DRAFT REPORT

TUMBARUMBA INTEGRATED WATER CYCLE MANAGEMENT STRATEGY

Evaluation Study

Prepared for

TUMBARUMBA SHIRE COUNCIL

June 2008

Prepared by

Nielsen Environmental Pty Ltd

sustainable water cycle management solutions

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ACKNOWLEDGEMENTS

This report has been prepared with the assistance of Gus Cox, Tanya Wilesmith, Kay Whitehead and Robyn Cannon (current Tumbarumba Shire Council staff) as well as Ian Chaffey, Brent Livermore and Julie Goulter (previous Tumbarumba Shire Council staff).

Information sources have all been acknowledged where possible.

EXECUTIVE SUMMARY

Preamble

Tumbarumba Shire Council commenced this Integrated Water Cycle Management (IWCM) Study in April 2006 because of several water-related issues and the desire to improve compliance with Best-Practice management of water resources and services. This study has taken more than two years to complete for a number of reasons, including that Council has used it as a catalyst for implementing several Best-Practice management initiatives, including development of Demand Management and Draught Management strategies, revision of Strategic Business Plans and Pricing Policies and improved water metering. The outcomes of these initiatives have been included in this Evaluation Study report.

The objectives of the Evaluation Study are as follows:

- To describe the various components of the urban water services and identify relationships between these components.
- To collect and review available reports, strategies and data for adequacy, ie accuracy and sufficiency, for IWCM planning purposes so that additional data/information requirements can be identified.
- To audit existing data against water service objectives and obligations in order to determine whether Tumbarumba Shire Council is meeting its service obligations in the provision of urban water services by identifying operating issues, issues resulting from catchment impacts on Council activities (eg availability of water) and problems resulting from Council impacts on the catchment (eg water quality impacts on streams).
- To identify which IWCM Issues would be addressed by existing Council actions and commitments, ie Business as Usual (BaU).
- To identify the remaining IWCM Issues that BaU would not solve and recommend the type of Strategy Plan required to solve these issues.
- To prepare a report that describes the outcomes of the Evaluation Study.

Issues

This evaluation has assessed IWCM Issues and Secondary Issues for the following aspects: data, catchment, water resources, urban water supply systems, urban sewerage systems and urban stormwater systems.

Only IWCM Issues need to be addressed in the IWCM study. However, Secondary Issues should be noted to ensure that the IWCM Strategy has a high level of community ownership and can be effectively implemented. Secondary Issues should be periodically reviewed because they could become IWCM Issues in the future.

The following IWCM Issues were identified:

- Asset Register is out of date.
- Detailed Water Demand Projections have not been undertaken.
- Inadequate security of water supply in Tumbarumba.

- Small volume of water storage dam at Tumbarumba township.
- The current water supply system in Tumbarumba only has one public health barrier, ie chlorination.
- The water trunk mains and reticulation systems in Khancoban are nearing the end of their theoretical useful lives.
- Non-compliance with DECC Licence requirements at Tumbarumba and Khancoban WWTPs (during wet weather).
- Much of the sewerage trunk mains and reticulation systems in Tumbarumba and Khancoban are nearing the end of their theoretical useful lives

All of the identified IWCM Issues would be addressed by existing Council Business as Usual actions and commitments. Therefore, this Evaluation Study has not justified the development of a subsequent Strategy Plan as there are no IWCM Issues that need "new" actions which are not already included in Council's strategic business planning.

Implementation

The IWCM Issues will be addressed during 2008/09 and 2009/10, as indicated in Table 5.1.

Data Collection and Monitoring Requirements

It is considered that current monitoring of water sources, treated water and wastewater treatment plants is adequate. However, a number of issues have been identified regarding data. Council should pay particular attention to the following data issues:

- Update the Asset Register.
- Review the integrity and quality of management systems and revise as necessary.
- Ensure adequate and on-going staff training so that management and reporting systems are properly used by current and future Council staff.
- Monitor water quality in Mannus Lake.
- Monitor water quality in Tumbarumba Creek upstream of the water intake pumps.
- Monitor the high level of Unaccounted for Water in Tumbarumba township (27% during 2005/06) and investigate options to reduce the level of Unaccounted for Water if it continues to be higher than 10% to 15%.
- Repair/relocate ultrasonic flow meter at Tumbarumba WWTP so that accurate effluent flow data are obtained for all flow conditions.

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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AC	Asbestos Cement
ADWF	Average Dry Weather Flow
ADWG	Australian Drinking Water Guidelines
BaU	Business as Usual
BOD/BOD_5	Biochemical Oxygen Demand/5 day Biochemical Oxygen Demand
cfu/100 mL	Colony Forming Units per 100 Millilitres
CMA	Catchment Management Authority
COAG	Commonwealth Organisation of Australian Governments
DECC	Department of Environment and Climate Change
DEUS	Department of Energy, Utilities and Sustainability
DNR	Department of Natural Resources
EP	Equivalent Person
EPA	Environment Protection Authority
GDP	Gross Domestic Product
HU	Hazen Unit
IWCM	Integrated Water Cycle Management
kL	Kilolitre
L	Litre
LBP	Local Best Practice
LWU	Local Water Utility
m	Metre
mg/L	Milligram per Litre
mL	Millilitre
ML	Megalitre
mm	Millimetre
NFR	Non Filterable Residue
NPWS	National Parks and Wildlife Service
NTU	Nephelometric Turbidity Unit
PVC	Polyvinyl Chloride
POEA	Protection of the Environment Administration Act 1997
PRG	Project Reference Group
SAR	Sodium Adsorption Ratio
SS	Suspended Solids
TBL	Triple Bottom Line
TSS	Total Suspended Solids
WMA	Water Management Act
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 BACKGROUND

Tumbarumba Shire Council has undertaken this Integrated Water Cycle Management (IWCM) Evaluation Study to aid in the identification and development of management strategies for the delivery of sustainable urban water services for the next 30 years. Specific objectives are to:

- Describe the various components of the urban water services operated by Tumbarumba Shire Council and to identify relationships between these components.
- Identify IWCM Issues (both current and future) and their likely impacts on the future delivery of urban water services.
- Recommend a strategy that provides a sound framework for the future management of urban water services within Tumbarumba Shire in the context of sound business planning principles.
- Incorporate stakeholder issues and priorities in the IWCM Study.

1.2 WHAT IS INTEGRATED WATER CYCLE MANAGEMENT?

Integrated Water Cycle Management is a core requirement for Local Water Utilities (LWUs) to achieve Best-Practice management of water resources. The key goals of IWCM are to:

1. provide access to all relevant information;
2. improve interactions with other systems;
3. ensure information is transparent to stakeholders; and
4. ensure balanced decisions are made.

These goals are achieved by adopting the following basic principles:

- Consideration of all water sources (including wastewater) in water planning;
- Sustainable and equitable use of all water sources;
- Consideration of all water users;
- Integration of water use and natural water processes; and
- A whole of catchment integration of natural resource use and management.

These principals require the effective and efficient delivery of urban water services as well as the implementation of sustainable water conservation and water demand practices. IWCM requires integrated management of all sources of urban water using a whole-of-catchment approach. These sources include the three main water services operated by LWUs (ie water supply, sewerage and stormwater) as well as water generated by other relevant services (eg road drainage, waste collection). These sources have traditionally been regarded as separate components of the water cycle.

Integrated Water Cycle Management provides a framework to assist in identifying water resource and water service issues and to address these issues by determining appropriate management responses so that Local Water Utility (LWU) obligations are met. It aims to minimise the potential for poor or ill-informed decisions and to ensure the optimal use of water resources. IWCM is also intended to improve business

management as well as to improve management of water resources and water services. Specific benefits of IWCM include: obtaining maximum value from water resources; minimal environmental impacts; improved customer satisfaction; reduced costs; and, reduced risks to customers.

Therefore, the net outcome of IWCM planning is a strategy that demonstrates how the water cycle will be managed to ensure sustainable operation of water services and to provide the required water (in terms of volumes and water quality) over a long term planning horizon (typically 30 years).

1.3 THE INTEGRATED WATER CYCLE MANAGEMENT PROCESS

Development of an IWCM Strategy consists of the first or both of the following two parts:

1. **Evaluation Study** (this study), which addresses the question "What are the issues?" and answers the question "Which issues can be fixed by existing Tumbarumba Shire Council actions and commitments?"

   The Evaluation Study describes the current urban water system services (water, sewerage and stormwater) and the water system related parts of the catchment. It audits the available data against key LWU/community/government targets or expectations for adequacy for IWCM planning purposes and. The audit assists in identifying how well the urban water service systems are understood and managed and identifies IWCM Issues. It also identifies which issues would be addressed by current Council actions and commitments (ie BaU) and recommends the type of Strategy Plan which would be required to solve the issue that would not be solved by BaU actions and commitments.

2. **Strategy Plan,** which consists of a Simplified Strategy Plan based on the Local Best Practice (LBP) Scenario or a Detailed Strategy Plan. The Plan puts in place a framework for implementing solutions for issues that would not be solved by the BaU actions and commitments. The Evaluation Study feeds directly into development of the Strategy Plan.

   The Simplified Strategy Plan demonstrates how the issues not solved by the BaU actions and commitments can be solved by the adoption of new best practices, minor capital works and/or significant capital works that would not be required within 10 years. The Detailed Strategy Plan is required if significant capital works are required within 10 years to solve IWCM Issues not solved by the BaU actions and commitments. It requires development and analysis of Traditional and Integrated Scenarios.

The IWCM process is shown in the following flow chart.

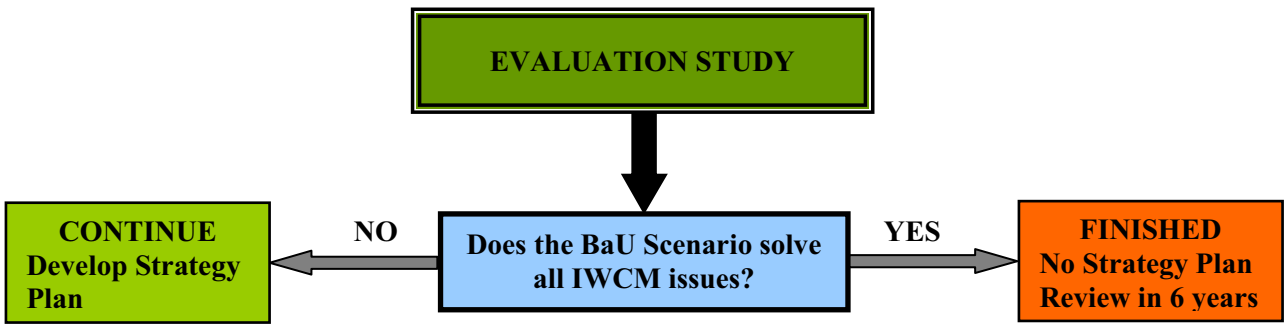

Figure 1.1: IWCM Process

1.4 OBJECTIVES OF EVALUATION STUDY

This Evaluation Study addresses the townships of Tumbarumba and Khancoban.

The objectives of the Evaluation Study are as follows:

- To describe the various components of the urban water services and identify relationships between these components.
- To collect and review available reports, strategies and data for adequacy, ie accuracy and sufficiency, for IWCM planning purposes so that additional data/information requirements can be identified.
- To audit existing data against water service objectives and obligations in order to determine whether Tumbarumba Shire Council is meeting its service obligations in the provision of urban water services by identifying operating issues, issues resulting from catchment impacts on Council activities (eg availability of water) and problems resulting from Council impacts on the catchment (eg water quality impacts on streams).
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- To prepare a report that describes the outcomes of the Evaluation Study.

1.5 STRUCTURE OF THIS DOCUMENT

The findings of the Evaluation Study are presented under the following section headings:

Executive Summary

1. **Introduction**, including background, an overview of IWCM and objectives of the Evaluation Study.
2. **Description of Catchment**, including catchment characteristics and water resources.
3. **Description of Urban Water Services**, including urban water supply services, urban sewerage services and urban stormwater services.
4. **Issues** (IWCM and Secondary Issues) to address system performance as identified by audits of data adequacy, the catchment, water resources and urban water supply, sewerage and stormwater services.
5. **Opportunities for Solving IWCM Issues**, including which IWCM Issues would be addressed by existing Council actions and commitments, the need for a subsequent Strategy Plan, implementation and data collection/monitoring requirements.
6. **References**

Appendix A. Relevant Technical and Planning Documents and Information
Appendix B. Audit Checklist
Appendix C. Minutes of PRG Meeting

2 DESCRIPTION OF CATCHMENT AND WATER RESOURCES

Characteristics in Tumbarumba Shire are described in this section in two parts: Catchment Characteristics and Water Resources. Catchment characteristics are presented to set the scene by providing an overview of physical attributes of the study area and environs. Water resource characteristics are important to determine how current and future water demands can best be met efficiently and sustainably. The quantity of available water may drive the search for alternative sources and more efficient use. The quality of the water available plays a role in determining the required treatment for particular uses and may impact on the cost of providing the water.

Although data are presented according to these parts for ease of presentation, it is important that they are considered in an integrated manner. Interactions between the catchment, water resources and the urban area are described where relevant throughout this report, particularly in Section 4 and 5.

2.1 CATCHMENT CHARACTERISTICS

Overview

Location		South-western slopes of the Snowy Mountains
Major Towns		Tumbarumba and Khancoban
Physical Characteristics	Area	4,371 square kilometres
	Topography	Mountainous
Shire Population		3,534 (2006 census, www.abs.gov.au)
Climate	Mean Daily Temperature	• 9.6 °C to 29.6 °C (summer) • -0.2 °C to 13.1 °C (winter)
	Mean Annual Rainfall	980 mm (mainly during winter and spring)
Geology and Soils	Geology	Highly deformed volcanic, granite and metamorphic rocks of Palaeozoic age and filled by tertiary and quaternary sediments
	Major Soil Types	• Tumbarumba: silty sandy clays with some granite soils-also some generally fertile chocolate soils on small pockets of basalt • Khancoban: granite and shale soils
	Impacts	• No salt affected area • No acid sulphate soils
Landuse/Economics	Annual GDP	More than $190 million (2005)
	Main industries	Timber & timber products, traditional agriculture, horticulture, viticulture, tourism

Main Data Sources (also refer Appendix A)

- ABS. 2001. 2001 Census QuickStats for Tumbarumba Local Government Area. Australian Bureau of Statistics.
- Linqage International. July 2002. *Sustaining the Magic. Tumbarumba 2002*. Community Strategic Plan.
- Murray Catchment Management Authority. 2006. *Catchment Action Plan 2006*. Draft Copy for Review, April 2006.
- www.rrdb.com.au/rivprofile/tumbarumba.htm. Riverine Regional Development Board Website.
- Storm Consulting. April 2001. Tumbarumba Draft Stormwater Management Plan.
- Tumbarumba Shire Council. September 2005. *Tumbarumba Shire Strategic Plan.*
- Tumbarumba Shire Council. June 2005. *2005-2006 Management Plan.*

2.1.1 Location

Tumbarumba Shire is located in the eastern part of the Murray Basin on the south-western slopes of the Snowy Mountains approximately 470 km south west of Sydney (refer Figure 2.1).

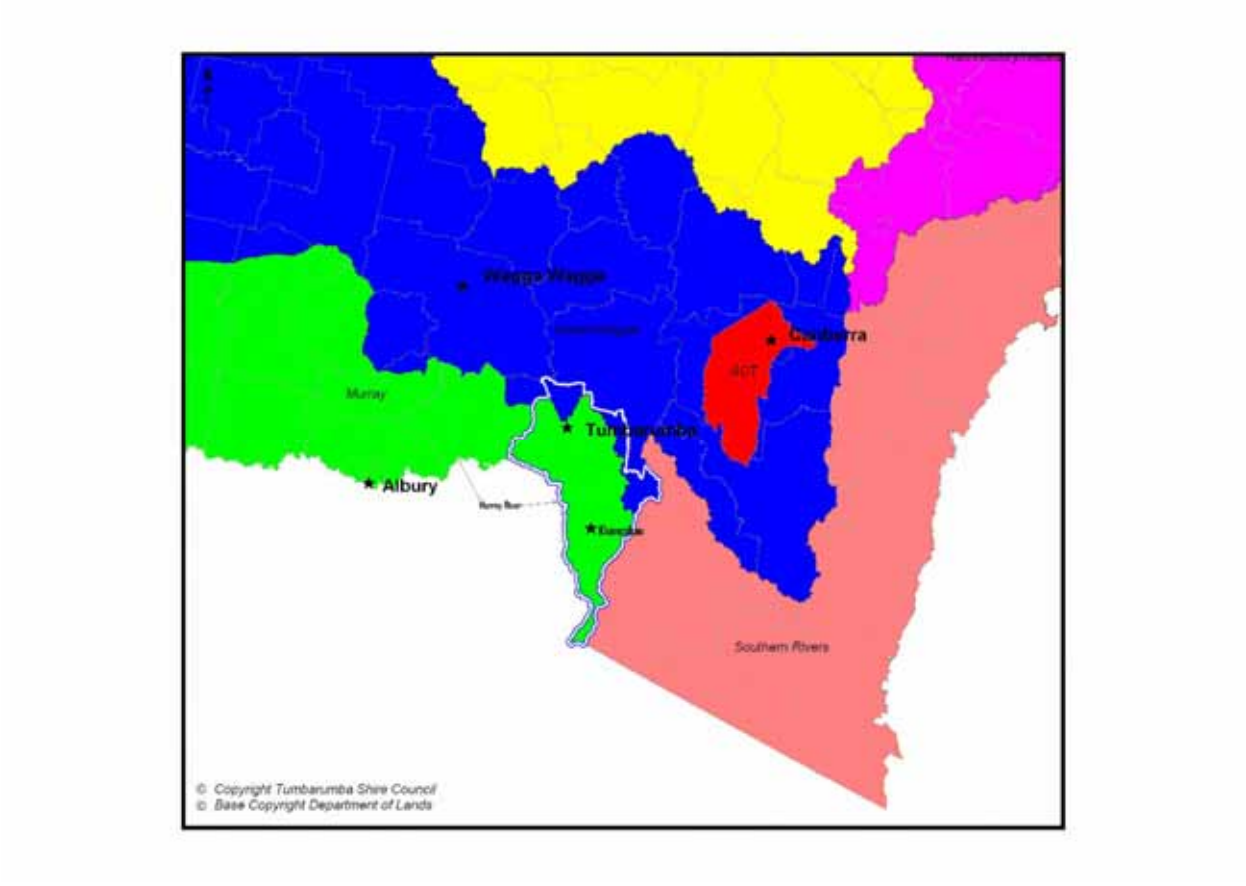

Figure 2.1: Location of Tumbarumba Shire

2.1.2 General Features

The main features of Tumbarumba Shire, including rivers and creeks, are shown in Figure 2.2. The shire covers an area of 4,371 square kilometres. It extends from Laurel Hill in the north to the Murray River and the New South Wales-Victoria border in the south. The main ridge of the Great Dividing Range forms the eastern boundary of the Shire and Jingellic marks the western boundary.

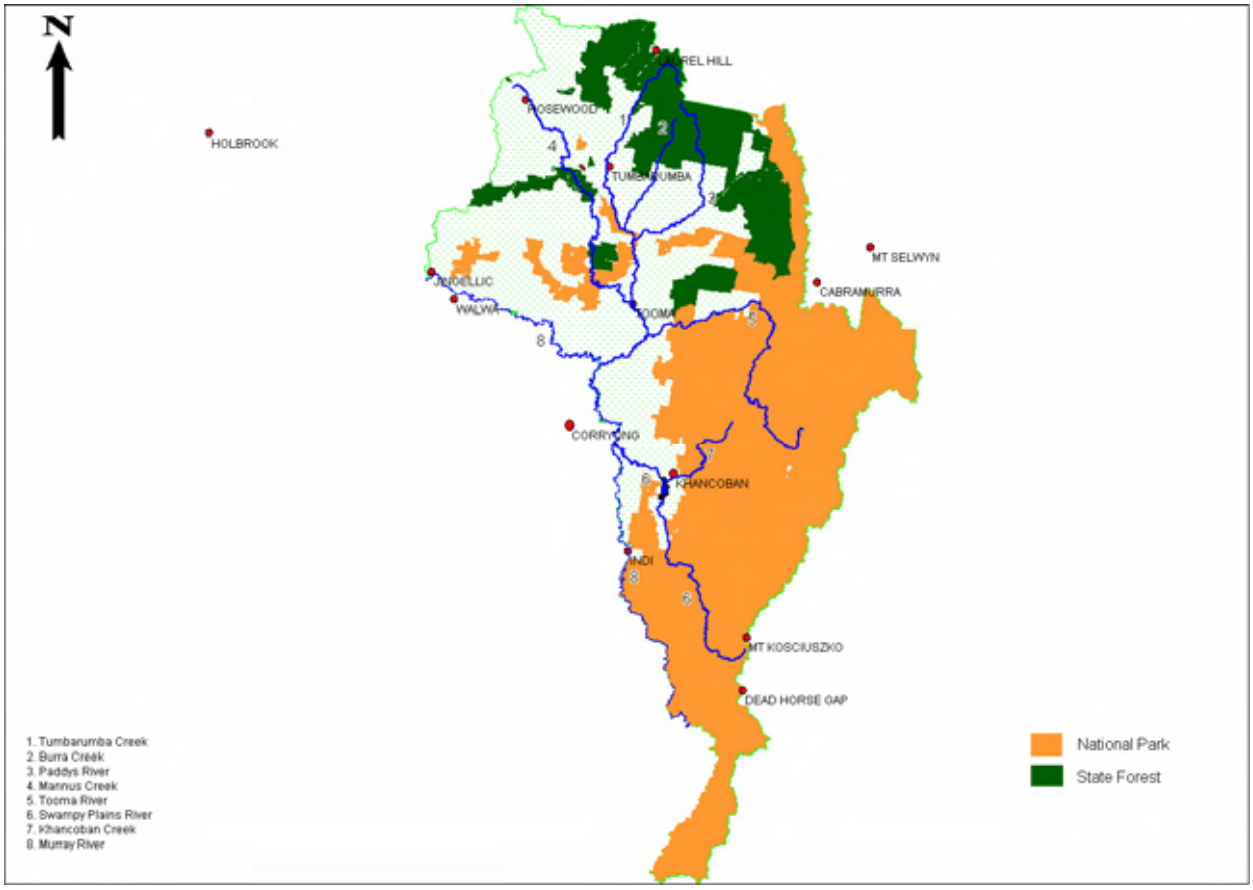

Figure 2.2: Features of Tumbarumba Shire

The Shire is located 300 to 2,731 metres above sea level. The topography changes from mountainous in the east to hilly and then undulating slopes in the west. The southern border of the Shire along the length of the Murray River from Jingellic to Khancoban incorporates areas of flood plains.

Much of the Shire has been cleared of native vegetation; however, there are significant areas of hardwood and softwood forests. The predominant vegetation type is hardwood native forest.

The Murray Catchment Management Authority (CMA) has advised that there are no wetlands in the Shire that are considered to be significant. However, smaller wetlands do exist, eg at the headwaters of Tarcutta Creek, which flows into the Murrumbidgee River.

There are five natural reserve areas in the Shire:

- Kosciuszko National Park 207,298.4 ha;

- Jingellic Nature Reserve: 2,139.6 ha;
- Bogandyera Natural Reserve: 8,681.1 ha;
- Clarkes Hill Nature Reserve: 2,130.1 ha; and
- Courabyra Nature Reserve: 239.7 ha.

Other protected areas are the native forests, which have special zoning by State Forests that only permit selective harvesting with special conditions.

2.1.3 Climate

Key climate characteristics are summarised in Tables 2.1 and 2.2.

Table 2.1: Climate by Season

Season	Highest Maximum Temperature	Lowest Minimum Temperature	Mean Monthly Rainfall	Mean Daily Evaporation
Tumbarumba (Tumbarumba Post Office, 1885 to 2004)				
Summer	39.4 °C	0.4 °C	61.8 mm	na
Winter	18.6 °C	-10.4 °C	105.6 mm	na
Khancoban (Khancoban SMHEA, 1961 to 2004)				
Summer	41.7 °C	1.1 °C	61.4 mm	6.3 mm
Winter	23.3 °C	-8.0 °C	100.4 mm	0.9 mm

Source: Bureau of Meteorology Website (www.bom.gov.au/climate/averages/tables)

Table 2.2: Climate by Month

Season	Mean Daily Maximum Temperature	Mean Daily Minimum Temperature	Mean Monthly Rainfall	Mean Daily Evaporation
Tumbarumba (Tumbarumba Post Office, 1885 to 2004)				
January	28.3 °C	11.9 °C	63.2 mm	na
February	28.0 °C	11.8 °C	52.5 mm	na
March	24.9 °C	8.6 °C	66.0 mm	na
April	19.9 °C	4.7 °C	66.2 mm	na
May	15.2 °C	2.4 °C	84.5 mm	na
June	11.5 °C	0.2 °C	104.2 mm	na
July	10.6 °C	-0.2 °C	105.5 mm	na

Season	Mean Daily Maximum Temperature	Mean Daily Minimum Temperature	Mean Monthly Rainfall	Mean Daily Evaporation
August	12.2 ºC	0.9 ºC	107.2 mm	na
September	15.2 ºC	3.1 ºC	91.4 mm	na
October	19.1 ºC	5.2 ºC	98.6 mm	na
November	22.3 ºC	7.1 ºC	71.8 mm	na
December	26.0 ºC	9.6 ºC	69.7 mm	na
Khancoban (Khancoban SMHEA, 1961 to 2004)				
January	29.6 ºC	12.8 ºC	62.1 mm	6.6 mm
February	29.7 ºC	13.0 ºC	47.2 mm	6.1 mm
March	26.4 ºC	10.4 ºC	56.7 mm	4.4 mm
April	21.2 ºC	7.0 ºC	62.8 mm	2.4 mm
May	15.7 ºC	4.2 ºC	86.8 mm	1.2 mm
June	11.6 ºC	1.8 ºC	85.2 mm	0.7 mm
July	11.0 ºC	1.4 ºC	101.7 mm	0.7 mm
August	13.1 ºC	2.6 ºC	114.3 mm	1.2 mm
September	16.3 ºC	4.4 ºC	99.5 mm	2.2 mm
October	20.2 ºC	6.9 ºC	101.5 mm	3.4 mm
November	23.7 ºC	8.9 ºC	80.6 mm	4.8 mm
December	27.0 ºC	11.3 ºC	74.8 mm	6.1 mm

Source: Bureau of Meteorology Website (www.bom.gov.au/climate/averages/tables)

Tumbarumba Shire has an alpine climate with warm summers and cold winters. January and February are the warmest months with mean daily temperatures of 12 ºC to 30 ºC. July is typically the coldest month with mean daily temperatures of a little less than 0 ºC to 11 ºC.

It rains throughout the year, with the highest rainfall occurring during winter and spring months. Heavy frosts and snow falls occur during winter months. The average annual rainfall throughout the Shire is 985 mm. No evaporation data are available for Tumbarumba township; however the average daily evaporation is 3.2 mm/day at Corryong, the nearest Bureau of Meteorology evaporation measurement site. The average daily evaporation is 3.3 mm/day at Khancoban.

Comparison of the rainfall and evaporation data indicates that evaporation exceeds rainfall during all months except from June to October. Therefore, irrigation is feasible during most of the year, particularly during summer months as well as some spring and autumn months.

2.1.4 Geology and Soils

Tumbarumba Shire is rimmed and underlain by highly deformed volcanic, granitic and metamorphic rocks of Palaeozoic age and filled by tertiary and quaternary sediments.

Soil types vary according to topography and geomorphology. The predominant soil types around Tumbarumba township are silty sandy clays with some granite soils. Generally fertile chocolate soils on small pockets of basalt also occur. Granite and shale soils predominate around Khancoban.

No parts of the Shire, including urban areas, are salt affected. Furthermore, no acid sulphate soils are known to exist in the Shire.

2.1.5 Land Uses and Economic Environment

Major land uses in the Shire are (as at 2001):

- National park: 2,073 square kilometres (Kosciuszko National Park);
- Farming: 1,820 square kilometres;
- State forest: 750 square kilometres; and
- Urban (low density): 5 square kilometres.

Agriculture and forestry are the dominant commercial land uses and employers in Tumbarumba Shire. There are currently more than 270 farms in the Shire. Over the last decade, significant expansion in the area planted with softwood forests occurred because of natural advantages provided by the local climate and altitude as well as Tumbarumba's location, which is close to the timber resources and the prime markets of Sydney and Melbourne.

The largest industry in Tumbarumba Shire is the Hyne & Son Pty Ltd Timber Mill on the outskirts of Tumbarumba township (refer Figure 2.3 for layout and Figure 3.1 for location). The mill produces a T2 product that has been treated with an oil blend containing a common insecticide (Permethrin). No copper, chromium or arsenic products are used for treating timber.

Other core industries in the Shire include timber manufacturing, traditional agriculture (mainly beef, wool, cropping, grains and seeds), horticulture (growth of apples, blueberries, herbs and oils), viticulture (growth of premium wine grapes), tourism and a centre for services to the hydroelectric industry in the southern part of the Shire in Khancoban. There are only seven dairy farms in the Shire, all located near the western boundary of the Shire.

Figure 2.3: Layout of the Hyne & Son Pty Ltd Timber Mill

The annual gross domestic product (GDP) of the Shire was estimated to be more than $160 million in 2002 and more than $190 million in 2005. Specific contributions to the Shire's GDP in 2002 are detailed in the following table.

Table 2.3: Gross Domestic Product Details (2002)

Industry Sector	Contribution to GDP ($ million)
Timber & Timber Products	69.75
Traditional Agriculture	33.7
Government Administration	15.6
High Value Horticulture	10.1
Retail	8.5
Transport	5.72
Viticulture	5.7
Accommodation, cafes, restaurants	4.6
Education	2.8
Health and Community Services	1.6
Other	2.0
TOTAL	160.07

Tumbarumba and its surrounding area were at best experiencing zero economic growth prior to 2001. The Hyne & Son Timber Mill and other economic activities in the Shire have resulted in an estimated growth in GDP of 20% since 2002. It is estimated that the mill will result in an annual growth rate in the Shire's GDP of 1.25% over the next 20 years.

The $120 million Hyne & Son Timber Mill, which was opened in 2001 and commenced production in 2004, demonstrates the business strength and confidence in the Tumbarumba area. This has been demonstrated by reference to the area in the NSW Parliament as "the economic miracle". The Hyne & Son Timber Mill will continue to be expanded for several years. Existing industries are expected to expand their services and other industries are expected to become established in Tumbarumba.

2.1.6 Main Urban Centres

The townships of Tumbarumba and Khancoban and the villages of Rosewood and Jingellic are the main urban centres (refer Figure 2.2 for locations). Council only provides water supply and sewerage services to Tumbarumba and Khancoban townships. Feasibility studies for the provision of water supply and sewerage services to Rosewood and Jingellic have been prepared by Council.

The 2006 census indicated that most (93%) of the population live in separate houses and that only 7% of the population lived in semi-detached, row or terrace houses, townhouses, flats, units, apartments or other types of dwellings.

Tumbarumba

The layout of Tumbarumba township is shown in Figure 2.4. It occupies an area of 1.5 square kilometres.

Tumbarumba is built along Tumbarumba Creek in a small protected valley. The elevation of the Creek is approximately 600 m at its lowest point in the township. The elevation on both sides of the township increases to a little more than 770 m over short distances.

Tumbarumba Creek flows through the township in an approximate north to south direction along land that is predominantly zoned for public recreation with some small areas zoned rural (1A). Tumbarumba Creek is fed by Pound Creek, which flows to the east of Batlow Road. Water is extracted from both of these streams for domestic and rural uses.

Tumbarumba Creek and Pound Creek are classified as uncontrolled streams by the Murray CMA and both are unregulated. Tumbarumba Creek flows to Mannus Creek, which is classified as a controlled stream with an altered flow pattern.

Figure 2.4: Layout of Tumbarumba Township

Within the Tumbarumba urban boundary, almost 45% of the land use is zoned for low density residential properties, almost the same area is zoned rural (1A), 5% is zoned for public recreation and 5% is made up of special uses (schools, hospital etc) and light industrial.

Khancoban

Khancoban township is located on the western boundary of Kosciuszko National Park, as shown in Figure 2 5. It covers an area of approximately 0.9 square kilometres.

Khancoban Creek, which is the water supply source for the township, flows from Kosciuszko National Park to Khancoban Pondage, which is part of the Snowy Mountains Scheme. Coldwater Creek flows intermittently through the township.

Khancoban is situated immediately to the west of mountainous terrain. The township has undulating topography and slopes towards Khancoban Pondage (the vertical slope is about 50 m).

Figure 2.5: Layout of Khancoban Township

2.1.7 Population

Tumbarumba Shire is a predominantly rural area that had populations of 3,545 at the 2001 census and 3,534 at the 2006 census (Source: www.abs.gov.au). This represents a decline in population of 0.3% between 2001 and 2006.

The populations in the main urban centres are shown in the following table.

Table 2.4: Populations in Main Urban Centres

Urban Centre	Population
Tumbarumba	1,800 (permanent) 2,000 (holiday)
Khancoban	300 (permanent) 500 (holiday)
Rosewood	150 (permanent)
Jingellic	50 (permanent)

The annual population growth rate in the Tumbarumba Local Government Area is anticipated to decline slightly (0.14% to 0.16% per year) to 2031 (NSW Department of Planning, 2007).

2.2 WATER RESOURCES

Overview

	Tumbarumba	Khancoban
Primary Water Source	Burra Creek supplemented with water from Tumbarumba Creek as required during summer months and from McMeekin Street bore as an emergency water supply.	Khancoban Creek
Median Flow	• Burra Creek: insufficient data to determine because monitoring has only been undertaken during low flow periods. • Tumbarumba Creek 74.91 ML/day (1/1/1964 to 31/12/2003)	Khancoban Creek: not available
Low Flow Conditions	Refer Tables 2.6 and 2.7	Khancoban Creek: not available
Other Uses	• Burra Creek: nil above weir • Tumbarumba Creek: rural residential drinking supplies, agriculture	Khancoban Creek: nil
Hydrological Stress	• Burra Creek: No • Tumbarumba Creek: No	Khancoban Creek: not known
Interim Water Quality Assessment	• pH and Turbidity in Burra and Tumbarumba Creeks comply with the target values for Protection of Aquatic Ecosystems • Median values of Total Nitrogen, Total Oxidised Nitrogen and Total Phosphorus in Tumbarumba Creek exceed the target values for Protection of Aquatic Ecosystems	No water quality data available

Main Data Sources (also refer Appendix A)

- GHD. February 2005. *Tumbarumba Water Treatment Plant*. Concept Design Report.
- Environment Protection Authority. 1999. *Water Quality and River Flow Interim Environmental Objectives*. Guidelines for River, Groundwater and Water Management Committees. Murray River Catchment (NSW).
- State of Environment Report. 2004.
- Tumbarumba Shire Council Data Bases.

2.2.1 Interim Environmental Objectives

River Flow

Interim catchment flow and water quality objectives were established for the Murray Catchment by the former Environment Protection Authority (EPA) (now the Department of Environment & Climate Change, DECC) in 1999. Streams in the Tumbarumba and Khancoban areas have been categorised as "uncontrolled streams" and "Streams affected by the Snowy Scheme", respectively.

The interim flow objectives for the Tumbarumba and Khancoban areas are shown in Table 2.5.

Table 2.5: Interim River Flow Objectives

Tumbarumba Area and Key Measures		Khancoban Area
 Protect pools in dry times	• No water extractions in periods of low flow • New or transferred licences should not allow extraction during low flows below the 80th percentile	The overall framework for the amounts of flow diverted to or from streams affected by the Snowy Scheme has been agreed by the NSW, Victorian and Commonwealth Governments and is regulated by the Snowy Water Licence under the NSW Snowy Hydro Corporatisation Act 1998
 Protect natural low flows	• Share low flows between the environment and water users and fully protect all very low natural flows	
 Minimise effects of weirs and other structures	• Implement NSW Weirs Policy • Improve fish passage	
 Manage groundwater for ecosystems	• Implement State Groundwater Policy • Identify groundwater impacts and threats	

Water Quality

The water quality objectives for streams in the Tumbarumba and Khancoban areas are to protect:

- Aquatic ecosystems;
- Visual amenity;
- Secondary contact recreation;
- Primary contact recreation;
- Livestock water supply;
- Irrigation water supply;

- Homestead water supply;
- Drinking water at point of supply-disinfection only;
- Drinking water at point of supply-clarification and disinfection;
- Drinking water at point of supply-groundwater; and
- Aquatic foods (to be cooked before eating).

Water quality trigger values from *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000) for the first five objectives are shown in Table 2.6. Water supplies for domestic needs, including drinking water, are required to comply with the *2004 Australian Drinking Water Guidelines* (NHMRC & NRMMC (2004), referred to as ADWG (2004) in this report) at the point of use, regardless of the source.

Table 2.6: Interim Water Quality Objectives

Parameter	Trigger Value
Aquatic Ecosystem Protection	
Total phosphorus	20 µg/L
Total Nitrogen	250 µg/L
Chlorophyll-a	na
Turbidity	2-25 NTU
Salinity (Electrical Conductivity)	30-350 µS/cm
Dissolved Oxygen	90% to 110% saturation
pH	6.5-8.0
Visual Amenity	
Surface films and debris	• Not noticeable • Free from floating debris and litter
Nuisance organisms	Not present in unsightly amounts
Secondary Contact Recreation	
Faecal coliforms	<1,000/100 mL (median)
Enterococci	<230/100 mL (median)
Algae & blue-green algae	<15,000 cells/mL
Primary Contact Recreation	
Faecal coliforms	<150/100 mL (median)
Enterococci	<35/100 mL (median)

Parameter	Trigger Value
Protozoans	Nil
Algae & blue-green algae	<15,000 cells/mL
pH	5.0 to 9.0
Livestock Water Supply	
Algae & blue-green algae	<11,500 cells/mL
Faecal coliforms	<100/100 mL (median)

2.2.2 Surface Waters

The following five surface water bodies are relevant because they are used as water sources or could potentially be used as future water sources (refer Figures 2.2, 3.1 and 3.4 for locations):

- Burra Creek.
- Tumbarumba Creek.
- Paddys River (potential future water source).
- Mannus Lake (potential future water source).
- Khancoban Creek.

All water extraction licences are issued under Section 115 of the Water Act 1912. Council has not had any correspondence with the Department of Water and Energy to date regarding a timeframe for conversion of water extraction licences to the Water Management Act 2000.

Water Sources

Tumbarumba

A total of up to 499 ML can be extracted in any year from all of the water sources, ie Burra Creek, Tumbarumba Creek and the McMeekin Street bore. The Department of Water and Energy has indicated that this may be reviewed in the medium term when the water sharing agreement for Tumbarumba catchment is reviewed.

The primary water source is Burra Creek, which is located approximately 9 km from the 68 ML open storage dam. Tumbarumba Shire Council currently has a licence to divert up to 4 ML/day from Burra Weir. The extraction licence also specifies an environmental flow based on the diameter of the weir outlet pipe, which has been calculated to be 2.17 ML/day.

When licensing requirements prevent extraction from Burra Creek due to environmental flow requirements in the creek, Tumbarumba Creek and McMeekin Street bore are used to supplement the town supply. Extraction of water from Tumbarumba Creek is only permitted if flows in the creek equal or exceed 5 ML/day as measured at the Tumbarumba Creek No 2 flow gauge station (No 401007). The McMeekin Street bore is used as an emergency water supply and has an upper licenced extraction limit of

0.864 ML/day (refer Section 2.2.2) (refer Figure 3.1 for locations of gauge 401007 and the McMeekin Street bore).

Tumbarumba Creek has no environmental flow requirements, although a "cease to pump" limitation of 5 ML/day stream flow has been imposed.

Paddys River is considered to be a potential future water source for Tumbarumba township. There is a disused water race from the headwaters of Paddys River to the headwaters of Burra Creek above the offtake weir. Paddys River was used as a water source prior to 1998. Tumbarumba Shire Council currently has an extraction licence divert up to 500 ML/year from Paddys River.

Mannus Lake is also considered to be a possible future water source for Tumbarumba township.

Khancoban

Water is supplied from Khancoban Creek, which flows into Khancoban Pondage. Council currently has a licence to divert up to 35 L/second (ie 3,024 kL/day) from Khancoban Creek. There are no environmental flow conditions specified in the extraction licence.

Khancoban Creek and Khancoban Pondage are controlled by Snowy Mountains Hydro Electric Authority.

Stream Flows and Mannus Lake Volume

Tumbarumba

No Department of Natural Resources (DNR) flow gauging station exists on Burra Creek. However, Burra Weir is a rated flow weir and Tumbarumba Shire Council has recorded flows at the weir during low flow periods since November 2002. DNR maintains a flow gauging station on Tumbarumba Creek at Tumbarumba township (Gauge Station 401007, refer Figure 3.1 for location).

Tumbarumba has a history of drought conditions. The most severe droughts occurred during the summer of 1968, 1982/83 (this was the worst drought in recent times) and from 2002 to 2008. Water restrictions were imposed during these periods, as described in Section 3.2.1.

Burra Creek

Flows recorded by Council at the Burra Weir are summarised in Table 2.7 and shown in Figure 2.6. These measurements include the flows that were diverted to the open storage dam at Tumbarumba. Flows have not been measured continuously at Burra Weir. They have been obtained to monitor low flow periods, typically at one to two week intervals.

Table 2.7: Summary of Low Flow Data-Burra Weir

Parameter	Unit	Value
Period of data	-	15/11/2002 to 18/12/2006
No of data	-	60
Minimum value	ML/d	0.85
Maximum value	ML/d	13.90
Mean value	ML/d	3.04
50 %ile exceedance value	ML/d	2.51
80 %ile exceedance value	ML/d	1.71
99 %ile exceedance value	ML/d	1.05

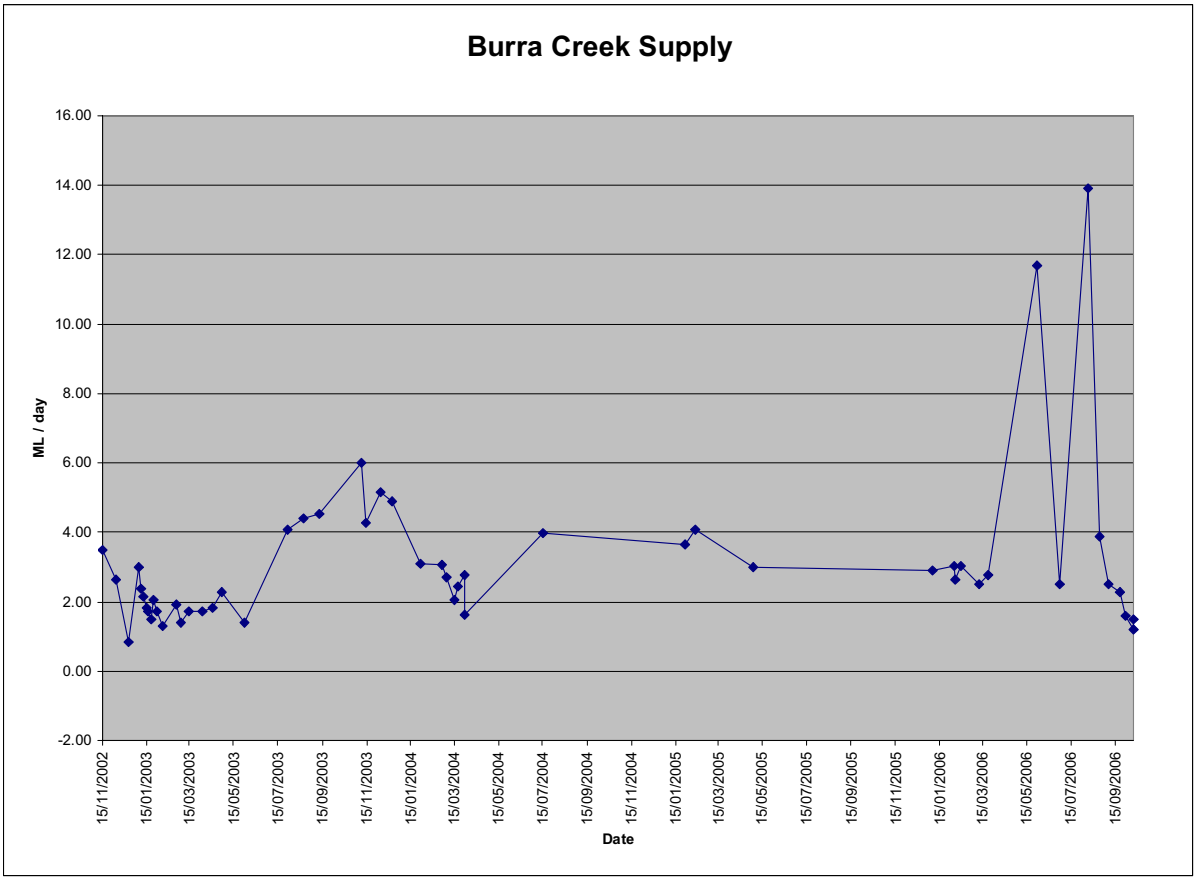

Figure 2.6: Plot of Measured Flows-Burra Weir

Burra Creek has a history of low flows, particularly during late January 2003 to the end of April 2003 and during the summer of 2006/07 when water from Burra Creek was not able to be used because of low flows in the creek. It was necessary to supplement water from Burra Creek with water from Tumbarumba Creek and McMeekin Street bore during these periods.

Tumbarumba Creek

Flow characteristics for Tumbarumba Creek are summarised in Table 2.8 and shown as a flow duration curve in Figure 2.7. There are considerable gaps in the data during this period. Data for the following years are incomplete and have not been included: 1977 and 1983 to 2000.

Table 2.8: Summary of Flow Data-Tumbarumba Creek (DNR Station 401007)

Parameter	Unit	Value
Period of data	-	1/1/1964 to 31/12 2003
No of data	-	7,670
Minimum value	ML/d	1.96
Maximum value	ML/d	1,849
Mean value	ML/d	115.09
50 %ile exceedance value	ML/d	74.91
80 %ile exceedance value	ML/d	36.70
99 %ile exceedance value	ML/d	7.73

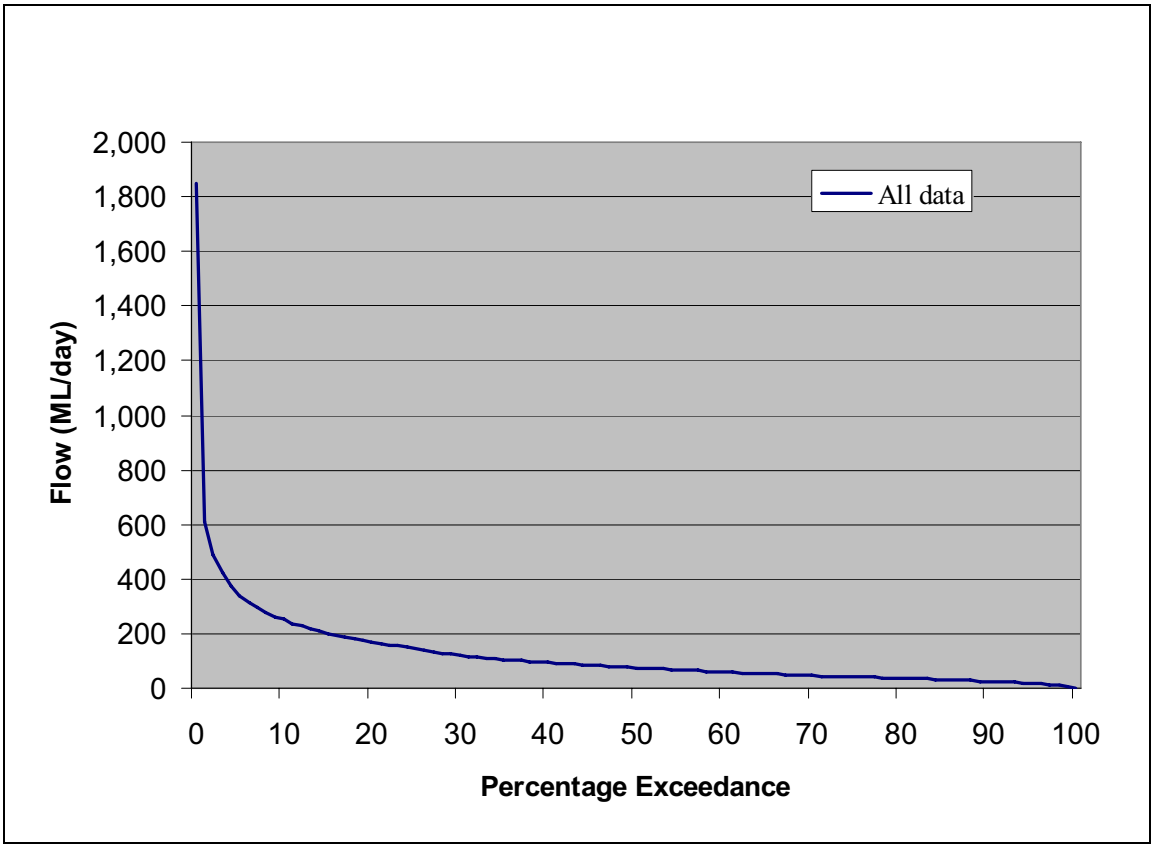

Figure 2.7: Flow Duration Curve-Tumbarumba Creek (DNR Station 401007)

Tumbarumba Creek also has a history of low flows. During the summer of 1968 the median recorded flow was 4.893 ML/day and flows as low as 1.96 ML/day were measured. The worst drought in recent times was the 1982/83 drought. Zero flows were measured during the summer of 1983. The area also experienced droughts from late 2002 to 2007. Flows in Tumbarumba Creek ranged from 8 to 15 ML/day during early to mid 2003 and zero flows occurred during the summers of 2006/07 and 2007/08.

Paddys River

No flow data are available for Paddys River.

Mannus Lake (the following information was obtained from Gordon Gibson Nominees (2007b) and Tumbarumba Shire Council)

Mannus Lake is located on Mannus and Munderoo Creeks, which is approximately 9 km south of Tumbarumba township. Most of the lake is on NSW State Forest land, although the dam wall is on Council land (Lot 2 DP 608847). Council has a licence for one diversion pipe at the dam wall (Licence No Murray/50SL48116).

The lake has an estimated capacity of 1,500 ML and has not been known to become empty. Mannus Lake could supply up to 1,000 ML/year if it was at full capacity at the start of summer and there was no inflow during the summer. This estimate takes into account evaporation losses (the lake has a large surface area

and there would likely be significant evaporation losses during summer-estimated at 400 ML) and leakage through a tunnel that was previously constructed for the purposes of feeding a former hydroelectric generator (estimated at approximately 100 ML/year).

Khancoban

No flow data are available for Khancoban Creek.

Khancoban Creek is fed by snow melt from a large catchment in Kosciuszko National Park. It has never been known to dry out during drought conditions. Council has advised that flows are likely to be higher than in Tumbarumba Creek.

Impact of Recent Drought Conditions

The primary water source for Tumbarumba township, Burra Creek, has a history of low flows, as described above.

During late January 2003 to the end of April 2003 and during the summers of 2006/07 and 2007/08 water from Burra Creek was not able to be used because of low flows in the creek. It was necessary to supplement water from Burra Creek with water from Tumbarumba Creek and the McMeekin Street bore during these periods. Periods when Burra Creek has been supplemented with water from these alternative sources are shown in the following table.

Table 2.9: Periods When Alternative Water Sources Were Used

Year[1]	Periods When Water was Used From Alternative Sources	
	Tumbarumba Creek	McMeekin Street Bore
2002	Nil	Nil
2003	21 Jan-28 Mar 1 Apr-2 Apr 7 Apr-11 Apr 17 Apr-28 Apr	Nil
2004	7 Dec-14 Dec	Nil
2005	Nil	Nil
2006	2 Nov 1 Dec-7 Dec 12 Dec-19 Dec 27 Dec-29 Dec	Nil
2007	17 Jan-20 Jan	1 Mar-25 Mar 12 Apr-21 Apr
2008 (to 14 May)	27 Mar-5 Apr	25 Jan-14 Feb 22 Feb-2 Mar 9 Mar-20 Mar

Notes
[1] Calender years, ie 1 January to 31 December.

The continued reliability of the Tumbarumba Creek water supply during drought conditions is questionable because of low flows in the creek (5 ML/day to 6 ML/day during the 2006/07 summer). Water from the McMeekin Street bore was used as an emergency measure during the summers of 2006/07 and 2007/08 when Tumbarumba Creek ceased flowing.

Water Quality

Tumbarumba

Streams

Water quality data for Burra Creek and Tumbarumba Creek obtained by Council from March 2004 to August 2005 are summarised in Tables 2.10 to 2.12. These data were obtained as part of the drinking water quality monitoring program and were obtained from Burra Weir and the water pumping station on Tumbarumba Creek. The Council data for Tumbarumba Creek was supplemented by data from the 2004 State of the Environment Report (Table 2.13) and with data obtained by local schools which monitored water quality at four locations along Tumbarumba Creek at approximate monthly intervals during an 18 month period during 1999 and 2000 (Table 2.14). Water quality data are only available for Paddys River for 2004 (refer Table 2.15).

Table 2.10: Water Quality Data-Burra Weir (1/03/2004 to 20/04/2005)

Water Quality Indicator	No of Samples	Minimum Value	Maximum Value	Average Value	Median Value	Guideline Value[1]
Colour (HU)	9	6.3	58.9	31.1	36.9	15 {Aesthetic}
Nitrate (mg/L)	7	0.00	0.11	0.05	0.05	50
Nitrite (mg/L)	16	0.72	16.4	7.28	6.98	3
pH	17	6.33	7.20	6.88	6.93	6.5-8.5 {Aesthetic} *(6.5-8.0)*
Phosphate (mg/L)	17	0.01	3.46	0.67	0.30	-
Total Alkalinity (mg/L)	16	20.5	87.6	61.1	68.7	-
Total Hardness (mg/L as $CaCO_3$)	14	3.9	60.8	22.7	16.8	200 {Aesthetic}
Total Copper (mg/L)	17	0.00	0.20	0.05	0.04	2
Total Iron (mg/L)	17	0.00	0.26	0.04	0.00	0.3 {Aesthetic}
Turbidity (NTU)	9	2.4	12.3	7.1	6.7	5 {Aesthetic} *(2-25)*

Notes
[1] Health values from ADWG (2004) except where noted. Corresponding trigger values for Protection of Aquatic Ecosystems (refer Table 2.6), as available, are shown in italics and parentheses.

Table 2.11: Additional Water Quality Data-Burra Weir (1/01/2001 to 31/12/2005)[1]

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[2]
Antimony (mg/ L)	1	0.001	0.003
Arsenic (mg/L)	1	0.005	0.007
Barium (mg/L)	1	0.008	0.7
Boron (mg/L)	1	0.0198	4.0
Cadmium (mg/L)	1	0.0005	0.002
Chromium (mg/L as Cr(VI))	1	0.005	0.05
Copper (mg/L)	1	0.02	2 {Health} 1 {Aesthetic}
Cyanide (mg/L)	1	<0.01	0.08

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[2]
Fluoride (mg/L)	1	<0.1	1.5
Iodine (mg/L)	1	0.053	-
Lead (mg/L)	1	0.005	0.01
Manganese (mg/L)	1	<0.01	0.5 {Health} 0.1 {Aesthetics}
Mercury (mg/L)	1	0.0005	0.001
Molybdenum (mg/L)	1	0.005	0.05
Nickel (mg/L)	1	0.005	0.02
Selenium (mg/L)	1	0.005	0.01
Silver (mg/L)	1	0.005	0.1
Sodium (mg/L)	1	4.8	180 {Aesthetic}
Sulphate (mg/L)	1	<1	500 {Health} 250 {Aesthetic}
Total Dissolved Solids (mg/L)	1	11	500 {Aesthetic}

Notes
[1] The sampling date for these data is not known.
[2] Health values from ADWG (2004) except where noted.

Table 2.12: Water Quality Data-Tumbarumba Creek (1/03/2004 to 17/08/2005)

Water Quality Indicator	No of Data	Minimum Value	Maximum Value	Average Value	Median Value	Guideline Value[1]
Colour (HU)	8	50.3	91.9	70.7	68.2	15 {Aesthetic}
Nitrate (mg/L)	6	0.00	0.08	0.04	0.03	50
Nitrite (mg/L)	12	0.00	10.10	5.33	5.57	3
pH	15	6.20	7.02	6.81	6.90	6.5-8.5 {Aesthetic} *(6.5-8.0)*
Phosphate (mg/L)	15	0.00	3.95	0.83	0.47	-
Total Alkalinity (mg/L)	15	24.2	87.6	65.2	75.5	-
Total Hardness (mg/L as $CaCO_3$)	15	0.0	29.3	13.4	13.4	200 {Aesthetic}
Total Copper (mg/L)	15	0.00	0.30	0.05	0.01	2

Water Quality Indicator	No of Data	Minimum Value	Maximum Value	Average Value	Median Value	Guideline Value[1]
Total Iron (mg/L)	15	0.00	0.46	0.07	0.00	0.3 {Aesthetic}
Turbidity (NTU)	8	11.2	16.9	15.3	16.2	5 {Aesthetic} *(2-25)*

Notes
[1] Health values from ADWG (2004) except where noted. Corresponding trigger values for Protection of Aquatic Ecosystems, as available, are shown in italics and parentheses.

Table 2.13: Water Quality Data-Tumbarumba Creek (Site 401007, SOE (2004))

Water Quality Indicator	Median Value (1997-2000)	Median Value (2000-2004)	Guideline Value[1]
Dissolved Oxygen (mg/L)	11	10	>85% *(90% to 110% saturation)*
Electrical Conductivity (µS/cm)	48	35	*(30-350)*
pH	7.6	7.0	6.5-8.5 {Aesthetic} *(6.5-8.0)*
Total Nitrogen (mg/L)	0.470	0.255	*(0.250)*
Total Oxidised Nitrogen (mg/L)	0.100	0.080	53
Total Phosphorus (mg/L)	0.100	0.058	*(0.020)*
Total Suspended Solids (mg/L)	-	9	-
Turbidity (NTU)	64	12	5 {Aesthetic} *(2-25)*

Notes
[1] Health values from ADWG (2004) except where noted. Corresponding trigger values for Protection of Aquatic Ecosystems, as available, are shown in italics and parentheses.

Table 2.14: Water Quality Data-Tumbarumba Creek (Schools, February 1999 to September 2000)

Site	Average Value[1]						
	Water Temp (^oC)	pH	EC (µS/cm)	Turb (NTU)	DO (mg/L)	PO_4 (mg/L)	NO_3 (mg/L)
Pound Creek (confluence with Tumbarumba Creek)	10.8	7.0	48.5	13.9	9.0	0.18	0.14
Bicentennial Park (u/s of billabong)	10.6	7.3	36.8	14.4	9.9	0.06	0.03
Bicentennial Park (d/s of Billabong)	11.8	7.0	88.5	13.9	6.8	0.18	0.04
Murray's Crossing (d/s urban boundary)	10.8	7.3	35.8	14.4	-	0.07	0.25
Trigger Values-Upland Rivers (ANZECC & ARMCANZ, 2000)		*6.5-8.0*		*2-25*	*90% to 110% saturation*[2]	*0.150 (as FRP)*	*0.150 (as NOX)*

Notes

[1] EC = Electrical Conductivity; Turb = Turbidity; DO = Dissolved Oxygen; PO_4 = Phosphate; NO_3 = Nitrate; FRP = Filterable Reactive Phosphorus; NOX = Oxidised Nitrogen (Nitrite-N + Nitrate-N)

[2] This range of DO saturation values corresponds to 9.9 mg/L to 12.1 mg/L at 11 ^oC

Table 2.15: Water Quality Data-Paddys River (22/06/2004 to 11/11/2004)

Water Quality Indicator	No of Data	Minimum Value	Maximum Value	Average Value	Median Value	Guideline Value[1]
Colour (HU)	6	17.0	78.6	46.1	40.0	15 {Aesthetic}
Nitrate (mg/L)	3	0.01	0.05	0.03	0.02	50
Nitrite (mg/L)	5	4.7	16.3	8.1	5.8	3
pH	6	6.43	6.86	6.64	6.60	6.5-8.5 {Aesthetic} *(6.5-8.0)*
Phosphate (mg/L)	6	0.09	3.37	0.81	0.40	-
Total Alkalinity (mg/L)	6	27	108	44	33	-
Total Hardness (mg/L as $CaCO_3$)	6	0	38.9	27.4	34.7	200
Total Copper (mg/L)	6	0.04	0.16	0.10	0.10	2
Total Iron (mg/L)	6	0	0.10	0.05	0.05	0.3
Turbidity (NTU)	6	5.1	14.2	7.8	6.1	5 {Aesthetic} *(2-25)*

Notes
[1] Health values from ADWG (2004) except where noted. Corresponding trigger values for Protection of Aquatic Ecosystems, as available, are shown in italics and parentheses

Water from Burra Creek, Tumbarumba Creek and Paddys River is soft, has low alkalinity and has approximately neutral pH. Levels of pH, Total Alkalinity, Total Hardness, Nitrate-N, Total Iron and Total Copper in water from these streams have been lower than the ADWG (2004) upper values. Furthermore, levels of Total Dissolved Solids and inorganic indicators in the one sample collected at Burra Weir were lower than the ADWG (2004) values. However, Turbidity, Colour and Nitrite levels in all of the streams have generally exceeded the ADWG (2004) values.

The Burra Creek catchment consists of old growth forest and is considered to be pristine. The Tumbarumba Creek catchment is not pristine because it contains rural residential properties and agricultural activities. Consequently, water quality in Burra Creek would be expected to be generally better than in Tumbarumba Creek. Comparison of water quality from the two streams indicates that Burra Creek has higher levels of Hardness and Nitrite than Tumbarumba Creek, but lower levels of Turbidity, Colour, Phosphate and Total Iron. Levels of the other water quality indicators are similar in the two creeks.

The measured data for pH in Tumbarumba Creek have complied with the target values for Protection of Aquatic Ecosystems and turbidity values generally fell in the middle of the range of target values for Protection of Aquatic Ecosystems. However, median values of Total Nitrogen, Total Oxidised Nitrogen and Total Phosphorus, as recorded in Tumbarumba Creek by SOE (2004), exceeded the target values for Protection of Aquatic Ecosystems by up to almost 6 times. Although these exceedances were lower in

magnitude than for the previous reporting period, they nevertheless serve as a warning for the need for additional action to improve surface water quality in the Shire.

It is difficult to draw any conclusions from the data collected by the schools (refer Table 2.14) because there are no obvious trends in these data and some of the data appear to be erroneous, eg the electrical conductivity results appear to be too low. These anomalies may have occurred because of inconsistencies in sampling and analytical methods used by the different groups that monitored each site. Despite these anomalies, levels of the measured water quality indicators are generally lower than the ANZECC & ARMCANZ (2000) trigger values.

Data collected under the Bug Watch program, which was overseen by the former Department of Land and Water Conservation indicated that Pound Creek and Tumbarumba Creek had pollution index values of 5.44 and 5.54, respectively. These results mean that a *good* stream quality rating applies to these streams within the Tumbarumba township urban area.

No data are available to quantify specific impacts of stormwater discharges, discharges from Tumbarumba WWTP, on-site sewage disposal or sewage overflows on Tumbarumba Creek.

A semi-quantitative risk assessment of the level of *Cryptosporidium* at the outlet from the 68 ML open storage dam and the required level of treatment to remove *Cryptosporidium* was recently undertaken (GHD, 2005). The assessment assumed extraction of equal volumes of water from Burra Creek and Tumbarumba Creek (1.6 ML/day extracted from both streams). The following indicative conclusions were made in the report:

- The *Cryptosporidium* concentration in water from the 68 ML open storage dam was calculated to be 1.7 oocycts/L. Based on this level, a 3 log reduction in *Cryptosporidium* would be required to meet the target *Cryptosporidium* concentration of 0.002 oocycts/L.
- The Burra Creek Catchment has a background *Cryptosporidium* concentration of 0.1 oocycts/L and was not considered to be a significant source of *Cryptosporidium*.
- The main source of *Cryptosporidium* is the Tumbarumba Creek Catchment. Potential sources of *Cryptosporidium* include faecal matter from humans and animals in the catchment (eg native animals, feral animals, cattle and sheep, and rural residential properties) and stormwater runoff from Tumbarumba township and agricultural areas in the catchment. Access of cattle and sheep to Tumbarumba Creek was identified as a high risk, contributing 85-95% of the *Cryptosporidium* load.

It should be noted that this assessment only provides order of magnitude results and has not been verified with *Cryptosporidium* monitoring data from the Tumbarumba Creek catchment. Furthermore, there are only seven dairy farms in the Shire, all located considerable distances from Tumbarumba township near the western boundary of the Shire. Therefore, it is not clear how access of cattle to Tumbarumba Creek could be a major source of *Cryptosporidium* to the open storage dam.

Mannus Lake

No water quality data are available for Mannus Lake. However, the lake drains surrounding farmland and it is likely that bacteria (*E coli*) and Turbidity levels may be high in the lake, that algal blooms may occur during warm weather and that there may be a risk of *Cryptosporidium* contamination.

Khancoban

A sample was obtained from Khancoban Creek on 25 October 2006 to test for compliance of this water source with the ADWG (2004) guideline values. The results are presented in the following table.

Table 2.16: Water Quality Data-Khancoban Creek (October 2006)

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[1]
Aluminium (mg/L)	1	0.04	0.2 {aesthetic}
Antimony (mg/ L)	1	<0.001	0.003
Arsenic (mg/L)	1	<0.001	0.007
Barium (mg/L)	1	0.005	0.7
Boron (mg/L)	1	<0.01	4.0
Cadmium (mg/L)	1	<0.0005	0.002
Calcium (mg/L)	1	4.83	-
Chloride (mg/L)	1	3.9	250 {Aesthetic}
Chromium (mg/L as Cr(VI))	1	<0.005	0.05
Copper (mg/L)	1	0.584	2 {Health} 1 {Aesthetic}
Fluoride (mg/L)	1	0.10	1.5
Iodine (mg/L)	1	<0.020	-
Iron (mg/L)	1	0.05	0.3 {Aesthetic}
Lead (mg/L)	1	<0.002	0.01
Magnesium (mg/L)	1	1.65	-
Manganese (mg/L)	1	<0.005	0.5 {Health} 0.1 {Aesthetic}
Mercury (mg/L)	1	<0.0001	0.001
Molybdenum (mg/L)	1	<0.005	0.05
Nickel (mg/L)	1	<0.01	0.02
Nitrate (mg/L)	1	<1.0	50
Nitrite (mg/L)	1	0.1	3
pH	1	7.1	6.5-8.5 {Aesthetic}
Selenium (mg/L)	1	<0.002	0.01
Silver (mg/L)	1	<0.002	0.1
Sodium (mg/L)	1	3.6	180 {Aesthetic}

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[1]
Sulphate (mg/L)	1	<1.0	500 {Health} 250 {Aesthetic}
Total Dissolved Solids (mg/L)	1	30	500 {Aesthetic}
Total Hardness (mg/L as $CaCO_3$)	1	14.8	200 {Aesthetic}
True Colour (HU)	1	1.1	15 {Aesthetic}
Turbidity (NTU)	1	0.9	5 {Aesthetic}
Zinc (mg/)	1	0.03	3 {Aesthetic}

Notes
[1] Health values from ADWG (2004) except where noted.

These results demonstrate that water from Khancoban Creek is soft with levels of physico-chemical water quality indicators that are considerably lower than the ADWG (2004) values.

2.2.3 Ground Water

Tumbarumba Shire is located in a low yielding groundwater system. There are a number of groundwater bores in or near the Tumbarumba township area that are mainly used for irrigation and domestic stock water purposes. Only one of these bores, the McMeekin Street bore (refer Figure 3.1 for location), has been authorised for the supply of town water. Although some of these bores could potentially be able to provide town water, none appear to have sufficient yield to serve as reliable sources of town water supply.

The McMeekin Street bore was drilled on 1 July 1983 to provide a booster supply of water for the top end of Albury Street in Tumbarumba township because that area experienced low pressures during peak summer periods due to its elevated altitude and the long distance from the supply reservoir. The bore was subsequently decommissioned due to contamination and because upgrade works were undertaken to rectify the low pressure. The upgrades included a booster pump at Wongal Street and upgrades of sections of the supply main from the reservoir.

Tumbarumba has recently been experiencing severe drought conditions, as discussed in Section 2.2.2. Council installed a small chlorination system on the McMeekin Street bore so that groundwater could be used to supplement the supply from Burra and Tumbarumba Creeks as an emergency measure during the summer of 2006/07. The McMeekin Street bore is now used as an emergency water source with an upper licenced extraction limit of 0.864 ML/day.

The results of water quality sampling undertaken of McMeekin Street bore water in October 2006 indicated that concentrations of all the parameters tested for were lower than the ADWG (2004) values for health. The water quality results are presented in the following table.

Table 2.17: Water Quality Data-McMeekin Street Bore (October 2006)

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[1]
E coli (cfu/100 mL)	1	<1	0
Aluminium (mg/L)	1	0.09	0.2 {aesthetic}
Antimony (mg/ L)	1	<0.001	0.003
Arsenic (mg/L)	1	<0.001	0.007
Barium (mg/L)	1	0.018	0.7
Boron (mg/L)	1	<0.10	4.0
Cadmium (mg/L)	1	<0.0005	0.002
Calcium (mg/L)	1	1.27	-
Chloride (mg/L)	1	4.0	250 {Aesthetic}
Chromium (mg/L as Cr(VI))	1	0.005	0.05
Copper (mg/L)	1	<0.005	2 {Health} 1 {Aesthetic}
Fluoride (mg/L)	1	<0.10	1.5
Iodine (mg/L)	1	<0.020	-
Iron (mg/L)	1	2.09	0.3 {Aesthetic}
Lead (mg/L)	1	<0.002	0.01
Magnesium (mg/L)	1	2.82	-
Manganese (mg/L)	1	0.302	0.5 {Health} 0.1 {Aesthetic}
Mercury (mg/L)	1	<0.0001	0.001
Molybdenum (mg/L)	1	<0.005	0.05
Nickel (mg/L)	1	0.01	0.02
Nitrate (mg/L)	1	<1.0	50
Nitrite (mg/L)	1	0.3	3
pH	1	6.0	6.5-8.5 {Aesthetic}
Selenium (mg/L)	1	<0.002	0.01
Silver (mg/L)	1	<0.002	0.1
Sodium (mg/L)	1	5.0	180 {Aesthetic}
Sulphate (mg/L)	1	<1.0	500 {Health} 250 {Aesthetic}
Total Dissolved Solids (mg/L)	1	31	500 {Aesthetic}

Water Quality Indicator	No of Samples	Value	ADWG (2004) Value[1]
Total Hardness (mg/L as $CaCO_3$)	1	14.6	200 {Aesthetic}
True Colour (HU)	1	<1.0	15 {Aesthetic}
Turbidity (NTU)	1	24.5	5 {Aesthetic}
Zinc (mg/)	1	0.32	3 {Aesthetic}

Notes
[1] Health values from ADWG (2004) except where noted.

3 DESCRIPTION OF URBAN WATER SERVICES

The urban water services operated by Tumbarumba Shire Council are described in this section. Data on the capacity and performance existing services are important for determining system performance and service delivery and to identify current and future constraints on service delivery.

Records of the water volumes produced and consumed are used to determine how efficiently the water supply systems are operated, to identify unaccounted volumes of water and to undertake appropriate water conservation measures. Records of sewage volumes and levels of treatment can be used to determine possible effluent management options. Urban stormwater quality and quantity data are important for determining how stormwater and stormwater pollution sources can be better managed and to determine whether stormwater can be used as a water resource.

3.1 MANAGEMENT PRACTICES

Current management practices include:-

- Implementation of all Best-Practice Management requirements as defined by DWE, including:
  - Annual performance reporting.
  - Strategic business planning, which incorporates the annual development of the Water and Sewerage Business Plan in accordance with Council's overall Management Plan.
  - Best-Practice water, sewage and trade waste pricing (two-tier user pays inclining block charging policy).
  - Developer charges policy.
  - Liquid trade waste management policy.
  - Drought Contingency and Emergency Response Plan.
  - Asset Management Strategy.
- Performance compliance and environmental management reporting. Council complies with the annual DWE, DECC, NSW Health and Department of Local Government reporting protocols.
- Stormwater Management Plan.
- Implementation of BASIX for all new developments.
- Implementation of several water conservation measures, including:
  - Leak reduction program.
  - Effective water metering (most premises are now metered).
  - Regular checking of bulk water meters. Domestic water meters are checked on request.
  - Endorsement and promotion of State water conservation schemes, eg rebates for water efficient shower heads and rainwater tanks.
  - Customer education, eg distribution of "Be Smart Watersmart" brochure.
  - Customer advisory services (fact sheets).
  - Water restrictions as required.

3.2 URBAN WATER SUPPLY SERVICES

Overview

Tumbarumba Shire Council provides potable drinking water to Tumbarumba and Khancoban townships. These services are summarised in the following table and described below.

	Tumbarumba	Khancoban
Water Source	Burra Creek supplemented with water from Tumbarumba Creek and McMeekin Street bore as required	Khancoban Creek
Environmental Flows	To maintain at least 2.17 ML/day in Burra Creek	Nil
Entitlements	Total Tumbarumba: • 499 ML/year (from all sources) • Up to 4 ML/day (Burra Creek, Licence: Murray/50SL029797) McMeekin Street Bore: • Up to 0.864 ML/day Paddys River: • 500 ML/year Licence: 50SL75439)	• 250 ML/year (Volumetric Entitlement, not yet included in Licence) • Up to 35 L/second (Licence: Murray/50SL075047)
Population Served	• 1,800 (permanent) • 2,000 (peak)	• 300 (permanent) • 500 (peak)
Urban Population Without Reticulated Water	0	0
Percentage With Tanks	Not known	Not known
Assessments: **- Urban Residential** **- Urban Non-Residential** **- Rural Residential & Farms**	 685 105 55	 260 15 5
Unmetered Customers	8	0
Total Water Supplied	390 ML	90.8 ML
Unaccounted for Water	27%	11%
Demand Management	Several water conservation measures have been implemented Draft Demand Management Strategy currently being considered by Council	

	Tumbarumba	Khancoban
Water Storage	68 ML (raw water storage)	1.5 ML (service reservoir)
Water Treatment	Chlorination	Fine screening Chlorination
Asset Replacement Cost (2006) **- Trunk main system** **- Reticulation system** **- Water treatment system**	 $2,234,000 $4,486,400 $950,000	 $1,663,335 $1,221,815 $7,455

Main Data Sources (also refer Appendix A)

- DNR water diversion licences.
- Albury City Council. 2006. Report on Pricing for Water Supply, Sewerage & Trade Waste.
- DEUS. 2006. 2004/05 NSW Water Supply and Sewerage Performance Monitoring Report.
- DLM Environmental Consultants. 2006. *Scoping Report. Water & Sewerage Asset Register/Condition Assessment Project*. Report prepared for Tumbarumba Shire Council, June 2006.
- GHD. February 2005. *Tumbarumba Water Treatment Plant*. Concept Design Report.
- Tumbarumba Shire Council. August 2006. Drought Contingency & Emergency Response Plan for Tumbarumba & Khancoban.
- Tumbarumba Shire Council data bases.

3.2.1 Tumbarumba

Water Supply System Assets

The Tumbarumba township water supply system consists of the following components:

- 12.57 km of trunk mains ranging in diameters from 100 mm to 250 mm. The dates of construction of the trunk mains are not known.
- 40.74 km of reticulation mains consisting of 75 mm (630 m total length), 100 mm (28.8 km total length), 150 mm (10.9 km total length) and 225 mm (405 m total length) nominal diameters pipes. These mains are either asbestos cement (AC) or polyvinyl chloride (PVC) and are 1 to 49 years old.
- Burra Weir.
- One off-stream open storage dam of 68 ML capacity to which water is supplied from Burra Weir and Tumbarumba Creek. The effective capacity is more likely to be in the order of 55 ML to 60 ML because of siltation.
- One concrete balance tank of 136 kL capacity.
- One chlorinator.
- The Tumbarumba Creek water pump station of 1.7 ML/day capacity.

- Albury Street booster pump station (75 mm).
- Batlow Road booster pump station (50 mm).
- McMeekin Street bore.

Council's asset data base for Tumbarumba township is currently being reviewed and the above data should be updated when the review has been completed.

Council has recently prepared a dam safety emergency plan for the open storage dam at Tumbarumba (GHD, 2008). This plan describes responsibilities and procedures to be followed in the event of non-dam failure emergencies and dam failure emergencies for three levels of alert levels. Water levels in the open storage dam are checked on a daily basis. The seven piezometers in the dam wall are also read every week to measure the amount of water in the wall. Weekly visual inspections are carried out for any cracking or movement of the wall. These data are entered into a database.

Burra Weir is desilted and flushed every month and the Burra pipeline is flushed biannually.

Water Supply and Treatment

The layout of the Tumbarumba township water supply system is shown in Figure 3.1.

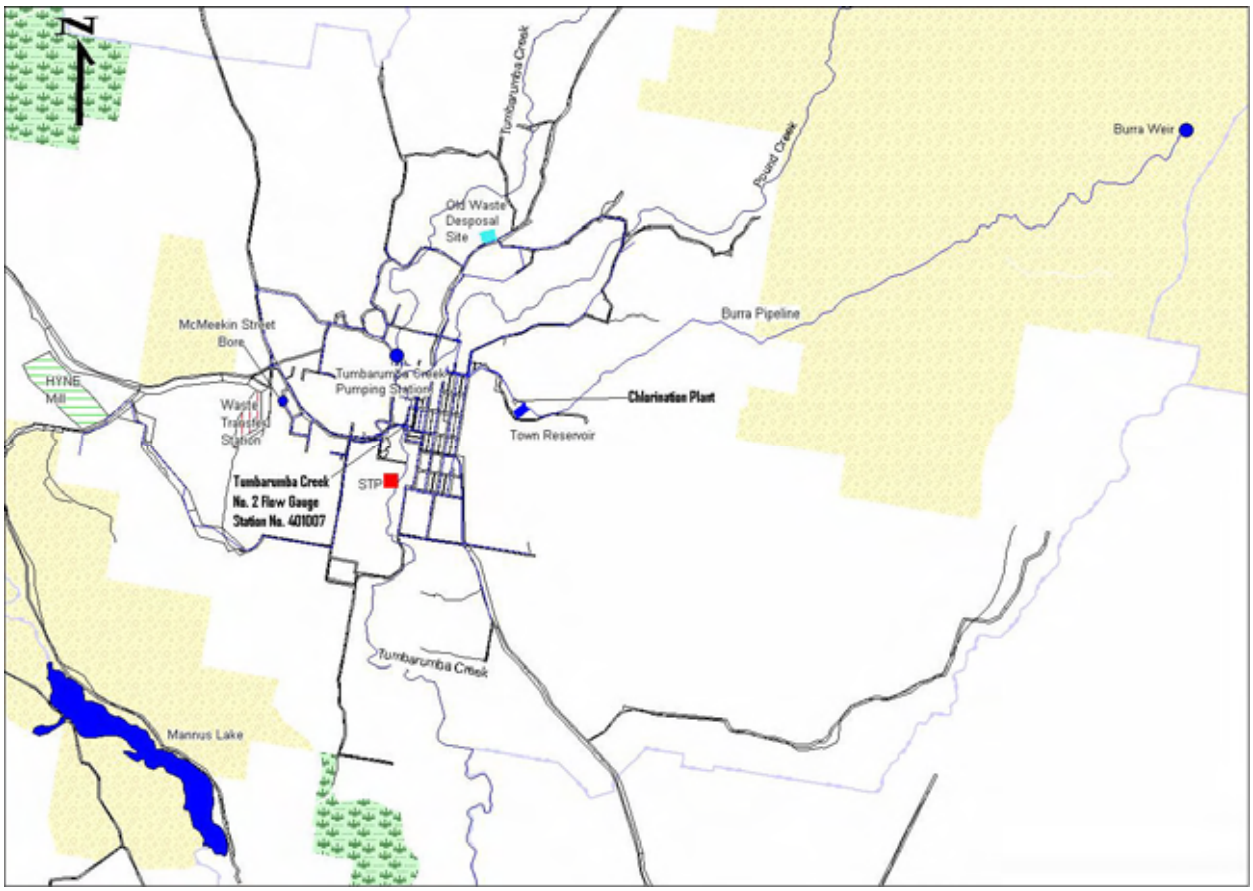

Figure 3.1: Layout of Water Supply System-Tumbarumba

The primary water source for Tumbarumba township is Burra Creek. Water gravitates from a weir on Burra Creek to the 68 ML open storage dam located above the township. The Burra Weir is located approximately 9 km from the open storage dam (refer Figure 3.1). Water from Burra Creek can be supplemented with water from Tumbarumba Creek, provided that flows in Tumbarumba creek equal or exceed 5 ML/day. Water from McMeekin Street Bore has also been used and was used during the summer of 2006/07 as an emergency water source.

Water from the open storage dam is chlorinated prior to distribution to the township. The chlorination plant is capable of delivering more than 5 ML/day at a peak rate of 40 L/second. Storage of treated water is provided by one 136 kL balance tank in Tumbarumba township.

The 68 ML open storage dam at Tumbarumba township provides less than one month storage at peak daily flows.

Water Production

Water has been obtained mainly from Burra Creek supplemented with water from Tumbarumba Creek and McMeekin Street bore during draught periods, as described in Section 2.2.2. The volumes of treated water produced from these sources from 2002/03 to 2006/07 have been monitored daily and are shown in the following table as annual totals.

Table 3.1: Annual Volumes of Treated Water Produced (2002/03 to 2006/07)-Tumbarumba

Year[1]	Volume Produced (ML/year)				Peak Day (ML/day)	Average Day (ML/day)
	Burra Creek	Tumbarumba Creek	McMeekin Street Bore	Total Annual		
2002/03	303	98.9	0.00	402	2.89	1.10
2003/04	310	0.00	0.00	310	2.66	0.846
2004/05	312	6.44	0.00	318	2.05	0.869
2005/06	390	0.00	0.00	390	3.71	1.07
2006/07	229	19.1	10.3	259	1.85	0.709

Notes
[1] Financial years (1 July to 30 June).

The annual water production from 2002/03 to 2006/07 has not exceeded the Volumetric Entitlement of 499 ML/year from all of the water sources, ie Burra Creek, Tumbarumba Creek and the McMeekin Street bore). An average of 336 ML/year of potable water was produced from 2002/03 to 2006/07. The increase in water consumption from 2004/05 to 2005/06 can be largely attributed to the Hyne & Son Timber Mill, which commenced operations in 2004 and currently has an annual water consumption of about 58 ML/year.

The Average Day and Peak Day Demands during past summers with no water restrictions have been approximately 1 ML/day and 3 ML/day, respectively.

The volume of water produced Average Day Demand and Peak Day Demand were considerably lower during 2006/07 because of the imposition of water restrictions (refer below in this section for a description of water restrictions).

The average monthly water production using data from 2002 to 2006 is shown in Figure 3.2 (the average daily consumption for each month (kL/day) is shown at the top of each monthly bar).

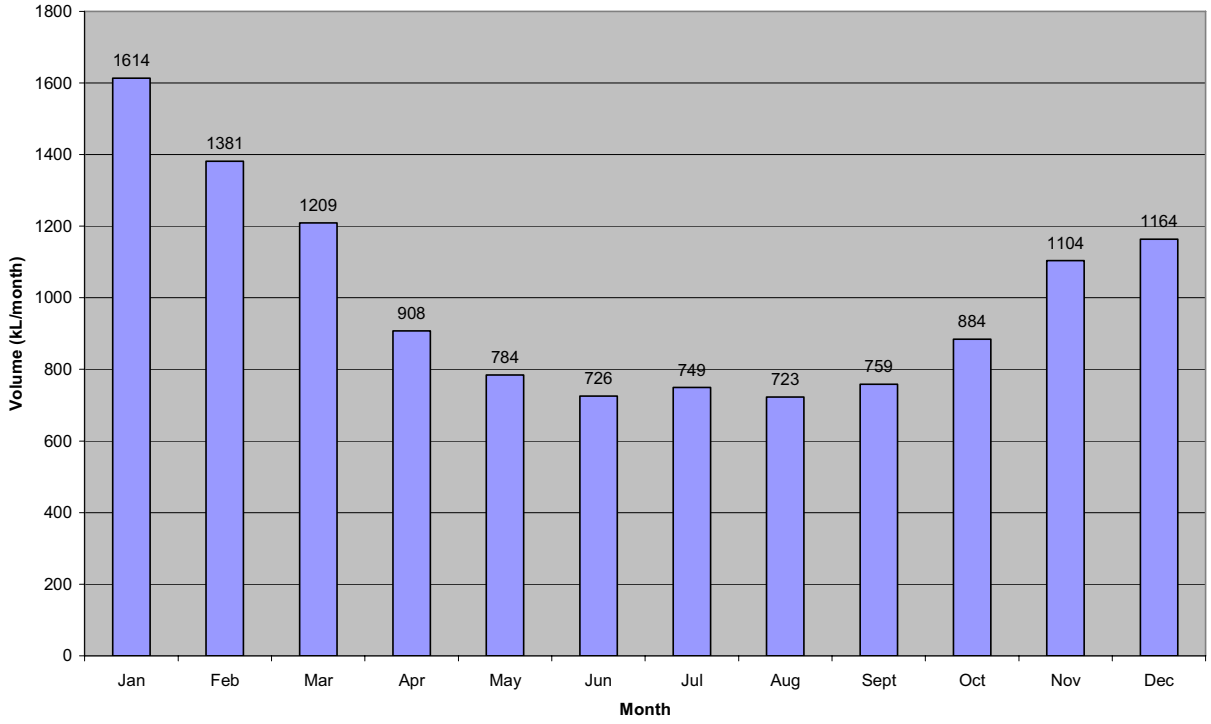

Figure 3.2: Average Monthly Water Production (2002 to 2006)-Tumbarumba

Demand Profile

The water demand profile for the 2005/06 financial year is summarised in the following table.

Table 3.2: Water Demand Profile (2005/06)-Tumbarumba

Type	Quantity	Annual Water Production/Consumption (ML/year)
Water Produced		389.8
Water Consumed		
Urban residential	685	142.9
Rural residential	55	20.2
Farming	11	3.3
Non-residential:		
– hotels/motels	90 beds	9.1
– caravan parks	55 sites	5.9
– schools	259 pupils	2.9
– hospital	36 beds	2.7
– aged care	8 beds	0.8
– bowling club	420 patrons	2.0
– golf club	313 patrons	1.2
– parks/sportsgrounds	-	20[1]
– transport	2	1.6
– commercial premises	90	13.8
– major industrial	1 (Hyne & Son Timber Mill)	58.2
Unaccounted for Water[2]		105.3
TOTAL	-	389.8 (1.07 ML/day)

Notes
[1] Estimate only. Parks and sportsgrounds are not metered.
[2] Unaccounted for Water is defined as the difference between the total annual volume of water produced and the total annual metered volume.

Water was supplied to 685 urban residential and 105 urban non-residential customers during 2005/06. The major categories of water users are urban residential and the Hyne & Son Timber Mill. Council has a 20 year agreement to supply water to the timber mill.

All rural residential properties are serviced by septic tanks that are all located below the water supply intake levels. Council actively participates in the Septic Safe program. A total of 889 existing septic tanks have been inspected. All new systems are registered and inspected.

No water has been carted for town usage.

Council has been progressively metering all water use customers. There were 36 unmetered customers at 30 June 2005 and 8 unmetered residences at 30 June 2006. Metering of all commercial properties was completed during 2005.

Analysis of the metered water records for 2005/06 has indicated the following:

- The average water consumption per metered residence was 222 kL/year. This value is low for inland areas in New South Wales.
- Residential customers used 42.7% of the water produced.
- The Unaccounted for Water was 27%. Unaccounted for Water is defined as the difference between the total annual volume of water produced (389.8 ML) and the total annual metered volume (284.5 ML). Although the Unaccounted for Water in Tumbarumba was reduced from 36% in 2004/05 to 27% in 2005/06, it is still considered to be high. Possible reasons for these high levels are:
  - Inaccurate water meter at Tumbarumba Reservoir prior to 2006. Drop test results indicated that this meter was over reading by 20%. A new electromagnetic flow meter was installed at the reservoir in late 2006 and a drop test confirmed that the new meter is accurate to within 3%.
  - Inaccurate water meters at consumer locations.
  - Other unmetered uses, such as public toilets and watering of public open areas.
  - Leaks and mains breaks in the water supply system.
  - Water used for flushing mains.

Council should continue to monitor the level of Unaccounted for Water. Anecdotal evidence indicates that LWUs have minimum Unaccounted for Water levels of 7% or 8% of the bulk water supply and that these levels are difficult to improve upon. It is recommended that Council investigate options to reduce the level of Unaccounted for Water if it continues to be higher than 10% to 15%.

Water Quality-Treated Water

Water from Burra Creek generally complies with ADWG (2004) values, as described in Section 2.2.2. Raw water quality can deteriorate when water is sourced from Tumbarumba Creek, as occurred for extensive periods during the summers of 2003, 2006/07 and 2007/08

Water quality data were obtained from several taps in Tumbarumba township between January 2001 and December 2008. These data are summarised in Tables 3.3 and 3.4. The numbers of samples are indicated in Table 3.3. The results in Table 3.4 represent 11 to 14 samples.

Table 3.3: Treated Water Quality (2001 to 2005)-Tumbarumba

Water Quality Indicator	ADWG (2004) Value	No of Samples	Measured Concentration		% Meeting ADWG (2004)
			Median	Max	
Site 101: garden tap, 133 Albury Street, Tumbarumba					
E coli (cfu/100 mL)	0	29	0	1	97
Total coliforms (cfu/100 mL)	0	32	31	548	28
Nitrite (mg/L as Nitrite)	3	1	<0.1	<0.1	100
True Colour (HU)	15	1	8.2	8.2	100
Turbidity (NTU)	5	1	1	1	100
Site 102: exterior tap on "stadium" wall, Show Ground, Tumbarumba					
E coli (cfu/100 mL)	0	27	0	0	100
Total coliforms (cfu/100 mL)	0	27	0	202	85
Site 103: garden tap, M Del Agnoli residence, Adelong Road, Tumbarumba					
E coli (cfu/100 mL)	0	19	0	0	100
Total coliforms (cfu/100 mL)	0	23	0	203	57
Nitrite (mg/L as Nitrite)	3	2	<0.1	<0.1	100
True Colour (HU)	15	2	6.2	7.5	100
Turbidity (NTU)	5	2	1	1.2	100
Site 104: garden tap, 41 William Street, Tumbarumba					
E coli (cfu/100 mL)	0	27	0	0	100
Total coliforms (cfu/100 mL)	0	27	0	203	67
Site 105: curb side tap, cnr Bridge & Winton Streets, Tumbarumba					
E coli (cfu/100 mL)	0	30	0	0	100
Total coliforms (cfu/100 mL)	0	30	0	203	70
Site 106: garden tap, 56 Mate Street, Tumbarumba					
E coli (cfu/100 mL)	0	26	0	1	96
Total coliforms (cfu/100 mL)	0	20	8	202	33
Site 107: garden tap, Chaffey residence, cnr Batlow & Pound Creek Roads, Tumbarumba					
E coli (cfu/100 mL)	0	26	0	0	100
Total coliforms (cfu/100 mL)	0	24	14	202	31
Nitrite (mg/L as Nitrite)	3	1	<0.1	<0.1	100
True Colour (HU)	15	1	4.5	4.5	100

Water Quality Indicator	ADWG (2004) Value	No of Samples	Measured Concentration		% Meeting ADWG (2004)
			Median	Max	
Turbidity (NTU)	5	1	2.8	2.8	100
Site 108: external tap, Council depot, cnr Clara & Winton Streets					
E coli (cfu/100 mL)	0	27	0	0	100
Total coliforms (cfu/100 mL)	0	28	4	202	43
Nitrite (mg/L as Nitrite)	3	1	<0.1	<0.1	100
True Colour (HU)	15	1	8.6	8.6	100
Turbidity (NTU)	5	1	1.4	1.4	100
Site 109: garden tap, 128 Batlow Road, Tumbarumba					
E coli (cfu/100 mL)	0	20	0	5	95
Total coliforms (cfu/100 mL)	0	20	0	649	60
Nitrite (mg/L as Nitrite)	3	1	<0.1	<0.1	100
True Colour (HU)	15	1	5.1	5.1	100
Turbidity (NTU)	5	1	1.3	1.3	100

Table 3.4: Treated Water Quality - Chemical (2001 to 2008)-Tumbarumba

Water Quality Indicator	ADWG (2004) Value	Measured Concentration			% Meeting ADWG (2004)
		Mean	Median	Max	
pH	6.5-8.5	7.1	7.1	7.3	100
Turbidity (NTU)	5	3.6	1.4	12.1	82
Total Dissolved Solids (mg/L)	500	15	14	30	100
Aluminium (mg/L)	0.2	0.14	0.11	0.34	82
Antimony (mg/L)	0.003	0.001	0.001	0.001	100
Arsenic (mg/L)	0.007	0.001	0.001	0.005	100
Barium (mg/L)	0.7	0.006	0.005	0.008	100
Boron (mg/L)	4	0.081	0.099	0.099	100
Cadmium (mg/L)	0.002	0.0005	0.0005	0.0005	100

Water Quality Indicator	ADWG (2004) Value	Measured Concentration			% Meeting ADWG (2004)
		Mean	Median	Max	
Chloride (mg/L)	250	3.2	2.9	4.7	100
Chromium (mg/L)	0.05	0.005	0.005	0.005	100
Copper (mg/L)	2	0.044	0.018	0.188	100
Cyanide (mg/L)	0.08	<0.01	<0.01	<0.01	100
Fluoride (mg/L)	1.5	<0.1	<0.1	<0.1	100
Iodine (mg/L)	0.1	0.02	0.02	0.05	100
Iron (mg/L)	0.3	0.23	0.18	0.46	64
Lead (mg/L)	0.003	0.003	0.002	0.01	93
Manganese (mg/L)	0.5	0.008	0.008	0.014	100
Mercury (mg/L)	0.001	0.0002	0.0001	0.0005	100
Molybdenum (mg/L)	0.05	0.005	0.005	0.005	100
Nickel (mg/L)	0.02	0.009	0.01	0.01	100
Nitrate (mg/L)	50	1.3	0.99	5.4	100
Nitrite (mg/L)	3	<0.1	<0.1	0.1	100
Selenium (mg/L)	0.01	0.002	0.002	0.005	100
Silver (mg/L)	0.1	0.002	0.002	0.005	100
Sodium (mg/L)	180	2.5	2.3	4.8	100
Sulphate (mg/L)	500	<1	<1	<1	100
Total Hardness (mg/L as $CaCO_3$)	200	7.9	7.2	11.4	100
True Colour (HU)	15	6.2	6.0	8.6	100
Zinc (mg/L)	3	0.05	0.04	0.17	100

These data demonstrate that microbiological water quality in Tumbarumba township meets the ADWG (2004) criteria for safe water on the basis of the *E coli* results at all of the monitoring sites except for Site 109 (which showed 95% compliance). The results indicate that the drinking water is not contaminated with faecal matter. However, compliance with ADWG (2004) for Total Coliforms was considerably lower. It should be noted that ADWG (2004) does not recommend the use of Total Coliforms as an indicator of potential faecal pollution because they can be present as normal inhabitants of soil and water and can grow in water distribution systems in the absence of faecal contamination. Nevertheless, they should not be detected in water sampled immediately after disinfection.

All True Colour and Nitrite levels complied with ADWG (2004) levels, although concentrations of these indicators exceeded ADWG (2004) levels in the water sources (refer to Tables 2.10 to 2.13 for chemical water quality in Burra and Tumbarumba Creeks). Turbidity levels, which also exceeded ADWG (2004) levels in Burra and Tumbarumba creeks, also generally complied with ADWG (2004) levels (82% compliance). All of the chemical indicators complied with ADWG (2004) levels except for Aluminium (82% compliance), Iron (64% compliance) and Lead (93% compliance).

Draught and Emergency Management

Tumbarumba Shire Council has a Drought Contingency and Emergency Response Plan for Tumbarumba and Khancoban (August 2006). The identified water consumption targets are:

- Annual Consumption: 293 ML (Tumbarumba); 101 ML (Khancoban)
- Peak Day Demand: 2.8 ML/day (Tumbarumba); 1.0 ML/day (Khancoban)

Demand management during droughts or emergencies focuses on a five stage system of water restrictions:

- Level 1: Voluntary reductions only, enhanced by public awareness campaigns.
- Level 2 (Low Level): Pavement hosing not permitted and sprinkler use only permitted for three hours each day.
- Level 3 (Moderate Level): Total ban on fixed sprinklers.

  Garden and lawn watering restricted to hand held hoses only with trigger nozzles fitted between 7 pm and 11 pm (or 3 pm and 7 pm). If daily consumption exceeds target, these times will be further reduced.

  Where deemed necessary and appropriate, a roster system for garden watering may be introduced, based on an odds and evens house numbering system.

  Pool top up only permitted during watering times.

  Garden Club permitted to water between 6 am and 9 am (or 7 am to 10 am)-hand held only.

  Bowling green watering permitted between 6 am and 9 am (or 7 am to 10 am).

  Hosing of pavements and vehicles not permitted.

  Council agreed reductions in industrial and commercial use.

  Revised Level 3 restrictions have been implemented, eg changes in watering times and restrictions on permitted areas that can be watered.

- Level 4 (Severe Restrictions): Total ban on all outdoor garden/lawn watering, hosing of pavements, car washing, filling of swimming pools and standpipe use.

  Ban on light or heavy vehicle washing except for Emergency Service vehicles

  Negotiated reductions in industrial and commercial use.

- Level 5 (Emergency Restrictions): Supply restricted to 60 litres per person per day, with negotiated shutdowns for industry.

Situations that would trigger an emergency response are:

- Total failure of flow in supply creeks (Burra Creek, Tumbarumba Creek and Khancoban Creek);
- Contamination of the water supply;
- Widespread power failure;
- Major system failure and
- Bushfires in supply catchments.

Water restrictions have been imposed as required. Level 2 water restrictions were imposed in Tumbarumba township from 2 January 2003 to 10 March 2003. This restriction was relaxed to a Level 1 restriction from 11 March 2003 to 9 April 2003. Level 2 restrictions were also imposed from 11 March 2003 to 9 April 2003. More stringent Level 3 restrictions were imposed in the Shire for most of the time from 1 November 2006 to 20 March 2008, when Level 4 restrictions were imposed in Tumbarumba township.

Leak Reduction Program

The following leak reduction activities were undertaken from 2003/04 to 2005/06:

- Mains rehabilitation:
  - 2 km (2003/04);
  - 2.8 km (2004/05);
  - 1.4 km (2005/06).
- Service connection rehabilitation:
  - 6 (2004/05);
  - 15 (2005/06).

Water Demand Management

Although several water conservation measures have been implemented by Council in Tumbarumba township (refer Section 3.1), no formal demand management program has been implemented. A draft Demand Management Strategy is currently being considered by Council.

Future Water Demands-Preliminary Estimates

Prior to 2006, Tumbarumba and its surrounding area were at best experiencing zero economic growth. However, the economic stimulus provided by the establishment of the Hyne & Son Timber Mill will result in the following additional water demands by industrial and residential developments:

- Expansion of the Hyne & Son Timber Mill will continue for several years. The Mill currently uses 58 ML/year (refer Table 3.2) and it is anticipated that it will shortly require 65 ML/year (Gordon Gibson Nominees, 2007a).
- A new industrial estate in Linden Roth Drive, almost opposite the Hyne & Son Timber Mill. Three major industries are proposed: I Beam Plant, Waratah Industries and a grape crushing plant. The total water demand for these industries is anticipated to be 6.3 ML/year (Gordon Gibson Nominees, 2003).
- Council has purchased land in the vicinity of Mitchell and Langland Streets for a new 60 lot urban subdivision with town water and sewerage. The first stage of 22 lots has been completed and four new dwellings have been constructed. The total water demand for this subdivision is estimated to be 12.5 ML/year (based on current urban residential water consumption, refer Table 3.2).
- A new 12 lot rural residential subdivision with town water and sewerage. One dwelling is currently being constructed. The total water demand for this subdivision is estimated to be 4.4 ML/year (based on current rural residential water consumption, refer Table 3.2).
- Twelve home units on five existing residential lots close to the Central Business District have been approved by Council, with three being close to completion. The total water demand for this development is estimated to be 2.5 ML/year (based on current urban residential water consumption, refer Table 3.2).

The approach taken to estimate future water demands and wastewater flows was as follows:

- The 2005/06 water production of 389.8 ML/year was adopted as the starting point.
- An annual population change of -0.15% (refer Section 2.1.7 for future population changes) was applied to this starting point water production value to estimate future water demands for the current population in Tumbarumba township.
- The additional water demands by the new industrial and residential developments were added to the future water demands for the current population. It was assumed that:
  - the increased water demand for the Hyne & Son Timber Mill would occur over the next two years;
  - the increased water demand for the new industrial estate in Linden Roth Drive, the new subdivision in the vicinity of Mitchell and Langland Streets and the new rural residential subdivision would occur over the next ten years; and
  - the increased water demand for the new home units would occur over the next five years.
- Wastewater flows were estimated by assuming that 75% of water produced would be discharged to sewer.

It should be noted that the future projections of annual water production as estimated by this approach are preliminary estimates because they do not include the effects of climate change, changes in demographics such as decreasing household sizes (which would result in decreasing water consumption per residence) or water demands by tourists. Furthermore, they assume that the 2005/06 level of Unaccounted for Water (27%, refer Table 3.2) will not change in the future. Council should undertake detailed water demand projections to include these factors.

The preliminary annual water production and wastewater flow estimates are shown in Figure 3.3.

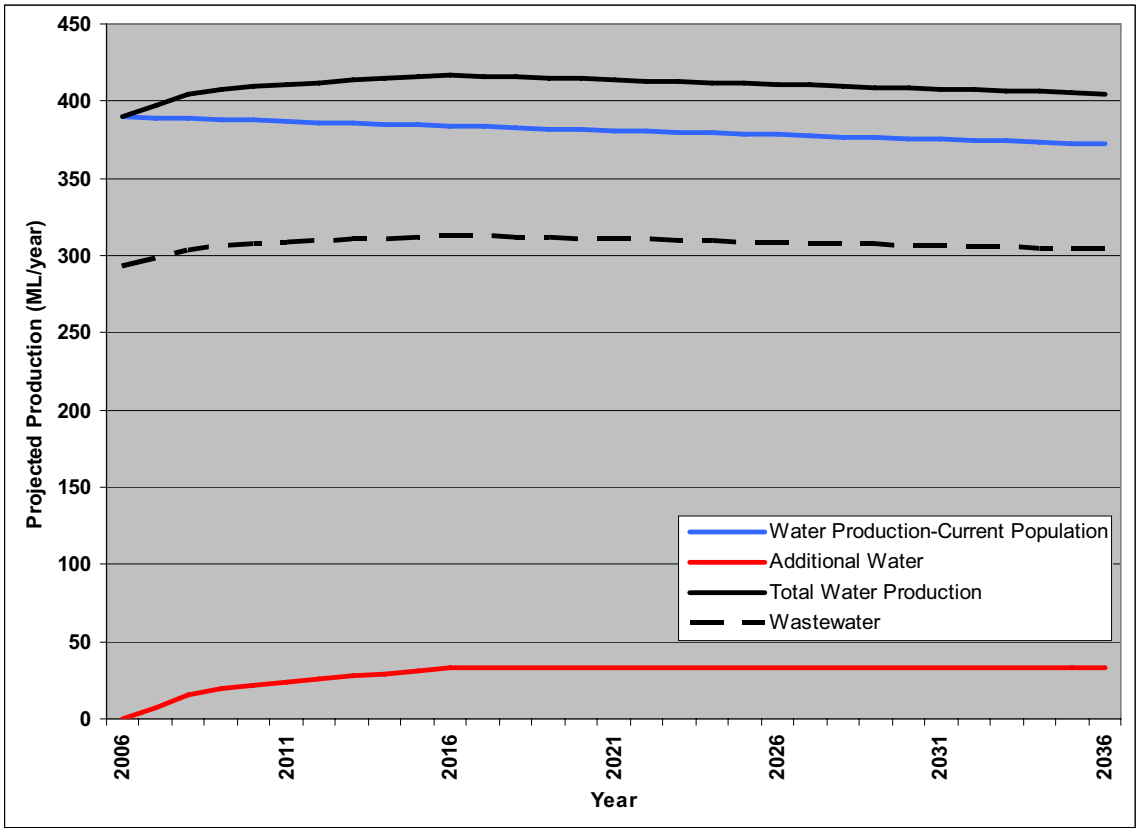

Figure 3.3: Preliminary Water Production and Wastewater Flow Projections-Tumbarumba

These estimates indicate that water production should increase by about 7% over the next ten years and then decline slightly to a 4% increase by the year 2036. Wastewater flows follow a similar trend.

3.2.2 Khancoban

Water Supply System Assets

The Khancoban water supply scheme was taken over by Council from the Snowy Mountains Hydro Electric Authority in June 1993.

The Khancoban township water supply system consists of the following components:

- 10.42 km of trunk mains consisting of 100 mm (1.73 km total length), 150 mm (1.91 km total length) and 200 mm (6.78 km total length) nominal diameter pipes constructed of steel, AC, ductile iron cement lined and PVC. The trunk mains are approximately 40 to 50 years old.
- 14.26 km of reticulation mains consisting of 50 mm (1.7 km total length), 75 mm (157 m total length), 100 mm (6.7 km total length), 150 mm (4.6 km total length) and 200 mm (1.1 km total

length) nominal diameter pipes. All of these reticulation mains are AC and were installed in 1960. The reticulation system is nearing the end of its theoretical useful life.

- Two pump stations on Khancoban Creek of 30.3 L/second and 27.6 L/second capacities.
- One fine stainless steel screen (0.8 mμ pore size).
- One chlorinator.
- One header tank of 100 kL capacity.
- One service reservoir of 1.5 ML capacity.

An extensive mains replacement program was recently undertaken in Khancoban township. Council's asset data base is out of date. It is currently being reviewed and the above data should be updated when the review has been completed.

Water Supply and Treatment

The layout of the Khancoban township water supply system is shown in Figure 3.4.

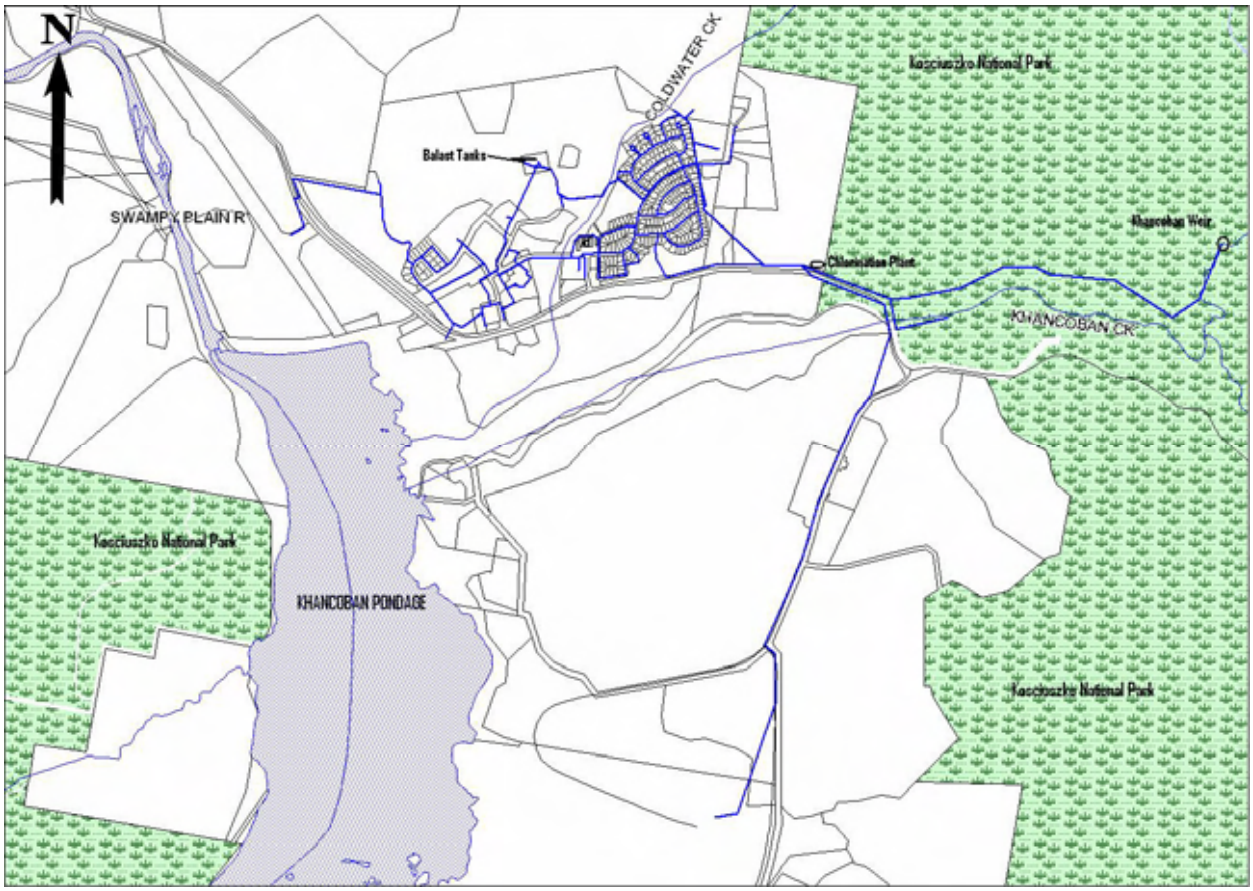

Figure 3.4: Layout of Water Supply System-Khancoban

Water is supplied by gravity from Khancoban Creek with a dual pump back up system. The gravity system can deliver water at 10.11 L/second and the pumps can each deliver approximately 30 L/second.

Council currently has a licence to divert up to 35 L/second (ie 3,024 kL/day) from Khancoban Creek. No bore water is provided.

Water from Khancoban Creek is screened and chlorinated. It is then stored in a 1.5 ML steel service reservoir. The chlorination plant is capable of delivering 2.5 ML/day.

The 1.5 ML service reservoir at Khancoban township only provides a little more than 1 day of storage at peak daily flows. This is not considered to be an issue because Khancoban Creek appears to have considerable flows at all times and the pumping capacity (a maximum of 35 L/second is permitted) is more than sufficient to keep the service reservoir full at all times if required.

Water Production

Water produced at the chlorination plant at Khancoban township is monitored daily. Water production records at Khancoban are only available from August 2001. The volumes of treated water produced from 2002/03 to 2006/07 are shown in the following table as annual totals.

Table 3.5: Annual Volumes of Treated Water Produced (2002/03 to 2006/07)-Khancoban

Year[1]	Volume Produced (ML/year)	Peak Day (ML/day)	Average Day (ML/day)
2002/03	128	1.16	0.350
2003/04	102	0.718	0.279
2004/05	92.5	1.04	0.253
2005/06	90.8	0.999	0.247
2006/07	98.6	1.11	0.271

Notes
[1] Financial years (1 July to 30 June).

An average of 102 ML/year of potable water has been produced during the five years shown in Table 3.5. Water production was higher in 2002/03 than in more recent years. The Average Day and Peak Day Demands during past summers with no water restrictions have been approximately 0.3 ML/day and 1 ML/day, respectively. Surprisingly, water production, Average Day Demand and Peak Day Demand increased in 2006/07 despite the imposition of water restrictions.

The average monthly water production using data from 2002 to 2006 is shown in Figure 3.5 (the average daily consumption for each month (kL/day) is shown at the top of each monthly bar).

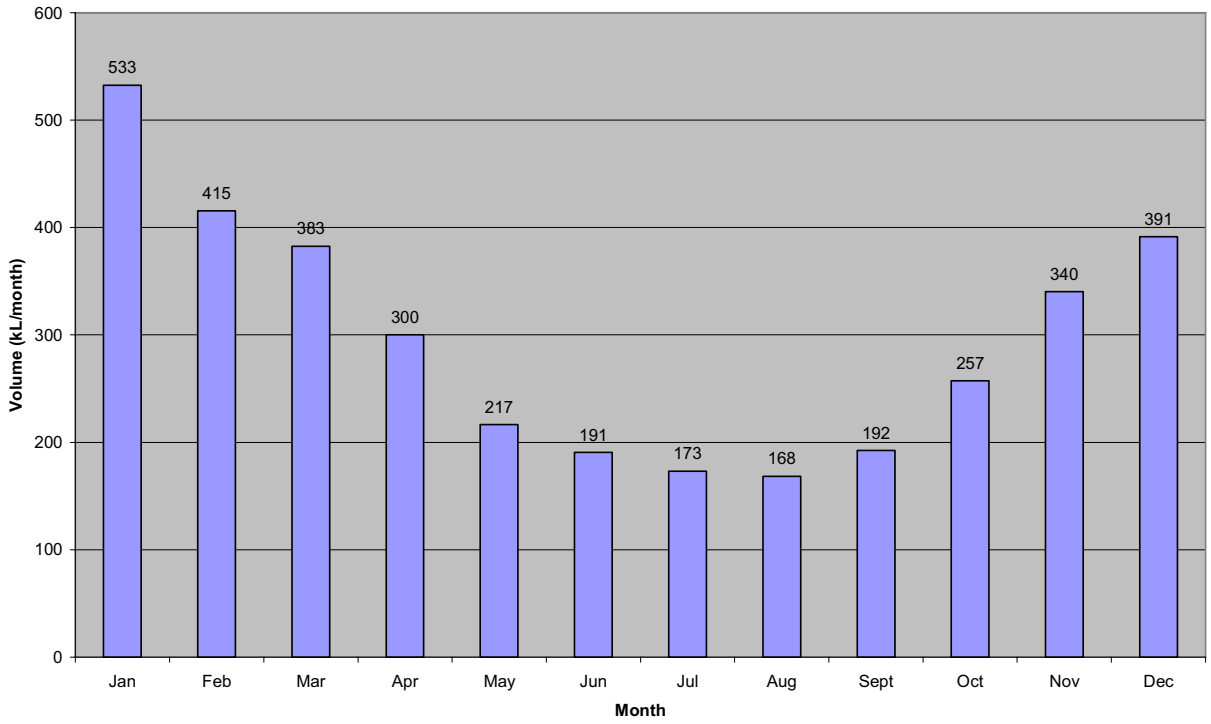

Figure 3.5: Average Monthly Water Production (2002 to 2006)-Khancoban

Demand Profile

The water demand profile for the 2005/06 financial year is summarised in the following table.

Table 3.6: Water Demand Profile (2005/06)-Khancoban

Type	Quantity	Annual Water Production/Consumption (ML/year)
Water Produced		90.8
Water Consumed		
Urban residential	260	41.6
Rural residential	5	1.6
Farming	2	0.8
Non-residential:		
– hotels/motels	98 beds	10.8
– caravan parks	42 sites	2.2
– schools	21 pupils	0.3
– golf club	215 patrons	1.7
– parks/sportsgrounds	-	12[1]
– commercial premises	5	1.7
– major industrial	1 (Snowy Hydro Limited)	8.3
Unaccounted for Water		9.8
TOTAL	-	90.8 (0.25 ML/day)

Notes
[1] Estimate only. Parks and sportsgrounds are not metered.

Water was supplied to 260 urban residential and 15 urban non-residential customers during 2005/06.

All rural residential properties are serviced by septic tanks that are all located below the water supply intake level. No water has been carted for town usage.

All residential properties have been metered since 2004. Analysis of the metered water records for 2005/06 has indicated the following:

- The average water consumption per metered residence was 165 kL/year, which is 25% lower than in Tumbarumba township and is low for New South Wales.
- Residential customers used 48.5% of the water produced.
- The Unaccounted for Water in Khancoban was 11%, based on 2005. This level of Unaccounted for Water is considered to be low and does not warrant expenditure on improvement works. Anecdotal evidence indicates that LWUs have minimum UFW of 7% or 8% of the bulk water supply and that these levels are difficult to improve upon.

Water Quality-Treated Water

The quality of treated water in Khancoban township from January 2001 to February 2006 is summarised together with the corresponding ADWG (2004) values in Table 3.7. These data were obtained from taps located at Khancoban WWTP, Khancoban Country Club, the boat ramp, the caravan park and the Council Depot.

Table 3.7: Treated Water Quality (2001 to 2006)-Khancoban

Water Quality Indicator	ADWG (2004) Value	No of Samples	Measured Concentration		% Meeting ADWG (2004)
			Median	Max	
E coli (cfu/100 mL)	0	129	0	24	98
Total coliforms (cfu/100 mL)	0	134	0	2444	96
Aluminium (mg/L)	0.2 {aesthetic}	4	0.07	0.13	100
Antimony (mg/ L)	0.003	4	0.001	0.001	100
Arsenic (mg/L)	0.007	4	0.001	0.001	100
Barium (mg/L)	0.7	4	0.005	0.005	100
Boron (mg/L)	4.0	4	<0.1	<0.1	100
Cadmium (mg/L)	0.002	4	0.005	0.005	100
Calcium (mg/L)	-	4	3.12	3.97	-
Chloride (mg/L)	250 {aesthetic}	4	3.6	3.9	100
Chromium (mg/L as Cr(VI))	0.05	4	0.005	0.005	100
Copper (mg/L)	2 {Health}	4	0.306	1.404	100
Cyanide (mg/L)	0.08	1	<0.01	<0.01	100
Fluoride (mg/L)	1.5	4	<0.1	<0.1	100
Iodine (mg/L)	-	4	0.0198	0.0198	100
Iron (mg/L)	0.3 {aesthetic}	4	0.075	0.090	100
Lead (mg/L)	0.01	4	0.002	0.002	100
Magnesium (mg/L)	-	4	0.98	1.19	-
Manganese (mg/L)	0.5 {Health} 0.1 {Aesthetic}	4	0.005	0.005	100
Mercury (mg/L)	0.001	4	0.0001	0.0001	100
Molybdenum (mg/L)	0.05	4	0.005	0.005	100
Nickel (mg/L)	0.02	4	<0.01	<0.01	100
Nitrate (mg/L as Nitrate)	50	4	<1	<1	100

Water Quality Indicator	ADWG (2004) Value	No of Samples	Measured Concentration		% Meeting ADWG (2004)
			Median	Max	
Nitrite (mg/L as Nitrite)	3	4	<0.1	<0.1	100
pH	6.5 to 8.5 {aesthetic}	4	7.0	7.3	100
Selenium (mg/L)	0.01	4	0.002	0.002	100
Silver (mg/L)	0.1	4	0.002	0.002	100
Sodium (mg/L)	180 {aesthetic}	4	2.6	3.3	100
Sulphate (mg/L)	500 {health}	4	<1	<1	100
Total Dissolved Solids (mg/L)	500 {aesthetic}	4	20	23	100
Total Hardness (mg/L)	200 {aesthetic}	4	12	15	100
True Colour (HU)	15 {aesthetic}	4	3.2	3.6	100
Turbidity (NTU)	5 {aesthetic}	4	1.5	2.7	100
Zinc (mg/L)	3 {aesthetic}	4	0.035	0.060	100

All of the chemical and physical water quality indicators have shown 100% compliance with the ADWG (2004) guideline values for drinking water.

The microbiological indicators, for which there are considerably more data, have shown slightly lower compliance (96% and 98% compliance for Total Coliforms and *E coli*, respectively). The level of compliance for *E coli* was similar to the NSW State median (97% and 98% for 2003/04 and 2004/05, respectively).

The high *E coli* value of 24 cfu/100 mL was measured during the 2003 bushfires when the water was not being chlorinated.

Draught and Emergency Management

Tumbarumba Shire Council has a Drought Contingency and Emergency Response Plan for Tumbarumba and Khancoban (August 2006), as described in Section 3.2.1.

Water restrictions have been imposed as required. Level 4 restrictions were imposed during the drought period from 28 February 2003 to 5 March 2003 as a result of a contaminated water supply caused by the 2003 bush fires. Level 3 water restrictions were imposed in Khancoban on 1 November 2006 and were still in force as at 20 March 2008.

A Boil Water Alert for the Khancoban water supply system was issued on 20 December 2004 because the *E coli* level exceeded the ADWG value in the drinking water sample obtained during that month. This high level was caused by rain during early December 2004.

Leak Reduction Program

The total length of water mains replaced at Khancoban during 2003/04 and 2004/05 was 1.303 km. No mains rehabilitations were undertaken during 2005/06. Six service connection rehabilitations were carried out in 2005/06.

Water Demand Management

Although several water conservation measures have been implemented by Council in Khancoban township (refer Section 3.1), no formal demand management program has been implemented. A draft Demand Management Strategy is currently being considered by Council.

Future Water Demands-Preliminary Estimates

A 56 lot residential subdivision has been completed in Khancoban, with one dwelling currently under construction.

The approach taken to estimate future water demands and wastewater flows was the same as used for Tumbarumba township (refer Section 3.2.1), ie

- The 2005/06 water production of 90.8 ML/year was adopted as the starting point.
- A population change of -0.15% (refer Section 2.1.7 for future population changes) was applied to this starting point water production value to estimate future water demands for the current population in Khancoban township.
- The additional water demand by the new residential subdivision was added to the future water demands for the current population. It was assumed that the increased water demand for the new subdivision would occur over the next 20 years.
- Wastewater flows were estimated by assuming that 75% of water produced would be discharged to sewer.

It should be noted that the future annual water production projections as estimated by this approach are preliminary estimates for the same reasons as previously discussed for Tumbarumba township. Council should undertake detailed water demand projections to include the effects of climate change and demographic changes.

The preliminary annual water production and wastewater flow estimates are shown in Figure 3.6.

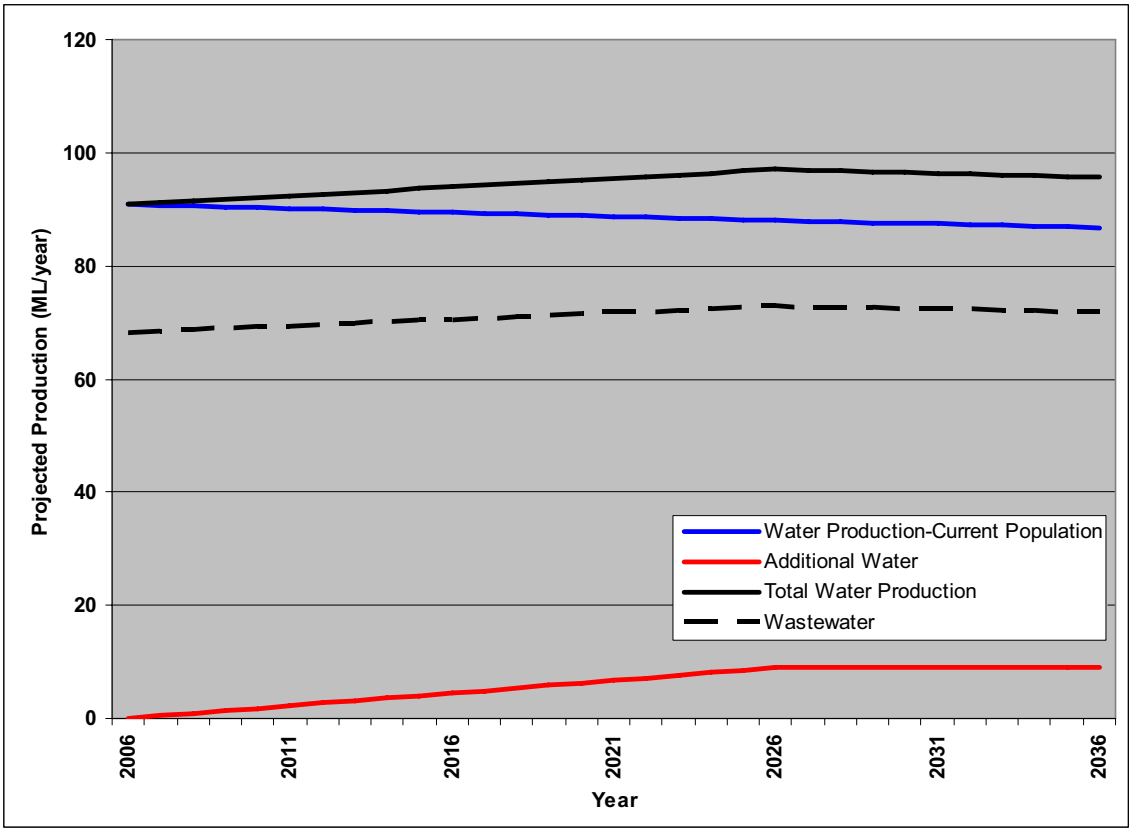

Figure 3.6: Preliminary Water Production and Wastewater Flow Projections-Khancoban

These estimates indicate that water production should increase by about 7% over the next 20 years and then decline slightly to a 5% increase by the year 2036. Wastewater flows follow a similar trend.

3.3 URBAN SEWERAGE SERVICES

Overview

Tumbarumba Shire Council provides wastewater collection and treatment services in Tumbarumba and Khancoban townships. These services are summarised in the following table and described below.

	Tumbarumba	Khancoban
Population Served	• 1,800 (permanent) • 2,000 (peak)	• 300 (permanent) • 500 (peak)
Connected Urban Properties **- Residential** **- Non-Residential**	 680 100	 255 12
Unsewered Urban Properties	3	8
Large Trade Waste Dischargers	1	0
Tankered Flows (Septic Tanks, Grease Trap Wastes)	0	Approximately 8 kL/week from Murray 1 and Murray 2 Power Stations
Volume of Sewage Treated	152.2 ML/year	58.9 ML/year
Wastewater Treatment	Trickling filtration WWTP	Trickling filtration WWTP
Effluent Recycled	• 0% for urban applications • 100% for maintaining downstream flows in Tumbarumba Creek	0% for urban applications
Quantity of Biosolids	12 dry tonnes	2 dry tonnes
Biosolids Reused	0 %	0 %
Infiltration/Inflow	100 ML/year (estimate)	na
DECC Licence	Licence No 448	Licence No 4400
Licence Compliance	Main non-compliance is that the upper flow limit has been exceeded during wet weather	Only non-compliance is that the upper flow limit has been exceeded during wet weather
Asset Replacement Cost (2006) **- Trunk main system** **- Reticulation system** **- Wastewater treatment plant**	 $358,734 $6,049,799 $1,948,000	 $714,303 $3,674,177 $2,488,000

Main Data Sources (also refer Appendix A)

- Albury City Council. May 2006. Report on Pricing for Water Supply, Sewerage & Trade Waste.
- DEUS. 2006. 2004/05 NSW Water Supply and Sewerage Performance Monitoring Report.
- DLM Environmental Consultants. June 2006. Scoping Report. Water & Sewerage Asset Register/Condition Assessment Project.
- Environment Protection Licence No 448. Tumbarumba Sewage Treatment Works.
- Environment Protection Licence No 4400. Khancoban Sewage Treatment Plant.
- Tumbarumba Shire Council data bases.

3.3.1 Tumbarumba

Sewerage System

The Tumbarumba township sewerage system consists of the following components:

- 1.08 km of trunk mains of 225 mm (281 m total length) and 300 mm (794 m total length) nominal diameters. The trunk mains system was constructed in 1962/63 and much of the system is nearing the end of its theoretical useful life.
- Approximately 27.5 km of reticulation mains of 150 mm (22 km total length), 80 mm (1.38 km total length) and 50 mm (4.1 km total length) nominal diameters. Much of the 150 mm diameter reticulation system (16.8 km) was constructed in the early 1960s and is nearing the end of its theoretical useful life.
- Rising main of approximately 5 km in length.
- One sewage pump station at the Hyne & Son Timber Mill (about 5 ML/year).
- One sewage pump station at Chaffey Close that services six properties.
- A 3,500 Equivalent Person (EP) Trickling Filter Wastewater Treatment Plant (WWTP).

Council's asset data base is out of date. It is currently being reviewed and the above data should be updated when the review has been completed.

The layout of the Tumbarumba township sewerage system is shown in Figure 3.7.

Figure 3.7: Layout of Sewerage System-Tumbarumba

Wastewater Treatment Plant

The Tumbarumba WWTP is a trickling filter system that consists of the following components:

- 1 emergency overflow pond. High sewage flows that exceed the capacity of the WWTP are stored in this pond and then pumped through the WWTP when flows decrease.
- 2 longitudinal grit channels.
- 1 Parshall flume following the grit chambers.
- 4 bag filters.
- 2 rectangular primary sedimentation tanks.
- 3 fine screens following the sedimentation tanks.
- 1 trickling filter.
- 1 rectangular humus tank.
- 6 holding lagoons.
- 2 anaerobic sludge digesters

- 6 sludge drying beds.

Treated effluent is discharged to Tumbarumba Creek downstream of Tumbarumba township and none is reused for non-potable uses such as irrigation. Dried sewage biosolids are spread on site.

DECC Licence Conditions

The DECC Licence conditions for Tumbarumba WWTP are shown in the following table.

Table 3.8: Current DECC Licence Conditions-Tumbarumba WWTP

Pollutant	Units	Condition
Flow		Not to exceed 900 kL/day Not to exceed 200 ML/year
Effluent Quality (100 percentile concentration limits)		
pH	-	6.5 to 8.5
Oil & Grease	mg/L	10
Biochemical Oxygen Demand (BOD_5)	mg/L	20
Total Suspended Solids (TSS)	mg/L	30
Sampling	-	Quarterly effluent monitoring at effluent holding lagoon
Load limits	-	Nil

No Pollution Reduction Programs are in place.

Wastewater Flows

Effluent flows from the Tumbarumba WWTP are measured daily with an ultrasonic flow metre located downstream of the humus tank. Flows for 2001/02 to 2006/07 are shown in the following table.

Table 3.9: Annual Effluent Flows (2001/02 to 2006/07)-Tumbarumba WWTP

Year[1]	Effluent Flow		
	Peak Day (kL/day)	Average Day (kL/day)	Total Annual (ML/year)
2001/02	1,608	577	204.7
2002/03	1,760	514	187.5
2003/04	1,620	557	204.0
2004/05	1,796	609	220.7
2005/06	1,124	494	152.2
2006/07	1,139	479	172.7

Notes
[1] The DECC reporting periods were:
- 15 September to 14 September (2006/07)
- 30 September to 14 September, ie 349 days (2005/06)
- 30 September to 29 September (prior years)

An average annual effluent flow of 190.3 ML/year has been recorded during the last six years. There was a decline in effluent flows during 2005/06 and 2006/07. The low values recorded during these years were the results of the short recording year during 2005/06 and the flow meter being damaged during an electrical storm and being out of operation for 40 days during 2006/07.

The total volume of effluent in 2004/05 (220.7 ML) corresponds to 69.4% of the total volume of water produced (318 ML) during that year. This value is a little lower than the range of values expected for rural towns (typically 70% to 80%), possibly because the flow meter at Tumbarumba WWTP provides erroneous measurements during periods of high flows when high flow levels swamp the meter. The percentage of effluent to total water produced during 2005/06 was considerably lower (39%) for the reasons described above.

The Average Dry Weather Flow (ADWF) for the Tumbarumba WWTP has been estimated to be about 450 kL/day using measured effluent flows for dry periods during 2002 to 2005.

Council has estimated that 100 ML/year of sewage flows may be caused by infiltration/inflows into the sewerage system. Nevertheless, peak daily effluent flows during wet days have not exceeded the ADWF by more than four times. Council has indicated that the ultrasonic flow meter provides erroneous measurements during periods of high flows when high flow levels can swamp the flow meter.

Effluent Quality

Effluent quality is monitored at approximately quarterly intervals at the discharge pipe from the final holding lagoon. Data for 2004 to 2007 are shown in Table 3.10.

Table 3.10: Effluent Quality (2004 to 2007)-Tumbarumba WWTP

Indicator	Sampling Date												
	24/2/04	31/3/04	31/6/04	8/9/04	10/2/05	29/4/05	14/7/05	21/9/05	9/3/06	16/5/06	13/12/06	6/3/07	21/5/07
Electrical Conductivity (µS/cm)	380	450	376	317	361	443	362	256	676	661	615	685	663
pH	-	-	-	-	8.8	7.6	7.5	6.8	-	-	9.1	8.4	7.5
Total Suspended Solids (mg/L)	5	15	12	4	14	1	20	6	36	10	20	39	6
BOD_5 (mg/L)	3	6	28	4	10	2	10	4	34	5	8	75	5
Oil & Grease (mg/L)	-	-	-	-	<5	<5	5	<5	<5	<5	<5	<5	5
NOx (mg/L)	2.40	8.80	9.16	8.51	4.60	2.41	14.2	2.91	10.1	10.2	1.91	2.67	8.54
Total Nitrogen (mg/L)	6.2	13.4	20.2	18.9	8.6	8.2	28.4	11.0	19.8	25.3	2.7	6.9	20.9
Total Phosphorus (mg/L)	8.40	8.36	5.69	4.50	8.02	5.65	5.22	4.11	9.54	4.19	9.67	7.84	10.60
Faecal Coliforms (cfu/100 mL)	16	<2	54	66	46	6	134	5	<2	62	50	14	8

When compared with water quality objectives for the Protection of Aquatic Ecosystems (refer Table 2.6), Electrical Conductivity levels in effluent from Tumbarumba WWTP are only slightly higher and pH levels generally comply with the range of pH value objectives. Effluent faecal coliform levels have been considerably lower than the objectives for primary contact recreation (refer Table 2.6).

Compliance with DECC Licence Conditions

The DECC Licence conditions for Tumbarumba WWTP are shown in Table 3.8. Non-compliances with the DECC Licence from 2002/03 to 2005/06 are shown in the following table.

Table 3.11: Summary of Licence Non-Compliances (2002/03 to 2005/06)-Tumbarumba WWTP

Year	Type of Non-Compliance	No of Occasions
2002/03	Daily flow limit exceeded	15
2003/04	Annual flow limit exceeded Daily flow limit exceeded BOD_5 limit exceeded	- 20 1
2004/05	Annual flow limit exceeded Daily flow limit exceeded pH limit exceeded	- 45 1
2005/06	Annual flow limit exceeded Daily flow limit exceeded BOD_5 limit exceeded TSS limit exceeded	- 5 1 1

The main type of non-compliances with the DECC Licence has been exceedance of the flow limit during wet weather as a result of stormwater infiltration/inflows into sewers. Council introduced a stormwater levy during 2005/06 to ensure that funds are available for the investigation and repair of sewers where stormwater infiltration/inflow occur. Effluent quality non-compliances have occurred occasionally as a result of wet weather and discharge of liquid trade wastes to the sewerage system. Council adopted a Liquid Trade Waste Policy during 2005/06 to control liquid trade waste discharges to the sewerage system.

It should be noted that Load Based Licencing commences for sewage flows in excess of 219 ML/year. This flow is only slightly higher than the upper flow limit of 200 ML/year (refer Table 3.8). Council should resolve the high level of stormwater infiltration/inflows into sewers so that Load Based Licencing fees are not imposed as a result of infiltration/inflows.

It is anticipated that DECC will require effluent from Tumbarumba WWTP to meet effluent quality objectives for discharge to Sensitive Waters as adopted by the former EPA. These effluent quality objectives are shown in Table 3.12.

Table 3.12: Effluent Quality Objectives for Sensitive Waters

Pollutant	Units	90 Percentile Concentration Limit[1]
pH	-	6.5 to 8.5
Oil & Grease	mg/L	2
Biochemical Oxygen Demand (BOD_5)	mg/L	10
Total Suspended Solids (TSS)[2]	mg/L	15
Total Nitrogen	mg/L	10
Ammonia Nitrogen	mg/L	2
Total Phosphorus	mg/L	0.3
Faecal Coliforms	cfu/100 mL	200

Notes
1 90 percentile concentration limits for 1.5 times design peak dry weather flows.
2 Also termed "Non Filterable Residue (NFR)".

Comparison of the data in Tables 3.10 and 3.12 indicates that levels of Total Nitrogen and Total Phosphorus effluent from Tumbarumba WWTP have generally been considerably higher than those required for discharge to Sensitive Waters. It is also likely that levels of pH, Total Suspended Solids, BOD_5 and Oil & Grease would on occasion not have complied with the Sensitive Waters effluent objectives.

Biosolids Quantity and Quality

Twelve dry tonnes were produced in 2005/06.

No biosolids quality data are available.

Sewer Rehabilitation

Council has an on-going sewer replacement and rehabilitation program. 0.2 km of sewer mains was constructed in 2003/04 and 1 km was constructed in 2004/05. Four house connections were rehabilitated in 2003/04 and six house connections were rehabilitated in 2004/05.

Effluent Reuse

No treated effluent or stormwater is reused on urban sites in Tumbarumba township. However, treated effluent is used to maintain flows in Tumbarumba Creek so that the risk of downstream users not having sufficient water is lessened.

Effluent from Tumbarumba WWTP cannot be reused on urban sites in the township, eg for watering parks and gardens (20 ML of treated water was estimated to be used for this purpose in 2005/06), without additional treatment, namely disinfection. Reuse of treated effluent should be investigated when

Tumbarumba WWTP is upgraded to comply with effluent quality objectives for discharge to Sensitive Waters.

There is no potential for reusing effluent from Tumbarumba WWTP at the Hyne & Son Timber Mill because the company has access to an on-site bore that is capable of providing most of its water needs. The Mill management have also indicated that they may investigate the use of reclaimed water for on-site non-potable uses.

3.3.2 Khancoban

Sewerage System

The Khancoban sewerage system consists of the following components:

- Approximately 4.85 km of trunk mains of 225 mm (1.65 km total length) and 300 mm (773 m total length) nominal diameters. 86% of the trunk mains are constructed of concrete. All of the 300 mm and about 80% of the 225 mm trunk mains were constructed in 1960 and are nearing the end of their theoretical useful lives.
- Approximately 16.2 km of reticulation sewers of 150 mm nominal diameter. The majority (88%) are concrete pipes constructed in the early 1960s, which are nearing the end of their theoretical useful lives.
- A 2,500 EP Trickling Filter wastewater treatment plant.

The layout of the Khancoban township sewerage system is shown in Figure 3.8.

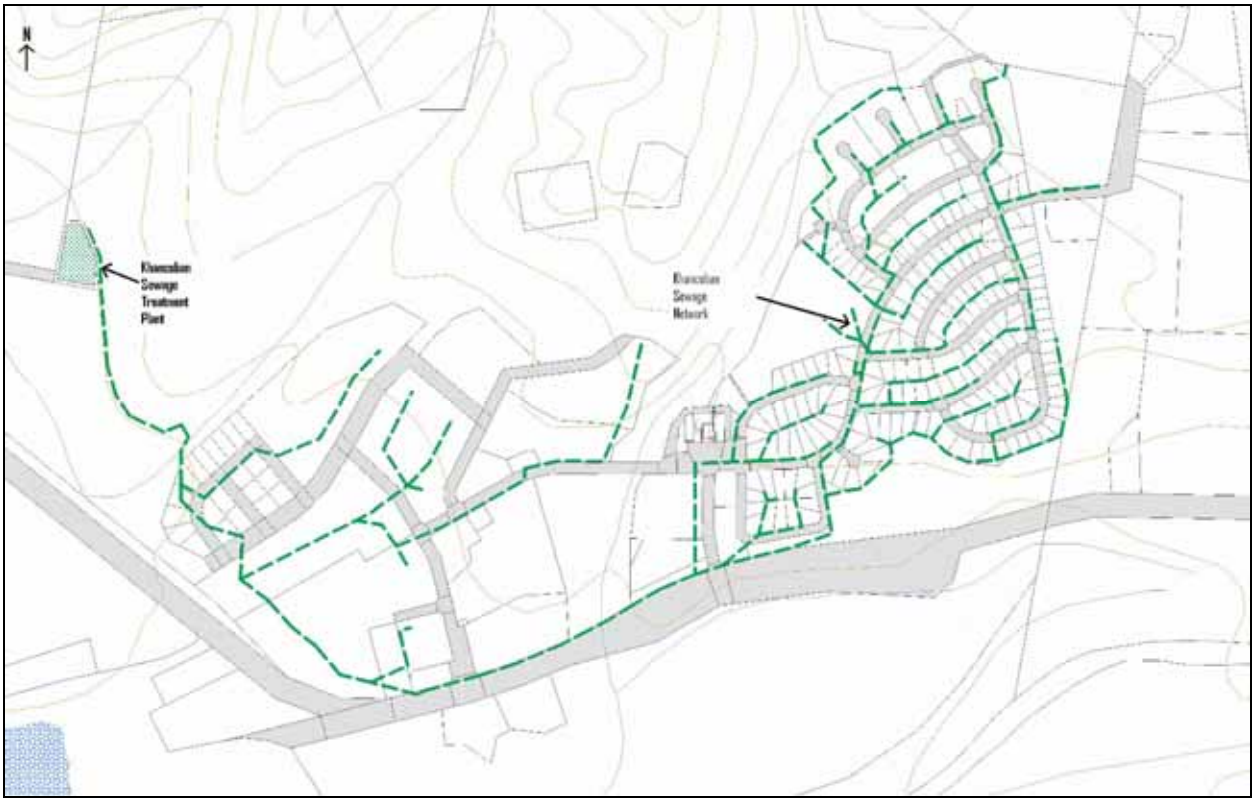

Figure 3.8: Layout of Sewerage System-Khancoban

Wastewater Treatment Plant

Approximately 8 kL/week of sewage from Murray 1 and Murray 2 power stations is treated at Khancoban WWTP in addition to wastewater from Khancoban township.

The Khancoban WWTP is a trickling filter plant that consists of the following components:

- 1 bag filter.
- 1 coarse screen.
- 1 horizontal grit chamber.
- 1 Imhoff tank.
- 2 trickling filters (1 operational).
- 1 rectangular humus tank.
- 5 effluent evaporation lagoons located downstream of Khancoban township (on the other side of airport).
- 8 sludge drying beds.
- 4 emergency concrete overflow tanks (2 at WWTP inlet and 2 after grit chambers).
- Tertiary evaporation pond.

Khancoban WWTP discharges treated effluent to a tertiary evaporation pond which is located adjacent to Swampy Plains River, approximately 10 km from the Murray River. No data are available to assess water quality impacts on the Murray River. Khancoban WWTP would not be expected to have significant water quality impacts on the Murray River because of the relatively long distance of the tertiary evaporation ponds from the Murray River.

No effluent is reused for non-potable purposes such as irrigation. Dried sewage biosolids are spread on site.

DECC Licence Conditions

The DECC Licence conditions for Khancoban WWTP are shown in the following table.

Table 3.13: Current DECC Licence Conditions-Khancoban WWTP

Pollutant	Units	Condition
Flow		Not to exceed 800 kL/day
Sampling	-	Quarterly effluent monitoring at tertiary evaporation pond
Concentration limits		Nil
Load limits	-	Nil

No Pollution Reduction Programs are in place.

Wastewater Flows

Effluent flows from the Khancoban WWTP are measured daily. Flows for 2001/02 to 2006/07 are shown in the following table.

Table 3.14: Annual Effluent Flows (2001/02 to 2006/07)-Khancoban WWTP

Year	Effluent Flow		
	Peak Day (kL/day)	Average Day (kL/day)	Total Annual (ML/year)
2001/02	650	207	75.2
2002/03	1,013	142	51.4
2003/04	661	158	56.8
2004/05	931	179	65.5
2005/06	522	269	58.9
2006/07	790	162	57.7

Notes
[1] The DECC reporting periods were:
- 15 September to 14 September (2006/07)
- 30 September to 14 September, ie 349 days (2005/06)
- 30 September to 29 September (prior years)

An average annual effluent flow of 60.9 ML/year has been recorded during the last six years. Annual effluent flows were highest during 2002/03 and have been reasonably constant since 2003/04.

Effluent Quality

Effluent quality is monitored at approximately quarterly intervals at the tertiary evaporation pond. Data for 2004 to 2007 are shown in Table 3.15.

Table 3.15: Effluent Quality (2004 to 2007)-Khancoban WWTP

Indicator	Sampling Date												
	24/2/04	31/3/04	31/6/04	8/9/04	10/2/05	29/4/05	14/7/05	21/9/05	9/3/06	16/5/06	13/12/06	6/3/07	21/5/07
Electrical Conductivity (µS/cm)	420	420	252	209	381	375	245	161	298	258	200	308	302
Sodium Adsorption Ratio	2.75	1.37	2.25	1.85	2.41	2.26	1.58	1.05	2.45	2.55	1.49	1.61	2.12
BOD_5 (mg/L)	16	9	17	9	6	13	5	7	10	10	10	9	15
Total Nitrogen (mg/L)	6.3	24.3	20.6	11.3	19.1	22.7	14.5	10.7	29.5	26.4	14.4	25.5	21.2
Total Phosphorus (mg/L)	6.84	7.51	3.96	1.90	5.71	4.41	2.15	1.78	4.50	3.30	4.42	4.30	5.80

When compared with water quality objectives for the Protection of Aquatic Ecosystems (refer Table 2.6), the highest Electrical Conductivity levels in effluent from the Khancoban evaporation pond are only slightly higher than those recommended for the Protection of Aquatic Ecosystems.

Soil structure can be affected by Sodium Adsorption Ratio (SAR) and Salinity. Comparison of these data from the above table with the DNR (1997) plot of SAR versus salinity as they collectively affect soil structural loss indicates that most of the effluent values fall in the "stable soil structure" region. Therefore, it can be concluded that effluent from the Khancoban evaporation pond would not degrade soil structure.

Compliance with DECC Licence Conditions

The DECC Licence conditions for Khancoban WWTP are shown in Table 3.13. Non-compliances with the DECC Licence from 2002/03 to 2005/06 are shown in the following table.

Table 3.16: Summary of Licence Non-Compliances (2002/3 to 2005/06)-Khancoban WWTP

Year	Type of Non-Compliance	No of Occasions
2002/03	Flow limit exceeded	17
2003/04	Nil	0
2004/05	Flow limit exceeded	4
2005/06	Nil	0

The only type of non-compliances with the DECC Licence has been exceedance of the flow limit during wet weather as a result of stormwater infiltration/inflows into sewers.

Biosolids Quantity and Quality

Two dry tonnes were produced in 2005/06.

No biosolids quality data are available.

Sewer Rehabilitation

A total of 1.3 km of sewer mains was replaced during 2004/05.

Effluent Reuse

No treated effluent or stormwater is reused on urban sites in Khancoban township.

Effluent from Khancoban WWTP cannot be reused on urban sites in the township, eg for watering parks and gardens (12 ML of treated water was estimated to be used for this purpose in 2005/06) without additional treatment, namely disinfection. The use of less potable water and/or treated effluent or stormwater for watering parks and gardens should be investigated by Council.

3.4 URBAN STORMWATER SERVICES

Urban stormwater quality and quantity data are important for determining how these potential sources of water and pollution sources can be better managed. Stormwater is a potential water resource which if used can reduce the volume of potable water used.

Overview

	Tumbarumba	Khancoban
Stormwater Catchment Area	900 ha	170 ha
Urban Subcatchments	2	1
Discharge Points	Tumbarumba Creek and Pound Creek	Coldwater Creek and Khancoban Pondage
Runoff Coefficients	Not available	Not available
Infrastructure	Concrete kerb and guttering, table drains, underground drainage pipe network, riprap constructed channel in Bicentennial Park and a billabong in Bicentennial Park	Concrete kerb and guttering, table drains, underground drainage pipe network, 2 sedimentation ponds
Asset Replacement Cost	$1,566,000	$901,000
Stormwater Monitoring	4 sites monitored by local schools during 1999/2000	Nil
Management Plan	Draft, April 2001	No

Main Data Sources (also refer Appendix A)

- Storm Consulting. 2001. Tumbarumba Draft Stormwater Management Plan.
- Tumbarumba Shire Council data bases.

3.4.1 Tumbarumba

Stormwater System

The general layout of the stormwater system is shown in Figure 3.9.

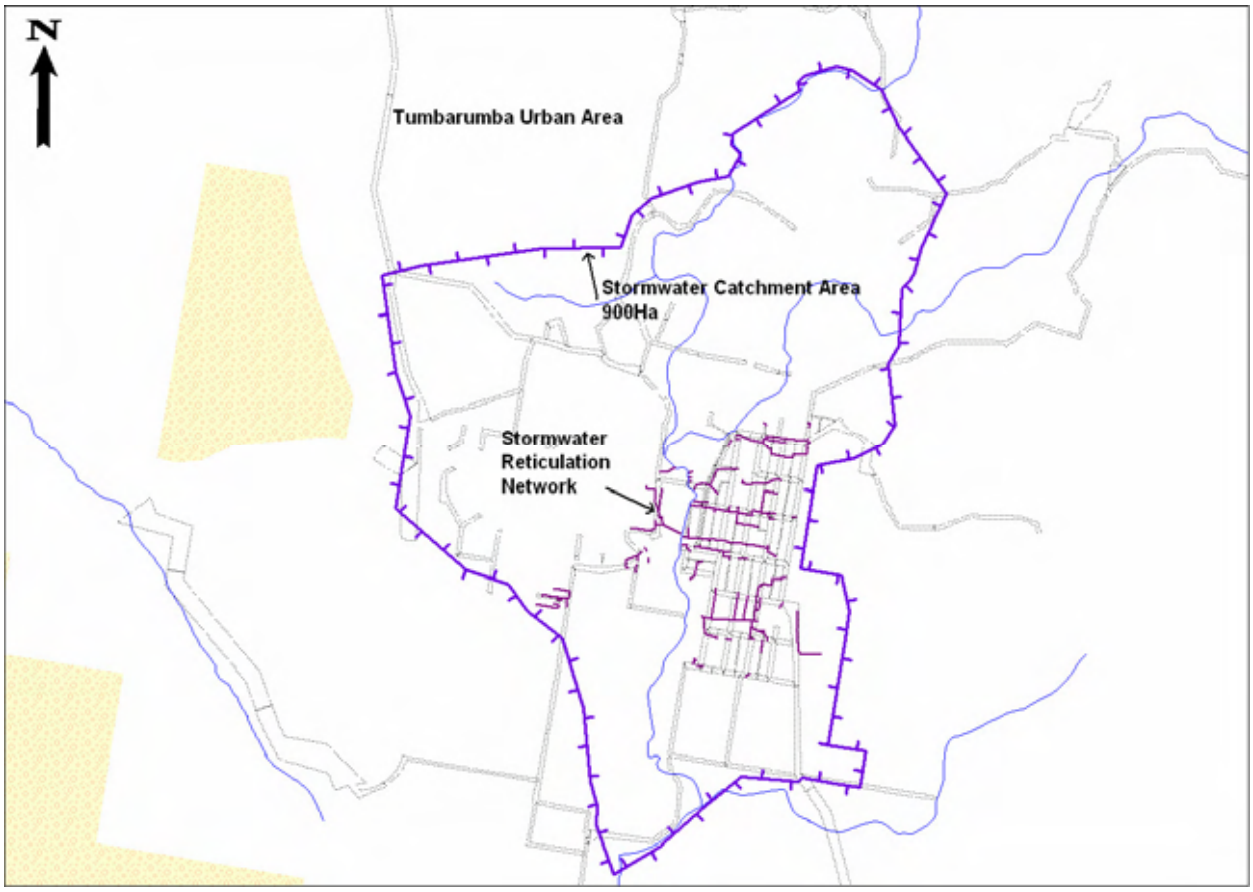

Figure 3.9: Layout of Stormwater System-Tumbarumba

The stormwater infrastructure in Tumbarumba township consists of the following components:

- 20.2 km of concrete kerb and guttering;
- Table drains-grassed or sealed;
- A network of underground drainage pipes (20.2 km) and inlet pits;
- A riprap constructed channel in Bicentennial Park; and
- A billabong in Bicentennial Park.

All stormwater eventually drains to Tumbarumba Creek or Pound Creek. Tumbarumba Creek flows through the township in an approximate north to south direction along land that is predominantly zoned for public recreation with some small areas zoned rural (1A). It is fed by Pound Creek, which flows to the east of Batlow Road (refer Figure 2.4).

There are 46 stormwater outlets to Tumbarumba Creek and Pound Creek. There are no stormwater quality improvement devices in Tumbarumba township.

The stormwater infrastructure in Tumbarumba township is considered to be old and poorly constructed.

The generally basaltic soils are generally impermeable to water, except near the creeks where alluvial soils occur, which can add to flooding problems. The basaltic soils are also generally susceptible to erosion, which can be increased by stormwater runoff.

Stormwater Management

Tumbarumba Shire Council has adopted the following stormwater management initiatives:

- Appropriate erosion and sediment controls for construction sites and road works as specified by Council's development application process.
- Council operates an Integrated Management System and has environmental quality procedures for:
  - noxious weed control;
  - treatment of native vegetation in declared areas;
  - water and sediment control;
  - disposal of vegetation by burning;
  - disposal of surplus material;
  - erosion control;
  - fuel spillages and contaminated stormwater management;
  - litter and rubbish control (township streets);
  - leaf removal from township streets during autumn in particular;
  - fire prevention;
  - specific environmental requirements; and
  - Review of Environmental Factors (REFs) and Environmental Management Plans (EMPs).
- Training and education of Council's field staff for environmental awareness prior to commencing work within Kosciuszko National Park.
- Stormwater system maintenance including system inspections, repairs as required, removal of litter and vegetation, regular mowing of grass in parks, gardens and reserves, street sweeping and emptying of rubbish bins in public areas.
- Collection of water from the vehicle fuelling and wash down areas for treatment in an interceptor before being discharged. Council's Liquid Trade Waste Policy prohibits the discharge of stormwater to the sewerage system. However, it is recognised that it may not always be possible or practical to prevent all stormwater entering the sewerage system at some liquid trade waste premises. The discharge of limited volumes of first flush stormwater from such areas to sewers is tolerated by Council where roofing cannot be provided to collect and divert stormwater to the stormwater system.
- A water quality monitoring program of Tumbarumba Creek.
- A stormwater levy on all urban properties ($25/year for residential properties and $75/year for commercial properties).

During the last few years Council has undertaken a Creekscape Program whereby willows have been removed from Tumbarumba Creek, the creek in the central township has been remediated and the land has been returned to parkland and a picnic area. Some parts of residential land through which the creek flows were rezoned as proposed public recreation areas.

Stormwater Flows

Flows in Tumbarumba Creek have been described previously (refer Section 2.2.2). Flows are highly variable and respond rapidly to rain events.

Potential Stormwater Pollutants

Tumbarumba Shire Council has identified a number of point source pollution within Tumbarumba township. These are listed in the following table.

Table 3.17: Potential Sources and Types of Stormwater Pollutants

Pollution Point Source	Description/Comment	Potential Pollutants
Sewage Treatment Plant	Discharges to Tumbarumba Creek	Nutrients (nitrogen, phosphorus) Microorganisms
Depots and workshops	Council Service stations	Sediments Hydrocarbons
Commercial areas	Central Business District	Litter Hydrocarbons
On-site sewage disposal	Septic tanks Adsorption trenches	Nutrients (nitrogen, phosphorus) Microorganisms
Garbage depot	Rubbish tip on Batlow Road	Organic matter Litter Other
Industrial	Concrete batching plant	Sediment Concrete slurries
Parks and gardens	Sports Ground Pony Club Ground Show Ground Golf course Parks	Fertiliser Herbicides Weeds Manure

Stormwater Quality

Water quality in Tumbarumba Creek has been described in Section 2.2.2. It is not possible to draw any conclusions from these data regarding impacts of stormwater on water quality because the sampling sites used by Council and government agencies are not downstream of Tumbarumba Township and there were no obvious trends in the data obtained by the schools.

Water quality impacts in Tumbarumba Creek resulting from the following upstream sources was identified as issues in the Stormwater Management Plan:

- Application of fertiliser on Golf Course.
- Animal manure from upstream rural properties and Pony Club carnivals.

- Septic tank on rural allotments.

No hydrological studies have been undertaken to determine contaminant loads from the hydrological subcatchments in Tumbarumba township.

Flooding

The map of Tumbarumba showing the area that can flood (hatched area) is shown in Figure 3.10.

Figure 3.10: Aerial Photo of Flood Prone Area-Tumbarumba

The Caravan Park, Show Ground and creekscape along Tumbarumba Creek are prone to flooding because they are located on the floodplain of Tumbarumba Creek.

The water chlorination plant is located outside the floodplain and is not prone to flooding. The Tumbarumba WWTP holding lagoons are located on the boundary of the floodplain. Intermittent flooding of the wastewater treatment plant lagoons was last recorded in 1994. The risk of the lagoons flooding has been reduced because Council has introduced an annual program to remove willows from Tumbarumba Creek.

3.4.2 Khancoban

Stormwater System

There is only one hydrological subcatchment within Khancoban township. The general layout of the stormwater system is shown in Figure 3.11.

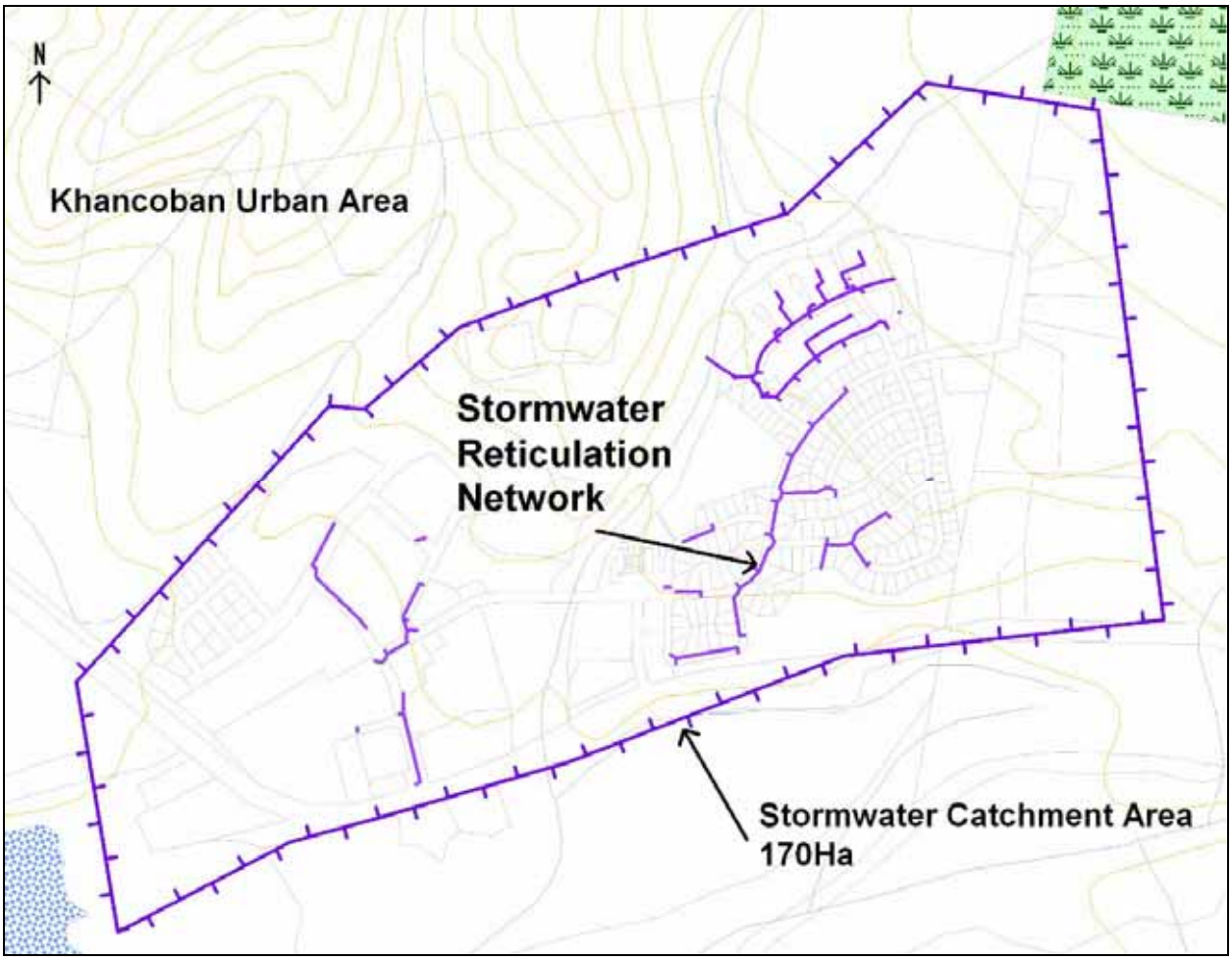

Figure 3.11: Layout of Stormwater System-Khancoban

The existing stormwater infrastructure in Khancoban township consists of the following components:

- 4.9 km of concrete kerb and guttering;
- Table drains;
- 4.1 km drainage pipe network; and
- 2 small sedimentation ponds located within the township limits (adjacent to the Alpine Way and Mahon Place).

Khancoban township drains to the Khancoban Pondage and Coldwater Creek (refer Figure 2.5 for locations). There are 12 stormwater outlets. No stormwater quality improvement devices have been installed in Khancoban.

The stormwater infrastructure in Khancoban township is considered to be old and poorly constructed.

Stormwater Management

The stormwater management initiatives used by Tumbarumba Shire Council are similar to those used in Tumbarumba, except that no water quality monitoring has been undertaken by Council or the community in Khancoban.

Stormwater Quality

No stormwater quality data are available for Khancoban Pondage or Coldwater Creek. No hydrological studies have been undertaken to determine contaminant loads from the Khancoban hydrological subcatchment.

Flooding

The gravity water supply feed line is located in the bed of Khancoban Creek and has been previously washed away. However, there do not appear to be any risks of flooding to the rest of the water supply or sewage treatment infrastructure because they are located 10 m to 15 m above the high water level.

4 ISSUES

The data described in Sections 2 and 3 are compared with Council's obligations in water resource management and in providing urban water services to determine how well the urban water service systems are understood, operated and managed. The results of this process are used to identify IWCM Issues that require remedial action.

4.1 TYPES OF ISSUES

The following two types of issues are described below:

- **IWCM Issues** are a potential cause of failure in the provision of urban water services. They are identified when:
  - the available data identifies failure or non-compliance with Council obligations in providing the required levels of services in terms of licence and health requirements;
  - the available data indicates that Council is not minimizing or managing impacts on the environment; and/or when
  - data are not available to demonstrate compliance.
- **Secondary Issues** refer to more minor issues that Council should be aware of.

Only IWCM Issues need to be addressed in the IWCM study. However, Secondary Issues should be noted to ensure that the IWCM Strategy has a high level of community ownership and can be effectively implemented. Furthermore, Secondary Issues should be periodically reviewed because they could become IWCM Issues in the future.

4.2 DATA

4.2.1 IWCM Issues

- Council's Asset Register is out of date.
- Future Water Demand Projections. A preliminary analysis of future water demands in Tumbarumba and Khancoban townships has been undertaken. A more detailed analysis is required for future water supply planning. Council is currently seeking proposals to undertake this analysis.

4.2.2 Secondary Issues

- Tumbarumba Raw Water Quality Data.
  - Algae can cause organic matter to accumulate in the reticulation system as well as causing taste and odour problems and some species of algae, particularly blue-green algae, can be toxic. Algae have not previously been considered to be an issue by Council because they have only been detected in a small part of the 68 ML open storage dam at Tumbarumba on a few occasions. No data are available on the types of algae and their levels in the 68 ML open storage dam at Tumbarumba. Council should be aware of the potential for algal contamination

in the Tumbarumba township open water storage dam and monitor for algae when they are detected.

- The risk of *Cryptosporidium* contamination in the Tumbarumba water supply, as identified by GHD (GHD, 2005), is considered to be minimal. Nevertheless, Council should be aware of the potential for this type of risk.

- No water quality data are available for Mannus Lake.
- Urban Stormwater Data. It is not possible to draw any conclusions from the data regarding impacts of stormwater on the water quality in Tumbarumba Creek and no stormwater quality data are available for Khancoban Pondage or Coldwater Creek.

4.3 CATCHMENT AND WATER RESOURCES

4.3.1 Characteristics

Tumbarumba Shire has a large area (4,371 square kilometres) and a small population (3,534 at the 2006 census, www.abs.gov.au). The main land uses are for agriculture, State forests and National parks; there is only a small total urban area (about 500 ha). Tumbarumba and Khancoban are the largest urban areas with a combined permanent population of 2,100. Tumbarumba Shire Council provides water supply services and sewerage services to these townships.

Burra Creek is the main water supply for Tumbarumba township. Flow measurements have been made relatively infrequently and generally only to monitor the onset and duration of low flow conditions. Therefore, annual discharge characteristics in Burra Creek are not known accurately. This is not considered to be a major issue because flow measurements to date have been adequate to determine when water from Burra Creek has required to be supplemented with water from Tumbarumba Creek. The Burra Creek catchment is considered to be pristine. Burra Creek has better water quality than Tumbarumba Creek and generally complies with ADWG (2004) values.

Tumbarumba Creek serves as a supplementary water supply for Tumbarumba township and was used during the summers of 2003, 2006/07 and 2007/08. Extensive flow data are available for Tumbarumba Creek. The water quality data available for this stream, although not extensive, are sufficient to demonstrate that Turbidity, Colour and Nitrite levels generally exceed the ADWG (2004) values.

Water from the McMeekin Street bore was used to supplement the Tumbarumba township water supply during the summers of 2007 and 2008. This bore has an upper licenced extraction limit of 0.864 ML/day. The results of water quality sampling undertaken in October 2006 indicated that concentrations of all the parameters tested for were lower than the ADWG (2004) values for health.

A total of up to 499 ML can be extracted in any year from all of the water sources, ie Burra Creek, Tumbarumba Creek and the McMeekin Street bore.

No flow and only limited water quality data are available for Khancoban Creek. This is not considered to be an issue because of the small population in Khancoban township and because Khancoban Creek flows from Kosciuszko National Park and is not used for other purposes. There has not been a shortage of water in Khancoban Creek for drinking purposes in the past. There are no environmental flow requirements for Khancoban Creek. The results of water quality sampling for Khancoban Creek undertaken in October 2006 indicated that concentrations of all the parameters tested for were lower than the ADWG (2004) values for health.

Khancoban WWTP discharges treated effluent to a tertiary evaporation pond which is located adjacent to Swampy Plains River, approximately 10 km upstream of the Murray River. There are no data available to assess water quality impacts on the Murray River. Khancoban WWTP would not be expected to have significant water quality impacts on the Murray River because of the relatively long distance of the tertiary evaporation ponds from the Murray River.

4.3.2 IWCM Issues

Catchment

Nil. No salt affected areas and acid sulphate soils are known to exist in the Shire area. Therefore, catchment salinity and acid soils are not affecting the water supplies and the urban areas.

Water Resources

- The current water supplies for Tumbarumba township provide inadequate security of supply for current and future water demands.

  Burra and Tumbarumba Creeks have histories of low flows during droughts. Recent hydrologic modelling by DWE has indicated the potential for failure of the existing water supply system during drought periods because of periods when there could be inadequate flows in both Burra Creek and Tumbarumba Creek to satisfy the required water demands. Therefore, these creeks are not reliable water sources for Tumbarumba township at all times.

  Tumbarumba Creek has no environmental flow requirements, although a "cease to pump" limitation has been imposed. Previous investigations have indicated that Tumbarumba will not have sufficient storage during droughts unless the "cease to pump" limitation is set higher than the 90 percentile flow.

  The 68 ML open storage dam can only be filled from Tumbarumba Creek by a small pump (1.7 ML/day capacity), which is less than the typical water demand for a summer day. Increased water security is required during drought conditions and to cater for future increased water demands, mainly as a result of the expansion of the Hyne & Son Timber Mill that may result in this plant significantly increasing its water usage. Council's 2008/2009 Management Plan has identified the development of a long-term drought-proof water storage solution, particularly in relation to future industrial growth requirements.

4.3.3 Secondary Issues

Catchment

Nil.

Water Resources

- Adverse water quality in Tumbarumba Creek from upstream activities.

4.4 URBAN WATER SUPPLY SERVICES

4.4.1 System Performance

Performance data for the Tumbarumba and Khancoban water supply systems for 2005/06 and the corresponding State median values (from the *2005/06 NSW Water Supply and Sewerage Performance Monitoring Report*, DEUS (2006)) for a representative cross section of Triple Bottom Line (TBL) criteria are shown in the following table.

Table 4.1: Triple Bottom Line Performance Data-Water Supply Systems

Indicator	State Median	Tumbarumba Township	Khancoban Township	Comment
Compliance with Best-Practice Management Guidelines				
Current Strategic Business Plan and Financial Plan (1)	-	Yes		All Best-Practice requirements are in place or will be in place during 2008/09
Pricing (full cost recovery, without significant cross subsidies (2)	-	Yes		
Complying Residential Charges (2a)	-	Yes		
Residential Charges ≥ 50% in 2006/07, 60% in 2007/08 and 75% in 2008/09 (2b)	-	Partial		
Complying Non-Residential Charges (2c)	-	Yes		
DSP with Commercial Developer Charges (2d)	-	No		
Complete Performance Reporting Form by 15 September Each Year (3)	-	Yes		
Sound Water Conservation Implemented (4)	-	Yes		
Sound Drought Management Implemented (5)	-	Yes		
Integrated Water Cycle Management Strategy Commenced (6)	-	Yes-to be completed during 2007/08		
Performance				
Employees (/1,000 properties) (10)	1.3	1	0.5	Lower than State median

Indicator	State Median	Tumbarumba Township	Khancoban Township	Comment
Typical Residential Bill ($/assessment) (14)	345	445	446	Higher than State median
Typical Developer Charges ($/equivalent tenement) (16)	4,100	410	410	Considerably lower than State median
Microbiological Water Quality Compliance (%) (20)	99	100	100	Higher than State median
Water Quality Complaints (/1,000 properties) (25)	6	4	2	Lower than State median
Customer Interruption Frequency (/1,000 properties) (27)	58	10	2	Considerably lower than State median
Number of Main Breaks (/100 km) (30)	11	11	4	Similar to State median in Tumbarumba
Total Days Lost (%) (32)	3.2	0	0	Lower than State median
Average Annual Residential Consumption (Potable) (kL/connected property) (33)	190 (all LWUs) 310 (inland LWUs)	222	165	Considerably lower than State median for inland utilities
Economic Real Rate of Return (%) (43)	1.4	3.0	3.0	Higher than State median
Operating Cost ($/property) (49)	280	224	215	Lower than State median
Management Cost ($/property) (51)	110	80	80	Lower than State median
Treatment Cost ($/property) (52)	27	14	19	Lower than State median
Pumping Cost ($/property) (53)	24	7	23	Lower than State median

All Best-Practice requirements are in place or will be in place during 2007/08.

Average annual residential consumptions of potable water in Tumbarumba and Khancoban townships were lower than the State median for inland LWUs. The microbiological water quality compliance was higher than the State median and water quality complaints were lower than the State median. Typical Residential Bills were higher than the State median whereas Typical Developer Charges were low. Operating, management, treatment and pumping costs were also lower than State median costs.

4.4.2 IWCM Issues

No IWCM Issues were identified from Table 4.1. However, the following IWCM Issues have been identified from the description of urban water supply services (refer Section 3.2).

- The small storage volume provided by the 68 ML storage dam at Tumbarumba township, which provides less than one month storage at peak daily flows.
- The current water supply system in Tumbarumba township only has one public health barrier, ie chlorination. It is considered to provide inadequate public health protection.
- The water trunk mains and reticulation systems in Khancoban township are nearing the end of their theoretical useful lives.

4.4.3 Secondary Issues

- The high level of Unaccounted for Water in Tumbarumba township (27% during 2005/06). Council should continue to monitor the level of Unaccounted for Water. It is recommended that Council investigate options to reduce the level of Unaccounted for Water if it continues to be higher than 10% to 15%.
- Typical Developer Charges are considerably lower than the State median. Council should review its water pricing policy.

4.5 URBAN SEWERAGE SERVICES

4.5.1 System Performance

Performance data for the Tumbarumba and Khancoban sewerage systems for 2005/06 and the corresponding State median values (from the *2005/06 NSW Water Supply and Sewerage Performance Monitoring Report*, DEUS (2006)) for a representative cross section of TBL criteria are shown in the following table.

Table 4.2: Triple Bottom Line Performance Data-Sewerage Systems

Indicator	State Median	Tumbarumba	Khancoban	Comment
Compliance with Best-Practice Management Guidelines				
Current Strategic Business Plan and Financial Plan (1)	-	Yes		All Best-Practice requirements are in place or will be in place during 2008/09
Pricing (full cost recovery, without significant cross subsidies (2)	-	Yes		
Complying Residential Charges (2a)	-	Yes		
Complying Non-Residential Charges (2b)	-	Yes		

Indicator	State Median	Tumbarumba	Khancoban	Comment
Complying Trade Waste Fees and Charges (2c)	-	Yes		
DSP with Commercial Developer Charges (2d)	-	No		
Liquid Trade Waste Approvals & Policy (2e)	-	Yes		
Complete Performance Reporting Form by 15 September Each Year (3)	-	Yes		
Integrated Water Cycle Management Strategy Commenced (6)	-	Yes-to be completed during 2007/08		
Performance				
Employees (/1,000 properties) (8)	1.5	1	0.5	Lower than State median
Typical Residential Bill ($/assessment) (12)	400	368	390	Slightly lower than State median
Typical Developer Charges ($/equivalent tenement) (13)	3,500	430	430	Considerably lower than State median
Odour Complaints (/1,000 properties) (21)	0.8	0	0	Lower than State median
Customer Interruption Frequency (/1,000 properties) (23)	15	0	0	Considerably lower than State median
Total Days Lost (%) (25)	2.0	0	0	Lower than State median
Compliance with BOD Licence (% of samples) (34)	96	50 (1 of 2)	na	Lower than State median
Compliance with SS Licence (% of samples) (35)	93	50 (1 of 2)	na	Lower than State median
Sewer Chokes (/100 km of mains) (36)	49	0	0	Considerably lower than State median
Sewer Overflows to the Environment (/100 km of mains) (37)	7	0	0	Considerably lower than State median

Indicator	State Median	Tumbarumba	Khancoban	Comment
Economic Real Rate of Return (%) (46)	2.4	0	0	Considerably lower than State median
Operating Cost ($/property) (50)	290	88	140	Lower than State median
Management Cost ($/property) (52)	100	88	96	Lower than State median
Treatment Cost ($/property) (53)	85	120	204	Considerably higher than State median
Pumping Cost ($/property) (54)	48	6	0	Considerably lower than State median

All Best-Practice requirements are in place or will be in place during 2007/08.

There was only 50% compliance with the current DECC Licence requirements for effluent quality, however only two effluent quality samples were collected during the 2005/06 DECC reporting period. There were no odour complaints in 2004/05 or 2005/06 and zero incidences of sewer chokes and sewage overflows to the environment were recorded. Typical Residential Bills were slightly lower than the State median whereas Typical Developer Charges were low. Operating, management and pumping costs were lower than State median costs whereas treatment costs were higher than the State median cost.

4.5.2 IWCM Issues

The following issue was identified from Table 4.2:

- Non-compliance with DECC Licence water quality requirements.

  Non-compliance with DECC Licence flow requirements during wet weather at Tumbarumba and Khancoban WWTPs because of stormwater infiltration/inflows into sewers was also identified as an IWCM Issue from the description of urban sewerage services (refer Section 3.3). Stormwater infiltration/inflows has not been quantified and requires investigation by Council, although it has been estimated to be 100 ML/year in Tumbarumba township.

  Furthermore, the flow meter at Tumbarumba WWTP provides erroneous measurements during high wastewater flows because high flow levels swamp the meter. One consequence of this is that annual sewage flow data presented in this report are likely to be erroneous, although the extent of this error has not been determined. It is also possible that the annual returns made to DECC may be inaccurate.

The following IWCM Issue has also been identified from the description of urban sewerage services (refer Section 3.3):

- Much of the sewerage trunk mains and reticulation systems in Tumbarumba and Khancoban townships are nearing the end of their theoretical useful lives.

4.5.3 Secondary Issues

- It is anticipated that DECC will require effluent from Tumbarumba WWTP to meet effluent quality objectives for discharge to Sensitive Waters. Although this is not an issue at present because effluent generally complies with the DECC Licence conditions, the effluent quality is nevertheless relatively poor, particularly in terms of nutrients and microbiological quality. A major WWTP upgrade would be required if DECC requires that the effluent must meet Sensitive Waters quality requirements.
- Typical Developer Charges and the Economic Rate of Real Return are considerably lower than the State median. Council should review its water pricing policy.

4.6 URBAN STORMWATER SERVICES

The NSW State Government does not require the performance of stormwater systems to be regularly assessed as for water supply and sewerage systems. Therefore, quantitative system performance criteria are not available for urban stormwater systems. IWCM and Secondary Issues have been assessed as part of this project and are described as follows.

4.6.1 IWCM Issues

Nil.

4.6.2 Secondary Issues

- Old and poorly constructed stormwater infrastructure in Tumbarumba and Khancoban.
- No hydrological studies have been undertaken to determine contaminant loads from the hydrological subcatchments in Tumbarumba or Khancoban.
- Water quality impacts in Tumbarumba Creek resulting from the following upstream sources was identified as an issue in the Stormwater Management Plan:
  - application of fertiliser on Golf Course;
  - animal manure from upstream rural properties and Pony Club carnivals; and
  - septic tanks on rural allotments.

4.7 ADDITIONAL ISSUES IDENTIFIED BY THE PROJECT REFERENCE GROUP

The Project Reference Group (PRG) met on 11 June 2008. The meeting was facilitated by Dr Jeppe Nielsen, Nielsen Environmental Pty Ltd. The following topics were discussed.

- IWCM-what it is and how it is undertaken (as described in Section 1 of this report).
- Project Reference Group-membership, purpose, role and responsibilities. The role of the PRG was described as follows:
  - to identify urban water service levels of service;

  - to identify community and customer identified urban water management issues and concerns; and
  - to consider potential solutions for improved water cycle management.
- Overview of Draft IWCM Evaluation Study report.
- Current water system management practices undertaken by Council (as described in Section 3.1 of this report).
- Issues identified by the Evaluation Study-IWCM Issues and Secondary Issues (as described in Section 4 of this report).
- Opportunities for solving IWCM Issues (as described in Section 5 of this report).

The minutes of the PRG meeting are provided in Appendix C.

The PRG agreed with the issues as identified in this evaluation study. However, PRG members identified the following five additional issues:

- Although adequate management systems have been implemented by Council, there is concern about their integrity and quality.
- The quality of performance compliance and environmental management reporting needs to be improved. This issue follows on from the previous issue and results from the observation that some of the water supply and sewerage system data reported in the previous section differs from the data previously report to DWE.
- The need for on-going training to ensure that management and reporting systems implemented by Council are properly used by current and future Council staff.
- The impact of tourism should be included in estimating future water demands. Some PRG members considered this was not an issue because tourism only results in increased populations for short times of the year and the numbers of tourists are not large.
- Flooding of the Tumbarumba WWTP treatment plant may be an issue in the future. It was observed that Council undertakes a willow removal program in Tumbarumba Creek and that this program has been the main reason why flooding of the wastewater treatment plant lagoons has not occurred for several years.

The issues identified by the PRG are considered to be Secondary Issues.

5 OPPORTUNITIES FOR SOLVING IWCM ISSUES

The purpose of this section is to identify which IWCM Issues would be solved by existing Council Business as Usual actions and commitments and to determine whether a Strategy Plan is required to solve outstanding issues.

5.1 IWCM ISSUES THAT WOULD BE SOLVED BY BUSINESS AS USUAL ACTIONS AND COMMITMENTS

Only IWCM Issues need to be addressed in the Evaluation Study. The IWCM Issues identified in the previous section are listed in the following table together with Council Business as Usual actions and commitments to solve these issues.

Table 5.1: Opportunities for Solving IWCM Issues

IWCM Issue	Addressed in Management Plan or by Other Commitments	Comments
Asset Register is out of date	Yes	Currently being reviewed by Council.
Detailed Water Demand Projections		Council is currently seeking proposals to undertake this analysis. It should include impacts of climate change, changing demographics and water demands by tourists.
Inadequate security of water supply in Tumbarumba	Yes	Council's 2008/2009 Management Plan has identified the development of a long-term drought-proof water storage solution, particularly in relation to future industrial growth requirements. Options investigations undertaken (new water sources, increase capacity of open storage dam. Second water pump on Tumbarumba Creek to be installed in 2008/09.
Small volume of water storage dam at Tumbarumba	Yes	Refer previous comment.

IWCM Issue	Addressed in Management Plan or by Other Commitments	Comments
The current water supply system in Tumbarumba only has one public health barrier, ie chlorination	Yes	Relocate Sydney Water Greaves Creek Water Filtration Plant from Sydney. Construct additional required facilities (clear water storage, pump station & pipework, administration & chemical building).
The water trunk mains and reticulation systems in Khancoban are nearing the end of their theoretical useful lives	Yes	Asset replacement program to be drafted for 2009/10 Management Plan. Management of existing assets to be improved. System renewal to meet future levels of service to be planned.
Non-compliance with DECC Licence requirements at Tumbarumba and Khancoban WWTPs (during wet weather)	Yes	Council to resolve how the high level of stormwater infiltration/inflows into sewers can be reduced so that Load Based Licencing fees are not imposed as a result of infiltration/inflows. Repair/relocate ultrasonic flow meter at Tumbarumba WWTP.
Much of the sewerage trunk mains and reticulation systems in Tumbarumba and Khancoban are nearing the end of their theoretical useful lives	Yes	Asset replacement program to be drafted for 2009/10 Management Plan. Management of existing assets to be improved. System renewal to meet future levels of service to be planned.

All of the identified IWCM Issues would be addressed by existing Council Business as Usual actions and commitments. Therefore, this Evaluation Study has not justified the development of a subsequent Strategy Plan as there are no IWCM Issues that need "new" actions which are not already included in Council's strategic business planning.

5.2 IMPLEMENTATION

The IWCM Issues will be addressed during 2008/09 and 2009/10, as indicated in Table 5.1.

5.3 DATA COLLECTION AND MONITORING REQUIREMENTS

It is considered that current monitoring of water sources, treated water and wastewater treatment plants is adequate. However, a number of issues have been identified regarding data. Council should pay particular attention to the following data issues:

- Update the Asset Register.
- Review the integrity and quality of management systems and revise as necessary.
- Ensure adequate and on-going staff training so that management and reporting systems are properly used by current and future Council staff.
- Monitor water quality in Mannus Lake.
- Monitor water quality in Tumbarumba Creek upstream of the water intake pumps.
- Monitor the high level of Unaccounted for Water in Tumbarumba township (27% during 2005/06) and investigate options to reduce the level of Unaccounted for Water if it continues to be higher than 10% to 15%.
- Repair/relocate ultrasonic flow meter at Tumbarumba WWTP so that accurate effluent flow data are obtained for all flow conditions.

6 REFERENCES

ABS. 2001. *2001 Census QuickStats for Tumbarumba Local Government Area*. Australian Bureau of Statistics.

Albury City Council. 2006. *Report on Pricing for Water Supply, Sewerage & Trade Waste*. Prepared for Tumbarumba Shire Council, May 2006.

ANZECC & ARMCANZ. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Produced by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand, October 2000.

DEUS. 2004. *Integrated Water Cycle Management Guidelines for Local Water Utilities*. Published by the Department of Energy, Utilities and Sustainability, New South Wales Government, October 2004.

DEUS. 2006. *2004/05 NSW Water Supply and Sewerage Performance Monitoring Report*. Published by the Department of Energy, Utilities and Sustainability, New South Wales Government.

DLM Environmental Consultants. 2006. *Scoping Report. Water & Sewerage Asset Register/Condition Assessment Project*. Report prepared for Tumbarumba Shire Council, June 2006.

DNR. 1997. *Salinity Management Handbook.* Department of Natural Resources, Brisbane.

EPA. 1999. *Water Quality and River Flow Interim Environmental Objectives*. Guidelines for River, Groundwater and Water Management Committees. Murray River Catchment (NSW). Prepared by Environment Protection Authority, October 1999.

EPA. 2004. *Environment Protection Licence No 448. Tumbarumba Sewage Treatment Works*. Issued by NSW Environment Protection Authority, October 2004.

EPA. 2004. *Environment Protection Licence No 4400. Khancoban Sewage Treatment Plant*. Issued by NSW Environment Protection Authority, October 2004.

GHD. 2005. *Tumbarumba Water Treatment Plant. Concept Design Report*. Prepared for Tumbarumba Shire Council, February 2005.

GHD. 2008. *Tumbarumba Reservoir Dam Safety Emergency Plan.* Version 1, April 2008.

Gordon Gibson Nominees. 2003. *Report on Feasibility for Supply of Water and Sewerage Services to Hyne Timber Mill, Tumbarumba*. Prepared for Tumbarumba Shire Council, June 2003.

Gordon Gibson Nominees. 2007a. *Feasibility Report on Options for Augmenting Water Supply to Tumbarumba Township*. Prepared for Tumbarumba Shire Council, April 2007.

Gordon Gibson Nominees. 2007b. *Tumbarumba Water Supply. Feasibility Report on Using Mannus Lake to Augment Water Supply*. Prepared for Tumbarumba Shire Council, October 2007.

Murray Catchment Management Authority. 2006. *Catchment Action Plan 2006*. Draft Copy for Review, April 2006.

NHMRC & NRMMC. 2004. *Australian Drinking Water Guidelines*. Produced by the National Health and Medical Research Council and the Agriculture and Resource Management Council of Australia and New Zealand.

NSW Department of Planning. 2007. *New South Wales Statistical Local Area Population Projections 2001-2031. 2005 Release.*

SOE. 2004. *State of Environment Report 2004*. Australian Government Department of the Environment and Water Resources.

Storm Consulting. 2001. *Tumbarumba Draft Stormwater Management Plan*. Report prepared for Tumbarumba Shire Council, May 2001.

Tumbarumba Shire Council. 2006. *Drought Contingency & Emergency Response Plan for Tumbarumba and Khancoban*. August 2006.

APPENDIX A

List of Data

LIST OF DATA
(as at 17June 200)

Provided by Tumbarumba Shire Council

Albury City Council. May 2006. Report on Pricing for Water Supply, Sewerage & Trade Waste.

AMBS. June 1996. *Flora, Fauna & Preliminary Archaeological Investigation of the Proposed Dam Site at Hussels Gully, Tumbarumba*. Prepared for Department of Public Works and Services by Australian Museum Business Services.

Coffey Partners. July 1997. *Wastewater Reuse and Landfill Development Murrays Crossing Road Tumbarumba, NSW*. Report No E3512/1-AK. Prepared by Coffey Partners International Pty Ltd for Shire of Tumbarumba.

DNR. 2002. *Licence Under Section 12 of the Water Act, 1912 (Diversion from Paddys River).* Issues by the NSW Department of Natural Resources, 14 November 2002.

DEUS. 2006. *2004/05 NSW Water Supply and Sewerage Performance Monitoring Report*. Published by the Department of Energy, Utilities and Sustainability, New South Wales Government.

DEUS. 2005. *2003/04 NSW Water Supply and Sewerage Performance Monitoring Report*. Published by the Department of Energy, Utilities and Sustainability, New South Wales Government.

DLM Environmental Consultants. June 2006. *Scoping Report. Water & Sewerage Asset*. Register/Condition Assessment Project.

DPWS. June 1996. *Tumbarumba Water Supply Augmentation Hussels Gully Dam Site. Yield Study*. Report No DPWS 96057. Prepared for Tumbarumba Shire Council by Department of Public Works and Services.

DPWS. November 1995. *Tumbarumba Water Supply Augmentation Hussels Gully Dam Site. Yield Study. Interim Report*. Report No PW 95170. Prepared for Tumbarumba Shire Council by Department of Public Works and Services.

EPA. 2004. Environment Protection Licence No 448. Tumbarumba Sewage Treatment Works.

EPA. 2004. Environment Protection Licence No 4400. Khancoban Sewage Treatment Plant.

GHD. November 2005. *Tumbarumba Water Treatment Plant. Design Report*. Draft Report prepared for Tumbarumba Shire Council.

GHD. February 2005. *Tumbarumba Water Treatment Plant. Concept Design Report*. Prepared for Tumbarumba Shire Council.

GHD. April 2008. *Tumbarumba Reservoir Dam Safety Emergency Plan.* Version 1.

Gordon Gibson Nominees. June 2003. *Report on Feasibility for Supply of Water and Sewerage Services to Hyne Timber Mill, Tumbarumba*. Prepared for Tumbarumba Shire Council.

Gordon Gibson Nominees. October 2003. *Tumbarumba Water Supply System. Report on Computer Hydraulic Modelling and Analysis of Tumbarumba Water Supply System.* Report prepared for Tumbarumba Shire Council, March 2003 (revised October 2003).

Gordon Gibson Nominees. April 2007. *Feasibility Report on Options for Augmenting Water Supply to Tumbarumba Township*. Prepared for Tumbarumba Shire Council.

Gordon Gibson Nominees. October 2007. *Tumbarumba Water Supply. Feasibility Report on Using Mannus Lake to Augment Water Supply*. Prepared for Tumbarumba Shire Council.

Linqage International. July 2002. *Sustaining the Magic. Community Strategic Plan*.

PWD. December 1994. *Tumbarumba Dam. Condition Assessment of Outlet Pipe*. Materials Report No 140. Prepared by Water Technology Section, NSW Public Works Department.

PWD. September 1992. *Tumbarumba Water Supply Augmentation. Supplementary Report*. Report No 9203. Prepared for Tumbarumba Shire Council by Public Works Department of NSW.

PWD. January 1992. *Tumbarumba Water Supply Augmentation Investigation Report*. Report No 9106. Prepared for Tumbarumba Shire Council by Public Works Department of NSW.

PWD. November 1991. *Tumbarumba Water Supply Augmentation Investigation Report*. Report No 9106. Prepared for Tumbarumba Shire Council by Public Works Department of NSW.

State of Environment Report, 2004.

State Projects, PWD. Memo from Michael Milenko, Geotechnical Engineering, to Ken Bennet, Dams and Civil Projects. 8 September 1995. *Tumbarumba Water Supply. Hussels Gully. Reconnaissance Geological Investigation*.

Storm Consulting. May 2001. *Tumbarumba Draft Stormwater Management Plan*.

Tumbarumba Shire Council. August 2006. *Drought Management Strategy. Drought Contingency & Emergency Response Plan for Tumbarumba and Khancoban*.

Tumbarumba Shire Council. September 2005. *Tumbarumba Shire Strategic Plan.*

Tumbarumba Shire Council. June 2005. *Tumbarumba Shire Council 2005-2006 Management Plan*.

Tumbarumba Shire Council. *Tumbarumba Local Environmental Plan 1988*.

Tumbarumba Shire Council. Undated. *Fees & Charges for Water Sewerage & Trade Waste 2005/2006*.

Tumbarumba Shire Council. Undated. *Draft Community Social Plan*.

Tumbarumba Shire Council. Undated. *Tumbarumba & Khancoban Water Supplies. Strategic Business Plan.*

Tumbarumba Shire Council. Undated. *Tumbarumba & Khancoban Sewerage Services. Strategic Business Plan.*

Financial data for water supply and sewerage systems.

Shire of Tumbarumba. *Development Control Plans* (several in Draft form):

- No 1 (Areas of Environmental Significance)
- No 2 (Tourist Development)
- No 3 (Rural Residential Development)
- No 4 (Residential Flat Buildings)
- No 5 (Industrial Development)
- No 6 (Caravan and Camping Parks in Isolated Areas)
- No 7 (Residential Development in the Villages of Rosewood and Jingellic)
- No 8 (Residential Development)
- No 9 (Commercial Tree Plantation Activities)
- No 10 (Tree Clearing)
- No 11 (Outdoor Advertising)
- No 12 (Exempt & Complying Development)

System maps

Flood map for Tumbarumba

Various data, as follows:

- EPA Annual Returns
- Tumbarumba Treated Water Quality
- Stormwater quality data (4 sites in Tumbarumba)
- Threatened species data from NSW Threatened Species website
- Water extraction licence information
- Complaints
- Climate data
- Water demand data-Tumbarumba and Khancoban
- Water restriction data
- Reticulated water supply data-Tumbarumba
- Reticulated water supply data-Khancoban
- Water charges-Tumbarumba and Khancoban
- Sewerage charges-Tumbarumba and Khancoban
- Connection charges
- Asset Register
- On-site treatment system database
- Tumbarumba Water Reticulation System Monitoring (flows).xls
- DEUS. March 2004. Tumbarumba Sewage Treatment Plant Process Design
- 2650_001(Burra, Tumba Ck flows & WQ).pdf
- 2651_001(TC & FC data).pdf
- 2651_006(Tumba Ck WQ).pdf
- 2652_001(Tumba CK WQ).pdf
- 2652_003(Khancoban R WQ).pdf
- 2653_001(Water Restrictions).pdf
- 2711_001(Restrictions).pdf
- 2712_001(Leaking Water Meters).pdf
- 2713_001(Restrictions).pdf
- 2714_001(Water connection in Selwyn St).pdf
- 2715_001(KGG20LCD4 flow meter).pdf

Provided by DEUS

Burra Weir flow logs(also Tumba Ck).XLS

Evaporation at Hume Dam from1983 to 2003.xls

Flow in Mannus Ck 401017FLO.CSV

Flow in Mannus Ck 401017FLO.xls

Flow in Paddy's R 401007FLO.CSV

Flow in Paddy's R 401007FLO.xls

Flow in Tumbarumba Ck 401007FLO.CSV

Flow in Tumbarumba Ck 401007FLO.xls

Modelling Tumba & Burra for drought security.xls

Pros and Cons of Filter locations.xls

R Scott's Sampling Results.xls

Tumba Ck and Paddy's R WQ data.xls

Tumba Cr flows.xls

Tumba Flow percentiles.xls

Tumba Flows(GH vs Flow).xls

Water Consumption Register.xls

Provided by NSW Health

Tumbarumba site 101 2001 2005 results.xls

Tumbarumba site 102 2001 2005 results.xls

Tumbarumba site 103 2001 2005 results.xls

Tumbarumba site 104 2001 2005 results.xls

Tumbarumba site 105 2001 2005 results.xls

Tumbarumba site 106 2001 2005 results.xls

Tumbarumba site 107 2001 2005 results.xls

Tumbarumba site 108 2001 2005 results.xls

Tumbarumba site 109 2001 2005 results.xls

Tumbarumba site 300 2001 2005 results.xls

APPENDIX B

AUDIT CHECKLIST

Item	Factor	Tumbarumba	Khancoban	Information required
1. CATCHMENT - Landscape characteristics				
1.1	Forested area of the catchment	• Burra Creek catchment: Fully forested. Considered to be a "pristine" catchment • Tumbarumba Creek catchment: Not "pristine". It comprises: - 50% native forest - 26% pine plantation - 24% agriculture	100% forested - is completely within Kosciuszko National Park	Number and percentage cover of catchment
1.2	Is catchment currently subject to clearing	• Burra Creek catchment: no • Tumbarumba Creek catchment: yes (selective logging)	No	Yes/No. If yes, provide percentage annual removal of existing vegetation
1.3	Upstream extent of the estuary (tidal and saline)	Not relevant	Not relevant	Location, and where or how this may vary
1.4	Wetlands in the catchment	Insignificant overall	Small isolated bolts	Yes/No. If yes describe location and percentage cover of catchment
1.5	Predominant vegetation types	Hardwood native forest	Hardwood native forest	Hardwood native forest
1.6	Potential acid sulphate soils	Nil	Nil	Yes/No. If yes describe location of soils and proportions of catchment
1.7	Acid impacts in the catchment waters	Nil	Nil	Yes/No. If yes describe
1.8	Urban areas in areas of potential acid soils	Nil	Nil	Yes/No. If yes what proportion
1.9	Acid impacts in urban areas	Nil	Nil	Yes/No
1.10	Occurrence of dryland or irrigation salinity	Nil	Nil	Yes/no. If yes what type and where
1.11	Area of the catchment that is salt affected	Nil	Nil	Area
1.12	Urban areas that are salt affected	Nil	Nil	Yes/No. If yes what proportion
1.13	Salinity targets for waterways	Nil	Nil	
1.14	Predominant soil types in catchment	Silty sandy clays predominate in Tumbarumba township. Also some Granite	Granite & Shale	Describe
1.15	National parks in the catchment	No	Fully within Kosciuszko National Park	Yes/No. If yes describe
1.16	Protected areas in the catchment (including water supply catchments, aquifers, marine areas)	Special zoning by State Forests, light harvesting permitted with special conditions	All of Khancoban Creek catchment	Yes/No. If yes describe
1.17	Threatened species or critical habitats	Various • Montane Bogs and Fens • Montane Wet Sclerophyll Forests • Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands		Describe, provide GIS image if available
1.18	Topography	Mountainous	Mountainous	Describe, provide GIS image if available
1.19	Average catchment runoff	Not Relevant - water supplies obtained from creeks	Not Relevant - water supplies obtained from creeks	% of rainfall
2. URBAN and AGRICULTURE				
2.1	Sewage treatment plants (STPs) in your catchment	1 (Trickling Filter)	1 (Trickling Filter)	Yes/No. If yes give number, type, age and location
2.2	Current STP effluent quality	Available	Available	Mean effluent quality
2.3	Current STP discharges	152.2 (2005/06)	58.9 (2005/06)	Total annual discharge, ADWF
2.4	Current STP discharge locations	Tumbarumba WWTP discharges to Tumbarumba Creek d/s of Tumbarumba town	Khancoban WWTP discharges to evaporation ponds d/s of Khancoban township	Locations
2.5	Current nutrient and contaminant loads in STP discharges	Data available to calculate	Data available to calculate	Contaminant loads
2.6	STP discharges in 25 years			Total annual discharge, ADWF based on pro-rata population
2.7	Nutrient and contaminant loads in STP discharges in 25 years			Contaminant loads based on pro-rata population increase/decrease
2.8	Water treatment plants (WTPs) in your catchment	1 (Chlorination only)	1 (Coarse screening & chlorination)	Number, type and location
2.9	WTP final water quality	Microbiological water quality compliance 100%	Microbiological water quality compliance: 100%	Mean final water quality
2.10	WTP treatment capacity	more than 5 ML/day	2.5 ML/d	
2.11	Size and location of aquaculture	Nil	Nil	Number, type, size and location
2.12	Urban areas in catchment	• Burra Creek Catchment: nil • Tumbarumba Creek Catchment: 50 ha that drains into Tumbarumba Ck u/s of offtake	Nil	Boundaries and sizes
2.13	Types of agriculture	• Burra Creek Catchment: natural, hardwood forest, small grazing leases • Tumbarumba Creek Catchment: cattle, sheep, some cropping, orchards	Nil	Describe (grazing, dairy, cropping, horticulture, intensive etc)
2.14	Location and area of agriculture	24% of Tumbarumba Creek catchment area is agricultural	Nil	Locations and sizes
2.15	Modified or contaminated runoff from agriculture	• Burra Creek: nil • Tumbarumba Creek: pesticides, nutrients, sediments	Nil	Yes/No. If yes estimate contaminant loads in runoff
2.16	Catchment population	• Burra Creek Catchment: nil u/s of Khancoban • Tumbarumba Creek Catchment: about 150 u/s of pump station	Nil	
2.17	Urban population	Tumbarumba: 1200 permanent, 2000 peak	Khancoban: 300 permanent, 500 peak	
2.18	Expected urban population growth	0.14% to 0.16% population decrease projected	0.14% to 0.16% population decrease projected	
2.19	Expected non-urban population growth	0%	0%	
2.20	Number of on-site sewage treatment systems (septic)	807 in Shire		Number and locations

Item	Factor	Tumbarumba	Khancoban	Information required
2.21	Types of industry in catchment	• In/near Tumbarumba town - Hyne & Son Timber Mill - Commercial/industrial: 33 - Golf Club: 1 - In catchment: - Rural residential: 55 - Farming: 11	• Nil in catchment • Khancoban: tourism & 1 earthmover & 1 Country Club	Types and numbers
2.22	Location of industry			Describe
2.23	Volumes of industry wastewater discharges	Available	Available	Discharge volumes, quality and contaminant loads
2.24	Locations of industry wastewater discharges	To WWTP (except for quarry-only runoff to Tumbarumba Creek d/s of water intake)	To WWTP	Describe
2.25	Wastewater/ reclaimed water uses	0% for urban applications; 100% for maintaining flows in Tumbarumba	Nil	Describe and give reuse volumes and locations
2.26	Reuse water quality			Volumes, quality and contaminant loads
2.27	Volumes of urban stormwater generated by each urban centre	No data available	No data available	Based on estimated urban runoff, urban area and local precipitation
2.28	Stormwater quality	• Available for 4 sites in Tumbarumba Creek and Pond Creek catchments. Monitored by local schools • Point sources of pollution have been identified	No data available	Quality and contaminant load
2.29	Expected stormwater flow volume in 25 years	Not known	Not known	Volumes based on pro-rata population increase/decrease estimates
2.30	Expected stormwater loads of nutrients and other monitored contaminants in 25 years	Not known	Not known	Loads based on pro-rata population increase/decrease estimates
2.31	Contaminated sites	Nil	Nil	Locations, types and areas
2.32	Flooding in urban areas	• WWTP lagoons could be flooded • No risk to water supply system • Flood map for Tumbarumba provided	No risk to water services infrastructure - 10 m to 15 m above high water level	Identify locations and susceptible infrastructure
2.33	Occurrence of algal blooms	Only occurs in 68 ML open storage dam	Not relevant	Location and type of bloom
2.34	Water produced	390 ML (2005/06)	90.8 ML (2005/06)	Provide records of all urban water demands
2.35	Water consumption	284 ML (2005/06)	81 ML (2005/06)	Quarterly or annual volumes of water consumed. Provide information from customer billing database. Use consumer categories as per the NSW Water Supply and Sewerage Performance Comparison Report
2.36	Energy consumption (kWh/ML) for water and wastewater facilities and bill for each	• Water supply: 7 MWh (2003/04 & 2004/05) • Electricity tax invoices for Tumbarumba WWTP provided (2005, 2006)	Electricity tax invoices for Khancoban WWTP and water pump provided (2005, 2006)	Total energy consumed, tariff type
2.37	Operating costs for sewerage and water supply per 100 km of mains	Available	Available	Separate costs for sewerage and water supply
2.38	Operating costs for sewerage and water supply per property	Available	Available	Separate costs for sewerage and water supply
2.39	Sewerage and water supply service complaints	Available	Available	Separate totals for sewerage and water supply complaints per 1000 properties
2.40	Water supply quality complaints	4	2	per 1000 properties
2.41	Number of supply main breaks	11	4	per 100 km of mains
2.42	Sewer chokes and collapses	0	0	per 100 km of mains
2.43	Sewer overflows to the environment	0	0	per 100 km of mains
2.44	Sewer overflows to the environment	0	0	Frequency, volume, quality impact
2.45	Typical developer charges	• Water: $410 • Sewerage: $430	• Water: $410 • Sewerage: $430	$/equivalent tenement
2.46	Typical residential bills	• Water: $445 • Sewerage: $354	• Water: $446 • Sewerage: $354	$/connected property
2.47	Volume of sewage treated per property	192 kL/year	220 kL/year	kL/annum, spreadsheet of daily treated water production volumes for
2.48	Urban properties without reticulated public sewerage and water supply	• Water: 0 • Sewerage: 3	• Water: 0 • Sewerage: 8	% value for each sewerage and water supply
2.49	Water usage charges - as per fees & charges provided	• $0.98/kL for first 200 kL • $1.64/kL for > 400 kL	• $0.98/kL for first 200 kL • $1.64/kL for > 400 kL	
2.50	Annual water allowance (if given)	Nil	Nil	kL/assessment
2.51	Access charge	Available	Available	$/assessment
2.52	Drinking water quality tests	Available	Available	Preferably as spreadsheet (last 3 years)
2.53	Raw water quality at extraction point	Available	Available	Preferably as spreadsheet (last 3 years)
2.54	STP effluent quality licence monitoring results	Available	Available	Preferably as spreadsheet
2.55	Water quality monitoring results for local waterways	Available	Available	Preferably as spreadsheet
2.56	Water supply, sewerage & stormwater system maps	Yes	Yes	Preferably on GIS
2.57	Number of residential dwellings	Available	Available	Total as well as % occupied
2.58	Range of typical residential block sizes	1000 m2	1000 m2	% for each size range
2.59	Number and size of rainwater tanks	Not known	Not known	Locations, age, nature of usage
2.60	Number of tanks connected to the potable system for top up	Nil	Nil	Number, sizes and locations of tank. Water usage, potable system
2.61	Rainwater tank rebate	Nil	Nil	Amount of rebate and conditions
2.62	Polluted atmospheric fallout over urban area	Nil	Nil	Type, source, frequency and contaminants
2.63	On site detention policy	No	No	Copy of policy and areas covered
Other-2.64	Water restrictions	As required	As required	

Item	Factor	Tumbarumba	Khancoban	Information required
Other-2.65	Leak reduction program	Yes	Yes	
Other-2.66	Sewer rehabilitation	On-going sewer rehabilitation	On-going sewer rehabilitation	
Other-2.67	Volumetric entitlement	499 ML/year	250 ML/year	
Other-2.68	Service reservoirs	69 ML open storage for raw water	1.5 ML closed storage	
3. CATCHMENT - Climate				
3.1	Mean annual rainfall	985 mm	973 mm	Number(s)
3.2	Mean annual evaporation	3.2 mm (at Corryong)	3.3 mm	Number(s)
3.3	Rainfall seasonality	Area is predominantly a winter/spring rainfall area • Lowest mean monthly rainfall = 52.5 mm (Feb) • Highest mean monthly rainfall = 107.2 (Aug)	• Lowest mean monthly rainfall = 47.2 mm (Feb) • Highest mean monthly rainfall = 114.3 (Aug)	Typical rainfall by month
3.4	Temperature - monthly max and min temperatures	• Mean Daily Min Temp = -0.2 (July) • Mean Daily Max Temp = 28.3 (Jan)	• Mean Daily Min Temp = 1.4 (July) • Mean Daily Max Temp = 29.7 (Feb)	Typical max and min temperature by month
4. WATER RESOURCES - River and Groundwater				
4.1	Water quality of dry weather river flows	• Available for Burra Creek & Tumbarumba Ck	No water quality data available	Mean values
4.2	Total annual dry weather discharge volume	Burra Ck: Not known Tumbarumba Ck: • 42,186 ML/year - flow data available since 1946/47	No flow data available	Mean values
4.3	Annual dry weather contaminant loads	Not available	Not available	Calculate from quality and volume above
4.4	Wet weather water quality	Not available	Not available	Mean values
4.5	Mean annual wet weather discharge	• Burra Creek: not available • Tumbarumba Creek: available	Not available	Volume
4.6	Annual wet weather contaminant loads	Not available	Not available	Calculate from quality and volume above
4.7	Environmental flow requirements for catchment streams	• Burra Creek: 2.17 ML/d for Burra Ck (based on the diameter of the weir outlet pipe) • Tumbarumba Creek: 5 ML/day	Nil	Yes/No. If yes have they been implemented or are they planned for future implementation
4.8	Location of each catchment dam	Nil	Nil	Number, locations and storage types (on-stream of off-stream)
4.9	Capacity of each catchment dam	Not relevant	Not relevant	Volume for each dam
4.10	Secure yield of each catchment dam	Not relevant	Not relevant	Volume for each dam
4.11	Water quality in each catchment dam	Not relevant	Not relevant	Mean water quality for each dam
4.12	Locations of all catchment weirs	Burra Creek	Nil	Number, locations and types
4.13	Capacities of all catchment weirs	20 KL intake weir on Burra Ck	Not relevant	Volumes for each weir
4.14	Secure yields of all catchment weirs	Not relevant	Not relevant	Volume for each weir
4.15	Water quality in each catchment weir	Not relevant	Not relevant	Mean water quality for each weir
4.16	Return flow requirements from catchment dams or weirs	Nil	Not relevant	Yes/No. If yes give current or intended volume for each storage or
4.17	Water quality of return flows	Not relevant	Not relevant	Is it expected to be the same as water quality in dam or weir? If yes
4.18	Extent and nature of groundwater resources	McMeekin Street Bore	Not known. Alternate emergency water source would be Khancoban Pondage	Estimated volume (for specific aquifer if available) and annual recharge (as a percentage of average annual rainfall)
4.19	Presence of estuarine habitats	Not relevant	Not relevant	Yes/No. If yes what is the ambient water quality of the estuary, provid
4.20	Licenced water extractions	• Burra Creek: licenced to divert up to 4 ML/day • Tumbarumba Creek: as required (1.74 ML/day capacity) • 0.864 ML/day	• Khancoban Creek: licenced to divert up to 35 L/second	Yes/No. If yes give source, location, extraction purpose and volume
4.21	Licenced town water extractions	As above	As above	Yes/No. If yes give source, location, extraction purpose and volume
4.22	Projected town water demand for the next 25 years	Increase of about 5% (preliminary estimate)	Increase of about 10% (preliminary estimate)	Based on current population usage

APPENDIX C

MINUTES OF PRG MEETING

THE MINUTES OF THE IWCM PROJECT REFERENCE GROUP MEETING HELD IN THE TUMBARUMBA SHIRE COUNCIL CHAMBERS, BRIDGE STREET, TUMBARUMBA, ON WEDNESDAY 11 JUNE 2008 COMMENCING AT 10.10 A.M.

PRESENT:

Dr Jeppe Nielsen	Nielsen Environmental Pty Ltd
Cllr Col Goldspink	Deputy Mayor, TSC
Cllr Stuart Styche	Councillor, TSC
Cllr Graham Smith	Councillor, TSC
Cllr Jan Walker	Councillor, TSC
Brian Pearson	General Manager, TSC
Garry Stoll	Director of Environmental Services, TSC
Gus Cox	Health and Building Surveyor, TSC
Mark Bradley	Maintenance Supervisor, TSC
Chris Skeels-Piggins	Hyne Timber
Bruce Wright	Hyne Timber
James Allward	Greater Southern Area Health Service

APOLOGIES:

Cllr Dave Robertson	Mayor, TSC
Clare Purtle	Department of Water and Energy
Jeremy Corke	Department of Water and Energy
Peter Keep	Department of Water and Energy

The meeting commenced with Dr Nielsen outlining to the PRG the IWCM process and issues that Tumbarumba Shire Council need to deal with.

Dr Nielsen worked through with the reference group what is an Integrated Water Cycle Management Plan, its aims, and the process to complete the evaluation study (this project). The objectives of the evaluation study were then discussed with the reference group together with the role of the reference group being fully discussed and determined. Council invited a total of 19 stakeholders representing Council, community, business, industry, NSW Government Departments to attend the project reference group meeting. A copy of the invitee list summary is attached to the Minutes.

The project reference group then resolved to work through the draft evaluation study developed to date and spoke about the structure of the valuation study, the description of catchment and water resources, descriptions of urban water services within Tumbarumba Shire.

The primary IWCM issues and the secondary IWCM issues were discussed at length and additional secondary issues to be included to the list were discussed by the committee and agreed upon in regards to catchment and water resources, urban water supply issues, urban sewerage services, and urban stormwater services.

The group resolved the following additional issues as identified would be included in the draft evaluation study.

Following discussions in regards to updating some data an inclusion of the Mannus Lake known data the revised draft evaluation study will be presented to Tumbarumba Shire Council on Thursday 26 June 2008 for adoption and referral to the NSW Department of Water and Energy.

B J Pearson
Minute Taker

Title and Name	Company Name
Councillor Dave Robertson	
Councillor Jan Walker	
Councillor Colin Goldspink	
Councillor Ron Blyton	
Councillor Noelene Haslett	
Councillor George Martin	
Councillor Graham Smith	
Councillor Stuart Styche	
Ms Clare Purtle	Department of Water & Energy
Mr Tony Burns	Greater Southern Area Health Service
Mr Chris Skeels-Piggins	Hyne Timber
Mr David Leslie	Murray Catchment Management Authority
Mr John Jervois	NSW Farmers Association
Mr Chris Brice	Tumbarumba Chamber of Commerce
Ms Maria Roche	Tumbarumba MPS
Mr Garry Stoll	Tumbarumba Shire Council
Mr Gus Cox	Tumbarumba Shire Council
Mr Mark Bradley	Tumbarumba Shire Council