each of the seven Management Themes through improvement in **indicators of catchment health.**

The efficiency of an M&E program is in ensuring that the measures are adequately indicate the goal, objective or target that they represent. This requires that **representative indicators** are clearly identified. Some indicators for M&E are being measured currently. There will be other actions required.

The Restoration Plan is based on change management. A significant requirement of M&E is show that investment in practice change is resulting in resource condition improvement. However, brokering practice change according to a prepared Restoration Plan is undertaken within a continuously changing 'operating environment' (i.e. the social, economic and environmental factors that influence normal decision-making processes). An important component of change is through improved understanding and knowledge of the systems being managed.

The processes that allow adjustment of decisions in response to a changing operating environment are described as **adaptive management**. Figure D1 shows the adaptive management cycle that is based on planning, action, monitoring and review.

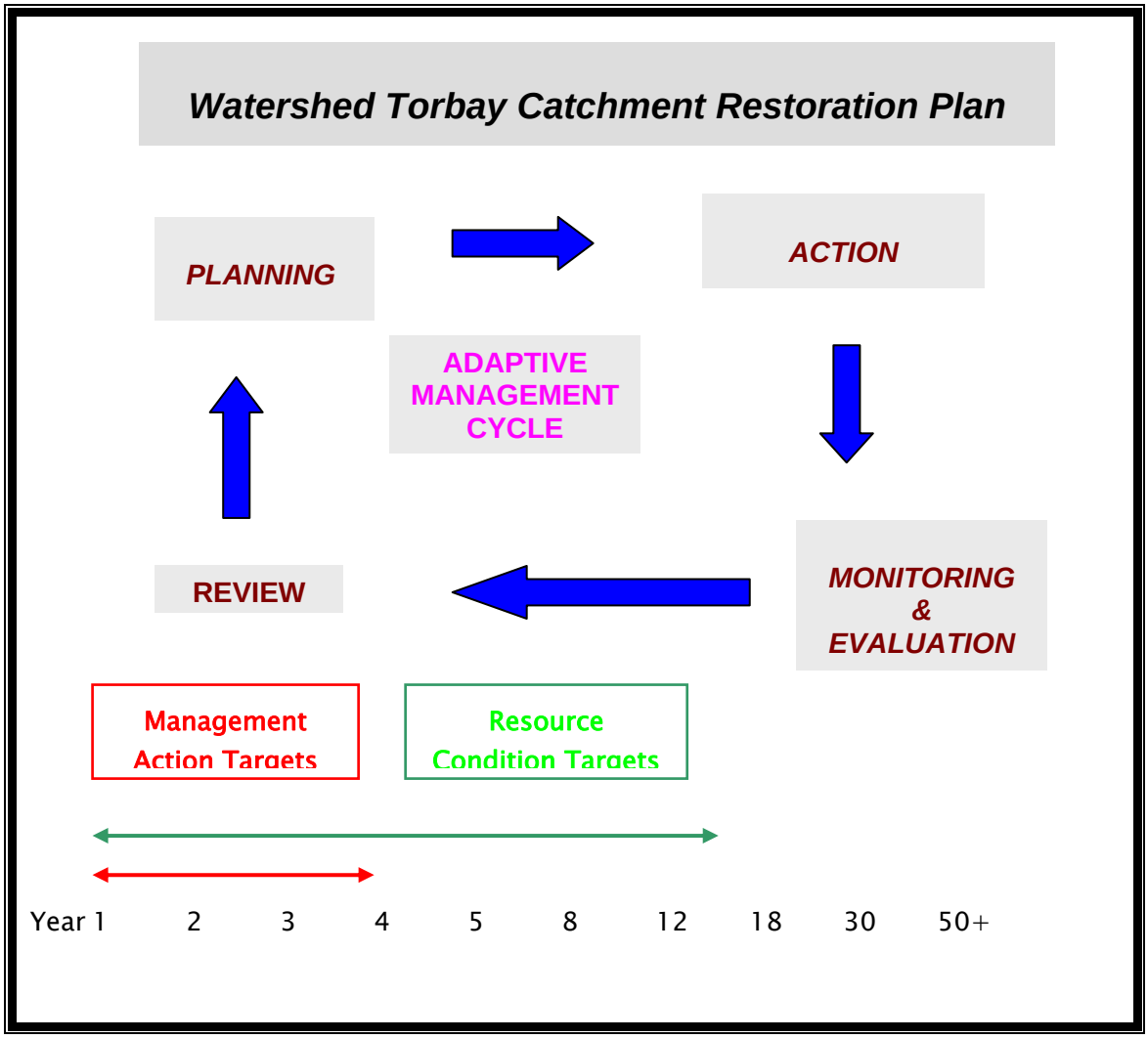


Figure D1 Monitoring and evaluation in the Adaptive Management cycle.

Evaluation of the measures of indicators for change should be delivered into the Adaptive Management Cycle. The performance of the implementation program is measured against the Management Action Targets over time. The effectiveness of the actions in achieving resource condition change is also measured over time.

The review processes are critical to the effectiveness of the adaptive management cycle. Monitoring information is to be evaluated in accordance with the implementation program to enable the Implementation Steering Committee to adjust priorities for investment. It is proposed that this is a specific set of tasks undertaken by the Implementation Steering Committee lead by the Department of Environment on a 6-month basis.

Section D2 with review current monitoring programs. These will be aligned where appropriate with representative indicators for resource condition and management action targets identified in Section D3. The recommended processes for evaluation and reporting are provided in Section D4.

D2.0 Current M&E Measurement

Monitoring within Torbay catchment is continuing to occur in three key areas:

- Surface water (quantity and quality)
- Groundwater (level and quality), and
- Catchment health indicators.

D2.1 Surface water monitoring

There are 6 gauging stations within the Torbay catchment with monitoring records since January, 1997. They are located to measure stream flow in:

- Five-mile Creek
- Seven-mile Creek
- Cuthbert Drain
- Grassmere Creek
- Marbelup Brook
- Torbay Drain

The location of these monitoring stations is shown in Figure B2.

The gauging stations provide measures of Total Nitrogen (TN), Total Phosphorus (TP) and turbidity (T – a measure of sediment load). Each of these are recorded as concentrations (both observed and flow-weighted) although can be converted to annual load measurement (as a product of average concentration and annual stream flow).

An analysis of the trends for TN, TP and T for the 1997-2002 period is provided in the resource kit.

D2.2 Groundwater Monitoring

Groundwater has been monitored at 24 locations in the lower catchment since June 2003. Water level is measured in all wells monthly. Nitrogen and phosphorus concentrations are measured for 12 of the bores every three months. The location of the monitoring wells is shown in Figure B6.

D2.3 Catchment Health Indicators

Catchment Health indicators show achievement of the communities' aspirational goals and targets. The selection of catchment health indicators for the Torbay catchment is described by Duxbury (2003). The environmental, economic and social characteristics for which indicators are proposed were derived from a social survey undertaken during 2002. They are:

- Quality of water in waterways and lakes
- Weed infestation in the catchment
- Level of protection and extent of native vegetation and fauna
- Level of rehabilitation of waterways and drains with vegetation and bank stabilising
- Status of fish stocks in the Inlet and waterways
- Income levels of people living in the catchment
- Level of community participation in local organizations
- Degree of satisfaction about living in the catchment area

The suggested indicators for each of these characteristics are given in the resource kit.

D3.0 Indicators of change

The effectiveness of monitoring is dependent upon having indicators that are representative of the resource condition or practice change that is expected through implementation of the planned actions. Selection of indicators depends on a range of criteria, described by the SMART acronym:

Simple	Easily interpreted, easily monitored, appropriate for community use, mappable.
Measurable	Statistically verifiable, reproducible and comparable, able to be combined with others to forms of indices, able to show trends over time.
Accessible	Regularly monitored, currently used by public and private managers, cost-effective.
Relevant	Indicative of resource condition change or practice change.
Time-bound	Measure that show change within time periods that relate to targets.

Catchment Health indicators are identified for the Goals and Objectives in Table D1. These are to reflect the characteristics for which community expects change (as proposed in Appendix 5). Measurement of these indicators is to be based on measures of community perception of change through periodic social surveys. These indicators are important to demonstrate to the community that their aspirations for a healthy catchment in the future is progressing according to the Vision statement. The indicators for community goals and objectives may not meet all SMART criteria.

Indicators are listed for Resource Condition Targets and Management Action Targets for the seven Management Themes in Table D1. These indicators are identified as measures to be taken that objectively indicate change. The significance of these measures is in providing information for decisions undertaken within the Adaptive Management Framework.

Table D1. Indicators of Change for Goals, Objectives and Targets.

THEME 1 – WATER QUALITY & ALGAL BLOOMS			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals and algal blooms are minimal. Water in Marbelup Brook remains suitable for drinking. Other waterways and waterbodies are suitable for recreation, domestic and agricultural use.	Observations of frequency and size of algal blooms. Complaints of mal-odours. Can you drink the water? Can you swim in the water?		
OBJECTIVES The source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and managed so that: • There are no fish kills due to poor water quality, • The incidence of algal blooms is reduced, • The transport of nutrients, sediments and contaminants into waterways and wetlands is minimised, • Management practices are adopted that minimise public health and environmental risks for drinking water from Marbelup Brook.	Records of fish kills. See T1RCT1 See T1MAT1 See T1RCT2	Increase public awareness to ensure fish kill are reported.	Signs about fish kills in the catchment are required

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET **T1RCT1** Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbelup Brook by 2025 **T1RCT2** Nutrient loads discharge from the sub-catchments are reduced by the following percentage by 2020: **Sub-catchment** **Current Load** **Load Reduction** **TN TP TN TP** **Torbay Drain:** **Marbelup Brook:** **Seven Mile Creek:**	Routine phytoplankton sampling. Annual flow-weighted measures at existing gauging stations.	Initiate sampling on a routine basis with a frequency that ensures all algal blooms are sampled. Existing monitoring.	The frequency of sampling may alter during the year according to seasonal risk of algal blooms.

Five Mile Creek: **Cuthbert Drain:** **Grassmere Creek:** **T1RCT3** The quality of water in Marbelup Brook meets national criteria for public drinking water supply (NHMRC & ARMCANZ, 1996) by 2015.	Routine sampling of salinity, nutrients and potential pathogens (eg *E. coli* counts).	Standard water quality monitoring procedures.	

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T1MAT1.** Discharge of nutrients to the Torbay catchment from the disposal of wastewater does not increase beyond current levels of x tonnes Nitrogen and x tonnes Phosphorus per annum (as approved through the Ministerial Conditions).	Measurement of TN and TP at Seven-mile Creek gauging station.	Continue with existing measurement.	
T1MAT2(a) All third and fourth-order waterways in Marbelup have permanent vegetated stream buffers established by 2010. **T1MAT2(b)** By 2015, 70% of all first and second order streams have permanent perennial vegetation.	The length (km) of waterways fenced annually. The length (km) of waterways with permanent revegetation established annually.	GIS map to show length of waterways currently fenced and the annual additional length of fencing	Communications should express this indicator as a percentage (%) of all 3rd and 4th –order waterways that are fenced on an annual basis. As above for 1st and 2nd –order waterways.
T1MAT3. Three trials demonstrations of nutrient reduction from stream flow and sediments implemented by 2007.	Implementation of three demonstration sites.		
T1MAT4. Future land use development in the Marbelup Brook catchment complies with public water supply objectives for the catchment.	Audit of compliance of conditions imposed on development approvals.	Initiate compliance assessment processes for the Marbelup Brook catchment as a part of the Public Drinking Water Source Protection Plan.	

THEME 2 – WATER QUANTITY			
	INDICATORS	ACTIONS	COMMENTS
GOALS (2025). Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.	Observations of bird populations, fish stock and fringing vegetation condition.	Long-term community-based monitoring of bird species richness and abundance is a valuable indicator of environmental values.	Opportunity for routine involvement by Birds Australia and affiliated organisations in systematic surveys and monitoring.
OBJECTIVES • Flow in Marbelup Brook is adequate to maintain ecological requirements.	Stream flow measurement downstream from future surface water extraction point for public water supply.	This measure to be assessed against objective Environmental Water Requirement criteria – yet to be determined.	
• Water regimes in Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals.	See T2RCT1 SeeT2RCT2		
• The drainage district is managed to meet the needs of current land uses, future land uses, and the environment.	Annual fees collected for ecosystem services.	See T6MAT8 for actions.	There is considerable social and administrative change required to meet this objective. The indicator is expected to remain zero for at least 3 years.
• Those who benefit from the use of the catchment to provide ecosystem services contribute to the costs of restoration.			

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET T2RCT1 Major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions by 2015.	Measures of depth and period of inundation in the respective water bodies.	These measures to be compared against minimum water criteria – yet to be determined.	
T2RCT2 **Maximum use of s**urface water and groundwater resources for private and public benefit within identified sustainable yield.	Estimates of water availability according to a water allocation plan.	Prepare a broad water allocation plan which includes Environmental Water Requirements.	
MANAGEMENT ACTION TARGETS **T2MAT1.** Environmental Water Requirements are determined for Marbelup Brook, Lake Powell, Lake Manarup and Torbay Inlet by 2007. **T2MAT2.** Water resources in the Marbelup Brook Catchment are proclaimed under the *Rights in Water and Irrigation Act (1914)* and a Water Resource Allocation Plan is prepared, including an assessment of changing land use and climate change, by 2007.	Peer-reviewed report prepared. Water Resource Allocation Plan is prepared for the proclaimed catchment.	Arrange standard format for assessment of Environmental Water Requirements.	

THEME 3 – DRAINAGE MANAGEMENT			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.	Community acceptance that drainage is well managed.		Complaints from community about mal-odours, risk of flooding, impacts on fishing etc. are a good measure of community acceptance.
OBJECTIVES • The impact of flooding on horticulture is minimised, • Flooding in residential areas is minimised, • The potential adverse effects of drainage management on fisheries in minimised (including commercial fisheries and native fish species), • The impact of drainage management on algal blooms is minimised, and • The drainage system is managed to prevent or minimize sedimentation of receiving water bodies.	Successful production of potatoes. Records of flood impacts. Reduced commercial fish harvest attributed to drainage management. See T1RCT1 See T3RCT2		

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGET T3RCT1 Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds) by 2025.	See T2RCT1 and T2 RCT2		
T3RCT2 Sediment transport in drains and sediment deposition in Torbay Inlet and Lake Powell and is reduced by 50% by 2010.	The lake bed level (meters AHD)	Repeat surveys of lake bed bathymetry (standard monitoring transects only, not comprehensive survey).	The detailed bathometric survey provides a basis for measuring increase in sediment deposition in the lake beds.
T3RCT3 The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025.	Water quality measures in North Creek and Marbelup Drain.	Routine water quality monitoring sites to be initiated.	Tasks may be suitable for community involvement through 'Ribbons of Blue' program.
MANAGEMENT ACTION TARGETS T3MAT1. Options for change to drainage management to maximise water quality and public amenity in Marbelup Brook (including the section downstream of the Marbelup Plug) and Lake Powell are fully assessed by 2006	Reviewed documentation of the assessment of drainage options.	Actions are listed in Section C.	

	INDICATORS	ACTIONS	COMMENTS
T3MAT2. The required regime for salt water flushing and maintenance of adequate water depth to improve environmental values in Torbay Inlet is identified and agreed between key stakeholders, and is being implemented through management of sandbar openings by 2007.	Record of artificial sandbar openings in comparison with an agreed regime for salt water flushing.	Actions in Section C for developing the agreed sandbar opening regime.	
T3MAT3. Lake Manarup is being maintained with adequate water to ensure ecological function (without disadvantage to Lake Powell and Torbay Inlet) by 2007.	See T2RCT1 and T2 RCT2		
T3MAT4. Public and private drains identified with high risk of erosion or sediment transport are permanently stabilised by 2010.	Length of drain (km) stabilised.	Initial actions to identify the extent of drains at risk to erosion.	The indicator should be communicated as a percentage (%) of the total length of drainage at risk.
T3MAT5. The processes and extent to which sulphuric acid, nutrients and other potential pollutants are released from acid sulphate soils due to the current operating strategy of the drainage systems is known by 2006.	Peer-reviewed report based on field survey and measurement completed.		

THEME 4 – HABITAT & BIODIVERSITY MANAGEMENT			
	INDICATORS	**ACTIONS**	**COMMENTS**
GOAL (2025) Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.	Community perception of biodiversity enhancement.		
OBJECTIVES • Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained, • The condition of foreshore vegetation and in-stream habitat is maintained or improved, • The habitat value and habitat connectivity for native fauna is improve and increased, • Population sizes and diversity of native freshwater fish and crustacea are maintained, • Requirements for fish passage and spawning in waterways are maintained, • Representative and adequate areas of pre-European vegetation types are retained, • The impact of exotic pest animal species on native fauna is reduced, and • The impact of weeds on native vegetation and aquatic ecosystems is reduced.	See T2RCT1 and T2 RCT2 Foreshore conditions survey scores. The percentage (%) of tree cover in the catchment. See T4MAT7 See T4 MAT7 Percentage (%) of vegetation types in reserves and other protected areas. Relative abundance of exotic pest animals. Measure of relative extent (Ha) of priority weeds.		

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGETS **T4RCT1** Major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions by 2025. (NOTE: actions for this target are included in Themes 1, 2, 3 & 5).	See T2RCT1 and T2 RCT2		
T4RCT2 All 'pristine' foreshore vegetation (Class A) is permanently maintained and all 'good' foreshore vegetation (Class B) is returned to 'pristine' condition by 2025.	Foreshore vegetation survey scores (Pen and Scott, 1995)		
T4RCT3 All 3rd and 4th – order waterways have established permanent foreshore vegetation by 2010.	See T1MAT2(a)		
T4RCT4 Identified waterway corridors are established for wildlife habitat as a part of a regional 'macro-corridor' by 2015.	Length (km) of wildlife corridors established.	Macro-corridor plan for the catchment to be finalised. Note links to actions in T1MAT2(b).	Indicator should be communicated as a percentage (%) of the total length of wildlife corridor establishment proposed for the Torbay catchment.
T4RCT5 Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.	See T4 MAT2	Mapping required to establish the area that requires protection.	
T4RCT6 All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.	Foreshore vegetation survey score.	Need to establish the required width of foreshore vegetation for ecosystem functions.	

T4RCT7 Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.	Measures of aquatic species richness and abundance.		
MANAGEMENT ACTION TARGETS **T4MAT1a.** More than 150km of priority waterways within the Torbay catchment currently unfenced are fenced and revegetated according to local 'best practice' for permanent management of foreshore vegetation by 2010.	The length (km) of waterways fenced and revegetated.	Maps to be prepared to show the priority areas for waterway fencing and revegetation.	The indicator is best communicated as a percentage (%) of the total length of waterways on a sub-catchment basis.
T4MAT1b. A further 100km of vegetated stream buffers are established according to priority areas by 2010.	The length (km) of stream buffers established.		The indicator is best communicated as a percentage (%) of the total length of waterways on a sub-catchment basis.
T4MAT3. All viable remnant vegetation patches of regionally inadequate vegetation types greater than 1 Ha are fenced and managed according to local 'best practice' by 2010.	The area (Ha) of remnant vegetation fenced for each vegetation type.		The indicator is best communicated as a percentage (%) of the total area of each vegetation type within the Torbay catchment.
T4MAT4. More than 75% of the length of foreshore for Lake Powell, Lake Manarup and Torbay Inlet have a minimum 20 meter foreshore vegetation margin by 2015.	Length (km) of foreshore vegetation.	Mapping required to establish the current extent and priority areas for restoration.	
T4MAT5. Priority environmental weeds are mapped and have management programs for control to achieve 10% per annum reduction, with total control by 2015.	The percentage (%) annual reduction in the mapped area of priority environmental weeds.	Mapping required for the current extent of priority environmental weeds.	

T4MAT6. The environmental requirements of freshwater and marine fish and crustacea in waterways and wetlands of the Torbay catchment are understood and being managed by 2010.	Measures of aquatic species richness and abundance.		

THEME 5 – FARMING SYSTEMS			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) The farming communities have adopted 'best practice' systems for sustainable land use resulting in measurable agricultural and environmental benefits.	Number of farms adopting 'best management practices'	BMP for each industry needs to be defined. Surveys of BMP adoption required.	
OBJECTIVES • Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy, • Farm nutrient loss is reduced, • Soil loss from farms is reduced, and • The impact of weeds on agricultural production is reduced.	Locally acceptable 'Best Management Practice' information sheets are prepared. Percentage (%) nutrient load reduction shown by voluntary farm nutrient auditing. Turbidity measures at stream gauging stations The percentage (%) annual reduction in the mapped area of priority agricultural weeds.	Action for development of BMPs in Section C. Linked to actions for farm nutrient audits and nutrient budgets in Section C. Mapping required for the current extent of priority agricultural weeds.	Existing monitoring information.

	INDICATORS	ACTIONS	COMMENTS
RESOURCE CONDITION CHANGE TARGETS **T5RCT1** The total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus by 2025.	Analysis of soil test results for Total Phosphorus at 5-year intervals. Analysis of farm nutrient audits for Total Nitrogen at 5-year intervals.	Link to actions for increased adoption of soils testing. Arrange for results to be coordinated on a catchment-scale. Link to actions for adoption of farm nutrient audits and budgets. Arrange for results to be coordinated on a catchment-scale.	See also T1RCT2 for nutrient reduction in stream flow.
MANAGEMENT ACTION TARGETS **T5MAT1**. Intensive animal industries and annual horticulture located in high or medium risk sites have adopted management practices that result in a reduction of the current industry nutrient surplus by 40% by 2010.	On-site monitoring of nutrients according to nutrient management plans.	Link to Action 3 (Section C)	
T5MAT2. More than half of the landholders in the Torbay catchment, who derive more than 50% of their income from farming their properties, have prepared a 'farm nutrient surplus' calculation and response plan by 2010.	Records of preparation of calculations and response plans.	Link to Actions 1-3 (Section C)	Key task for TCG Coordinator.
T5MAT3. More than 30 viable farming enterprises have nutrient management plans and are demonstrating achievement of defined nutrient surplus reduction targets without production loss by 2010.	Response to landholder survey undertaken at 5-year intervals.	Standardise baseline information to ensure surveys are undertaken in a consistent way.	Assessment of current level of adoption to be documented.
T5MAT4. A total of 75% of land used for grazing is established with perennial plants (trees, shrubs or pastures) by 2015.	Response to landholder survey undertaken at 5-year intervals.	As above.	Need to assess the extent of existing perennial plant cover. Proposed actions will assess the benefits for nutrient management by increasing the extent of cover.

THEME 6 – LAND USE PLANNING			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) Regional and local planning provides the policies and mechanisms to implement new actions that are beneficial for natural resource condition, ensure that land is used according to its capability and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.	Survey of community perception of sustainable land use practice within the catchment.	Link to community survey processes.	An informed community will provide a clear perception about the extent to which sustainable practices are adopted.
OBJECTIVES • Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current land use, • Land use intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart's Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines, • Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands.	See T6MAT1. See T6MAT2 See T6MAT3		

• Priority water resources are protected for beneficial use now and into the future, • Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained, • Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands, • The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations, • The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit, • The current landscape mosaic characterised by agriculture and natural vegetation is maintained, and • Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.	See T6MAT4 See T6MAT5 See T6MAT6 See T6MAT7 See T6MAT8 Response to community survey about landscape values. Response to community survey about recreational opportunities.		

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T6MAT1** Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information and adopt 'Net Nutrient Reduction' principles for planning propo*sals* by 2007.	Compliance audits for conditions for environmental management listed for new develop	Prepare 'check-list' of conditions for compliance auditing.	Arrange for information about the *Watershed Torbay Catchment Restoration Plan* to be provided with all development approvals so that the proponents are informed about the purpose of the audit procedures and support this purpose.
T6MAT2 Assessment of all applications for land development or sub-division are based on a revised land capability analysis framework for the Torbay catchment using currently available land resource information by 2007.	Records of statutory application assessment processes.		Arrange with CoA to maintain records of adoption of land capability by proponents for development applications.
T6MAT3 All proposals for additional deep drainage and significant maintenance works within the Torbay catchment are assessed as Development Applications and on the basis of a presumption against drainage in areas identified at risk by 2007.	Records of statutory application assessment processes.		As above.
T6MAT4. The Water Resource Protection Plan for the Marbelup Brook sub-catchment is recognised as a priority area within the Lower Great Southern Regional Planning Strategy and the Local Planning Strategy and Town Planning Scheme for the City of Albany by 2007.	Adoption within the planning documents.		
T6MAT5 Proposals for commercial tree plantations within identified priority areas of the Torbay catchment are assessed as Development Applications through the TPS for the City of Albany with the presumption	Records of statutory application assessment processes.		Arrange with CoA to maintain records of adoption of land capability by proponents for development applications.

against this development in these areas by 2007.			
T6MAT6. Urban growth in the town of Elleker is planned to ensure no additional risk to waterways and wetlands and that the potential for flooding of residential development is minimal by 2007.	Records of statutory application assessment processes for residential development.		As above.
T6MAT7. Priority areas for conservation protection or enhancement are identified and linked to local government and regional planning processes by 2007.	Adoption of defined priority areas within planning documents.	Link to Actions 1-2 (Section C)	
T6MAT8. The value of ecosystem services is understood and a trial system for compensation under a 'beneficiary pays' principle within the City of Albany is established by 2008.	Survey of community attitude within the City of Albany.	Prepare information for community about 'ecosystem services', particularly with Case Studies and an outline of the proposed trial.	Liaison with the Water Corporation and the City of Albany require through all stages of this target area.
T6MAT9. Priority Agricultural Areas in the Torbay catchment are revised and a preferred landscape description prepared for consideration by regional and planning processes by 2005.	Adoption of revised areas within planning documents.		Development of a preferred landscape description to be undertaken by TCG with close cooperation of CoA and DPI.
T6MAT10. Opportunities for increased social and recreational values within the Torbay catchment have been reviewed through regional and local government planning processes by 2007.	Adoption of revised areas within planning documents.		TCG to propose opportunities for increased social and recreational values to CoA and DPI.

THEME 7 – COMMUNITY EDUCATION AND INFORMATION			
	INDICATORS	ACTIONS	COMMENTS
GOAL (2025) The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the shared vision for the catchment.	Survey of community perception of catchment values and the effectiveness of the Restoration Plan.		This will be a strong indication of the effectiveness of information and communication strategies.
OBJECTIVES • All key stakeholders are willingly involved in implementing the restoration plan.	Landholder survey to show level of adoption of proposed actions at 5-year intervals.		
• There is a high level of community awareness about the values of the catchment and about the best practices for sustainable management.	Survey of community perception of catchment values and the effectiveness of the Restoration Plan.		
• Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes.	Survey of community understanding of key environmental processes and priority issues.		Effective communication required for this objective.
• There is a significant level of community involvement in reviewing the restoration plan on a five yearly basis.	The attendance/number of responses to processes for reviewing the plan.		Workshop survey processes expected as a part of reviewing the Restoration Plan.

	INDICATORS	ACTIONS	COMMENTS
MANAGEMENT ACTION TARGETS **T7MAT1** More than half of landholders and residents in the Torbay catchment are able to express clear understanding and support for the catchment Vision and restoration plan by 2010.	Response to a landholder and community survey held at 5-year intervals.	Clarify the criteria to measure 'understanding and support' for use in the survey.	Document current information about community understanding and support.
T7MAT2. More than 40% of landholders are attending at least one group event annually and have copies of or direct access to current research and information relevant to actions for implementation of the Restoration Plan by 2010.	Attendance at field days or other information dissemination events. Response to landholder and community survey about access to information.		