TORBAY CATCHMENT RESTORATION PLAN

WATERSHED Torbay

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PREFACE

The Torbay Catchment Restoration Plan has been 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 its 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 (RCTs) for seven Management Themes. The RCTs provide a measure of what may reasonable be expected to be achieved within approximately 20 years through investment into the proposed actions.

Section C identifies the actions required to achieve Management Action Targets (MATs). The MATs 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 Marbellup 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 wastewater. Increasing numbers of people are moving into the area, putting more pressure on resources, which demands good planning. In addition, there are increasing sources of nutrients from agriculture and urban development.

It is important to recognise the valuable assets in the catchment, the resources we use, the aspects we treasure and our historical links. If we truly value these 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, before things get any worse.

This 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 project steering committee, the technical advisory group, the drainage management sub-committee, 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 making things happen, and I am pleased that key organisations have pledged their ongoing support. 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 and satisfied in 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
Torbay Catchment Group ChairWatershed Torbay Project Steering Committee Chair

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, the Torbay catchment was eventually nominated by the Water and Rivers Commission to the Consortium.

The Water and Rivers 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 Torbay Catchment Group enthusiastically welcomed the opportunity to participate in the project, with their enthusiasm being reinforced through an early visit by Phil Price, former CEO of Land and Water Australia, and myself to the Torbay Catchment Group.

Julie Pech, Luke Pen and myself prepared the formal project submission, 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 project 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 sub-committee, 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 project steering committee, and Andrew Marshall, Chairman of the Torbay Catchment Group, who also chaired the project 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

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 also 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, this being 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 (DAWA) and the Water Corporation (WC).

The 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 the 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 sulfate 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 wastewater, sourced from Albany, is discharged to a tree farm in the catchment. Water resources for public supply are sought from the Marbellup 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. Community 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, as 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 19 targets for resource condition change and 33 Management Action Targets. The 3 year Action Plan (Section C) provides the actions, priorities, estimated costs and roles 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 (M&E) 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.

Purpose of Restoration Plan

The Torbay Catchment Restoration 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. 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.

Structure of the Restoration Plan

The Torbay Catchment Restoration Plan consists of four sections (Figure A1). 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 A1 – Sections of the Torbay Catchment Restoration Plan

The Torbay Catchment Restoration Plan is supported by a Compendium, in which all supporting information is compiled. Associated information is also available on the Watershed Torbay website (www.torbay.scric.org).

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Abbreviations used in this plan

ABS	Australian Bureau of Statistics
AEITF	Albany Effluent Irrigated Tree Farm
AHD	Australian Height Datum
CALM	Department of Conservation and Land Management*
CENRM	Centre of Excellence for Natural Resource Management
CoA	City of Albany
DAWA	Department of Agriculture Western Australian
DoE	Department of Environment (formerly Water and Rivers Commission)*
DPI	Department of Planning and Infrastructure
DRF	Declared Rare Flora
FPC	Forest Products Commission
LPS	Local Planning Strategy
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
WALIS	West Australian Land Information System
WRC	Water and Rivers Commission
WC	Water Corporation

* *In January 2006 the Department of Water was created. In July 2006, the Department of Environment, and Department of Conservation and Land Management were merged to form the Department of Environment & Conservation (DEC).*

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 and includes several small waterways inter-connected through a series of wetlands. The low-lying wetlands were naturally influenced by marine inflow and tidal sequences. These 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 well-being of the catchment was adopted. The project proposal developed by the lead agency, the Western 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 (DAWA) 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
- 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 Communication Learning Log is available on the website www.torbay.scric.org and will be available on the Compendium CD, a compilation of all the information gathered and produced during the Watershed Torbay project.

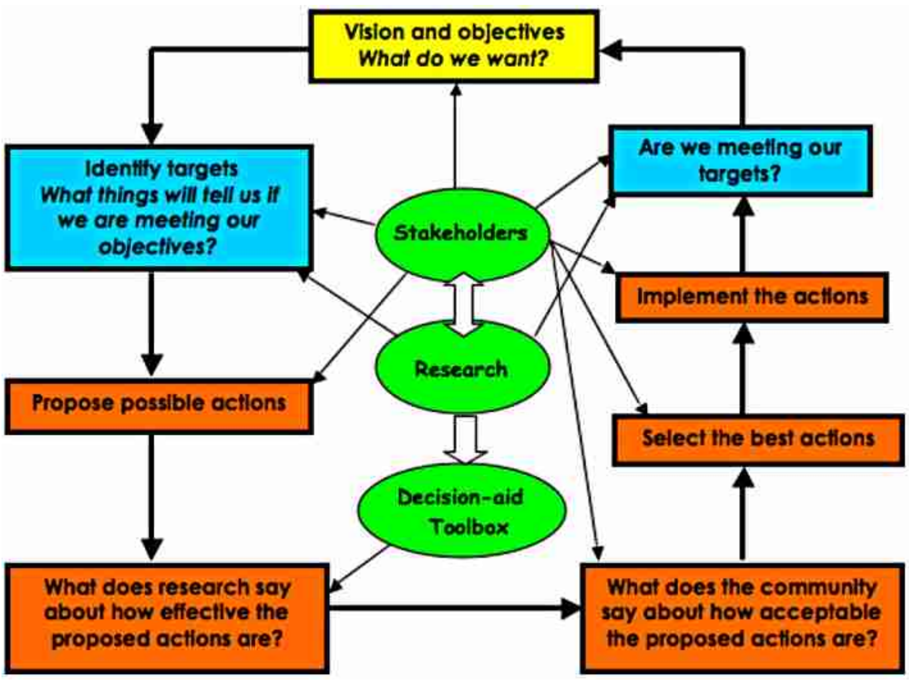
A1.2 Approach to Restoration Planning

The framework for the Torbay catchment restoration plan is shown in Figure A2, and 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 advisory group and contract researchers have provided information on possible actions to meet the objectives, adding to those suggested by the community and the project steering committee. The technical advisory 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 project 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.



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 or tourism while others are seeking a semi-rural lifestyle. 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. See Appendix 2 for the outcomes of these forums. 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 the drainage system
- Loss of lifestyle quality for residents over several months of the year during blooms
- Degradation of streams
- Meeting Albany's drinking water requirements.

The community's priority issues raised during the community forums and survey has been the basis for development of seven management themes 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. Community education and communication.

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 the 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. These include 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 project steering committee was established to oversee the project, ensure a participative approach and to broker arrangements.

The Watershed Torbay project 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 catchment restoration plan.

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

The specific requirement to 'develop a plan to improve drainage management' in the catchment has been addressed by the drainage management sub-committee 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 Westcott, community
Terri Harwood, community
Diane Evers, local government
Danny Burkett, Water Corporation
Sarah Comer, CALM
Peter Collins, CALM
Kim Kershaw, 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 project 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 project 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?

See Appendix 1 for a further explanation of the research program. A summary of relevant research projects coordinated through the TAG is provided in the compendium.

A2.0 Catchment Description

A2.1 Location and Overview

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

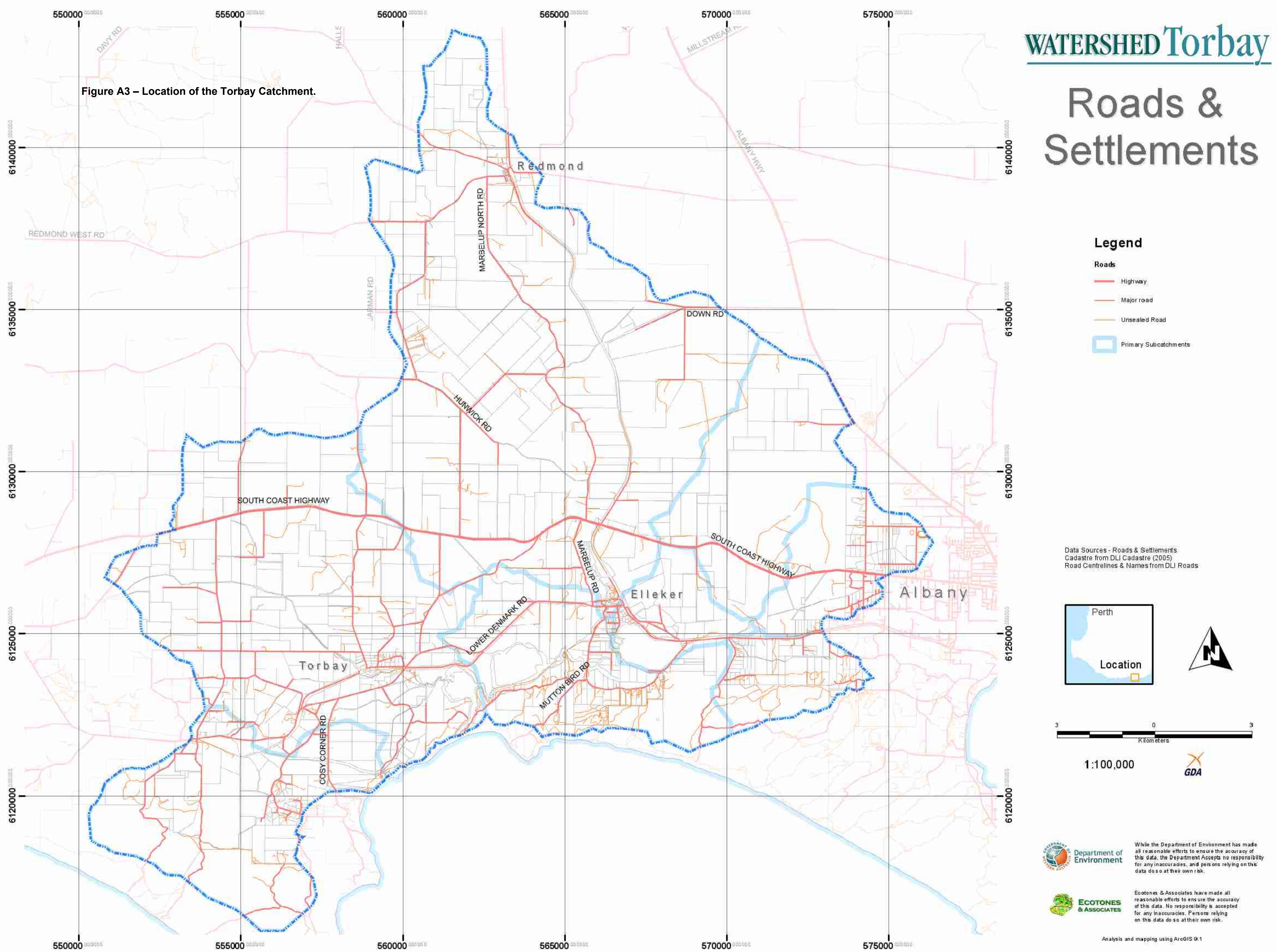


Figure A3 – Location of the Torbay Catchment.

The area of the catchment is 330 km^2 of which 33% remains as natural vegetation, 51% is used for grazing, 9% is other agriculture, 5% has commercial timber plantations and 1.6% is occupied by waterways and wetlands.

Other land uses in the catchment include annual and perennial horticulture (irrigated and non-irrigated), intensive animal industries (including dairies and a piggery), seasonal commercial fishing (in Torbay) and a growing tourism industry. A wastewater 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. This treated water is now irrigated to a commercial timber plantation within the catchment.

The climate in the Torbay catchment is Mediterranean, 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 1000 mm near the coast to 800 mm away from the coast. Variability of rainfall is low for Western Australia. The pan evaporation rate is about 1200 mm per annum, and is less than the 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 120 hectares.

The West Cape Howe National Park is a significant local feature of the catchment. The district is serviced by major and minor roads and the Perth-Albany freight railway.

A2.2 Geology, Soils and Landforms

The valley floor of the Torbay catchment is underlain by granite, gneiss and dolerite 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.

The catchment valley floor (sometimes referred to as Grasmere Valley) is of deep (up to 150 metres) 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.

These geological formations have given rise to the two soil systems, the Albany Sandplain Zone and the Warren Denmark Southland Zone. These are mapped in Figure A4. The major characteristics of these soil systems are:

Albany Sandplain Zone

A gently undulating plain dissected by a number of short rivers flowing south. Eocene marine sediments overlying Proterozoic granitic and metamorphic rocks. Soils are sandy duplex soils, often alkaline and sodic, with some sands and gravels.

Warren Denmark Southland Zone

Rises in a series of broad benches from the Southern Ocean north to the Blackwood Valley. Deeply weathered granite and gneiss overlain by Tertiary and Quaternary sediments in the south. Swampy in places.

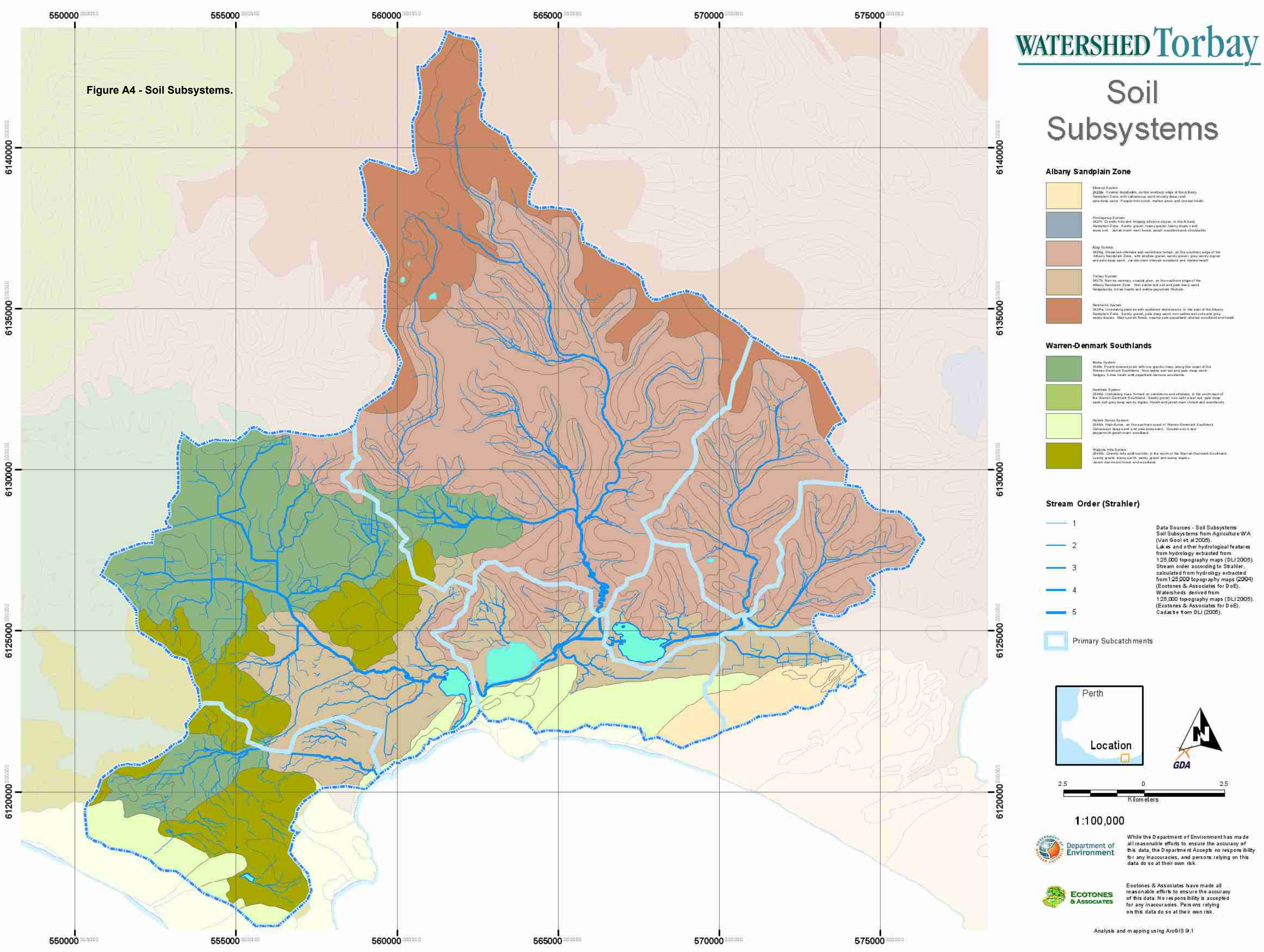


Figure A4 - Soil Subsystems.
550000
555000
560000
565000
570000
575000
6140000
6135000
6130000
6125000
6120000
WATERSHED Torbay
Soil Subsystems
Albany Sandplain Zone
Warren-Denmark Southlands
Stream Order (Strahler)
1
2
3
4
5
Primary Subcatchments
Data Sources - Soil Subsystems
Soil Subsystems from Agriculture WA (Van Gool et al 2005).
Lakes and other hydrological features from hydrology extracted from 1:25,000 topography maps (DLI 2005).
Stream order according to Strahler, calculated from hydrology extracted from 1:25,000 topography maps (2004) (Ecotones & Associates for DoE).
Watersheds derived from 1:25,000 topography maps (DLI 2005). (Ecotones & Associates for DoE).
Cadastre from DLI (2005).
Perth
Location
GDA
2.5
0
2.5
Kilometers
1:100,000
Department of Environment
While the Department of Environment has made all reasonable efforts to ensure the accuracy of this data, the Department Accepts no responsibility for any inaccuracies, and persons relying on this data do so at their own risk.
Ecotones & Associates
Ecotones & Associates have made all reasonable efforts to ensure the accuracy of this data. No responsibility is accepted for any inaccuracies. Persons relying on this data do so at their own risk.
Analysis and mapping using ArcGIS 9.1

Low-lying areas in near-coastal parts of the Torbay catchment are underlain by estuarine and shallow marine silts 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 expose acid sulfate soils and the risk of discharging acidity and metals into the drainage system. Acid sulfate soils in the Torbay catchment were first identified at Ewart Swamp, when 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.

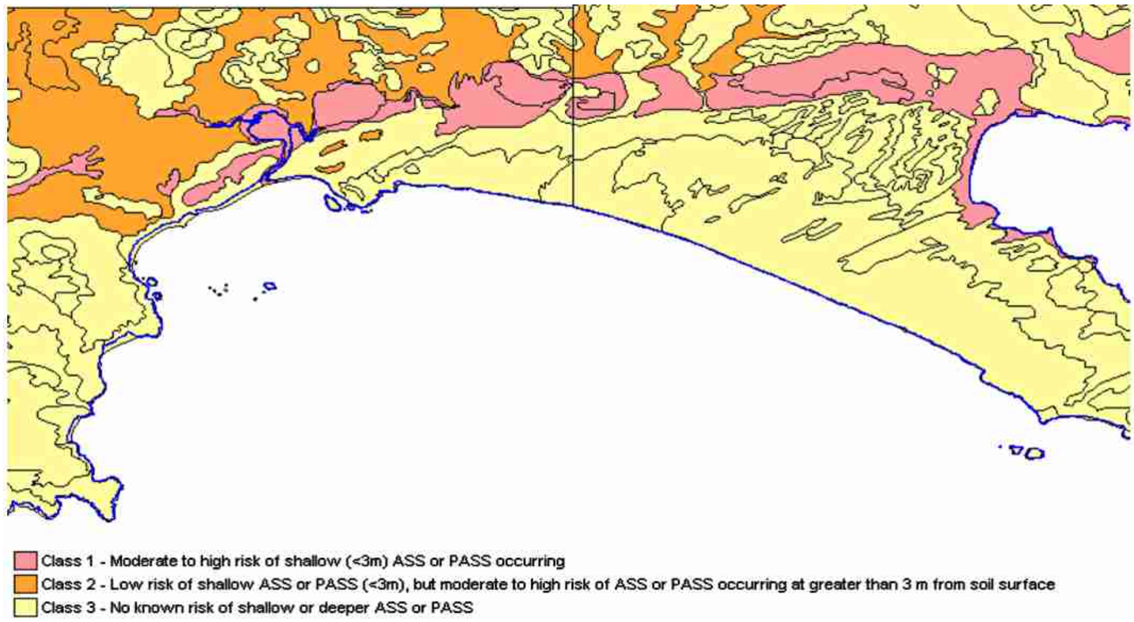


Figure A5 - Acid Sulfate Soils risk in the Lower Torbay Catchment

The topography of the Torbay Catchment is characterised by a broad, shallow valley that takes in the three key waterbodies in the catchment. Large areas of the catchment are subject to inundation during the wetter months of the year. Conversely, much of the catchment’s coastline is comprised of steep coastal cliffs, with high points at Torbay Hill.The topography of the Torbay Catchment is shown in Figure A6.

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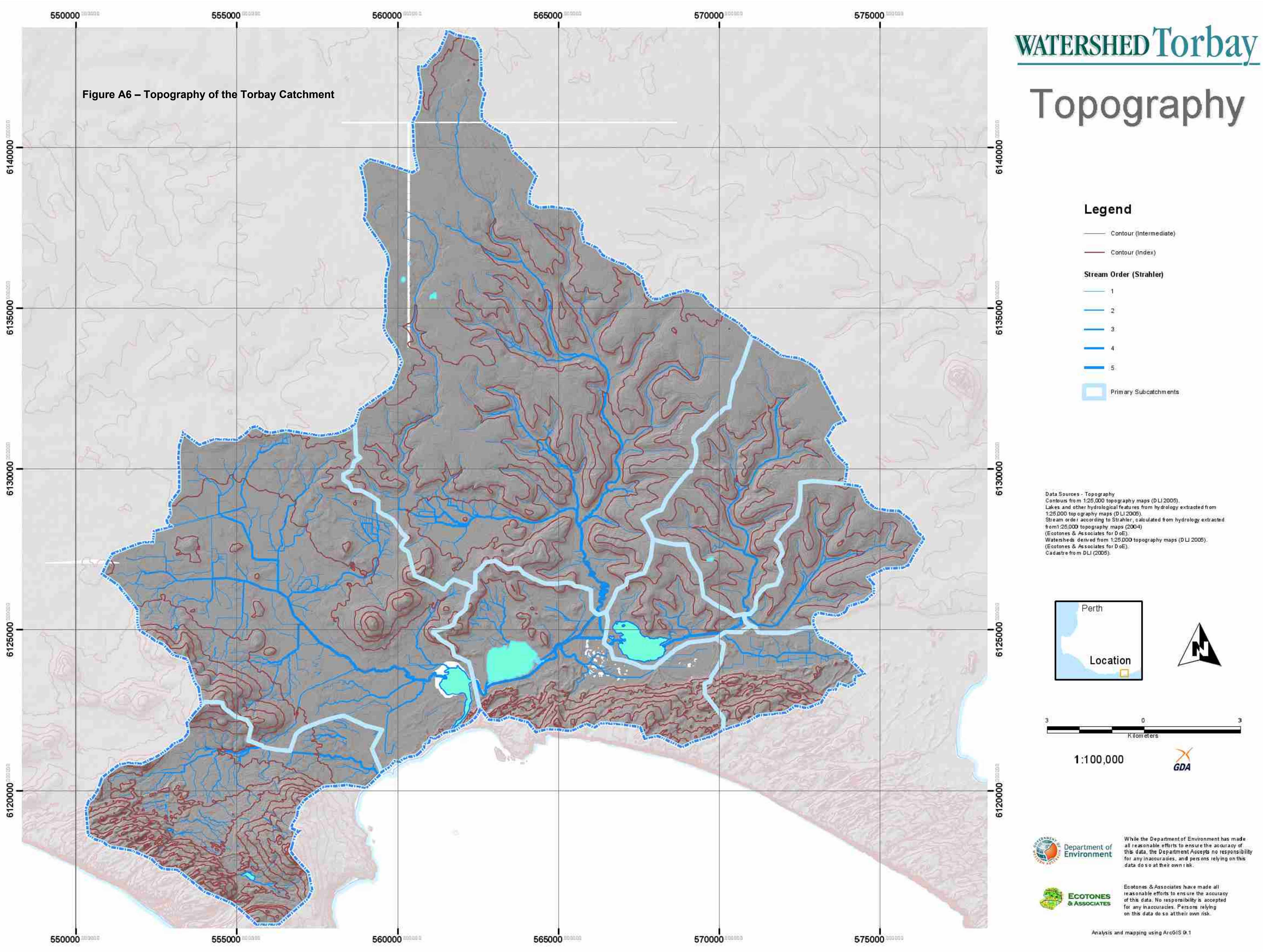


Figure A6 – Topography of the Torbay Catchment

A2.3 Wetlands and waterways

The location of wetlands and waterways in the catchment is shown in Figure A7.

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 artificial 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 metres AHD (Australian Height Datum) behind the bar.

Marbellup Brook, Five Mile Creek and Seven Mile Creek previously all discharged into Lake Powell (Marbellup Brook flow has now been diverted directly into Torbay Inlet). The lake was originally of greater area (bounded by the approximate location of Elleker Grasmere Road) and discharged through an outlet that is now known as North Creek. Overflow from the lake was direct into Lake Manarup (also previously known as Red Hill Lagoon) that discharged to Torbay when the sand bar was breached and water levels in Torbay Inlet were lowered.

Lake Manarup is a shallow lake approximately 1km^2 in area. It has a wide margin of fringing vegetation in good condition. Lake Manarup originally received water from Marbellup Brook, prior to the development of the drainage system, and now receives flow only from the North Creek Drain.

The hydraulic gradient of the natural wetland system is very low. The amplitude of tides within Torbay ranges from 40 cm to 130 cm. Larger tidal sequences caused salt water to intrude upstream of the Lower Denmark Road along Marbellup 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.

Anecdotal reports suggest that Lake Powell was quite deep (estimates of over 4 metres) and with white sand beaches, however, Hodgkin and Clark (1990) note that the original depth was probably about one metre and is now about half that depth.

The lake extended to an area that is approximately bounded by the Elleker Grasmere 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 water birds (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 fertile soil and was developed for agriculture in the late 19th century when drains were dug in Seven Mile Swamp (now known as Ewart 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 180 kilometres of waterways within the catchment. Foreshore surveys show some to remain in good ecological condition (see Compendium and www.torbay.scric.org). The major waterways (listed from east to west) are Five Mile Creek and Seven Mile Creek, which drain into Lake Powell, and Marbellup Brook and Torbay Main Drain that drain into Torbay Inlet (Figure A7).

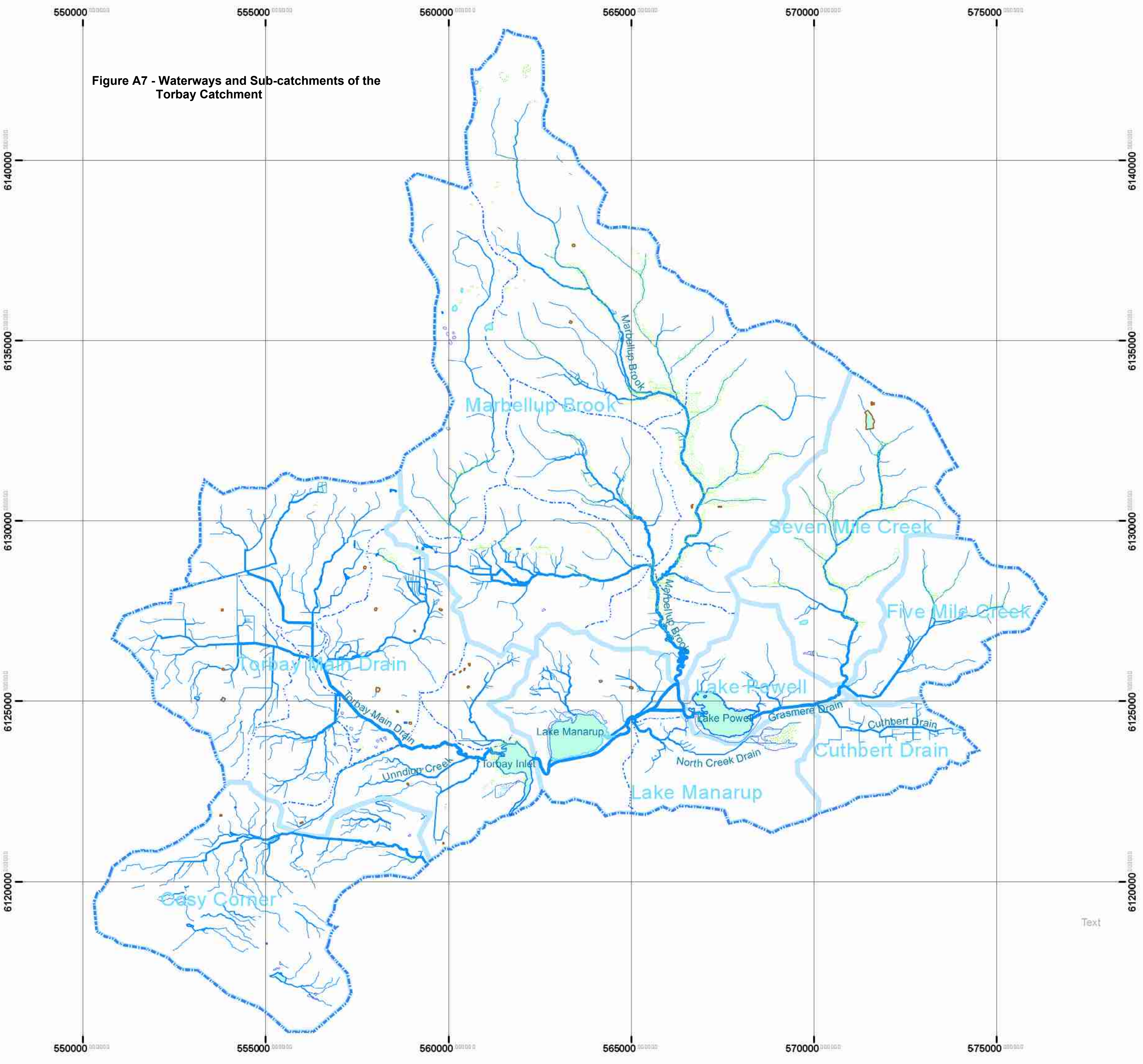


Figure A7 - Waterways and Sub-catchments of the Torbay Catchment

WATERSHED Torbay

Waterways & Subcatchments

Legend

Stream Order (Strahler)
- 1
- 2
- 3
- 4
- 5

Primary Subcatchments

Fine Subcatchments

Waterbodies
- Earth Dam
- Lake - artificial
- Lake - non-perennial
- Lake - perennial

Wetlands
- Area Subject to Inundation
- Marsh Area
- Swamp - non-perennial
- Swamp - perennial

Data Sources
Lakes and other hydrological features from hydrology extracted from 1:25,000 topography maps (DLI 2005).
Stream order according to Strahler, calculated from hydrology extracted from1:25,000 topography maps (2004) (Ecotones & Associates for DoE).
Watersheds derived from 1:25,000 topography maps (DLI 2005).
(Ecotones & Associates for DoE).
Cadastre from DLI (2005).

Perth
Location

2 0 2
Kilometers

1:100,000

GDA

Department of Environment

Ecotones & Associates

Analysis and mapping using ArcGIS 9.1

A2.4 Torbay Catchment Estuary

Like most other estuaries of the south west of Western Australia, sandbars obstruct tidal exchange into Torbay Inlet for much of the year 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 and Lake Powell. Floodgates prevent estuarine 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, being only about 6000 years old. In the last ice age, the sea level was more than 100 metres lower than it is now. The coastline was 30-40 kilometres 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; seawater 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 dunes has narrowed the mouths of most south west estuaries. Now exchange with the sea is restricted to periods when the bars are open; so 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 two 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 Marbellup Water Reserve was formed in 1986 to gazette the Marbellup sub-catchment for future use as a public drinking water source to supplement the Lower Great Southern Town Water Supply Scheme. Consideration is being given to the allocation of 5 gigalitres (GL) of the total 16 GL of annual stream flow in Marbellup Brook. An estimation of Environmental Water Requirements is an important part of this consideration under the Watershed Torbay project.

A3.0 Community Characteristics

A3.1 Land Use and Community History

People from the Minang tribe 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 Department of Indigenous Affairs' register of 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 sixteenth 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. However, 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 km 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. 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 Grasmere I passed along mere rugged tracks which in winter must be veritable Sloughs of Despond"* (Albany Advertiser, 1899).

When the catchment was first settled the main farming activity was market gardening. This was quite successful as 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 ten kilometres from the sea. This land 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 farmland. It was built of Californian redwood and worked fairly well until about 1920. However, sand built up against the downstream side, decreasing the depth from five metres on the upstream side to sixty centimetres 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, 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 1930s 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 lakebed 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 acidic (pH 3.5 from the 1910s to 1940s).

Lake Manarup is now also shallow. It is managed as a compensation basin and some areas of the basin often evaporate to a depth of only a few centimetres in summer.

During the twentieth 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 wastewater 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 reaction 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 A1 a,b,c). Income is medium to low compared on a State basis.

Table A1(a) Age Structure of Torbay catchment residents

Resident Age	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 A1(b) Ancestry of Torbay catchment residents

Origin of ancestry	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 A1(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 2003 community 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 hectares) and 38% are less than 10 hectares. The most common land use is for cattle and sheep production although high proportions of landholders use their land mainly for residential purpose. At the time of the survey there were four aquaculture enterprises, two dairies and two 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.

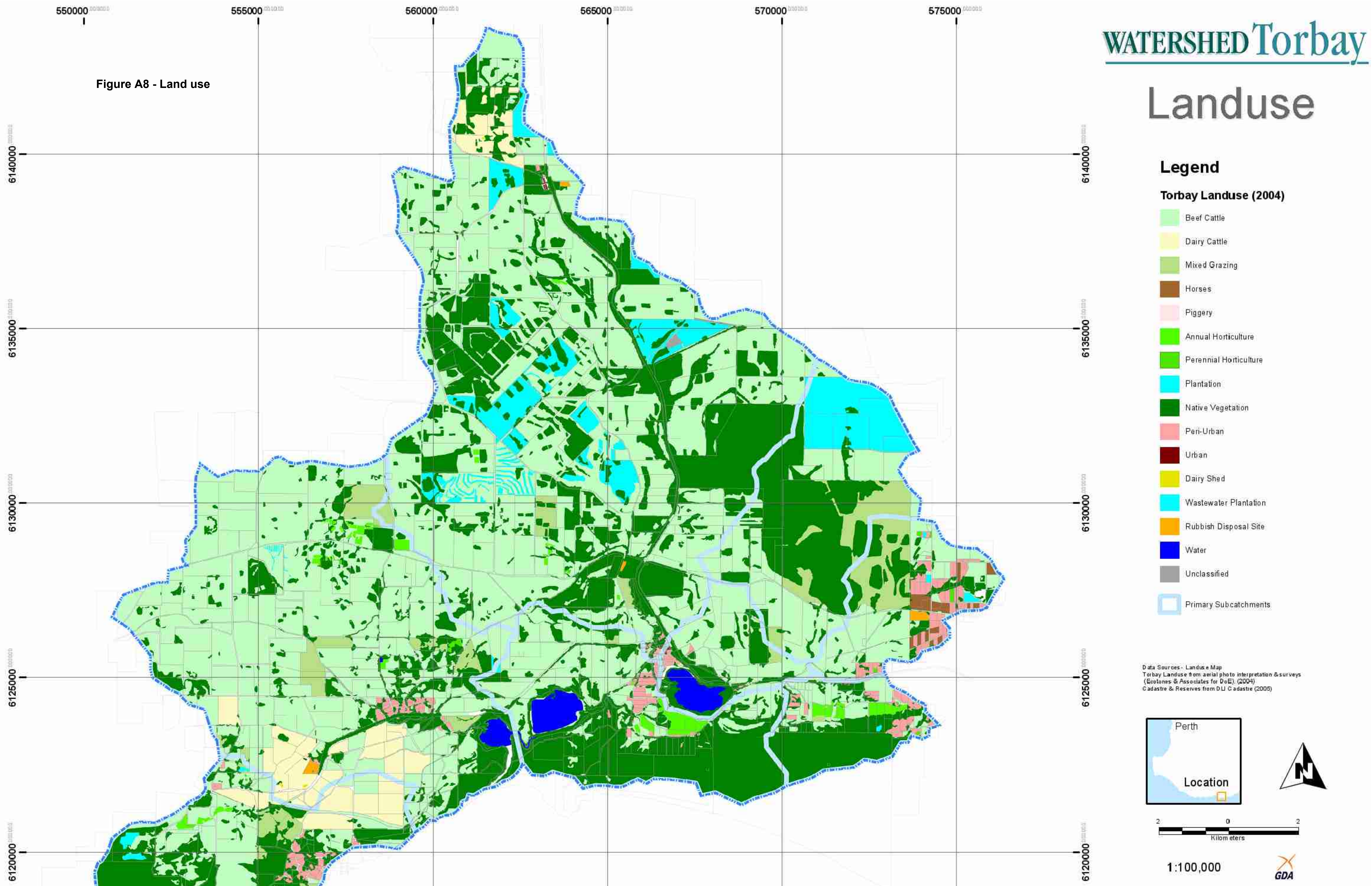
A4.0 Land Use and Natural Resource Management

A4.1 Introduction

Land in the Torbay catchment was originally settled and cleared for agricultural and horticultural use. Agriculture remains the dominant industry, however, land use is changing in response to increasing numbers of residents attracted to the area for lifestyle reasons. Watershed Torbay planning recognises the changes occurring, and aims to integrate the range of land uses (both current and future) into the Torbay Catchment Restoration Plan's management of natural resources.

Figure A8 shows the distribution of landuse within the Torbay Catchment.

Figure A8 - Land use



Data Sources - Landuse Map
Torbay Landuse from aerial photo interpretation & surveys (Ecotones & Associates for DoE). (2004)
Cadastre & Reserves from DLI Cadastre (2005)

Analysis and mapping using ArcGIS 9.1

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 hectares) is 51% of the catchment. There are limited areas cropped for cereal production, two dairies and two piggeries within the catchment. There are also many small land holdings, with landholders generating off-farm income.

A relatively recent change in land use is to commercial timber production, for wood chipping. Approximately 5% (1700 hectares) of the catchment is established to tree plantations. Most of this area is planted with Tasmanian Blue Gums (*Eucalyptus globulus*) in 10-12 year rotations under share-farm contract arrangements.

The existence of Cuthbert, Torbay, Elleker and Redmond townsites owe 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 area is well recognised as a traditional potato growing area, particularly for seed potato production. While a variety of produce is grown and the area is suitable for increased cauliflower production, potatoes are the major horticultural crop. The area currently produces about 50% of WA's requirements for seed potato production.

Two separate localities in the Torbay drainage system are under intensive horticulture. The first is on land serviced by the Cuthbert Drain, where there is an estimated 100 hectares of land suitable and potentially available for horticulture. The second locality is south of Lake Powell where there is an estimated 80 hectares of land suitable and previously used for horticulture. There are currently three growers in the Cuthbert area, using approximately 60 hectares annually and four growers in the Lake Powell area, using approximately 32 hectares 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 district drainage system reduces the risk of floods, water logging and crop drought, although some risk of these events remains.

For a viable seed potato industry to continue in these localities 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 water logging and inundations that would be economically comparable.

A4.4 Commercial Fishing

The commercial fishing industry that operates annually within Torbay is based on herring and salmon caught during February-April. Licensed operations exist at two locations, one at Cosy Corner on the west end of Torbay 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 site of Elleker is located adjacent to Lake Powell. Residential blocks of land within the town site are small but more recent residential development is on larger blocks of land in surrounding areas. There are a number of relatively small lifestyle properties (4-10 hectares) adjacent to the drainage system or overlooking the wetlands.

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

Most residential properties within these former lakebeds have on-site sewage treatment consisting of conventional septic tanks and leach drains. More recent housing approvals have required installation of nutrient retaining treatment systems. Both these systems can be a potential risk 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 Marbellup Brook immediately downstream from the Marbellup Plug are the main cause for concern. This location coincides with a former rubbish tip (not used since the mid-1970s) and with a depression in the streambed. Other complaints are about mal-odours from Lake Powell, particularly over summer and autumn when the incidence of algal blooms is peaking.

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 the population size of water birds. It is a regionally significant wetland. Having permanent water and reasonable depth give it a high value as a wetland for migratory water birds. The high nutrient levels and prolonged algal blooms do not seem to negatively affect bird breeding and use of the wetland, and the former may have a positive impact on bird numbers. Larger bird populations may be partly due to the raised nutrient status of the water encouraging the growth of the exotic Bulrush (*Typha domengensis*), which provides nesting areas and high levels of macro-invertebrate activity outside the periods of algal blooms.

Lake Manarup and Torbay Inlet are identified as Crown Reserves vested with the Water Corporation. The State Department of Planning and Infrastructure is the proprietor of these reserves, however 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, poor water quality and experiences intense algal blooms. Both wetlands presently have vegetated foreshore buffers of good quality native vegetation, which is in need of protection.

A4.7 Recreation Opportunities

Local memories of the wetlands are often about swimming in fresh water, sailing up the lagoon to Torbay Inlet and easily catching marron and 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 as a health risk to humans and animals.

An increasing number of people are attracted to the tranquillity of the valley. Many enjoy the Elleker Grasmere 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), both administered 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; and
- 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 the growth of Elleker, subject to the preparation of a detailed townsite plan. Figure A9 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).

At a regional scale, the Department of Planning and Infrastructure (DPI) 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.

Figure A9 - Residential development in Elleker and south of Lake Powell.

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 metres 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 Elleker Grasmere Road) and discharged through an outlet that is now known as North Creek. Overflow from the lake was directed into Lake Manarup. (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 Manarup previously discharged to Torbay when the sand bar was breached and water levels in Torbay Inlet were lowered.

The hydraulic gradient of the natural wetland system was very low. The amplitude of tides within Torbay ranges from 40 cm to 130 cm. Larger tidal sequences caused salt water to intrude upstream of where Lower Denmark Road now is, along Marbellup Brook and through Lake Powell to the current Cuthbert horticultural area when the inlet sand-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 developed ad-hoc until the current major drainage system was constructed during the 1950's. The Torbay Inlet drainage system is a part of the Albany Drainage District, one of six districts established and legislated for agricultural land drainage and flood control in Western Australia.

The natural sequence of surface water run-off has been altered considerably by drainage to control flooding and waterlogging in the six sub-catchments of Torbay catchment. Two of the sub-catchments, Torbay Main Drain and Cosy Corner, discharge directly to the inlet and the ocean respectively. Drainage in the other four sub-catchments is part of an integrated 3-level surface water control system. Drainage within the sub-catchments is described below:

- Five Mile Creek has 9.74 kilometres of drains from Five Mile Creek and Cuthbert horticultural area (the Cuthbert Drain) discharging via Grasmere Drain directly into Lake Powell (the 'Mid- Level' system).
- Seven Mile Creek has 1.3 km of drains discharging into Grasmere Drain.
- Marbellup Brook has 4.32 km of drains discharging directly into Torbay Inlet (the 'High Level' system) with a total annual flow of 16 gigalitres.
- Lake Manarup contains 16.78 km of drains (via North Creek) discharging directly into Lake Manarup (the 'Low Level' system).
- Torbay Main Drain has 33.22 km of drains that discharge directly into the western side of Torbay Inlet.
- Cosy Corner has 3.88 km of drains that have direct ocean outfall.

In total there are over 70 km of excavated drains in the Torbay Catchment, excluding feeder drains constructed on individual properties (Table A2). There is are over 180 kilometres of natural waterways within the catchment.

Subcatchment	Drains (km)	Natural Waterways (km)	Swales (km)	Total
Five Mile Creek	3.8	9.7	4.1	17.6
Seven Mile Creek	1.3	22.8	3.5	27.6
Marbellup Brook	0.0	110.0	16.3	126.3
Torbay Main Drain	72.5	41.9	47.2	161.6
Total of surveyed sub-catchments	77.6	185.4	70.0	333.0

Table A2 - Waterways within Torbay sub-catchments.

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 (North Creek) system into Lake Manarup
- Mal-odours from Marbellup Brook (below the Plug) and Lake Powell
- Water quality in North Creek for water-based recreation
- Algal blooms in Lake Powell, Torbay Inlet and Marbellup Brook.

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 three-level drainage system.