MINISTRY OF ENERGY AND UTILITIES
NEW SOUTH WALES GOVERNMENT

Kyogle Integrated Water Cycle Management

Part 1: Concept Study

June 2003

KYOGLE COUNCIL
GATEWAY TO THE RAINFORESTS

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Executive Summary

This report (the IWCM 'concept study') is the first phase in the development of an Integrated Water Cycle Management (IWCM) strategy for Kyogle Council's urban water services. Kyogle is experiencing several water-related issues that have given rise to the need to develop such a plan. These issues include:

- The urban water supply and sewage infrastructure requiring urgent structural work.
- The issuing of pollution reduction programme (PRP) notice by the NSW Environment Protection Authority (EPA) on the Kyogle sewage treatment plant, requiring construction of an Effluent Reuse Scheme, or reduction in nutrient loads from the STP to comply with EPA Sensitive Waters Guidelines;
- Water quality problems in Kyogle's water supply source (Richmond River); and
- Limited water availability resulting in water restrictions. Future requirements for environmental flows will create greater pressure on the existing resource.

The local government boundary for Kyogle overlies several catchments, with the Kyogle township being situated in the drainage area of the Richmond River. As this study focuses on urban water services, the subcatchments of the Upper Richmond River have been chosen as the study area.

The IWCM concept study has identified several issues within the Richmond River subcatchments. The identification of these issues allows objectives for Kyogle's water management to be defined and management measures to be developed. An examination and evaluation of these measures will be conducted during the second phase of the IWCM strategy.

IWCM Issues and Objectives:

IWCM is founded on three tenets, these being catchment, water resource and urban area issues. Each issue is summarised below along with their corresponding IWCM objectives.

Catchment Issues:

Kyogle is situated in the upper part of the Richmond River catchment. The major industries within the catchment includes agriculture (dairy, beef and pigs), forestry and tourism. A large portion (40%) of the Local Government Area has been cleared for agricultural activity. However, for some sub-catchments, the area of land cleared exceeds 85%.

The most productive land in the catchment is situated on the Richmond River alluvial soils between Kyogle and Casino. This area also has the highest demand for water for both urban and agricultural activities. The annual flow in the Richmond River generally exceeds the extractive demands, however the agricultural demand peak is between the months of August to November and for these months extractive demand exceeds the average annual flow.

Soil in the upper parts of the catchment are prone to erosion, especially gully erosion. Large sections of riverbank vegetation have been removed allowing cattle access to the river, resulting in erosion of the riverbanks under medium to high flows. The Northern Rivers Catchment Management Boards Catchment Blueprint has identified the Kyogle Area subcatchment as a priority for revegetation.

Algal blooms have been reported in both the Kyogle Weir pool and Toonumbar Dam.

Areas of dryland salinity occur in the upper subcatchment, above Kyogle and in southern sub-catchments of the Richmond River.

Water Resource Issues:

Water quality in the Richmond River catchment fails consistently for aquatic ecosystem protection, drinking water and primary recreation. These failures are generally based on the following water quality parameters not meeting the environmental objectives:

- Total Phosphorus;
- Turbidity;
- Faecal Coliforms; and
- Salinity.

Urban Issues:

Kyogle's has aging urban infrastructure and as a result is experiencing service problems with both their water supply and sewerage systems. These problems include:

- Lack of security (safe yield) in towns water;
- Variable raw water quality impacting on water treatment processes;
- Aging water supply infrastructure with identified structural problems;
- Lack of telemetry impacting on process control;
- Aging sewerage infrastructure producing poor quality effluent, which impacts on receiving water quality under low flows;
- Variable demand for water;
- Discharge of water filter backwash to the river;
- High level of stormwater infiltration into sewer; and
- Structural stormwater management only.

IWCM Outcomes (Potential Actions):

The IWCM concept study findings and objectives could potentially be addressed by the following management options (the ultimate viability and appropriateness of these potential options will be examined as part of the second phase of the IWCM strategy):

- Development of a strategic demand management programme.
- STP upgrade or revised effluent management practices to reduce nutrient and faecal contaminant loads to the environment.
- Consideration of effluent and stormwater as alternative water sources.
- Development of a data collection and management programme for water demands, sewage flows and water quality.
- Improved surveillance and implementation of audits for on-site systems.
- Consideration of rainwater tanks to supplement potable water supply for garden watering and toilet flushing.
- Explore alternative water supplies including off-stream storage, purchasing competing licences and supply from Casino.
- Review Strategic Business Plan in line with NSW Performance Comparison Reporting requirements; and
- Infiltration and exfiltration studies for sewerage system.

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1. Introduction

Kyogle Council, in conjunction with the Ministry of Energy and Utilities (MEU), has initiated an Integrated Water Cycle Management (IWCM) study to aid in the identification and development of management strategies for urban water cycle planning. Kyogle is experiencing several water-related issues, which have contributed to the initiation of the IWCM Study. These issues include:

- The issuing of a pollution reduction programme (PRP) notice by the NSW Environment Protection Authority on the Kyogle sewage treatment plant;
- Water quality problems in the Kyogle's water supply source (Richmond River); and
- Limitations to water availability resulting in water restrictions.

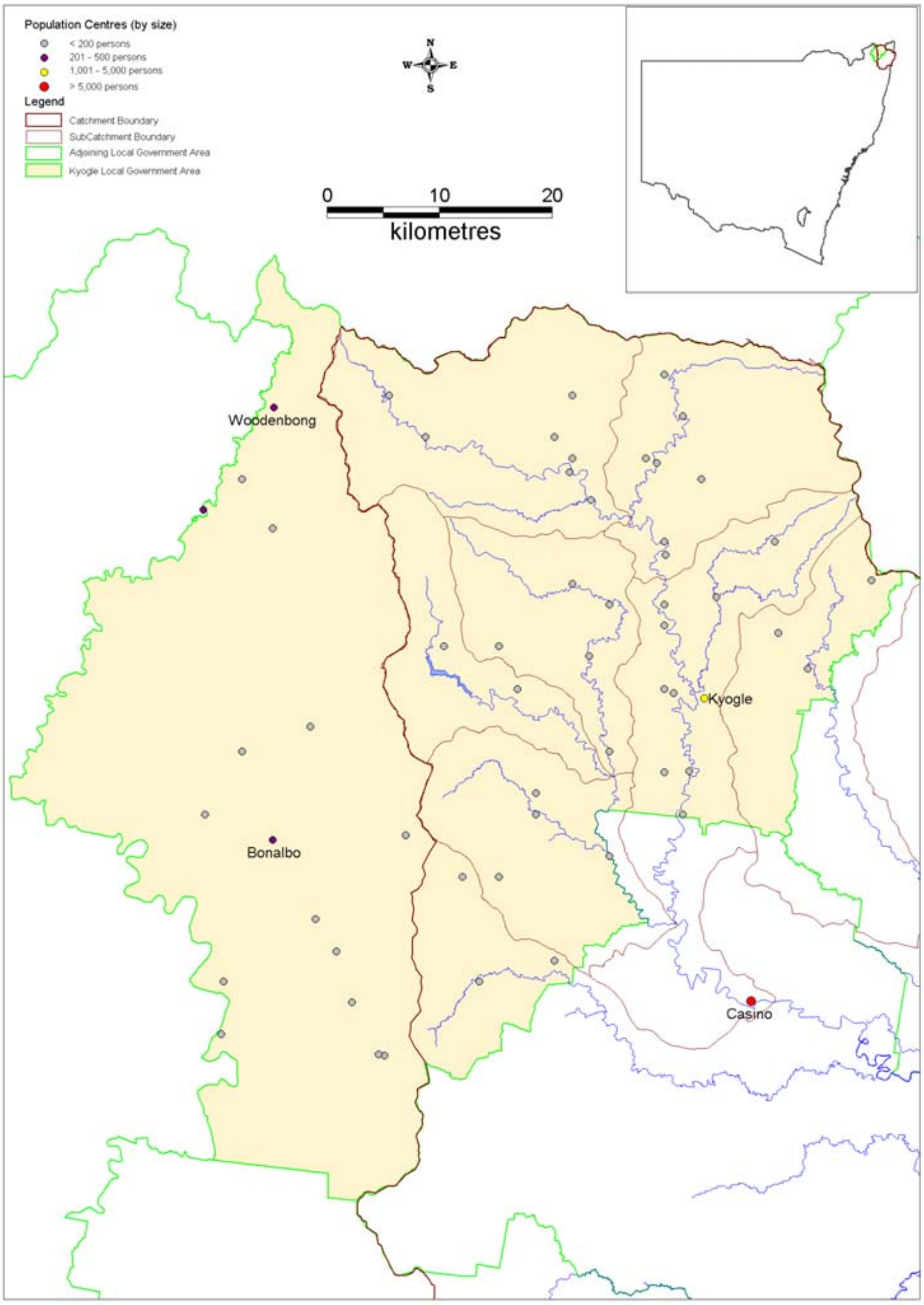
Although the IWCM process is catchment based, the local government boundary for Kyogle overlies several catchments. However, most of Kyogle's population is situated around the Richmond River subcatchment (**Figure 1**). As this study focuses on urban water services the Richmond River subcatchment has been chosen as the study area for this IWCM study.

IWCM is viewed as the integrated management of the water supply, sewage and stormwater services, within a whole of catchment strategic framework having regard to the catchment blueprints and other water management plans. The key principles for an IWCM study, its implications and outcomes are shown in **Table 1**.

Table 1: The Principles of Integrated Water Cycle Management.

Principle	Implications	Outcomes
1. Consideration of all water sources (including waste water) in water planning	Planners and water users will have to recognise what water sources are available to them and the opportunities and drawbacks that each source offers.	Improved recognition and use of the water resource.
2. The sustainable and equitable use and reuse of all water sources	To achieve sustainability and equity, the extraction of water will have to be considered relative to the resource body from which it is extracted. Where available, water should be reused to replace extractive uses. However, water should only be reused where it is sustainable to do so. In some cases, consideration of 'equity' may result in the water being returned to the environment, with the appropriate level of treatment.	Reduction in extraction of water. Increased sustainable use of all water sources. Equitable use and reuse of all water sources.
3. Consideration of all water users	Water can no longer be extracted or returned to the environment without due consideration of all water users, including the environment. The issues and limitations associated with extraction, reuse and discharge will have to be identified and the appropriate actions implemented to control or at least manage the identified issues and limitations.	Acknowledgement of other users and their needs. Improved knowledge and management of the likely issues to all users resulting from the use and reuse of water.
4. Integration of water use and natural water processes	Planners and users will have to understand how their urban water activities are related to one another as well as to their water sources and the disposal of waste water.	An awareness of the urban and natural links in the water cycle. Integration of sewage, stormwater and water supply.
5. A whole of catchment integration of natural resource use and management	Catchment users will have to understand how their activities impact upon the catchment as a whole. The use of resources in one part of the catchment or subcatchment will have to be carried out with due regard to the sustainable and equitable use of that resource. Resource use will therefore require the knowledge of other activities within the catchment and the integration of those activities in resource-use decision making and management.	Linking of natural resource use with the water cycle. Improved knowledge of natural resource use in catchments. Sustainable use of natural resources. Improved management of natural resources.

Figure 1: Kyogle Local Government Area (LGA) and study area.

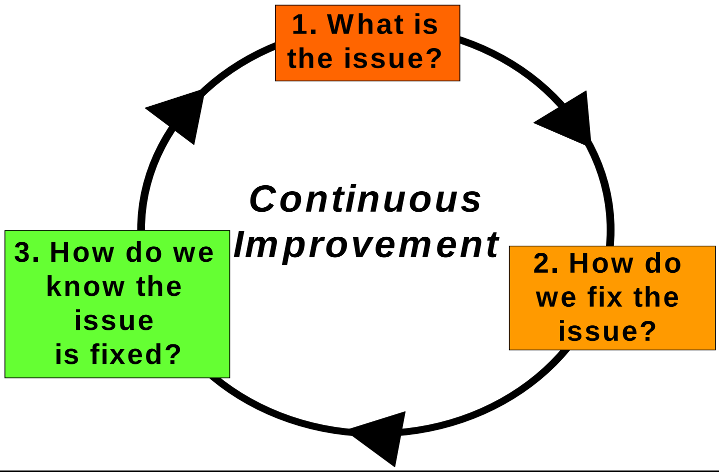


The methodology behind IWCM is based on the following three simple questions (**Figure 2**) with a stepwise approach taken to solving each of these questions. The resulting answers form the basis of IWCM.

- **"What is the issue?"** relates to water cycle management impacts (or perceived impacts) as well as water management problems. To answer this question necessitates an understanding of the catchment in order to set a benchmark on the resource needs and availability.

- **"How do we fix the issue?"** looks at addressing water management problems and requires an understanding of State Government water policies, which describe key water management issues and the appropriate management responses to them.
- The last question **"How do we know the issue is fixed?"** is the process by which we confirm that all impacts are managed to the desired level and water use is optimised using social, economic and environmental objectives.

Figure 2*:* The Basis of Integrated Water Cycle Management.



The answers should also help to identify whether any 'knock-on' effects have developed from implementing the management options and whether the relevant issues have indeed been addressed. The continuous cycle indicates the need for continued diligence in identifying and managing emerging problems in your system.

1.1. The Integrated Water Cycle Management Process

The IWCM process essentially consists of two main parts:

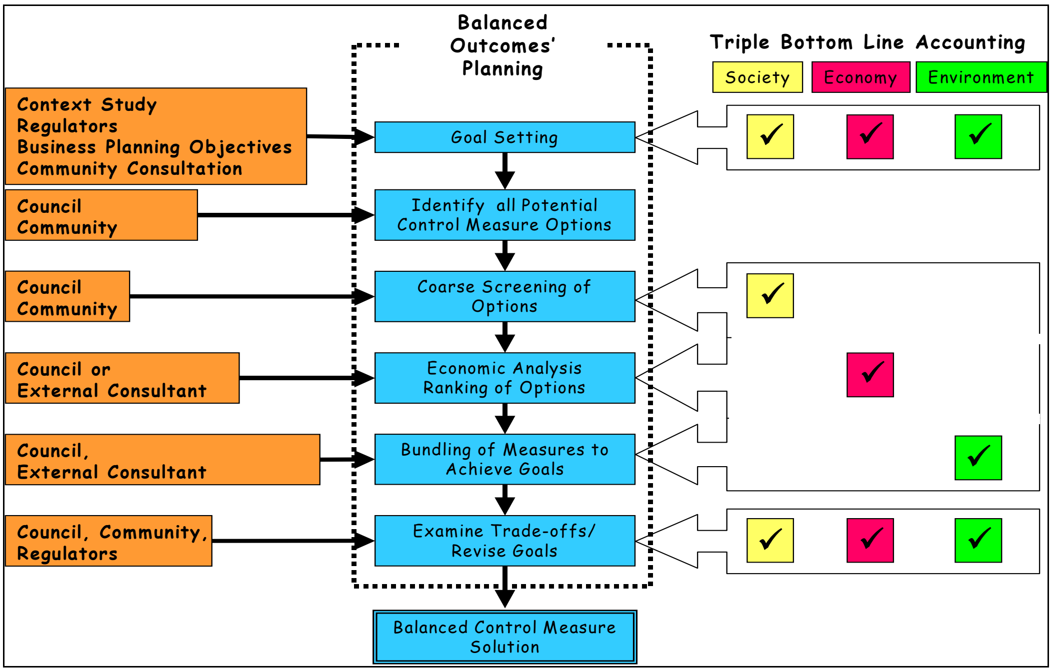
- Phase 1: An IWCM concept study (this document); and
- Phase 2: A Strategy Plan (to be scoped and to follow on from this study).

The MEU is undertaking the Phase 1 IWCM concept study for Kyogle local water utility. The second phase of works will then be competitively tendered out by the local water utility and MEU to consultants or undertaken by council. The methodology for each phase is dictated by the three questions set out in **Figure 2**, and the process is illustrated in **Figure 3**.

This IWCM concept study has as its objectives:

- To identify and summarise the key water cycle issues within Kyogle Local Government Area (LGA) (specifically in the Richmond River subcatchment);
- To identify those issues appropriate to the urban water cycle context; and
- To suggest potential actions for managing the water cycle issues.

Figure 3: The IWCM Process.



The process for the IWCM concept study can be summarised in the following steps:

1. Knowing your catchment water cycle issues and identification of the connecting urban system components;
2. Auditing the system against the key government/community outcomes or expectations;
3. Identification of issues to be addressed by your Integrated Water Cycle Management Study;
4. Identification of the water management activities associated with, or contributing to, those issues;
5. Integration and implementation of activities to manage those issues to produce positive outcomes; and
6. Consolidation of these activities into objectives for inclusion into council management plans.

The IWCM concept study will also feed directly into the second part of the IWCM study by facilitating the scoping of the IWCM Strategy. The aim of the IWCM Strategy will be to assess the ultimate viability and appropriateness of the potential management actions identified against the triple bottom line economic, social and environmental criteria. In order to develop these criteria, the IWCM Strategy phase will include input from the community via a series of community consultation workshops.

1.2. The IWCM Partnership

Kyogle Council and MEU are jointly undertaking an IWCM study for Kyogle. MEU will review and report on the key natural resource issues to be considered for inclusion as IWCM objectives. This process also includes the communication and discussion of review outcomes with the local Water Management Committee and Catchment Management Board. The team for the IWCM context study consists of the people outlined in Table 2.

Table 2: Kyogle IWCM Context Study: Team Details.

Name	Position	Organisation	Address	Telephone	Fax	Email
Ernie Bennett	Mayor	Kyogle Council	Kyogle Council, PO Box 11, KYOGLE, NSW 2474	66647291	6632 2228	council@kyogle.nsw.gov.au
Graham Kennett	Engineer Asset Services	Kyogle Council	Kyogle Council, PO Box 11, KYOGLE, NSW 2474	6632 0228	6632 2632	graham.kennett@kyogle.nsw.gov.au
Chris Hennessy	Senior Natural Resource Officer ((Urban Water)	Ministry of Energy and Utilities		6627 0113	6628 6011	chennessy@dlwc.nsw.gov.au
Adrian Langdon	Effluent Reuse and Biosolids Planner	Ministry of Energy and Utilities	PO Box 3720, PARRAMATTA, NSW 2124	9895 5942	9896 5967	alangdon@dlwc.nsw.gov.au
Russell Beatty	Water System Coordinator	Ministry of Energy and Utilities	PO Box 3720, PARRAMATTA, NSW 2124	9895 5917	9896 5967	rbeatty@dlwc.nsw.gov.au
George Freeman	Stormwater Coordinator	Ministry of Energy and Utilities	PO Box 3720, PARRAMATTA, NSW 2124	9897 5987	9898 5967	gfreeman@dlwc.nsw.gov.au

The final outcome is expected to include a range of water management options that provides better integration of water services with one another and the environment. The IWCM should also provide a clear strategy for meeting the community's future water needs as well as the NSW State Government's Water Reform agenda.

In partnership with the community, Local Water Utility and the MEU, the IWCM concept study aims to deliver the following:

- Stakeholder knowledge of the urban water system and its relationship to the catchment;
- A framework for balanced outcomes planning and informed decision making; and
- Guidance on how to achieve the desired outcomes.

1.3. Structure of this Document

The following parts of this document can be categorised against two of the three questions posed in **Figure 2** as follows:

- **What is the issue?** 'Kyogle – Background Information' (**Section 2**) is a summary of the available data about the catchment within which the study area lies as well as the urban context of that catchment. **Section 3** 'Kyogle – The Audit Interpretation' is an analysis of the available data in order to define the relationship between Kyogle's water cycle and the catchment issues.
- **How do we fix the issue?** In 'Kyogle – Analysis of Potential Actions' (**Section 4**) the potential actions which could be undertaken to address the identified issues are presented as well as a preliminary scoping of these. A Summary of the conclusions of the IWCM concept study is provided in **Section 5**.

The IWCM Strategy will address the final question, **How do we know the issue is fixed?** through the development of monitoring strategies to be used to continually assess, review, refine and improve the IWCM.

2. Kyogle – Background Information

Knowing your system is an important first step to undertaking an IWCM strategy. The following summary (based on the data contained in **Appendix A**) provides a regional context. The data gathered for the "Kyogle System" is presented in three parts: Catchment Context, Water Resource Context, and Urban Context. It is important to recognise from the outset however, that although this division is conducive to data collection, the IWCM process is about **integration**. Therefore, for an IWCM strategy to be produced, it is necessary for the links between the catchment, the water resource, and the urban area to be clearly identified (**Section 4**).

2.1. Catchment Context

In this section, the characteristics of the catchment important to this study are defined.

2.1.1. Location

Importance of Location Data to IWCM: Location data describes the main features of the study area. Location will not only influence climate and hence the type and availability of water resources, but will also influence the types of land uses, and urban development within the study area.

Data Sources: Mapping of the study area and Council State of the Environment Report.

Discussion: Kyogle township is situated on the Richmond River in northern NSW, located 30 km north of Casino and 810 km north of Sydney. As the LGA's major urban area is situated within the Upper Richmond River subcatchment, this area will be the focus of this IWCM study (**Figure 1**).

Kyogle is situated in the Upper subcatchments of the Richmond River

Kyogle Location Data:

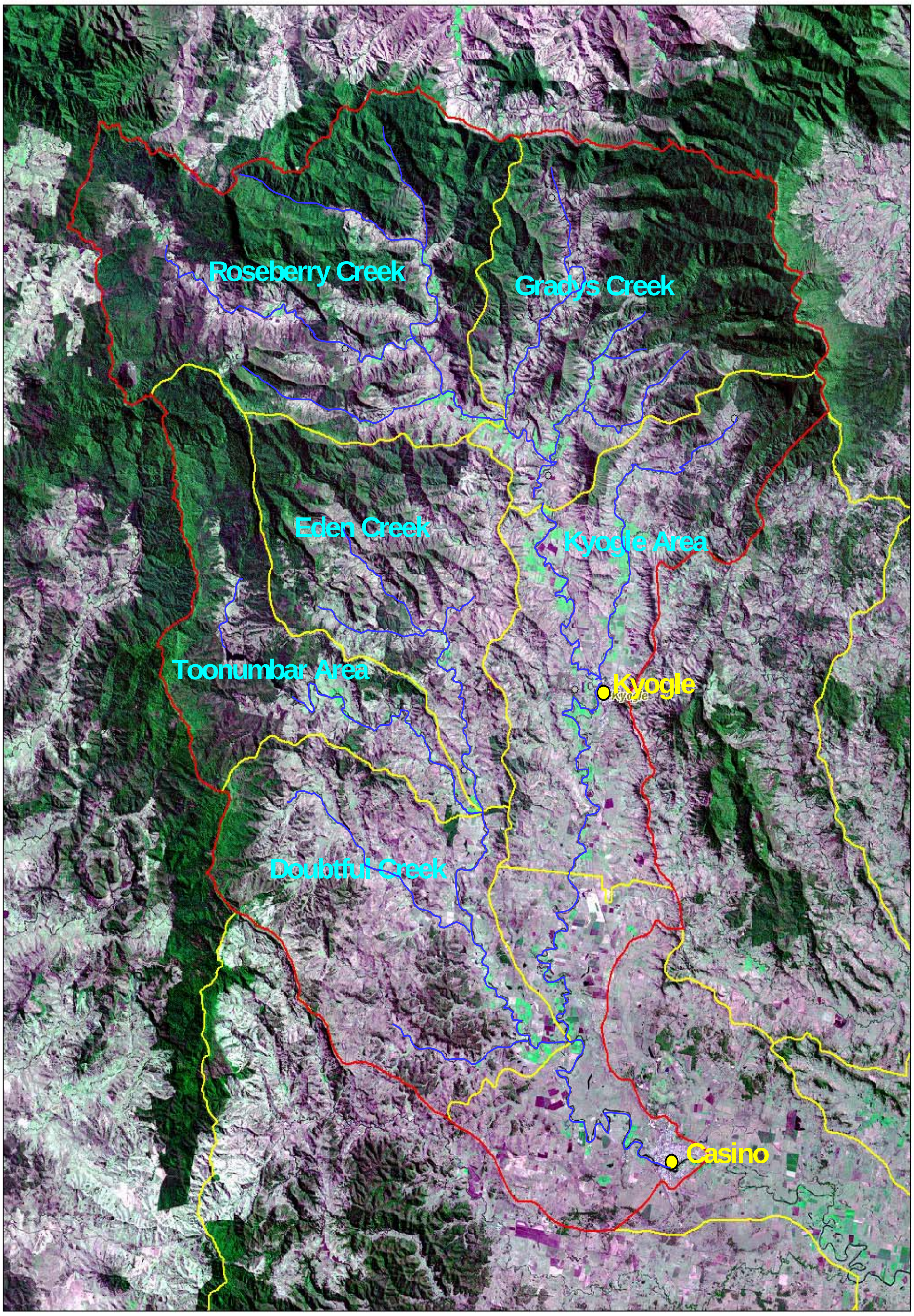
Location:	Northern Rivers
Local Government Area:	3 600 km^2
IWCM Study Area:	Upper Richmond River Catchment (1708 km^2)
Major River:	Richmond River
Major Towns:	Kyogle (13 km^2)
Villages:	
Urban Area:	0.7% of Catchment Area (13 km^2)
Other Features:	

The Richmond Catchment has an area of over 7,000 km^2 and a population of approximately 100,000 people. Almost 70% of the population live in rural communities within the catchment. The majority of the Kyogle LGA lies in the upper reaches of the Richmond River and includes the sub-catchments of Gradys Creek, Roseberry Creek, Eden Creek, Toonumbar Area, Doubtful Creek and Fawcetts Creek. The north and western areas of the LGA are flanked by steep slopes while the southern area ranges from undulating to flat.

2.1.2. Population

Importance of Population Data to IWCM: Population forecasts are important in assessing and designing for future demands on urban water infrastructure (dams, treatment plants, pipelines etc). Population information is also important for planning water conservation programmes. The nature and location of population growth will also determine future stormwater and sewerage requirements.

Figure 4: Richmond River subcatchment within the Kyogle LGA.



Data Sources: Kyogle Council population data were collected from the ABS and Council. ABS data included 1996 Census information and 2001 Census preliminary estimates. The local water utility provided information on the population presently supplied with water and sewage services and estimated future growth within the LGA.

Population in Kyogle has been declining over the past 20 years

Kyogle Population Data: based on 1996 data

▪ LGA Population:	9169
▪ Study Area Population:	≃6500
▪ Major Towns:	Kyogle: 2737 
▪ Villages:	
▪ Supplied with Water Services:	2866 (1996), 3000(2000)
▪ Future Growth Estimates	0.7% pa (Council) 0% pa (ABS)

Discussion: Kyogle is a small rural council with a population of about 9,169 people (2001 census). It encompasses some 3,600 km^2 just over half of the Richmond Catchment area. Most of the LGA area lies in the upper reaches of the Richmond River and is experiencing moderate annual growth of between 0.5 – 1.0%.

The Council provides water and sewerage services to the three townships of Kyogle (and its suburb of Geneva), Bonalbo and Woodenbong (both of which are outside the study area) serving a combined population of approximately 5,300 people.

Kyogle is the largest of these townships with an estimated 2,737 people (2001, census). The population in Kyogle has been declining since 1981, when the population was 3070. An expected increase in population due to the overflow from the coast has not yet eventuated. Kyogle counsel however has identified Kyogle as its major area to promote future growth within the LGA.

2.1.3. Climate

Importance of Climate Data to IWCM: Rainfall, runoff and evaporation data are important for determining the nature and availability of surface and groundwater resources. Climate interacts with topography and geology to influence the available water resource.

Kyogle Climate Data:

▪ Average Temperatures:	Summer: 27-32 ºC Winter: 11-16ºC
▪ Rainfall Months:	Summer (November to March)
▪ Mean Annual Rainfall:	1196.5 mm (Kyogle Post Office) (113 year record period)
▪ Mean Annual Evaporation:	1886 mm (113 year data set)
▪ Other Features	Periodic drought

Predominantly summer rainfall following a dry springs

Data Source: Climate data were obtained from the Bureau of Meteorology's records.

Discussion: The Richmond Catchment falls within the sub-tropical area along the east coast of Australia. The summers tend to be warm and humid, while the winters are mild. Although rain occurs at all times of the year, the North Coast is a predominantly summer rainfall area. Summer months average from twice to four times the rainfall of winter months, while springtime is usually the driest period. Despite the high average rainfall, dry spells are common and can last for several months. Some extended periods of drought have been recorded for the region particularly between 1986-94.

Rainfall over the region ranges from 1,650 mm on the coast to less than 1,025 mm over the western boundary. Annual averages of greater than 2,050 mm are also found in localised areas on the McPherson Ranges. On average 65 % of rain falls between the months of November to March. Over the north west corner of the region thunder days average more than 60 days per year.

2.1.4. Soils & Geology

Importance of Soil Data to IWCM: Soil characteristics influence the water quality of the study area, and will also impact on the type of land use (particularly agricultural) within the study area.

Data Source: Soil data were obtained from *the Regional Report of Upper North East New South Wales* by the Resource and Conservation Assessment Council, and the DIPNR Acid Sulphate Soil Mapping.

Land degradations issues include soil erosion, acidification and low septic adsorption potential

Discussion: Basaltic soils occur on the steeper slopes of the catchment and result from Tertiary volcanic flows. These soils are generally fertile and well drained. The alluvial soils, occurring on the floodplain and the coastal strip are sedimentary and include clays and sandstone.

Kyogle Area Soil Data:

- Geological Features: Tertiary Lamington Volcanics
- Parent Materials: Basaltic or Sedimentary.
- Major Soil Types: Red and Brown Earths, Yellow and Red Contrast Soils and Red Clay Loams;
- Soil Characteristics: Low to high fertility, low to high porosity, low to moderate water holding capacity;
- Other Features: gully erosion, dryland salinity, soil acidification;

Three soil types exist in the Kyogle LGA. The upper catchments of Roseberry and Gradys Creek generally consist of well structured red and brown earths. The red earths are non-calcareous soils with a high potential of being acidic. These soils have a low nutrient status, moderate water holding capacity, and a high potential for agricultural use. Land degradation problems for these areas include soil acidification, gully erosion and water logging where springs and localised seepage break out.

The southern sub-catchments of Eden Creek, Doubtful Creek and Toonumbar consist of yellow and red texture contrast soils. These soils are hardsetting, acidic, of low fertility, little organic matter, low porosity, low water holding capacity and poor structure. Runoff from these soils is high due to both the hardsetting nature of the surface soils. Soil erosion can be severe if vegetation is removed. Land degradation problems include extensive gully erosion, scattered outbreaks of dryland salinity and increasing soil acidification.

The Kyogle Area has deep structured red clay loams which are strongly acidic and have a soft friable topsoil with good infiltration. Although the total nutrient status is usually high, levels of calcium, magnesium and potassium are often low. The soils are high in phosphorus but also have a high phosphorus fixing ability. Problems can occur where toxic levels of aluminium are released from the soil due to increasing acidity. Notwithstanding this, these soils are some of the most productive agricultural soils in the State. The degree of aggregation and their overall moderate permeability indicate that these soils have a low septic absorption potential and are not appropriate for on-site disposal of septic effluent.

2.1.5. Land Use

Importance of Land Use Data to IWCM: Land use is an important factor in determining river water quality. Forested areas may limit exposure of source waters to potential pollutants, whilst agricultural, urban and industrial land areas are often accompanied by diffuse and point sources of pollutants including nutrients and faecal contaminants.

Land use data are also important for determining the type and level of development occurring in an area, which will impact on the urban water services required.

Data Source: Land use data were primarily sourced from the ABS and Council. Industry data were sourced from the NSW EPA Protection of the Environment Operations Act Public Register, and the MEU Trade Waste Register.

Main industries in the area include beef and dairy farming, forestry and tourism

Kyogle Area Land Use Data:

- Primary Land Use in Shire: Agriculture
- Value of Agriculture: $204.5 million
- Major Agriculture Type: Beef, Dairy & Pigs
- Major Industries: Forestry. Tourism
- National Parks & State Forests: 28% of Shire
- Urban Development: Low density, predominantly residential, approx 13km^2.
- Catchment Planning: Northern Rivers Blueprint

Discussion: There are a number of competing industries within the Richmond River Catchment. The four main industries are:

- Agriculture which in 1996-7 had an economic value of $204.5 million,
- Forestry with a turnover of $200 million dollars per annum in 1999-00;
- Tourism with an economic value of $180 million in 1993-94, (the most rapidly growing industry within the catchment).
- Finfish fishery to the value of $60 million annually.

Table 3: Catchment Agricultural Activities and Area within the Richmond Subcatchment.

Description	Numbers	Area (km^2)
National Parks		348
Forestry		271
Beef	116 413	791
Dairy	16 420	
Pigs	24 979	
Orchards		
Bananas		
Other agricultural		292

Source: ABS 1999

Table 4: Registered Industrial Activities within the Richmond Subcatchment.

Licence No. (if relevant)	Licensed Premises	Activity	Parameters	Volume (kL/d)	Monitoring
832	Kyogle Council	Sewage Treatment Systems	Volume Oil and Grease BOD Total Suspended Solids	4300	Volume – daily All other parameters –once a month (min. of 4 weeks)
3803	Winnaburra	Pig Production	(Effluent Reuse) Volume	300	
3312	R.E. Moore & CO	Pig Production	(Effluent Reuse) Volume	No volume specified	
3667	North Coast Plywood Products	Wood or Timber Milling	Air emissions – solid particles		
906	Boral Timber	Wood or Timber Milling	Air emissions – solid particles & Pollutants		

Source: NSW EPA Public Register
MEU Trade Waste Register

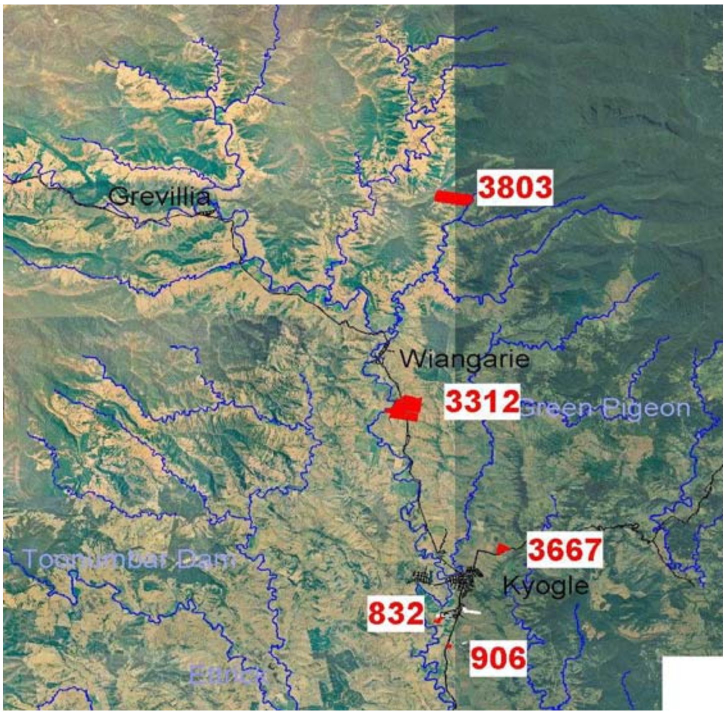


Figure 5 Location of EPA Licences.

2.2. *Water Resource Context*

Importance of Water Resource Data to IWCM: Knowing the characteristics of the water resource is important in determining how the demands on the resource can best be met. The quantity of water available will play a role in determining the storage requirements of communities and may drive the search for alternative sources and more efficient use. The quality of water available plays a role in determining the type of treatment the water will require in order to be used in a particular way, and may impact on the cost of providing the water. Understanding these characteristics is important in ensuring the resource is used in the most efficient and sustainable way.

2.2.1. *Surface Waters*

Kyogle Water Resources:

- Primary Water Source: Richmond River
- Annual Average Flow: 508 GL
- Low Flow Condition (80th%ile): 30.6 GL/a
- Town Water Use: 2.1 GL/a
- Kyogle Water Use: 0.5 GL/a
- Irrigation Water Use: 12.9 GL/a
- Subcatchment Hydrologic Stress: High Stress
- Future Pressures: Agricultural and Tourism
- Water Management Plan Priority: High
- Embargoes: Richmond River
- Interim Water Quality Assessment:

Data Source: Surface water data were obtained from DIPNR sources, principally: flow gauging records (Hydsys); water quality records; and the 1999 *Stressed Rivers* reports.

Discussion: Flow data for the Richmond River are shown in Table 6. While river flows at Kyogle have only ceased to flow once over the last 30 years, during the drought of 1994, flows in the river did drop below 20 ML/day from late September to early December. However, the river at Casino has ceased to flow on two occasions since 1970 and the daily flow is regularly below that of Wiangaree during low flow periods. (Flows data has not been obtained for the last year 2002/03, this period has been identified as the worst draught for 100 years. Modelling of water supply requirements will need to incorporate data from this period.) Seasonal variability is very high with 80th%ile flows in March being 4 to 5 times higher than in October.

2.4% of the mean annual flow of the Richmond River is presently being used by irrigators. Some sub-catchments are hydrologically stressed under low flow conditions especially between the months of August to November

Figure 6 Flow Data for DIPNR Station on the Richmond River

Flow Station	Flow Station Number	Mean Annual Flow	80th%ile	95th%ile
Wiangaree	203005	264,557	76	36
Casino	203004	538,568	118	34

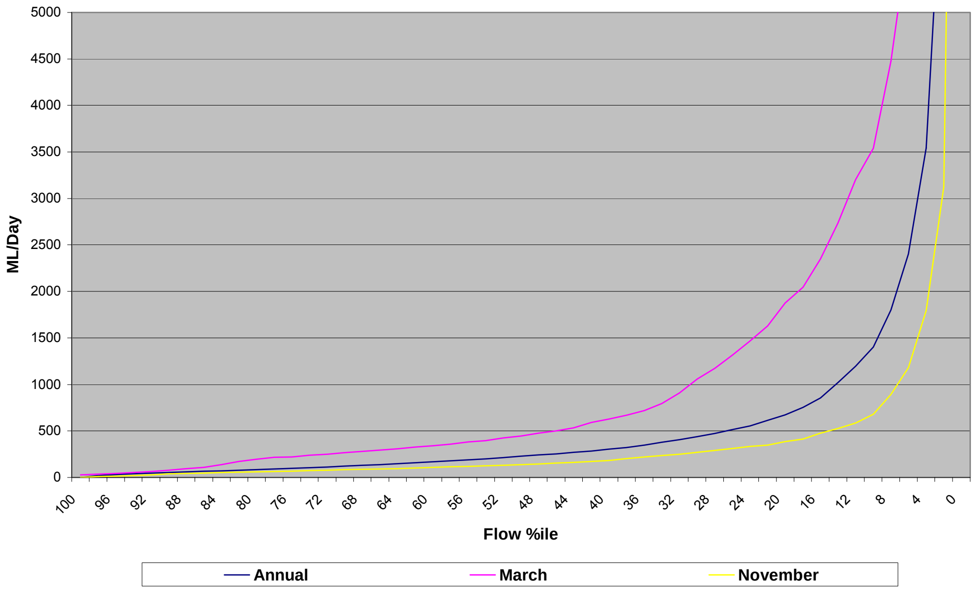


Figure 7 Flow duration curve for Richmond River at Kyogle.

Irrigation and town water extraction requirements in the upper reaches of the Richmond River are 12.9 GL/Year. The majority of this extraction occurs along the area of river floodplain, just upstream of Kyogle down to Casino (8.3 GL/Year) and in the north-western subcatchment of Roseberry Creek (2.5 GL/Year).

The southern part of the catchment produces significantly less runoff, and has less seasonal variation in the low flows. The variation in the 95thile and 80thile flows are generally approximately ± 20 ML/day due to regulating releases from Toonumbar dam.

The annual river flow and level of water extraction from the Richmond River Subcatchments are shown in Figure 8. The figure indicates that average annual town water extraction from the Kyogle Subcatchment area is about 0.4% of the annual mean river flow at Casino. This extraction represents approximately 6.8% of the low flow (taken to be 80th%ile flow), and represents 20% of total extraction within the subcatchment. The overall extractive demand (which includes irrigation) is 34% of the low flow and 2.0% of the total mean annual flow. However**, the irrigation period in this area is between the months of August to November and the extractive demand is 100% of the low flow during this period**.

The water quality within the Richmond River is generally poor under low flow conditions. The poor quality can be linked to the catchment geology and anthropogenic activities. Figure 9 shows the nutrient concentrations in the Richmond River Catchment during low flow periods. During high flow periods the concentration of nutrients and the load within the river increase significantly, with total nitrogen and total phosphorus concentrations ranging from 0.8 to 1.2 mg/L and 0.15 to 0.25 mg/L respectively.

Within the Kyogle LGA 2,512 km^2 of land has been cleared for agricultural activities leaving only 1072 km^2 for forestry and nature conservation. The study area is comprised of 1,708 km^2, of which 913 km^2 is uncleared, and 795 km^2 cleared for urban and agricultural activities. Table 5 shows the level of land cleared in each sub-catchment.

Greater than 40% of the study area and up to 85% of some sub catchments have been cleared for agricultural activity

Table 5: Levels of Land Clearance within each Subcatchment.

Subcatchment	Total Area	Tree Cover		National Park		State Forest	
	km^2	km^2	%	km^2	%	km^2	%
Roseberry Creek	400	299.3	75	135.7	34	87.8	22
Gradys Creek	318	227.5	72	142.2	45	0	0
Kyogle Area	288	68.4	15	18.2	4	4.6	1
Toonumbar Area	192	132.5	69	38.4	20	97.9	51
Eden Creek	226	117.5	52	0	0	56.7	25
Doubtful Creek	284	68.2	24	14.2	5	22.7	8

Agricultural activities are centred mainly within the 'Kyogle Area subcatchment' where the deep structured red clay loams occur (the most fertile soils within the catchment). Nutrient inputs to the above subcatchments from fertilisers are approximately 1,585 tonnes of nitrogen and 348 tonnes of phosphorus per year. There are also approximately 132,000 cattle and 25,000 pigs within the LGA. This number of stock has the potential to impact on water quality in relation to nutrient loads, turbidity and pathogens.

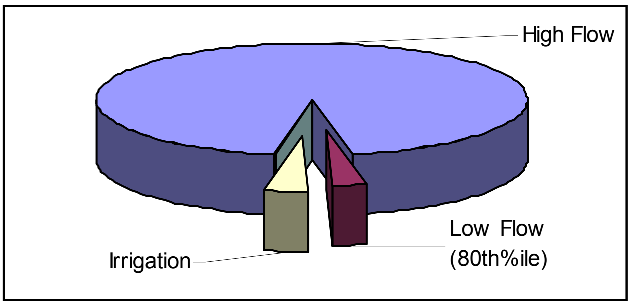
Forestry includes an area of 270 km^2 within the study boundaries. Forestry practices can impact on water quality in relation to increased loads of sediments entering the waterways as a consequence of soil disturbance from logging and road clearing.

Roseberry Creek and Kyogle Area subcatchments under hydrological pressure from water extraction during low flows

Figure 8: Water Extraction from the Richmond River Subcatchments.

Roseberry Subcatchment

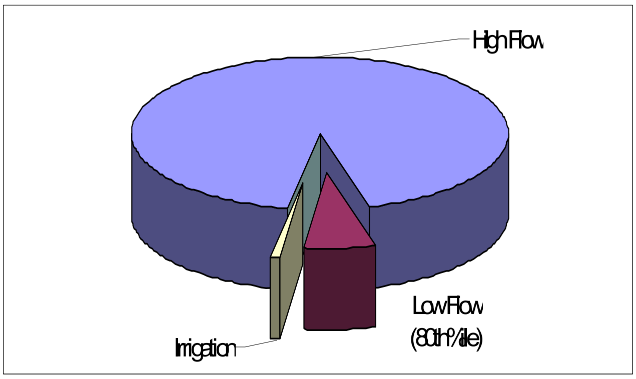
Drainage Area: 400 km^2



Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	75	
Low[3]	2.00	2.7
Irrigation	2.5	3.3
Town[4]	0	0

Gradys Subcatchment

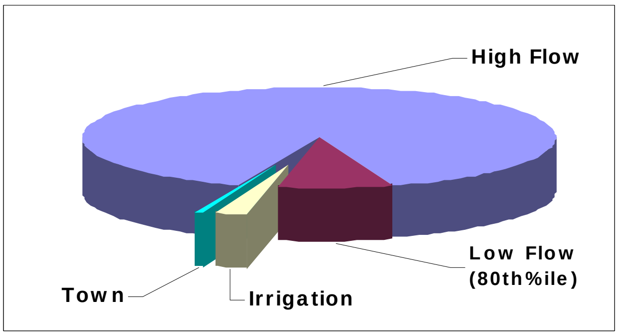
Drainage Area: 318 km^2



Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	190	
Low[3]	11.8	6.2
Irrigation	1.6	0.8
Town[4]	0	0

Kyogle Area

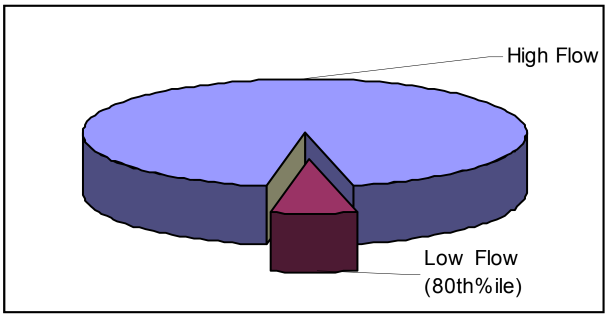
Drainage Area: 1008 km^2



Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	306	
Low[3]	30.6	5.7
Irrigation	8.3	1.5
Town[4]	2.1	0.4

Toonumbar Area

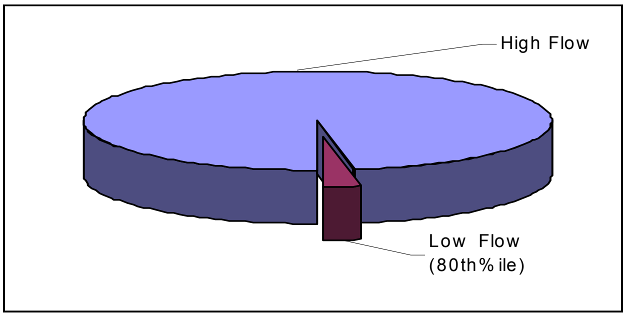
Drainage Area: 192 km^2



Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	28.0	
Low[3]	1.8	6.4
Irrigation	No Records	
Town[4]	0	0

Eden Creek Area

Drainage Area: 226 km^2

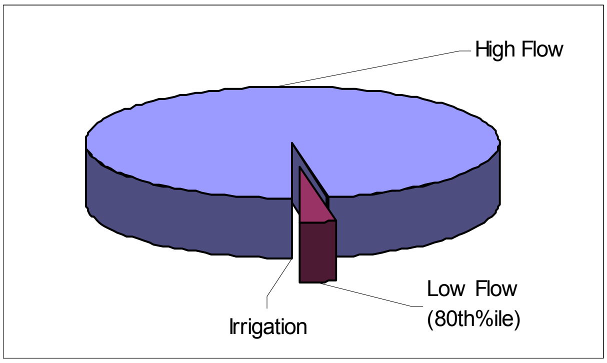


Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	74	
Low[3]	1.8	2.4
Irrigation	No Records	
Town[4]	0	0

Very little extraction occurs in the southern sub catchments

Doubtful Creek Subcatchment

Drainage Area: 284 km^2

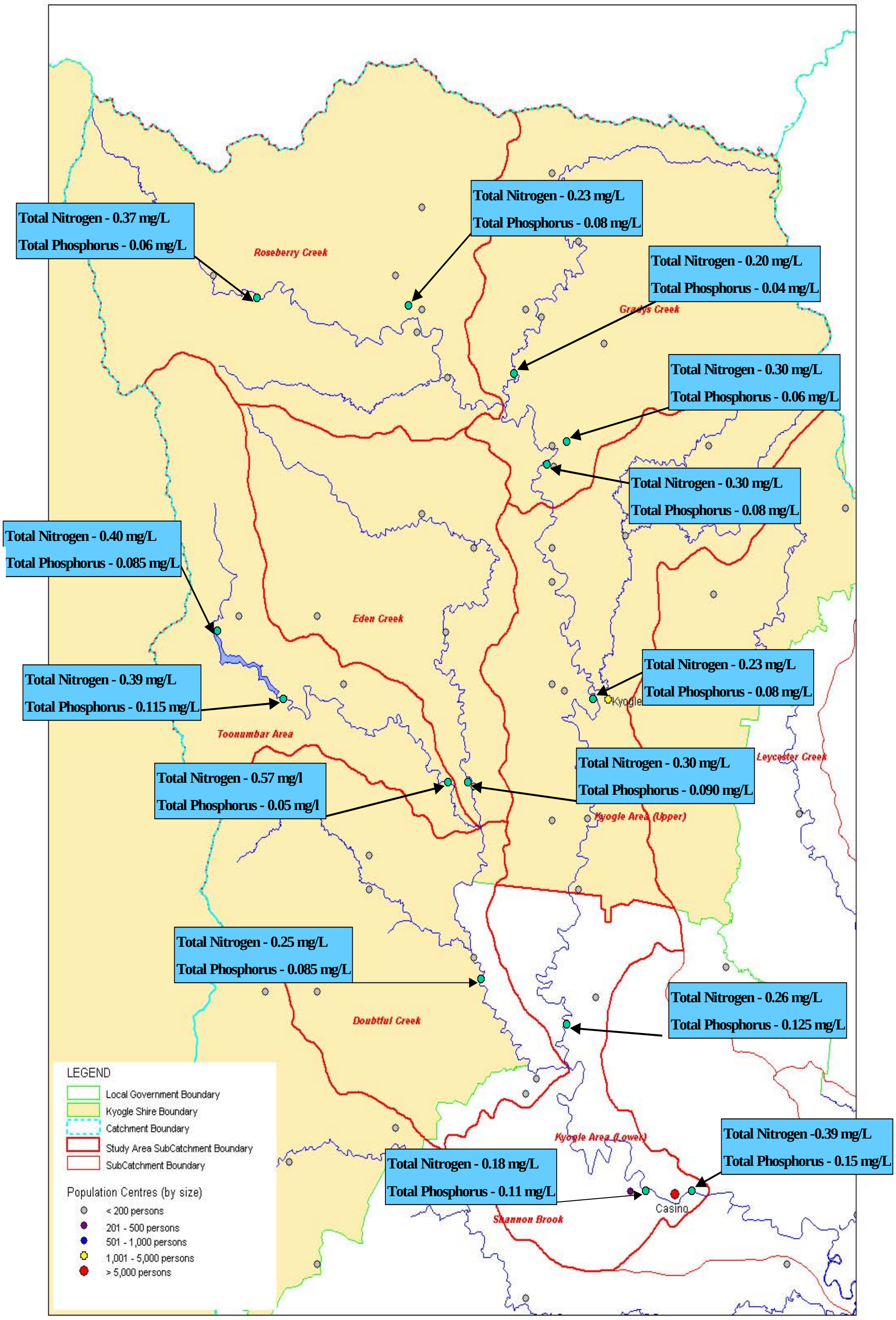


Flows	GL per Annum	~% of Annual Average Flow
Average Annual[1]	202	
Low[3]	5.3	2.6
Irrigation	0.1	0.005
Town[4]	0	0

1. Mean annual flow from records.
2. Median flow taken as 50th percentile flow
3. Low flow taken as 80th percentile flow
4. For explanation of town demand estimate see Appendix B

Figure 9: Nutrient Concentrations in the Richmond River in Low Flows

Total phosphorus levels within the Richmond Catchment generally exceed the environmental objectives



2.2.2. Groundwater

Data Source: Groundwater data were sourced from DIPNR records on bore licences and groundwater quality, and NSW *State of the Environment Reporting*.

Discussion: The Richmond River catchment has the highest groundwater usage of all the coastal basins in NSW, and has approximately 2,300 licensed bores. There are three aquifer sources present within the study area, the Richmond River Valley Alluvium, the Clarence-Morton Basin and the Tertiary Basalts Aquifer. The major source of groundwater within the area is the Richmond River Valley Alluvium.

Kyogle Water Resources:

Primary Water Source:	Richmond River Valley Alluvium
Town Water Extraction:	0 GL/pa licensed
Groundwater Licences: *(other than Town Water)*	13.2
Aquifer Risk Assessment:	High
Future Pressures:	Licensed entitlements
Land use / Irrigation	
Water Management Plan Priority:	High
Other Features:	Large number of unlicensed bores in existence

High levels of groundwater use within the catchment. A large number of unlicensed bores in existence

Figure 10 shows the Richmond River valley alluvium aquifer and location of groundwater licences within the area. The estimated volume of water stored in this aquifer is 426 GL, of which 255 GL has a low salinity and a hardness of about 266 mg/L. The annual recharge is approximately 38 GL/Yr. Groundwater usage as of 1995 was approximately 4.4 GL.

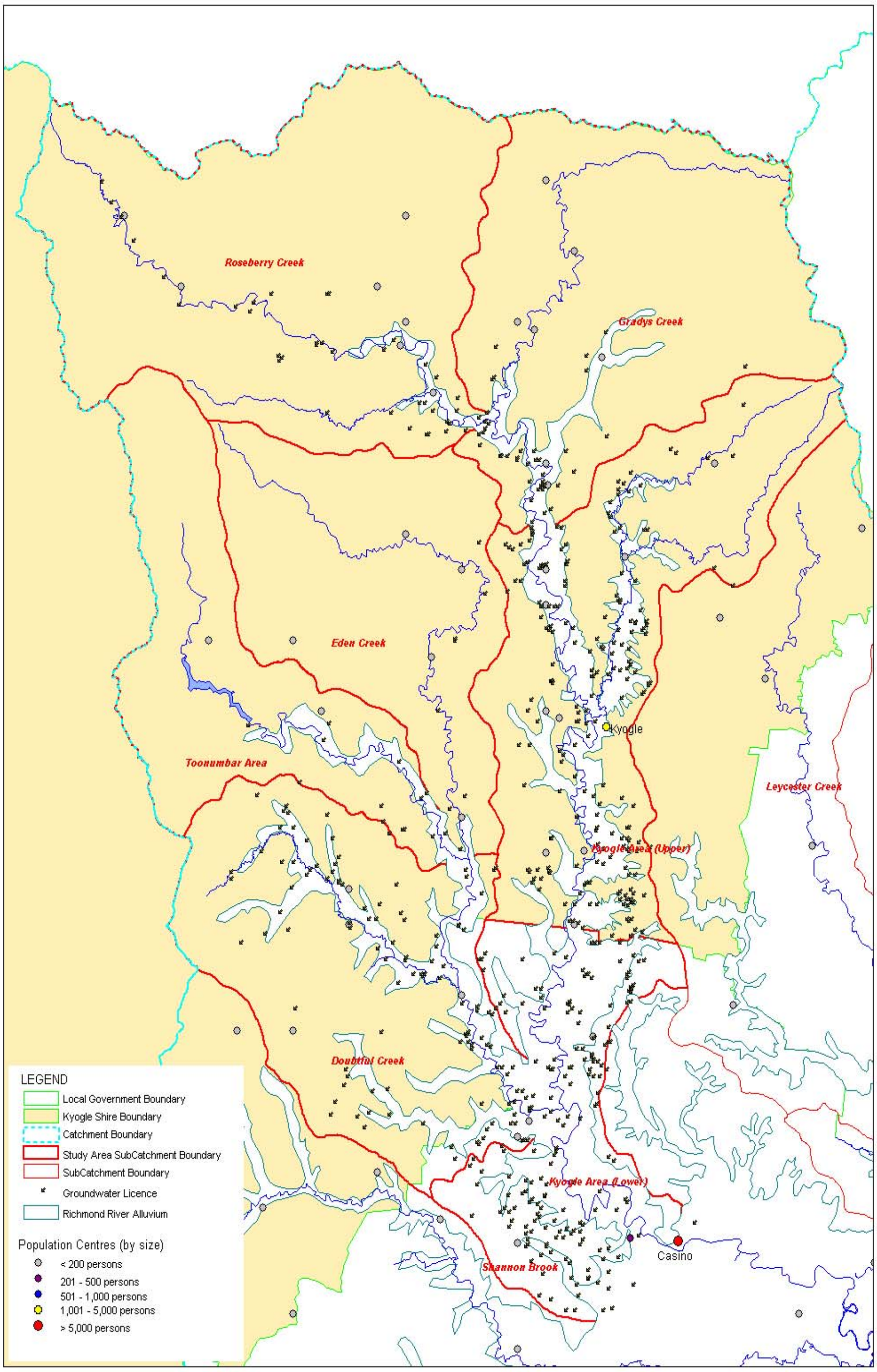
The Tertiary Basalts constitute one of the most important and reliable aquifer systems in the region. These aquifer systems have bore yields ranging from 0.5 to 15 L/s with a maximum of 30 L/s recorded. Groundwater quality is generally good with a low salinity (169 mg/L TDS) and a total hardness of 56 mg/L. The volume of water stored in the aquifer is approximately 7,130 GL with an annual recharge of 797 GL/Yr. Usage as of 1995 was approximately 8.8 GL.

The third source of groundwater in the area is the Clarence-Moreton Basin. The resource potential of this basin is not well known, as there has been only limited exploration. Bore yields are usually around 0.3 – 0.5 L/s, with elevated TDS concentrations of around 1,125 mg/L and total hardness of about 500 mg/L. The volume of water stored in the aquifer is approximately 2,104 GL with an annual recharge of 11 GL.

Current records on groundwater are likely to be an underestimate of the actual usage. Local DIPNR staff have indicated that a large number of unregistered bores exist within the Richmond River catchment.

Figure 10: Groundwater Entitlements.

Richmond River Catchment Groundwater Licences



2.3. Urban Context

In this section, the urban components relevant to the study area are defined.

2.3.1. Town Water Supply

Importance of Water Supply Data to IWCM: Data on the existing water supply system are important for determining how well the system is performing in terms of delivery of water services. Records of the water volumes extracted, treated and consumed are used to determine how efficiently the water supply system is operating and identifies places where water is lost or unaccounted for. Understanding how water is consumed allows water demand management planning, which includes the development of programmes to encourage people to use water wisely. Data on the capacity of the existing system are important for identifying places where the system may be improved.

Data Source: Water supply data were sourced from the local water utility's operational and monitoring data, and the Strategic Business Plan, MEU Performance Comparison Reports, utilities licensing and volumetric conversion data, and NSW Health reticulation water quality data.

Kyogle Town Water Supply:

Water Source:	Richmond River
Water Storage:	Kyogle weir (20 ML – on-stream)
Raw Water Quality:	High turbidity after rain and prone to algal blooms. TN – 0.09 mg/L TP – 0.06 mg/L
Environmental Flows:	Are to be provided from Kyogle weir.
Towns Served:	Kyogle & Geneva (pop. 2 737)
Water Treatment:	rectangular horizontal flow sedimentation tank and three rapid gravity sand filter & Pressure filter plant both with 1.5 ML/d capacity
Final Water Quality:	88% compliance for microbiological & 100% compliance for chemical & physical parameters
Town Water Extracted:	488 ML/pa (5 year average)
Licence Allocation:	564
Demand Management:	Limited Programme currently in place
Asset Replacement Cost:	$12million (year 2000 dollars).

Discussion: The existing water supply scheme serves a population of approximately 2737 people, located in Kyogle and its suburb, Geneva. Raw water is pumped from the weir on the Richmond River (north of the township) via a pressure main to the water treatment plant (WTP) on Bloore Street, Kyogle. The existing water supply scheme, consists of the following components (Figure 11):

Kyogle Water filtration plant was originally constructed in 1933 with additional capacity added in the 1950s

- Kyogle sources it's water supply from a weir, storage pool on the Richmond River, approximately one kilometre north of Kyogle. This pool provides an on-stream storage of 20 ML. The water is generally contaminated with high levels of coliforms, colour, turbidity and iron.
- A raw water pump station located 40 metres from the river intake. This consists of two pumps, one installed in 1976 and the other in 1933.
- A water treatment plant consisting of two plants operating in parallel. The original plant, built in 1933, is a rectangular horizontal flow sedimentation tank with three rapid gravity sand filters, producing 1.5 ML/day. A newer pressure filter plant, constructed in the 1950s, consisting of a radial flow flocculation tank/clarifier and a bank of eight in ground pressure sand filters producing 1.5 ML/day.
- There are also three service reservoirs with capacities of 1.5, 2.2 and 1.1 ML storage.

The condition of the infrastructure has deteriorated. This has required recent stabilisation work on the weir and the replacement of pumps and electrical works at the raw water pump station.

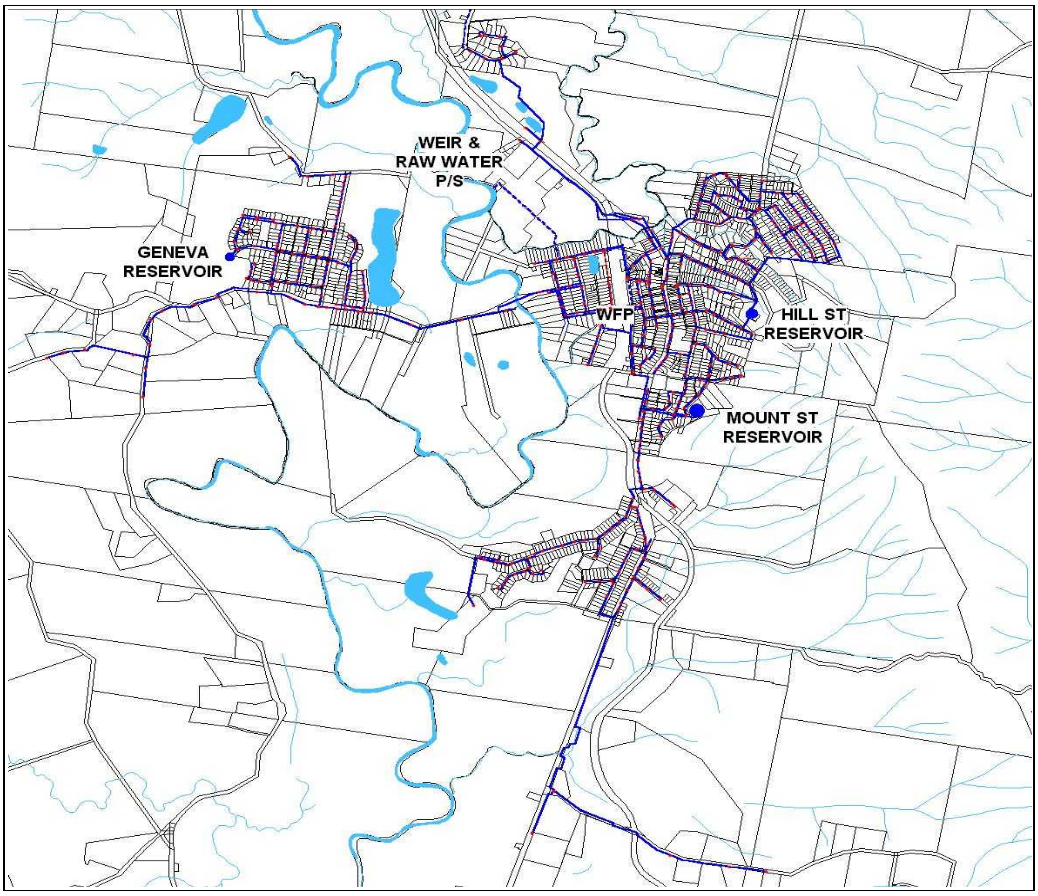
Water quality at Kyogle weir has been identified as poor, with faecal coliforms and high levels of turbidity, colour and iron. However, Kyogle's water supply generally complies with the Australian Water Quality Guidelines since 1998, with the exception of the 1999/00 microbiological requirements.

Inadequacy of on-stream storage is resulting in regular water restrictions

A number of issues have been identified in relation to the Water Supply in previous reports including:

- Poor condition of existing plant (structural/electrical/mechanical).
- Infrastructure construction prior to 1996 does not meet current OH&S standards.
- Inadequacy of existing on-stream storage.
- Lack of off stream sedimentation lagoons to assist treatment process.
- Regular water restrictions being imposed.
- Discharge of untreated filter backwash to river.
- Discharge of reservoir scour lines to private property.
- Lack of telemetry equipment for monitoring water filtration plant, pump stations and reservoirs.
- Poor condition of Hill Street reservoir.
- Accuracy of bulk water meters.

Figure 11: Schematic of Kyogle Water Supply Scheme.



Water consumption and peak day water demand data is provided in **Table 6**. Meters were installed in Kyogle and Geneva in mid 1987, while user pays water pricing was introduced in mid 1996. These demand management measures led to a significant reduction in consumption.

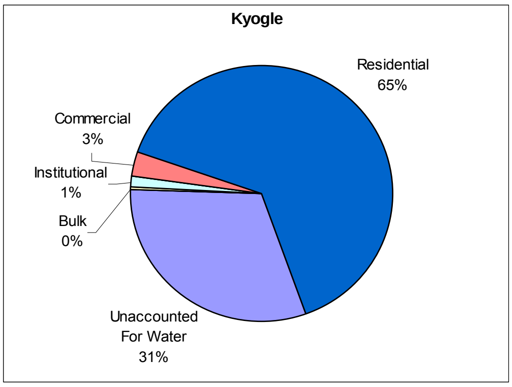
Table 6: Water volumes for 1997/98 – 2000/01.

Consumption	2000/01	1999/00	1998/99	1997/98
Water Consumption (ML/a) MEU records	650	482	426	402
Climate Corrected (ML/a) MEU analysis		502	439	396
Peak Day Consumption (ML/d)	xxxx	xxxx	3166	3827

A large increase in water use was recorded in 2000/01

The local water utility has limited data on consumption. An estimated breakdown of water consumption is provided in **Figure 12** and is derived from MEU Performance Comparison reports.

Figure 12: Water consumption breakdown for Kyogle.



The major water consumption is for residential supply, representing 65%.

There are no recent demand forecasts available for Kyogle, and a comprehensive demand management programme is not currently in place. Residential water consumption in Kyogle has increased dramatically over the last 12 months. The high level of unaccounted for water and recent increase in recorded total consumption could be related. The discrepancy between total recorded flow at the WFP and the total of meter readings suggests a high level of error on one or both of the recorded figures. The error is likely to be at the bulk water meter at the WFP, but should be investigated further.

Within the whole Richmond River catchment the total annual town water consumption is 3 710 ML/a for a population of approximately 21 000. Kyogle LGA population consumes 512 ML/a (based on the past 4 years) or 14% of the catchment town water extraction, and serves approx. 3700 people (or 18% of the catchment population), (DIPNR, 2001).

Kyogle Town Water Service:

- Water Consumption: 225 kL (3 year average)
  (per property) *State: 230 kL*
- Typical Residential Bill: $395 ($242 access charge)
  (per property) *State: $325*
- Operating Cost: $218
  (per property) *State: $200*
- Quality Complaints: 4
  (per 1000 properties) *State: 8*
- Service Complaints: 22
  (per 1000 properties) *State: 9*

Year 2000/01 Data

Water consumption in Kyogle is comparable with the state average, and less than the catchment average

2.3.2. Sewage Services

Importance of Sewerage Services data to IWCM: Data on the existing sewerage services in Kyogle are important for determining system performance and service delivery. Records of sewage volumes and the level of treatment achieved are important for determining the possible effluent reuse options, or determining appropriate methods of effluent disposal. Data on the capacity of the existing systems are important for identifying areas in need of improvement or where the system may fail to meet future requirements.

Kyogle Sewerage Services:

▪ Reticulated Areas:	Kyogle and Geneva
▪ Treatment Plants:	Kyogle (Trickling Filter)
▪ Effluent Discharge:	Richmond River downstream of Kyogle
▪ Licence Issues:	PRP to improve treatment.
▪ Effluent Reuse:	opportunistic
▪ Septic Tank Areas:	Refer to Figure 11.
▪ Septic Management:	Soils in some area have low septic absorption capacity
▪ Asset Replacement Cost:	$12 million (year 2000 dollars).

Year 2000/01 Data

Data Source: The local water utility sewage treatment plant data and Strategic Business Plan, MEU Sewerage Inspection Reports, EPA Licence Register.

Discussion: A schematic of the sewerage schemes for Kyogle LGA is presented in **Figure 13.** The sewage treatment works was constructed between 1941-50. The treatment works is a conventional trickling filter plant and consists of

- coarse screening;
- grit removal;
- Imhoff plant for gross solids removal;
- primary sedimentation;
- biological filtration;
- humus sedimentation;
- sludge digestion;
- sludge drying beds; and
- effluent ponding.

The effluent prior to being discharged to the Richmond River passes through a drainage channel to a neighbouring dam. The local farmer then uses the effluent for opportunistic reuse. The effluent is polished through this process with the average total nitrogen and total phosphorus concentrations in the dam being 4.3 and 4.2 mg/L respectively. The EPA authorised discharge point is located between the agricultural dam and the STP.

Recent works have been carried out at the plant including:

- ♦ New inlet works;
- ♦ Chemical phosphorus removal;
- ♦ New electrical switchboard and wiring;
- ♦ Lagoon mixer/pump pontoon for sludge removal from No. 1 lagoon.

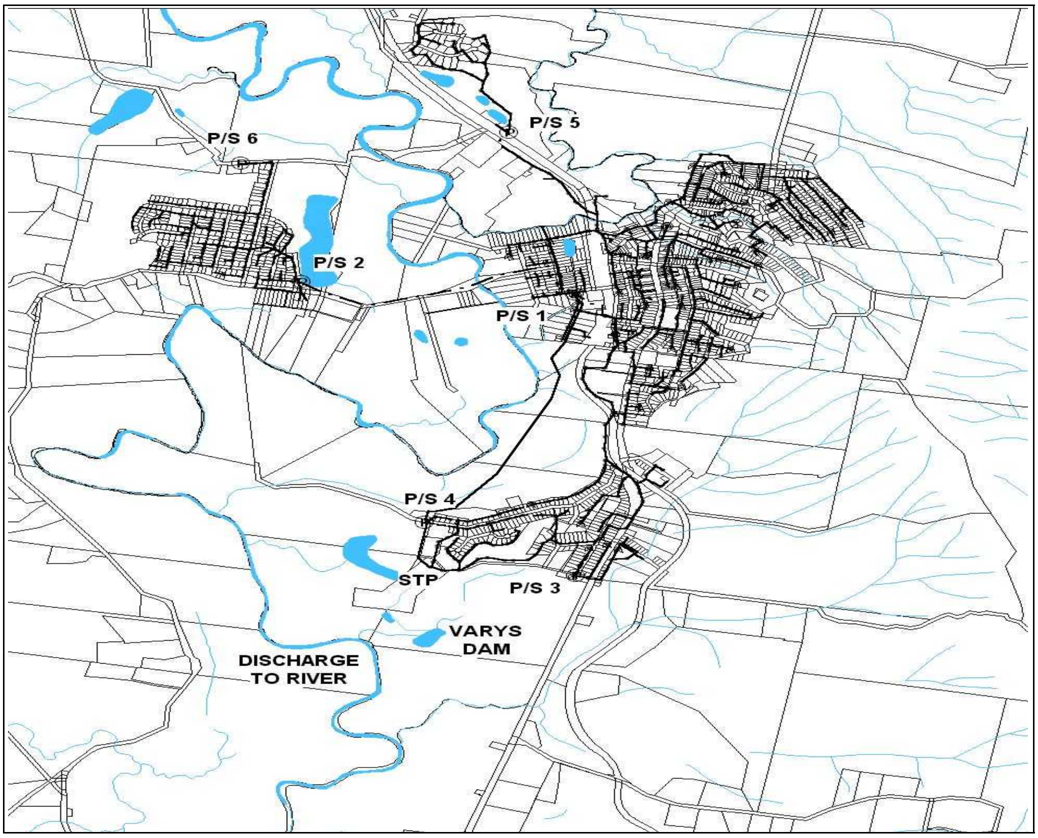
PRP issued to improve effluent quality

However, a number of issues have been identified in the existing sewerage system including:

- ♦ NSW EPA has issued a Pollution Reduction Programme (PRP) for the Kyogle treatment plant requiring Kyogle Council to implement works to improve the effluent quality to sensitive water quality or implement an effluent reuse scheme.
- ♦ The sewage treatment works are organically and hydraulically overloaded.
- ♦ Major inflow and infiltration problems exist in the system.

- Sewage treatment works outflow passes through private property prior to discharge to Richmond River.
- Minor structural problems exist.
- Electrical upgrade of pump stations is required.
- No telemetry on sewage works or pump stations.

Figure 13: Schematic of Kyogle Area Sewerage Schemes.



In a manner similar to water supply, the plan recognises that sewerage service provision, on-going maintenance and capital works programmes within the local government area are driven by the aging of current infrastructure and the tightening of regulatory operation requirements, rather than growth in the local government area.

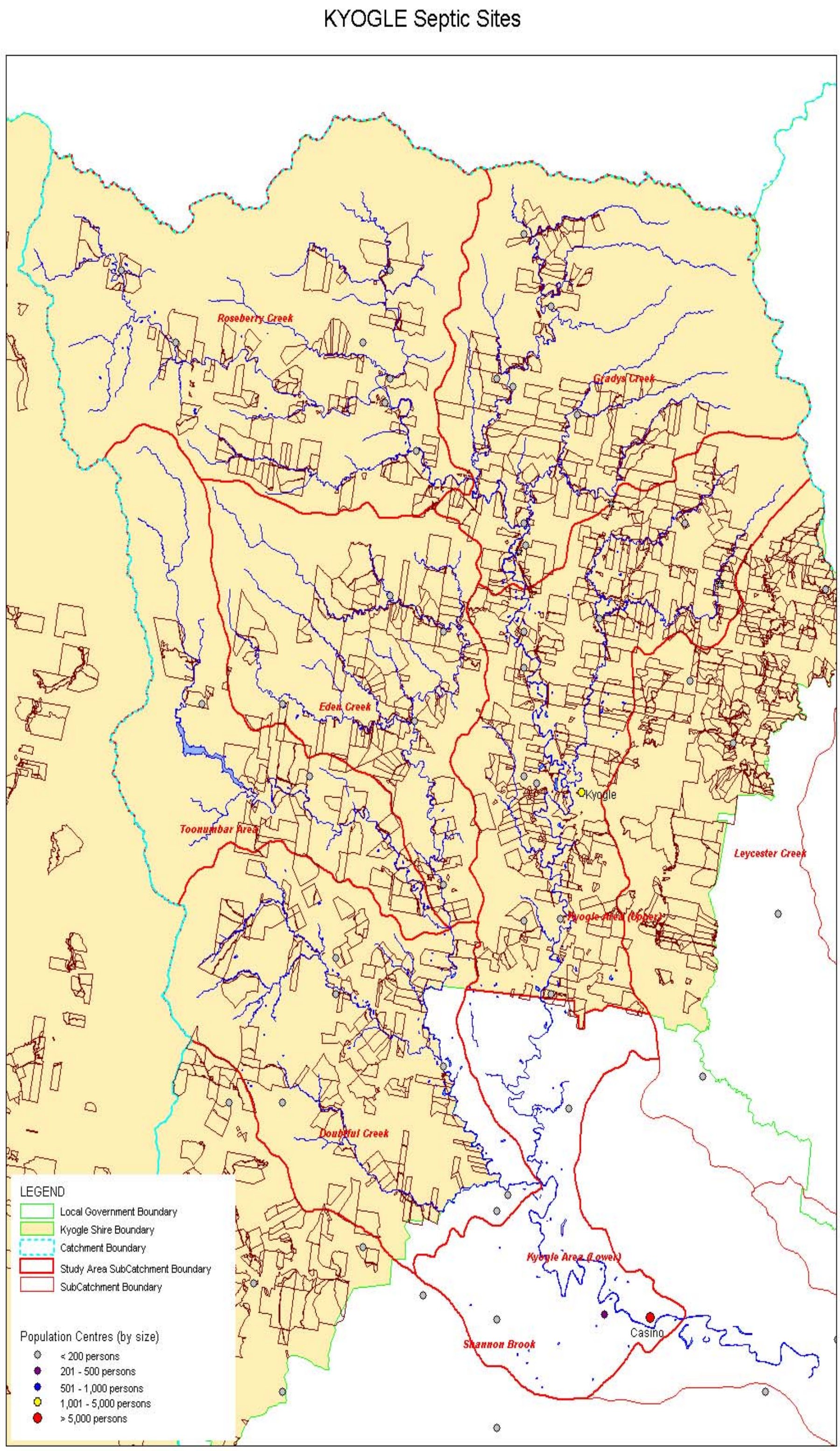
Kyogle Town Sewerage Service:

▪	Volume of Sewage Treated : *(per property)*	232 kL/a (3 year average) *State: 260 kL/a*
▪	Typical Residential Bill: *(per property)*	$313 ($266 access charge) *State: $335*
▪	Operating Cost: *(per property)*	$245 *State: $225*
▪	Sewer Choke/Collapse: *(per 100 km of main)*	54 *State: 30*
▪	Sewer Overflows: *(per 100 km of main)*	35 *State: 4*
▪	Odour Complaints: *(per 1000 properties)*	4 *State: 0.6*
▪	Service Complaints: *(per 1000 properties)*	14 *State: 11*

Year: 2000/01 Data

Soils within the *Kyogle Area* subcatchment have been identified as having low septic absorption potential. This may be resulting in water quality failures in local streams. Under the Local Government Act Kyogle Council is responsible for the inspection of septic systems within the local government area. Council's procedures for inspecting these system should take into account the soils in the area.

Figure 14: Parcels of land where on-site sewage systems are located



2.3.3. Urban Stormwater

Importance of Urban Stormwater Data to IWCM: Urban stormwater quality and quantity data is important for determining how this potential resource and untreated pollution source can be better managed. Dependent on the reliability of rainfall, it may be possible to reduce the volume of stormwater generated by harvesting rain to supplement potable water use. The quality of stormwater will also impact on the potential use of these resource and dictate appropriate treatment, reuse and disposal methods.

Kyogle Urban Stormwater Services:

▪ Infrastructure:	Concrete kerb and gutters, drainage pipe network and open drainage channels
▪ Discharge Points:	Richmond River & Fawcetts Creek
▪ Stormwater Monitoring:	No
▪ Other Data Sources:	DLWC, SWC studies in Sydney & Grafton TP = 0.3 mg/L, TN = 1.0 mg/L
▪ Management Plan:	Revised January 2002
▪ Existing Issues:	Erosion, siltation, litter.
▪ Asset Replacement Cost:	$850,000 (2000 dollars).
▪ Runoff Coefficients:	Catchment = 22% Urban = 35%

Data Source: Data on urban stormwater management in the study area were collected from Council Urban Stormwater Management Strategy (USMS) for Kyogle and the Council and EPA Stormwater Management Programme.

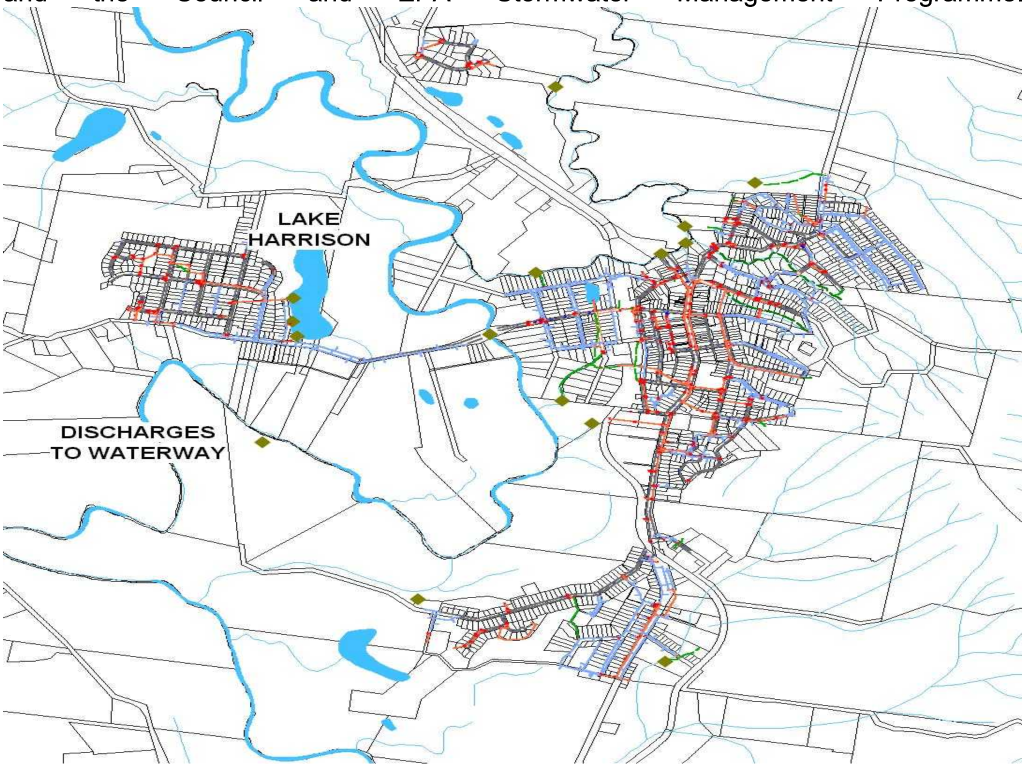


Figure 15 Schematic of Kyogle Stormwater Network.

Discussion: The existing stormwater drainage system in the Kyogle urban area consists of numerous catchments from which overland flow transport stormwater runoff to either shallow grassed or earth channels which in turn concentrate surface runoff for capture in kerbs and inlet structures. Kerbs and inlet structures are linked by a network of underground concrete drainage pipes and culverts which convey runoff to discharge points in the lower regions of the urban zone. Stormwater runoff discharges through various channels, open grassed paddocks or storage reservoirs such as

"Lake Harrison" before eventually finding its way to both the Richmond River and Fawcetts Creek.

The stormwater system in Kyogle has no formal sedimentation & erosion controls and no litter trapping devices. Issues have also been identified with the system in the Kyogle CBD and residential area with substandard infrastructure and evidence of soil erosion, siltation litter and stagnant water.

Kyogle council is actively involved in a Stormwater Education and Assessment (SEA) Project

Kyogle council is actively involved in a $1,000,000 Stormwater Education and Assessment (SEA) Project with the councils of Ballina, Byron, Lismore, Richmond Valley and Tweed.

Limited stormwater quality data are available for the study area. Stormwater quality parameters (0.3 mg/L TP and 1.0 mg/L TN) were assumed from monitoring work conducted by Sydney Water Corporation in Sydney and MEU in Grafton (Freeman, 1999 & Sydney Water, 1997). Stormwater volumes were estimated from rainfall estimates, assuming a 35% urban runoff coefficient. Calculations based on this information are presented in **Appendix D**.

2.4. Adequacy of Data

This section examines the adequacy of the available data. Data are assessed in terms of usefulness in performance review of operational and planning strategies, and in building community capacity for decision making in relation to the management of water resources and the provision of urban water services.

The following bullet points address areas of limitation in the existing Kyogle Data Set, and provide recommendations of approaches to improve the usefulness of the data collected in the future.

- **Population Assessment:** Predicting future population growth rates in the area is difficult. The coastal area of the northern Rivers catchments has been experiencing significant growth rates over the past 10 years. It was expected that some of this growth would spill over into Kyogle. However the urban growth in Kyogle has continued to decline over the past 10 years, with the recent census showing an annual decline of 0.9%. The "spill over" impact from the coastal growth has not been evident.

  Recommendation: As population growth in Kyogle is expected to continue to decline, a zero growth factor should be used as a part of the IWCM study. It is acknowledged that factors affecting growth may change in the future, but at present there is no indication that population growth in Kyogle is being affected by the "spill over" from coastal growth.

- **River Flow and Aquifer Yield Data:** The Department of Infrastructure, Planning and Natural Resources (DIPNR) operate a number of flow gauges on the Richmond River. Data from these gauges have been collected for up to 30 years, giving a good indication of flow within the system. However, little information appears to be available on the aquifers.

  Recommendation: As groundwater usage in the catchment is high and an embargo exists on further surface water extraction, more work is required on the groundwater hydrology.

- **Extraction Data:** Extraction demands for this report has been obtained from levels identified in the Stressed Rivers Assessment Report 1999. More accurate demand levels will be known once all licences have been converted to a volumetric allocation. Additional information in relation to the seasonal demands for agricultural irrigation will aid in the improved management of the resource.

  Recommendation: The volume of water extracted within the Richmond Catchment is small, compared with the annual flow in the river. DIPNR needs to convert all licenses to a volumetric allocation and determine seasonal demands to ensure better management of the resource.

- **River Water and Ground Water Quality Data:** The DIPNR collects and collates water quality data largely on a project basis. These data allows a general broad picture on river water quality. Limitation in the data exists in the relative absence of recent information. Also only limited information was available in relation to simultaneously collected water quality and flow data, which enables loads of pollutants to be calculated.

  Recommendation: Council and other agencies in the catchment need to coordinate data collection to enable an accurate determination of pollutant loads being transported through the catchment. This information is required to implement catchment management targets.

- **Town Water Supply Data:** A number of issues were identified with the town water supply data obtained from council. When compared to climatic data for the region, peak day demands did not match with hot dry periods.

  Recommendation: The flow meters on the town water supply need to be replaced with more accurate meters or at least recalibrated to ensure they are reading accurately.

- **Sewage Services Data:** Council has a flow meter installed and daily readings are kept in the operators running book. The STP has been recently fitted with a data logger as part of the electrical upgrade, but is yet to be brought on-line.

  Recommendation: The data logger needs to be brought on-line to provide up to date flow data for future sewage management option concepts and designs. This information will need to be examined as part of phase 2 of the project, to get a better understanding of the Kyogle sewerage system.

- **Urban Stormwater Data:** Pollutant contributions form urban stormwater are unknown due to a lack of stormwater quality monitoring. The stormwater management plan only raises negative aspects of stormwater. It generally indicates that stormwater management in Kyogle is fine, except in the CBD area. The plan also does not support any stormwater capture and reuse. The stormwater management plan does not clearly identify stormwater management issues in the context of broader catchment management issues.

  Recommendation: Key Performance Indicators (KPI's) for the stormwater management plan are extremely broad, confusing stormwater management issues with broader catchment management issues. Issues associated with the generation of stormwater need to be more urban focused, in relation to the reduction in volume and pollutant loads. The source of the water and pollutants need to be identified and management actions put in place.

3. Kyogle – Audit & Interpretation

Whilst the data presented in **Section 2** form the first step in 'Knowing your System', the audit process presented in the following sections is important for understanding how well your system is performing. Auditing involves the assessment of the available data on the current situation against the objectives for water resource management, urban water service delivery, government policy and regulation. Auditing is based on the level of achievement against these objectives for the purpose of formulating ways in which it can be improved. The audit process allows the local water utility to have a greater understanding of how well the **Kyogle System** is meeting the various objectives for water resources and will also help in setting priorities for future actions in order to achieve them.

The Kyogle audit has been undertaken in three parts: Catchment Audit; Water Resource Audit; and Urban Area Audit. Each part generally contains some initial analysis, and an assessment against the relevant objectives. A summary of Audit Outcomes that ties together the outcomes of each independent audit is also presented.

3.1. Catchment Audit

Details of Approach: The Kyogle catchment was audited for a range of catchment objectives represented by the icons below (**Figure 16**). These objectives have been developed to generally reflect the existing land and water management policies of NSW (including the Catchment Blueprints) as well as echo the framework on which the *Interim Water Quality Objectives* were derived. The objectives include issues such as salinity, deforestation, acid soils, erosion and water stress. For each objective, key drivers and criteria (a mix of quantitative and qualitative) were identified in order to assess the relevance of each objective to a particular catchment. Although the catchment objectives do not designate compliance with a single numeric value, they do serve to show where a particular issue e.g. salinity or acid soils, is of specific importance in a catchment and will need to be considered in relation to water resource management and the provision of urban water services. Further information on the objectives and their method of assessment is provided in **Appendix B**. A summary of the ranking of the catchment objectives is presented in **Table 7** and a summary of the audit results presented in **Figure 16**.

Table 7: Ranking of the Catchment Objectives.

Icon Colour	Ranking
Coloured icon	Objective **is identified** as an issue
White icon	Not enough information available on which to make an assessment
Grey icon	Objective **is not identified** as an issue

Figure 16: Summary of the Catchment Audit for Kyogle.

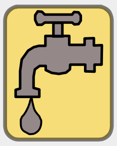
Further discussion of the Figure 16 summary is presented in the following sections.

3.1.1. Water Stress

Discussion: The available flow data were used to determine flow and extraction volumes for the Richmond River. While it was possible to compare extraction volumes against the annual low flow component, it is more relevant to compare extraction volumes against the low flow volume during the irrigation period. The main irrigation period in the Richmond River catchment is from August to November where the mean monthly evaporation exceeds the mean monthly rainfall. It is recognised that extraction for irrigation may occur outside this period depending upon climatic conditions. Extraction for town water purposes has been assumed to be relatively constant compared with other extractive purposes such as irrigation.

Water Stress Drivers in Kyogle:

- Extraction exceed low flow
- Limited information currently available on timing of extractions



Kyogle Area sub-catchment is hydraulically stressed

Audit Outcome: Volumetric allocation in the Richmond River is one third of the annual low flow component, however the irrigation extraction volume is equal to the low flow component of the river flow between the months of August to November. Consequently the Richmond River has been identified as having a high **water stress**.

3.1.2. Salinity

Discussion: Salinity can impact on our rivers and catchments by reducing the ability of runoff and groundwaters to be used as drinking and irrigation water sources. Land productivity is reduced and infrastructure maintenance costs increased. Water quality sampling within the catchment has indicated that the irrigation water criterion fail 40% of the time due to high salinity. The salinity criterion for this indicator is <280 μS/cm. The main problem areas are located in the Roseberry Creek, Eden Creek and Doubtful Creek subcatchments, with salinity criteria failing greater than 75% of the time.

Salinity Drivers in Kyogle:

- Areas of dry land salinity

These areas have yellow and red textured contrast soils, which experience land degradation problems including scattered patches of dryland salinity and soil erosion where vegetation has been removed. Poor land management practices in these areas are likely to exacerbate the problem.

Audit Outcome: Salinity issues have been identified within the study area, but at present are not impacting on the Kyogle urban water cycle. Therefore salinity is not considered as an issue for the IWCM strategy.

3.1.3. Acid Soil

Discussion: Soils within the study area were identified as having a high potential of being acidic. Land degradation problems associated with land clearing include soil acidification. Runoff from these areas can result in water quality failures for pH. Richmond River water quality being impacted by pH failures, but if land management practices result in further land degradation, changes in water quality pH may occur.

Acid Soil Drivers in Kyogle:

- Acidic soils within the study area.
- Land degradation problems include soil acidification.

Audit Outcome: Water quality in the Richmond River is presently not being impact by the occurrence of acidic soils in the catchment. The water quality should be monitored for changes as further land degradation within the catchment may result in water quality objectives for pH not being met.

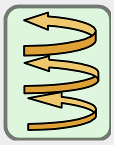
3.1.4. Soil Erosion

Soil erosion is an issue upstream of Kyogle impacting on Kyogle's raw water quality

Discussion: Eroded soils can impact on the quality of water sources. The presence of erodible and/or dispersible soils is not in itself a problem unless those soils are subject to disturbances. Turbidity was also identified to fail the criteria for freshwater aquatic ecosystems for approximately 20 % of the time during low flows and about 90% of the time during high flows. There are a number potential sources of turbidity within the catchment including:

Erosion Drivers in Kyogle:

- Erodible/dispersive soils in catchment
- Land disturbance practices present



– The soils in the upper parts of the catchment above Wiangaree and Toonumbar Dam. These soils are prone to land degradation problems such as gully erosion particularly where native vegetation has been removed.

– Agricultural clearing on land adjacent to the rivers. High flows and cattle access to the main channel can cause bank instability resulting in erosion of the riverbanks. The Northern Rivers Catchment Management Boards Catchment Blueprint has identified streambank erosion in the Kyogle area subcatchment as a priority management issue.

Audit Outcome: Soil erosion can result in turbidity and nutrient export (via runoff) into waterways. These impacts were identified for Kyogle's water source in the Water Quality Objectives' audit (see **Section 3.2.1**). **Soil erosion** is therefore identified as an issue for Kyogle's IWCM Strategy.

3.1.5. Chemical Cocktails

Discussion: A range of chemicals may be used by industries and for agricultural activities within the Richmond Catchment. These chemical include agricultural pesticides and herbicides, hydrocarbons from automotive vehicle and chemicals used in industrial processes. Although iron has been identified as an issue for Kyogle's drinking water, very little information in relation to other chemicals has been obtained.

Chemical Cocktails in Kyogle:

- Agricultural pesticides and herbicides
- Metals and hydrocarbons within urban centres

Audit Outcome: Data on the concentration of chemicals within the Richmond River is limited. Kyogle water quality monitoring has not identified any issues, but further work needs to be done to confirm the if chemicals are a risk or not.

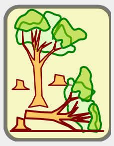
3.1.6. Deforestation

High level of deforestation in Kyogle subcatchment impact on in stream water quality

Discussion: Deforestation and clearing impact not only on quality but also quantity of the water harvest. Typical water-based impacts resulting from vegetation clearing practices include turbidity, nutrient export and sedimentation. Clearing will also increase the quantity of runoff increasing the river velocity and flood peaks.

Deforestation Drivers in Kyogle:

- Forestry activities within catchment
- Clearing of land for agriculture



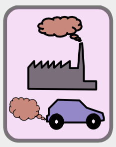
Audit Outcome: 38% of the study area has been cleared for agricultural activity, however in the Kyogle Area subcatchment the level of clearing is about 85%. Based on the degree of cleared land and the failure of water quality objectives for turbidity, **deforestation** is identified as an issue for Kyogle's water source.

3.1.7. Greenhouse Gases

Discussion: Enhanced greenhouse gas emissions have the potential to affect the availability and quality of water by affecting temperature and rainfall patterns and disturbing the frequency of El Ni̇̃o and La Niña cycles. Enhanced greenhouse gases can be caused by a number of activities including vehicle and industry emissions and land clearing practices. While Kyogle does not in itself accommodate large industries and practices that will have dramatic enhancement of greenhouse gases, it is located in a region likely to be affected by changes in rainfall patterns. This will result in increases frequent heavy rainfall events and associated flooding.

Greenhouse Gases Issues in Kyogle:

- Land clearing
- Hazard reduction burning
- Increase flood volumes and velocities
- Expected climate change



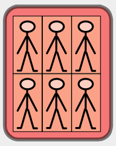
Audit Outcome: Based on Kyogle LGA's location in terms of greenhouse impacts, **greenhouse gases** has been identified as an issue of potential impact for Kyogle's water sources and infrastructure.

3.1.8. Monodiversity

Discussion: A trend towards biological monodiversity may manifest itself as an increase in weed (e.g. willows) and pest species (e.g. carp) in general as well as increase in mono-culture cropping regimes. Monodiversity issues will impact on water sources affecting both quality and quantity. Kyogle local government area, and the Richmond River subcatchment specifically, have extensive clearing and monodiverse agricultural pursuits. These pursuits have the potential to cause increases in runoff with associated nutrient and turbidity export into Kyogle's water sources which may lead to algal blooms (a monodiverse issue in its own right). Other monodiversity issues, such as carp, may be present in Kyogle's water sources but are currently unknown.

Monodiversity Drivers in Kyogle:

- Monodiverse agricultural pursuits
- Algal blooms (see also section 3.1.9)
- Potential of other monodiverse issues unknown



Audit Outcome: Algal blooms have been noted in Kyogle's storage as well as in Toonumbar Dam. **Monodiversity** has therefore been identified as an issue for consideration in Kyogle's water sources.

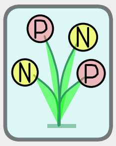
3.1.9. Algal Blooms and Nutrients

High levels of nutrients impacting on Kyogle's raw water quality

Discussion: Some land practices (**sections 3.1.3, 3.1.5**) can cause excess nutrients to be exported into waterways and may lead to algal blooms. Algal blooms can be toxic, can cause reduction in oxygen in waterways and can impact on water treatment processes. For low flow conditions, nutrient levels within the Richmond River normally exceed the freshwater aquatic ecosystem protection criteria (Appendix B) for total phosphorus, but not for total nitrogen. However, under high flow conditions, both total nitrogen and total phosphorus concentration are exceeded for greater than 80% of the time.

Algal Blooms and Nutrients Drivers in Kyogle:

- Blooms noted in Kyogle's water storage
- Blooms in Toonumbar Dam



Total nitrogen concentrations under low flow conditions generally range from 0.2–0.4 mg/L and variations seem to relate to local activities. During high flow conditions the mean concentration within the Richmond River catchment increases to 1.0 mg/L. Mean total phosphorus concentration exceed the criteria at all but one site within the study area under low flows, with concentrations generally increasing moving down the catchment.

The geology of the catchment is a significant contributor to the levels of phosphorus in the Richmond River. Basaltic soils in the catchment contain high levels of phosphorus and natural weathering and anthropogenic activities which increase levels of soils erosion result in the transportation of these soils into the local waterways. Agricultural activities in the catchment have a significant input of nutrients through the use of fertilisers within the catchment. Approximately 1,585 tonnes of nitrogen and 348 tonnes of phosphorus are used in the catchment annually.

Audit Outcome: Algal blooms were noted in both the waterways of the Richmond River subcatchment and in Kyogle's weir pool. As a consequence, **algal blooms and nutrients** have been identified as an issue for Kyogle.

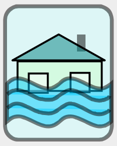
3.1.10. *Flooding*

Localised flooding an issue for Kyogle

Discussion: Flooding, although a natural phenomenon, can be caused and/or exacerbated by human impacts. Flooding may be caused by land clearing and urbanisation.

Flooding Drivers in Kyogle:

- Localised stormwater induced flooding



Audit Outcome: While generalised flooding in the Richmond River subcatchment is not an issue, Kyogle does experience localised stormwater induced flooding. Therefore, **flooding** has been identified as an urban issue for Kyogle. It is acknowledged that Kyogle council has initiated a flood management study to correct this problem.

3.2. *Water Resource Audit*

The Kyogle Water Resource Audit was undertaken in two parts. Firstly, an assessment of river water quality was undertaken by conducting an audit of the water quality data for the catchment against the *Interim Environmental Flow and Water Quality Objectives.* Secondly, an assessment of the water volume within the catchment was undertaken against the statutory planning instruments of the *Water Management Act 2000*.

3.2.1. *Water Quality Objectives*

Details of Approach: Water quality in Kyogle Local Government Area was assessed against the *Water Quality and River Flow Interim Environmental Objectives* defined for the Richmond River Catchment. Each of these objectives is represented by a series of icons that is defined by a group of water quality indicators and associated criteria. These criteria are essentially derived from the ANZECC (1992) Water Quality Guidelines. An example of environmental value icons and their criteria is identified in **Appendix C**.

As an environmental objective is represented by a group of indicators, all indicator criteria must be met for that environmental value to be considered protected. Each environmental objective is also ranked on its level of compliance to all of the criteria associated with its indicator group. A four colour coded ranking for the environmental objective icons, is provided in **Table 8**. The ranking highlights the level of compliance associated with each environmental objective in the Kyogle area. Where insufficient information is currently available to assess criteria, the icons are presented in black and white.

Water Quality Audit - Key Points:

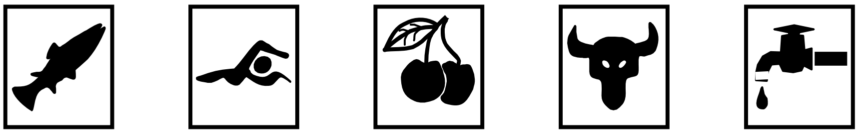
- Approach: Based on the *Water Quality and River Flow Interim Environmental Objectives*.
- Key Findings: Water quality deteriorates moving downstream;
  High turbidity, nutrient and water salinity levels;
  Point source impact of towns visible;
  Diffuse source impact of agriculture dominates.

Table 8: Ranking of Environmental Objectives.

Ranking	Lower Limit	Upper Limit	Icon Colour
Good	75%	100%	Green
Fair	50%	74%	Yellow
Poor	25%	49%	Orange
Very Poor	0%	24%	Red

Discussion: Data from each of the sites identified in **Section 2.2.1** were collated and analysed. Environmental values identified in the Interim Environmental Objectives applicable to the study area are presented in **Figure 17**.

Figure 17: Environmental Objectives for the Water Quality Audit.



Aquatic Ecosystem Protection | Primary Contact Recreation | Agricultural Irrigation | Agricultural Livestock | Drinking Water

The results of the audit for water quality data in the Kyogle area against the Interim Environmental Objectives are presented in **Figure 18**.

River water turbidity, nutrients, pH, faecal coliforms and salinity levels are the primary reasons for the poor water quality rankings within the Richmond subcatchment. These parameters are impacting on the suitability of the raw water source to be used for untreated town and agricultural supplies. Water quality deteriorates with distance downstream and as the level of agricultural activity and urban development increases.

Kyogle sewage treatment plant is the main point source of pollution in the system, discharging effluent downstream of Kyogle. However, the STP contributes only 1% and 2% of the annual nitrogen and phosphorus load respectively.

Agricultural activities are centred mainly within the ‘Kyogle Area’ where the deep structured red clay loams occur (the most fertile soils within the catchment). Nutrient inputs to these subcatchments from fertilisers are approximately 1,585 tonnes of nitrogen and 348 tonnes of phosphorus per year. There are also approximately 132,000 cattle and 25,000 pigs within the LGA. Agricultural practices can impact on water quality in relation to nutrient loads, turbidity and pathogens.

Forestry is also a major industry within the LGA with 270 km^2 of state forest within the study area. Forestry practices can impact on the water quality in relation to increased loads of sediments entering the as a consequence of land clearing, soil disturbance and road building related to forestry activities.

Within the LGA, there are presently 2,258 on-site sewage management systems, with 1,715 of these located in the study area. Urban centres and on-site sewage systems may contribute to reductions in water quality through increased loads of nutrients, suspended solids and pathogens.

Water quality parameters that do not meet environment objectives criteria are Total Phosphorus, Turbidity, Faecal Coliforms and Salinity

Outcomes of Audit: Water quality in the Richmond River catchment fails consistently for aquatic ecosystem protection, drinking water and primary recreation, with some additional failures for agricultural irrigation. These failures are generally based the following water quality parameters not meeting the environmental objects:

- Total Phosphorus;
- Turbidity;
- Faecal Coliforms; and
- Salinity.

3.2.2. Water Volume Assessment

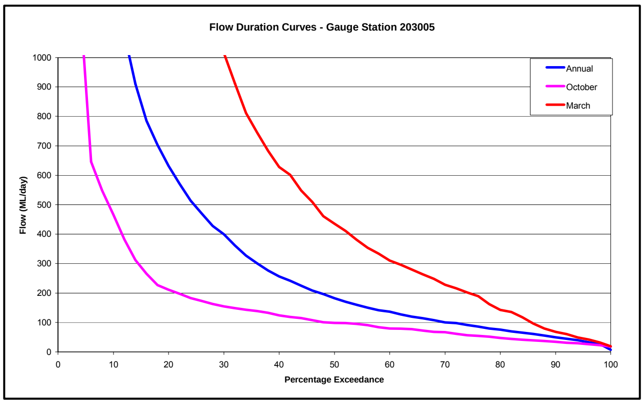
Water Volume Audit – Key Points:

- Approach: Statutory requirements of *Water Management Act*.
- Key Findings: Expect water sharing plan to be put into place;
  Expect environmental flow delivery requirements from Kyogle weir to be developed;
  Environmental flow delivery will result in the need to review weir secure yield; and
  Expect altered access conditions on town water and other licensed water extractions.

Details of Approach: Under the *Water Management Act 2000,* allocation of the State's water resources is currently being undertaken through the process of developing water-sharing plans. After the available resource was determined as part of the *Stressed Rivers* and *Aquifer Risk* assessment processes, these community developed plans are being put in place to allocate the resource between the environment, basic right holders, town water suppliers and licensed extractive users (in that order of priority). The water volume assessment for the Kyogle study area was undertaken by examining the local implementation of this new Act and its statutory planning instruments.

Richmond River is under hydrological stress in the period between August to November when flow is at its lowest

Discussion: A number of the subcatchments within the study area have been identified as being hydrologically stressed. These include both Roseberry Creek and the upper Richmond River subcatchment of Kyogle. Kyogle Area subcatchment is of particular concern, as it is the source of Kyogle's water supply, with the stress evidenced through the requirements for water restrictions for Kyogle town. Although flow in the river generally exceeds extractive requirements, for most of the year, demands exceed flows between the months of August to November. Climatic conditions in this period are generally dry and flow in the river is at its lowest. This is the period where restrictions are most likely. Roseberry Creek and The upper Richmond River at Kyogle have been identified as high priority for the development of a water-sharing plan and should be completed by 2006. The role of the water sharing plans is to ensure that water extractions are managed in a way to ensure that adequate water is made available to protect aquatic ecosystems and the remaining water is equitably divided between other users.



The River Flow Objectives identified for the Richmond River catchment are:

- Mimic natural drying in temporary waterways;
- Maintain natural flow variability;
- Maintain natural rates of change in water levels;
- Manage groundwater for ecosystems;
- Minimise effects of weirs and other structures.

The most important objective in relation to Kyogle council is the potential impacts of Kyogle weir. The structure presently does not provide fish passage and is not set up for the release of environmental flows.

Outcomes of Audit: The local water utility and other extractive users can expect that a water sharing plan for the Richmond River subcatchment will be in place by 2006. The allocation of water to the environment under this plan is likely to give rise to the need for Kyogle weir to deliver environmental flows, which will ultimately result in the need to review the secure yield. As the new licensing provisions of the act are put in place, town water and other licensed water extractors can expect altered access conditions. The Water Management Plan may also have further impacts on the current weir structure, requiring work to ensure any impacts of the weir are minimised.

3.3. Urban Area Audit

The Kyogle Urban Area Audit was undertaken in two parts. Firstly, a preliminary environmental assessment of existing urban area impacts on the water resource was undertaken. Secondly, the performance of the local water utility's existing water and sewerage infrastructure was assessed against Council's *Strategic Business Plan* and the performance of other utilities across the state.

3.3.1. Preliminary Operations Environmental Assessment

Details of Approach: A desktop environmental assessment of urban area impacts on water resources was undertaken. The focus of the assessment was on determining the relative impact of sewage effluent and urban stormwater as they are currently being managed.

Environmental Assessment of Operations – Key Points:

- Approach: Calculation of total nutrient loads from urban stormwater and sewage effluent discharge.
- Key Findings: Urban discharges have small impact on average annual nutrient loads in Richmond R at Kyogle.

  Impact of urban discharges at Kyogle increases significantly in dry weather.

Available data (see **Section 2.3.2**) on the quantity and quality of sewage effluent was utilised to determine estimates of the annual load of nutrients (nitrogen and phosphorus) discharged via sewage to the environment. The impact of sewage and stormwater discharges to the Richmond River was assessed against the water quality objectives for the Richmond River (see **Section 3.2.1**). Calculation details are presented in **Appendix D.**

Discussion: The calculated annual stormwater and sewage volumes and nutrient loads from urban areas are presented in **Table 9**. Sewage effluent form the Kyogle STP is discharged through a local dam (Vardy's Dam). The effluent receives some treatment via natural assimilation of nutrients in this process.

Table 9: Estimated Annual Stormwater & Sewage Volumes & Nutrient Loads.

Stormwater					
Urban Centre	Volume (ML/a)	TN Conc^n (mg/L)	TP Conc^n (mg/L)	TN Load (Tonnes)	TP Load (Tonnes)
Kyogle	5444	1.0	0.3	5.44	1.63
Sewage					
Urban Centre	Average Dry Weather Volume (ML/a)	TN Conc^n (mg/L)	TP Conc^n (mg/L)	TN Load (Tonnes)	TP Load (Tonnes)
Kyogle STP	237	16	5.5	3.8	1.30
Vardy's Dam#	237	4.3	4.2	1.0	1.0

Water quality in Vardy's Dam based on 13 samples provided by council.

As is clearly illustrated in **Figure 19 & 19** the contribution of Kyogle's sewage effluent to the annual average loads of total nitrogen and phosphorus in the Richmond River are minor under all but low flow conditions. Nutrient values used in these figures are for effluent leaving Kyogle STP, not Vardy's Dam.

Figure 18: Water Quality Audit of Richmond River Subcatchment.

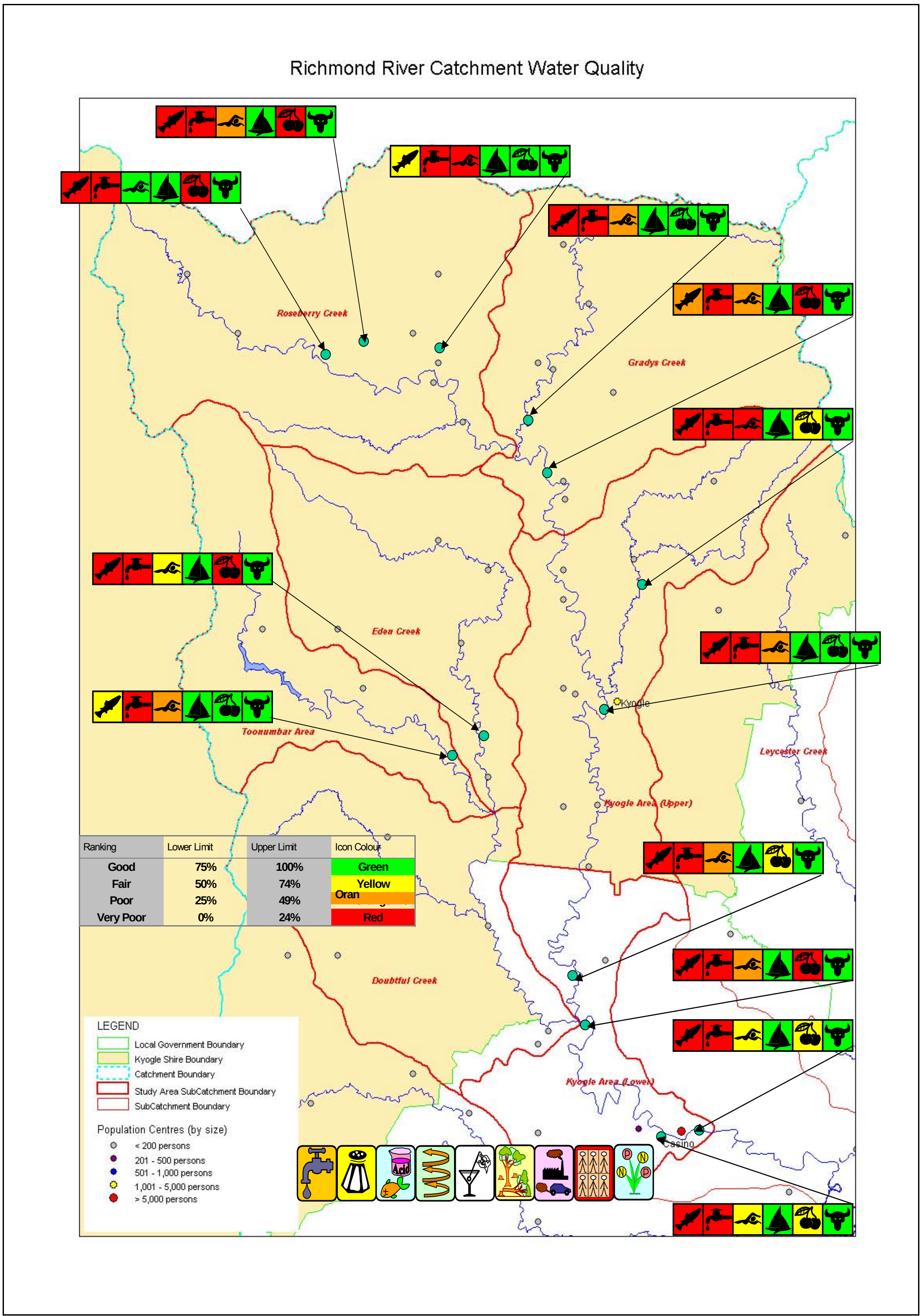
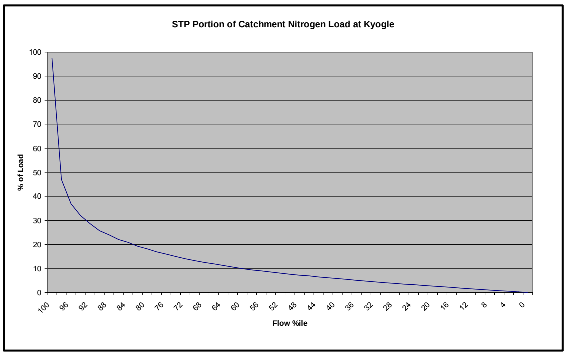


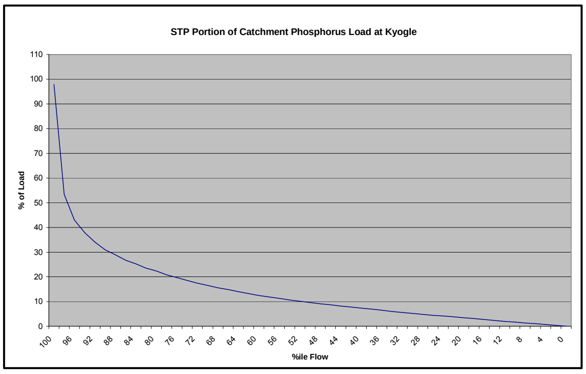
Figure 19: Total Nitrogen Sewage Loads for different flows at Kyogle.



Nutrient loads from the STP are more significant under low flows. Total nitrogen and total phosphorus loads from Kyogle sewage treatment plant represent <10% of the total load of these pollutants in the sytem at the 50%ile flow. However at flows less than the 80%ile flow the STP pollutant loads exceeds 20% of the total load of these pollutants in the river.

Nutrients from the Kyogle sewage treatment plant are impacting on water quality in the Richmond River during low flows

Figure 20: Total Phosphorus Sewage Loads for different flows at Kyogle.



Under extremely low flow, less than the 95%ile, the STP pollutant loads represents the dominant proportion of the pollutants in the system.

As urban stormwater loads of pollutants are similar to the STP and occur when flows in the system are high, stormwater loads will represent a small percentage of the total pollutant load.

3.3.2. Urban Services Performance Assessment

Details of Approach: An assessment of the performance of urban services was undertaken by comparing the performance of Kyogle's water supply and sewerage services against the *NSW Performance Comparisons*. Each year, local water utilities are required to submit water supply and sewerage performance data to the MEU for the development of a state-wide performance comparison document. Utilising the data in the report, a comparison can be made between the performance of Kyogle Council's utilities and that of other utilities of similar size as well as the state average.

Urban Services Performance Assessment – Key Points:

- Approach: Performance Comparisons
Strategic Business Plan Review
- Key Findings: Kyogle faces relatively high operating costs and receives a relatively large number of service complaints.

  Council's Strategic Business Plan does not have targets consistent with NSW Performance Comparison reporting.

  Existing targets are not well defined and in relation to customer service, are currently not

In order to help utilities better plan and operate their water and sewage businesses, utilities are required to develop a *Strategic Business Plan* (SBP). The implementation of this plan should also help the local water utility to manage the collection of the data they report to various agencies including the MEU, DSNR and EPA. By comparing the objectives and targets in Kyogle Council's SBP to the performance of Kyogle's urban water services, an assessment of progress towards these objectives can be made.

The following assessments were made on the basis of the 2000/01 *NSW Performance Comparisons*, and the current (developed in 1997) Kyogle Council *20 Years Strategic Business Plan for Water Supply and Sewerage Schemes*.

Detailed performance objectives and review details are given in **Appendix E**.

Discussion: A review of Kyogle Council's utilities performance, as reported in the *NSW Performance Comparisons* for 2000/01 highlighted the following:

- **Average annual residential water consumption** for Kyogle has varied dramatically over the past 3 years with 50kL variation between each year. However the average consumption over this periods is 225kL which is below the state average of 230 kL, and well below the average for towns of a similar size.

Water consumption in Kyogle has been extremely variable over past 4 years

- **Typical residential bills 2000/01** for water supply and sewerage have remained at approximately $650 per average assessment in NSW. Typical residential bills in Kyogle are approximately $708. This represents a 2% decrease over the past four years, but is still greater that the state average.
- **Microbiological results.** Of drinking water samples tested across the state in 2000/01, 96% contained no faecal coliforms, and microbiological compliance with the 1996 Australian Drinking Water Guidelines was 90-96% over the past 6 years. 100% of samples tested for Kyogle contained no faecal coliforms, and 97% of samples tested complied with the 1996 Guidelines for microbiological compliance, with the cause of the failures being total coliforms.

There has been a high number of service complaints

- **Water quality and service complaints** in Kyogle were 4 and 22 per 1000 connected properties respectively in 2000/01. Whilst quality complaints were well below the state average of 8, service complaints are very high.
- **Sewage odour and service complaints** in Kyogle were 4 and 14 per 1000 connected properties respectively. The number of odour and service complaints is comparable with a state average of 1 and 11 respectively.
- **Biochemical oxygen demand** in NSW STP's average 95% compliance with the EPA licence requirements. Kyogle reported a 95% compliance.

There has been a high number of reticulated sewage problems reported over the past 4 years

- **Sewer main chokes and collapses** and **overflows to the environment** – were 54 and 35 per 100 km of main respectively across the state. Kyogle has consistently performed poorly over the past 4 years, reporting sewage chokes and collapses of 101 per 100 km per year on average. 2000/01 was the first time council has reported overflows which also well exceeds the state average of 6.

Operating and management costs are steadily increasing

- **Operating (OMA) costs** for water supply and sewerage per connected property across the state were $200 and $225 respectively in 2000/01. In recent years Kyogle has faced increasing operating costs. Over the past four years water supply operating costs have increased from $188 to $218, whilst sewerage costs have increased from $199 to $245.
- **Management costs** for water supply and sewerage per connected property across the state were $80 and $75 respectively in 2000/01. Kyogle incurred management costs of $105 for water and $91 for sewerage in 2000/01, these costs have been increasing each year over the past 4 years.

Detail on Kyogle's performance in water supply and sewerage service delivery over the past four years are presented in **Appendix E**.

A review of Kyogle Council's SBP brought to light the following issues:

- The water supply scheme must meet regulations concerning environmental flows.
- There is a backlog of works that is yet to be completed, including upgrading to Occupational Health and Safety requirements

- Development of asset registers, including costs and condition needs to be implemented.
- Community consultation is perceived as an important part of a water supply and sewerage schemes development and operation.
- Increasing sewer loads causing overflow problems primarily due to stormwater inflow.

The Strategic Business Plan for Kyogle needs to be reviewed as a first step in identifying expected service delivery levels.

Outcomes of Audit:

The strategic business plan for Kyogle water supply and sewerage needs to be reviewed to ensure that performance targets are comparable to those in the performance comparisons report.

The operating environment may have also changed since the plan was put in place as there have been changes to the Water Management Act, Protection of the Environment Operations Act, and Local Government Act in recent years.

3.4. Summary of Audit Outcomes

Having undertaken individual assessments of the Catchment, the Water Resource and the Urban Area, it is important to draw together, and link where possible, the outcomes of those audit processes. By doing so, an integrated set of catchment, water resource and urban water service management issues can be developed. The audit outcomes can be identified as follows:

- The Richmond River between Kyogle and Casino has been identified as hydrologically stressed. The secure yield of the Kyogle weir is only 20 ML, which creates the need to implement more frequent water restriction.
- Water quality in the Richmond River is variable with high turbidity loads occurring during high flows. High turbidity is problematic for water treatment.
- At present the water quality in the Richmond River does not meet the environmental objectives for the following parameters: total phosphorus, turbidity, faecal coliforms and salinity. The township of Kyogle is contributing to 3 of the 4 parameters, total phosphorus, turbidity and faecal coliforms. The load from the town is small compared with the annual loads in the river, however the sewage treatment plant is providing a significant load of nutrient to the river during low flow periods.
- Other WMA obligations which council will need to address are the requirements for provision of environmental flows, for which the impact on the Kyogle weir will need to be examined. Water sharing plans for the Richmond River are likely to impact on the towns water supply. Catchment management blueprints have the potential to have requirements on the council to improve the management of land under their control, but also improve current water quality by contributing to improvements in land management upstream of the towns extraction point.

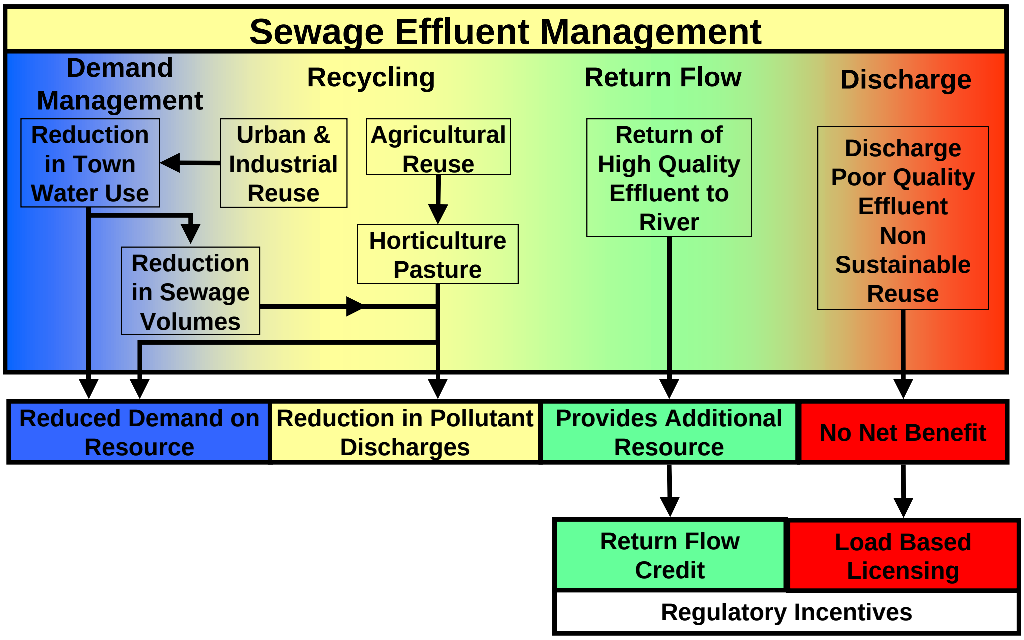
4. Kyogle – Analysis of Potential Actions

The audit of the **Kyogle system** has allowed those areas where the system is not performing as well as it could, in relation to water resource management and urban water service delivery, to be identified. The **IWCM Issues** identified by the audit are to be incorporated into the next phase in the planning process by:

- To identify actions that may improve system performance;
- To manage the identified issues while having regard to the various management objectives.

Having identified the driving causes and interrelationships between Kyogle's issues, it is possible to initiate a *potential* list of tools and actions by which these issues might be addressed. An outline of generic management tools is presented in **Figure 21**. Ultimately, the list of management options will be evaluated through the **balanced outcomes planning approach** (during the Phase two and following the completion of IWCM contept study), in conjunction with the local community.

Figure 21: Potential Water Resource Management Tools



In this section, a screening level analysis of the potential management options for Kyogle's identified issues is undertaken.

4.1. *Strategic Business Planning & Pricing*

The Possibilities: A strategic business plan should help the local water utility identify areas of its urban water supply and sewerage service business that need on-going operational planning, maintenance and improvement. By putting in place targets and strategies to achieve them, the local water utility will be able to continuously improve its business performance and the quality and efficiency of services. Utilising the state performance comparison parameters, the local water utility should be able to benchmark its performance against similar service providers throughout the state. Further, the business planning framework gives Kyogle's water utility the opportunity to consider introducing best-practice pricing to improve the efficiency of services.

Discussion: As Kyogle is presently looking at their infrastructure requirements for the next 30 years, it is important to ensure that the community objectives are satisfied.

While Kyogle presently has a strategic business plan, the current IWCM study provides a basis and opportunity for Council to reassess the adequacy of the plan in relation to the setting of community objectives and in definition of any new infrastructure requirements.

Recommendation: As council is presently in the process of planning their water cycle management requirements for the next 30 years it is essential they be aware of the communities expectations for service delivery standards. Review of the SBPs should involve a reassessment of the balance being achieved between Levels of Service, service charges and financial position. The review should be undertaken utilising the *Strategic Business Plans for Water Supply and Sewerage Schemes: Guidelines for Preparation.*

Kyogle should revisit its SBP as a part of any urban infrastructure upgrade to ensure any new works meet community expectations or service levels

The general structure of Kyogle's SBPs needs to be in accordance with the guidelines for preparing such plans. The following recommendations should be considered upon review of the SBP:

Operating Environment Review:

- Institutional & legislative: Update with respect to WMA 2000, POEO 1997, recent LGA 1993 amendments, Native Vegetation Conservation Act 1997, Crown Lands Act 1989 and Dams Safety Act 1978;
- Levels of Service: Review levels currently met against those set in last SBP, and indicate customer pressures for improvement. Also include detail on current pricing system including discussion of existing cross-subsidies;
- Corporate Policies: although such policies were not in place when previous SBPs were drafted, discussion on these policies and objectives should now be included.

Levels of Service:

- Consider the inclusion of Levels of Service consistent with MEU Performance Reporting, EPA & Health reporting obligations.

Asset Management & Finance:

- Existing SBP benchmarking parameters focus strongly on customer service provision. Inclusion of parameters that contemplate business characteristics, billing, financing, operating efficiency and pricing structure as per the Performance Reporting is recommended.

General:

- The deficiency of data collection and management systems has made it difficult to accurately assess the delivery of urban water services to customers. It is recommended that Council consider implementing a comprehensive data collection and management programme. This effort should take into account the significant resources Council has invested in improving their customer database.

  Triple bottom line accounting procedures have been introduced to the state wide performance reporting framework, which will seek to improve the understanding utilities have of their performance in terms of economic, social and environmental objectives. A review of Kyogle's utilities data collection and performance reporting at this point in time would allow Kyogle to be at the forefront of this process.

4.2. Water Supply Options

The Possibilities: Presently Kyogle is extracting it's water supply from the Richmond River at Kyogle, which is in the upper reaches of the Richmond River. Other sources of water include groundwater, rainwater harvesting and other surface water catchments. The use of these alternative sources may provide greater resource security to Kyogle, or reduce the cost of supplying water to the local community.

Analysis: The Kyogle area subcatchment has been identified as hydrologically stressed and has been identified as a priority area by the Northern Rivers Catchment Management Committee for establishing a water sharing plan by 2006. The Water

ntial water y upgrade d consider ve sources of water

Sharing Plan will ensure environmental flow requirements are established. This may impact on the security of the Kyogle water supply.

The Potential: A number of other potential sources have been identified and need to be further assessed in relation to their benefits and acceptability to the local community. These include:

1. Off-stream storage at Kyogle, which will increase the secure yield and reduce the dramatic changes in water quality which Kyogle presently experiences under high flow conditions.
2. Alternative surface water source from Iron Pot Creek. Iron Pot Creek is not as hydrologically stressed and the security of the water supply is high due to the regulated flow in the waterway from Toonumbar Dam in the upper parts of the catchment.
3. Receive treated water from Casino, which has been identified has having excess capacity.
4. Rainwater harvesting to increase reliability of main supply discussed further in section 4.4.

4.3. A Demand Management Programme

The Possibilities: Demand management simply means implementing initiatives designed to reduce the demand for (potable) water by consumers, and make better use of the water resource. Demand management programmes can include community driven initiatives such as the installation of more water efficient technologies (including showerheads, toilets, and washing machines), and education programmes to promote water conservation. Local water utilities can also take on demand management activities through the introduction of cost reflective pay-for-use pricing of water, and undertaking maintenance programmes to reduce leakage in distribution. Demand management can also involve the replacement of the use of potable water with the use of other water sources including recycled sewage or stormwater effluent, and rainwater harvesting.

The implementation of a demand management programme can have many benefits, including;

- Reduced town water consumption. This may result in reduced catchment water extraction and reduced hydrologic stress;
- Reduced treatment and transfer costs and a delay of capital works;
- The introduction of best-practice pricing. This removes cross-subsidies and may reduce residential bills;
- Reduced water consumption. This has flow-on effects in terms of reducing the volume of sewage to be treated;
- Use of rainwater tanks to reduce the volume of urban stormwater discharging to the environment; and
- Acknowledgement of the potential for use of treated effluent to substitute for potable water supply uses.

Analysis: Kyogle does not currently have a planned demand management programme in place, although the local water utility is to be commended for its efforts to raise community awareness about the need to save water. A preliminary analysis of the potential cost effectiveness of a number of typical demand management measures was carried out for Kyogle. The following opportunities for reducing water demand were considered in the analysis:

Utility Dependent Activities:

- Implementing a change in water pricing (introducing a two-part tariff);

- Utilising rainwater tanks to supplement non-potable outdoor use, washing machine and toilet flushing for all new development and retro-fitting a percentage of current customers; and
- Introducing a maintenance/upgrade programme to reduce water loss in the distribution system.

Community Dependent Activities:

- Undertaking an outdoor water use community education programme; and
- Installing water efficient shower roses and toilets in homes.

The identified opportunities were considered in isolation and also as a bundled programme. The analysis took into account that there will be some level of cross-interference between elements of a programme and hence the water savings from individual elements may be greater than those gained for an element when it is part of a programme. However, the net benefit from a structured programme will be greater than would be achieved from any single measure. The analysis also considered the impact of the natural uptake of more water efficient appliances into dwellings over time as technologies change (for instance, it is no longer possible to purchase a 12L per flush toilet).

Demand management has the potential to downsize any new urban water infrastructure

A detailed presentation of the demand management analysis is provided in **Appendix F**.

The Potential: The preliminary analysis demonstrated that a number of water conservation options have the potential to be cost effective for Kyogle. Table 10 shows the results of the analysis starting with the most cost effective measure.

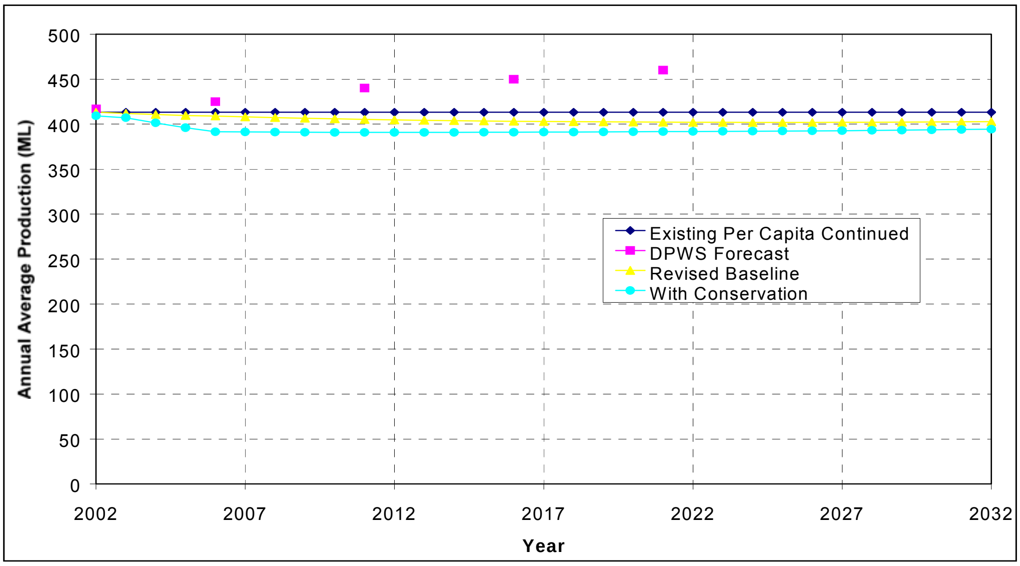
Table 10: Demand Management Options and their Cost Benefits on a Stand-Alone Basis.

Control Measure Name	Estimated Water Savings (ML/d):	Potential Cost Effectiveness
Real Price Increase 2003	0.003	Very High
UFW Measure Model	0.021	High
House Shower Retrofit	0.017	High
House Toilet Retrofit	0.020	Medium
Rainwater Tank Retrofit	0.047	Medium
External Use Education	0.012	Low

Given that the average daily water consumption for Kyogle's water users is approximately 1.5 ML/day, the water conservation options identified have the potential to save about 8% of the daily demand. This is illustrated in **Figure 22**, where each of these individual options has been incorporated into an overall programme, and annual water demands are clearly reduced.

What could not be determined as part of this assessment, but could be considered as part of a balanced outcomes planning process, is the willingness of a community to incur financial burdens beyond those which might be seen to be economically efficient for the sake of greater environmental benefits.

Figure 22: Impact of A Demand Management Programme on Annual Demands.



4.4. On-site Rainwater Harvesting

The Possibilities: On-site rainwater harvesting is usually undertaken for two purposes: to detain and slowly release the increased runoff caused by impervious urban areas (on-site detention); or to capture and utilise the water resource. Water sensitive urban design principles capture both of these purposes for harvesting rainwater, and promote technologies that maximise the value of water resources.

Rainwater tanks have the potential to reduce the demand on river extractions and decrease the amount of stormwater.

Much recent interest has been taken in the ability of rainwater tanks to not only capture water suitable for toilet flushing, clothes washing and outside garden usage, but as a consequence, reduce the volume of stormwater generated by urban developments. In addition to the above, rainwater tanks are a visual reminder of the need to conserve water and a valuable independent water supply if the main supply of potable water quality is compromised accidentally or deliberately.

Analysis: Rainwater tanks have been assessed for Kyogle based on daily climatic data over the past 100 years and for an average sized home. The analysis has considered the use of rainwater tanks to replace external water use and toilet flushing.

Preliminary modelling of a 10,000 L rainwater tank in Kyogle would reduce current annual water consumption by 88,000 L per year, based on an average annual rainfall year. This equates to 40 % of the average annual customer usage. It would also reduce the amount of runoff from the roof by approximately 60%. (Refer to Figure 23 for more detail)

Figure 23 Potential impact of Rainwater Tanks in Kyogle

ASSESSMENT OF RAINWATER TANKS - PER HOUSHOLD				File = KyogleTank+MainsDaily2-100yrs.xls		
IMPACT ON WATER MAINS SUPPLY AND ROOF STORMWATER RUNOFF						
Kyogle Rainwater Tank + Mains Supply (1889 to 2002)						
Roof Area (m2)	150	**OUTSIDE + TOILET**		Tank Size (L)	10,000	
First Flush Vol/ Storm (L)	20	Mains Topup Trigger Min Level (L)	600	Roof Runoff to Tank/Year (L)	148,970	
Wetting & Evap/Storm (L	0.5			Tank Overflow/Year (L)	61,079	41%
Roof Runoff Factor (%)	90			Rainwater Usage/Year (L)	87,891	59%
Tank Starting Volume (L)	1			Average Tank Volume (L)(%)	4,747	47%
Ann Av Outside Usage (L	182			No. of overflow Days/Year	26	
Av.Daily Toilet Usage (L/	126.8			Average Overflow Vol/Overflow Day	2,381	
				Max Day Overflow (113years) (L)	36,195	
No Tank Statistics				Days per Year Tank is Full	26	7%
Roof Runoff Days/Yr	119			NonTank Mains Usage per Year (L)	112,789	
				Mains Topup Usage per Year (L)	24,761	22%
Typical Water Cost ($/KL	0.5			**Mains Water Saving &**	**88.0**	
Future Water Cost ($/KL)	0.8			**Roof Stormwater Redn (KL/Yr)**		

The Potential: Rainwater could be harvested for a number of household uses such as toilet and all external use. These 2 uses equates to about 60% of the water used in the average home. This provides benefits in relation to reducing the size of the water utilities storage requirements and infrastructure (pipework and reservoirs). In addition it also reduce the amount of stormwater produced in the urban area. The installation of rainwater tanks in all new development and potential for retro-fitting present homes with tanks need to be considered. This assessment should consider the cost to the community in installing the tanks and the cost saving in relation to the sizing on storages, treatment works and related infrastructure. The opportunity for a customer rebate programme also needs to be assessed to ensure the cost saving are returned to the community.

4.5. Effluent Management Options

The Possibilities: Traditional effluent management has focussed on the disposal of wastewater. IWCM effluent management options basically seek to ensure that the value of all water resources is maximised by promoting the use of alternative water sources. For IWCM the most preferable management options would replace existing potable or extracted water sources with suitably treated effluent to provide for existing irrigation needs. Alternatively they could also return water to hydrologically stressed environments to meet environmental flow needs.

Analysis: A detailed report of this investigation is presented in **Appendix G**.

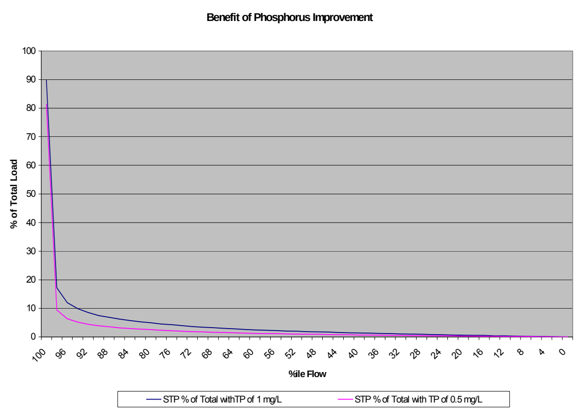
The results of the analysis are presented in **Table 11**.

Table 11: Results of Preliminary Effluent Reuse Modelling

Activity	Required Irrigation Area (ha)	Required Storage (ML)	Expected overflows during the modelled period
Lucerne	50-60	200	9

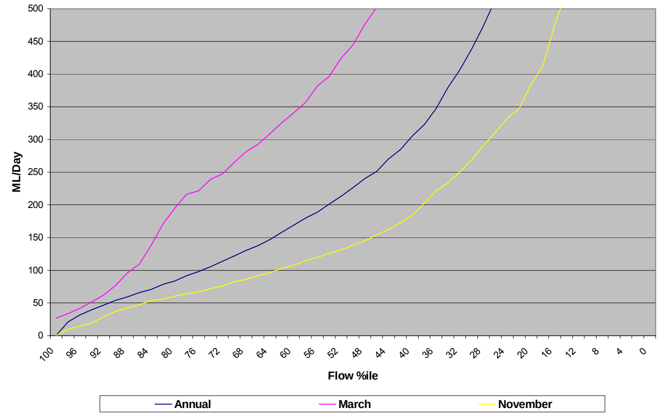
The Potential: The Richmond River within the *Kyogle Area* subcatchment has been identified as being hydrologically stressed. An embargo on any new licensed extractions has been issued for the river. As a consequence, sewage management options should focus on opportunities to present extractions.

Figure 24 Predicted Total Phosphorus Sewage Loads for different flows at Kyogle



The Kyogle sewage treatment plant has been identified as being a significant source of nutrients to the Richmond River at Kyogle during low flows and work is required to reduce the plant's impact. As total phosphorus has been identified as an issue for the Richmond River, the priority for Kyogle council should be to reduce the total phosphorus load leaving the plant. Figure 24 shows the percentage load from the plant for different flows, if the plant was upgraded to provide 1mg/L and 0.5 mg/L..

Figure 25 Flow duration curve for Richmond River at Kyogle.



The flow duration curve indicated the flow at which the Kyogle sewage effluent becomes a significant proportion of the nutrient load in the river. At the 92nd percentile flow (45 ML) the STP phosphorus load contributes 10% of the total load in the river.

One of two management options is preferable for Kyogle STP. They are:

1. Reuse of the sewage effluent on an adjacent agricultural property in place of river extraction. At present no property has been identified, but expressions of interest should be sought.
2. Improve the level of treatment at the Kyogle STP and return the effluent to the river. As the cost of any upgrade is a significant issue for council, there needs to be an assessment as to what level of improvement will provide the greatest cost benefit.

A range of treatment technologies may need to be assessed to deliver the required performance. A number of studies have previously been conducted in relation to improving the management of Kyogle's sewage effluent, these need to be reviewed as a part of stage 2 of the IWCM strategy. These include:

- Kyogle Effluent Re-Use - Site Receiving Capacity
- Augmentation of Kyogle STP Conceptual Design of Phosphorus Removal Facilities.
- Terrestrial Cropped Wetland for Kyogle.

- Kyogle Shire Water Supply and Sewerage Schemes – Safety Audits
- Kyogle Sewerage Augmentation – Feasibility Study
- Kyogle Sewerage System Proposal

As a priority, a number of further investigations need to be undertaken to ensure the best outcome can be achieved. These include:

1. Assessment of stormwater infiltration into the Kyogle sewerage system. The source of the infiltration needs to be investigated and repairs to sewage mains are needed to reduce infiltration. This will result in a significant improvement in plant capacity and reduce treatment costs and size of reuse areas and storages.
2. Investigation into any viable reuse options, where effluent could replace river water extractions. Interest will need to be sort from local landholders. This does not require assessment of the land, just whether there is local interest in the resource.

4.6. Review of the Draft Stormwater Management Plan

The Potential: Stormwater has traditionally been viewed as excess water that needs to be disposed of from urban areas to prevent water logging and flooding. By reviewing the draft stormwater management plan Council has developed in terms of IWCM, Council may be able to identify opportunities for utilising rainfall resources and reducing stormwater generation. Structural options for the mediation of stormwater impacts range from source controls such as on site detention, to transitionary measures such as sedimentation ponds and porous road gutters, to end of pipe solutions such as gross pollutant traps (GPTs). Management options range from public and school education programmes, through to street sweeping and use of water sensitive design in urban developments.

Analysis: Most structural stormwater management options represent a substantial capital cost and maintenance cost to the community. On-site detention, through use of rainwater tanks, provides the greatest potential for reducing environmental degradation from stormwater related impacts. Environmental degradation includes erosion, salinity impacts, habitat loss and increased turbidity and nutrient loads to local waterways. At present the estimated annual stormwater runoff from urban areas within Kyogle LGA is 5.4GL assuming an urban runoff rate of 35%. By comparison, catchment runoff for a similar sized area in the Richmond River catchment is expected to be approximately 18% which would generate 2.8 GL annually. Kyogle urban area consequently generates 2.6 GL of excess water.

The use of rainwater tanks for on-site detention has potential to reduce this excess volume. Reduction in required stormwater infrastructure development as a consequence of tank use has been estimated at 3%. Savings will also accrue from decreased requirements in water supply headworks (see demand management) and other supply infrastructure.

Stormwater management should be approached as a community issue, with people being encouraged and resourced to manage their concerns for stormwater. Sources of stormwater, the quality, impacts on the environment and options for capture and reuse should be explored along community lifestyle lines. In this way the community will own the issues and solutions.

The Potential: There exists a significant potential for management options to deal with stormwater in Kyogle. Table 12 identifies the priority stormwater management options (based on an initial assessment of the community's needs and the types of community to be serviced) for consideration by Kyogle Council.

Table 12: Potential Stormwater Management Options for Kyogle

Stormwater management plans need to consider the non engineered solutions to reduce contaminants at the source

Rank	Option
1	Include stormwater information in the council State of the Environment Report.
1	Promote the town as environmentally friendly and have that as one of council's goals.
1	Educate the public about catchment erosion and sediment control at problem areas – re-sealing rural roads, new development, construction areas, areas with loose surface soil (dirt car parks and industrial/commercial storage areas), council work areas, soil storage areas and landscaping areas. This will be linked to the Stormwater Education and Assessment (SEA) Project
1	Educate the public that stormwater discharges directly to the environment, NOT into the sewer system.
1	Promote the environmental work of school groups (Streamwatch and environmental studies).
1	Develop or expand community involvement in stormwater management.
2	Share expensive environmental equipment (water quality meters, street-sweeping machinery) with a wider group (other councils, schools).
2	Prepare cost estimates of both direct and indirect cost to the community and council of poor stormwater management, eg planning and investigation costs, construction costs, cleaning and disposal costs.
3	List all community, industrial, educational and government groups willing to support improved stormwater management (funding, promotion, advice, joint projects).
3	Keep records of sewer overflow sites regarding frequency, environmental impact and volume of overflows.
3	Adopt a locally focused stormwater / environmental slogan and integrate with Water Week, Save the Planet Day and Clean up Australia Day activities.
3	Run local environmental competitions with small prizes and awards; best environmental project, best photograph of poor stormwater practice (the idea of people with cameras looking for polluting practices will certainly get the attention of polluters), best environmentally friendly private, commercial or public garden.
3	Raise awareness of poor stormwater practice impact on the environment and reasons for community imposed penalties.
3	Inspect stormwater outlets into creeks and natural drains to assess erosion and pollutant discharge (litter, sediment).
3	Encourage rainwater tanks and suitable OSD (on site detention) for new and existing development.

4.7. Water Access

The Possibilities: The *Water Management Act 2000* has provided NSW with a way to better allocate and manage water resources. Given that the process of implementing the new Act is already under way, the local water utility could take a pro-active role in identifying how it can best meet its service delivery objectives and participate in the improved management of water resources. As part of the IWCM process, Council could investigate the potential access licence conditions it will pursue in the water sharing committee process.

Future urban water management needs to take into account environmental flow requirements

Discussion: In order to determine the environmental flow delivery requirements which will be placed on Kyogle Weir, Council could consider undertaking an environmental flow study in parallel with Phase two of the IWCM planning process. Not only should this hydrologic study look at the environmental flow constraints to be put in place, but the impact this will have on the secure yield of the weir.

In order to effectively undertake this work, the local water utility will need to improve its understanding of the nature of town demands annually, but also the variation in demand throughout any given year. In order to more accurately do this, the local water utility could consider developing better data management processes as part of the IWCM strategy process.

4.8. Other Potential Actions

Other potential actions to manage the water resource and urban water service delivery issues for Kyogle that have been identified by MEU are presented in **Table 13**.

Table 13: Kyogle Urban Issues, Contributing Activities and Actions to Address Issues.

ISSUE	CONTRIBUTING ACTIVITIES	POTENTIAL ACTIONS TO ADDRESS ISSUES
Salinity	Erosion leading to exposure of naturally saline subsoils	Liaise with Catchment Management Board. Liaise with DSNR (Salinity Action Plans). Develop and Implement Salinity Action Plans required by Blueprint.
Nutrients	Farming activities Urbanisation Reduced river flows	Improved land management through Blueprint process. Implement improved sewage treatment technologies. Amalgamation of existing sewage treatment infrastructure. Develop effluent re-use programmes. Audit management of on-site sewage systems to improve user knowledge. Sediment management strategies. Flow management strategies including environmental flow provision.
Faecal Coliforms	STPs Septic tank overflow	Include collection of this information in monitoring data set. Implementation of technologies such as microfiltration and UV disinfection. Audit management of on-site sewage systems to improve user knowledge. Development controls to help prevent runoff. Increased communication between water system managers. Stormwater capture and reuse. Sustainable land application. Leachate controls.
Dissolved Oxygen	Reduced flows Elevated algae, nutrients and organics Waste disposal	Include collection of this information in monitoring data set. Reduce nutrients entering waterways (see above). Reduce and improve management and disposal of stormwater. Reduce organic matter entering waterways e.g. via street sweeping, non-deciduous planting's etc Development approvals for solid waste disposal.
Turbidity	Catchment erosion Urban runoff	Liaise with Catchment Management Board Develop sediment control plans for construction and development sites. Implement strategies for managing and controlling bank erosion. Encourage best practice cultivation and land use through Blueprint. Development controls. Reduce and improve management and disposal of stormwater. Reduce organic matter entering waterways.
Environmental Release Requirements	Water Stress	Reduce town demand for water through demand side management. Utilise alternative water sources such as rainwater tanks Iron Pot Creek. High flow off stream storage to meet supply needs. Return treated effluent from STPs & detained stormwater to environment. Runoff detention with controlled low flow period releases.

Table 14: Potential IWCM Actions for Kyogle & Potential Assessment Criteria

Location	Catchment Issues	Water Issues	Urban Issues	No.	Integrated Option/s	Economic	Environmental	Social
Kyogle General	• Water Stress • Salinity • Soil Erosion • Deforestation • Greenhouse Gases • Monodiversity • Algal Blooms • Flooding	• Total Phosphorus • Turbidity • Faecal Coliforms • Salinity	• Limited secure yield of weir • Limited demand management programme • Aging water and sewerage infrastructure • Structural stormwater infrastructure • Inadequate flow monitoring data making urban water volume predictions inaccurate • Faecal contamination of raw water source • High turbidity in raw water under high flows impacting operation of treatment process • STP impact on river water quality under low flows		• EPIs for new development (exclude smaller areas with low growth if appropriate) to include rainwater tank (where feasible); • ASS development controls; • Dog faeces' management controls; • Sustainable energy and water DCPs on new development; • Investigation of rebate program to promote water efficiency; • Septic tank audit; inspection of rainwater tanks; • Improved land management through catchment blueprint process avenues; • Water management improved through water management planning process of WMA 2000.	1. Promotes full-cost reflective pricing: Options that involve pricing reform; water resource valuation; pricing signals to differentiate water being of fit for purpose, etc. 2. Promotes recognition of externalities: Options that internalise costs previously not incorporated in price: eg • Demand management may help avoid the environmental impacts of constructing and downsizing of infrastructure and reduction in energy use. • Effluent reuse may reduce water quality deterioration while providing an economic resource; ▪ Potential benefits of increased ecotourism. 3. Promotes user pays principles: Options that require the user of the resource to pay, rather than socialising the cost: eg matching the choice of option to the size and resources of a community, preventing cross-subsidy, promoting water efficiency. 4. Promotes transparency in costing: Options that compare technologies to common benchmarks, and cost water to reflect its source and potential uses. 5. Promotes equity in distribution of costs: Options that remove existing cross subsidies and consider inter and intra-generational equity.	1. Promotes efficient water use: Options that result in savings in water resources: low flow toilets and showers, water pricing, raised individual responsibility for part of the water supply (rainwater tanks). **2. *Promotes efficient resource use:*** *Options that result in savings in other resources: energy savings from reduced consumption (eg. transportation costs), land management practices.* 3. Protects environmental health: Options which protect water quality and river flows regimes: eg reduced extraction by town water supply due to demand management and the improved management of point source discharges. 4. Maintains resource integrity: Options that improve the quality and or quantity of available resource: eg result in the provision of water to other downstream users including the environment, improves land management. **5.** Protects public health: Options that help raise the standard of water quality (both water supply and recreational): eg treatment technologies and management options.	1. Complies with legislation and regulation: Options that promote the objectives and take into account the clauses of relevant legislation: eg WMA 2000, POEO Act 1997, NPWS Act 1975. 2. Considers policies and guidelines: Options that are consistent with policy and guidelines: eg COAG water reforms, groundwater quality protection policies, sewage management guidelines, SoE reporting obligations, Water Wise, Stormwater trust funding. 3. Promotes transparency in decision making: Options that promote balanced outcomes planning: eg pricing reforms leading to transparency in costing. 4. Improves urban water service levels: Options that improve the service level to the community. eg. improves security of town water supply, reduces service levels complaints, reduces odour complaints. **5.** Promotes community ownership: Options that require community acceptance and commitment: eg maintenance and operation of rainwater tank, education programs for water consumption and litter reduction.
Water supply:			Local Water Supply Upgrade	W1	Construction off-stream storage; Iron Pot Creek as alternative raw water source; Treated supply from Casino; Construction new treatment plant;	4. Promotes transparency in costing: 5. Promotes equity in distribution of costs:	3. Protects environmental health: 4. Maintains resource integrity: 5. Protects public health:	1. Complies with legislation and regulation: 4. Improves urban water service levels:
				W2	Demand Management: – Pricing restructure – Leakage reduction – Water efficient appliance retrofit – Rainwater tanks Improve water supply management: – Telemetry – Buffer zones around raw water source – Improved land management practices above raw water intake point Provide pump out of on-site systems	1. Promotes full-cost reflective pricing: **2. Promotes recognition of externalities:** 3. Promotes user pays principles: 4. Promotes transparency in costing: 5. Promotes equity in distribution of costs:	1. Promotes efficient water use: 2. Promotes efficient resource use: 3. Protects environmental health: 4. Maintains resource integrity: 5. Protects public health:	1. Complies with legislation and regulation: 2. Considers policies and guidelines: 3. Promotes transparency in decision making: 4. Improves urban water service levels: 5. Promotes community ownership:

Sewage:			Upgrade of Sewerage system	SW1	Construction of best management practice treatment works Construction stormwater detention ponds at STP Up-grade existing on-site sewage systems 100% reuse			
				SW2	Improve system management: – Improve flow and water quality knowledge – Optimise current treatment processes – Infiltration/exfiltration analysis – Provide additional technology to polish effluent (eg wetlands and UV disinfection) Opportunistic effluent reuse during low flow periods.	1. Promotes full-cost reflective pricing: **2. Promotes recognition of externalities:** 3. Promotes user pays principles: 4. Promotes transparency in costing: 5. Promotes equity in distribution of costs	1. Promotes efficient water use: 2. Promotes efficient resource use: 3. Protects environmental health: 4. Maintains resource integrity: 5. Protects public health:	1. Complies with legislation and regulation: 2. Considers policies and guidelines: 3. Promotes transparency in decision making: 4. Improves urban water service levels: 5. Promotes community ownership:
Stormwater:				ST1	Stormwater quality management - treatment – Stormwater detention basin – Stormwater treatment: GPT's,			

				ST2	Stormwater quality management – Preventative
					– Education, litter and behavioural changes
					– Assessment and management of sewage overflows
					– Assessment and management of sedimentation in mains
					– Manage stock access and animal faeces
					– Water sensitive urban design
					  – Rainwater tanks
					  – Pervious pavement
					  – Grass swales
					  – Stormwater reuse.			

5. Summary

Figure 26 summarises the key IWCM issues and objectives identified for the Richmond River Subcatchment within Kyogle LGA, and some of the potential options to manage them.

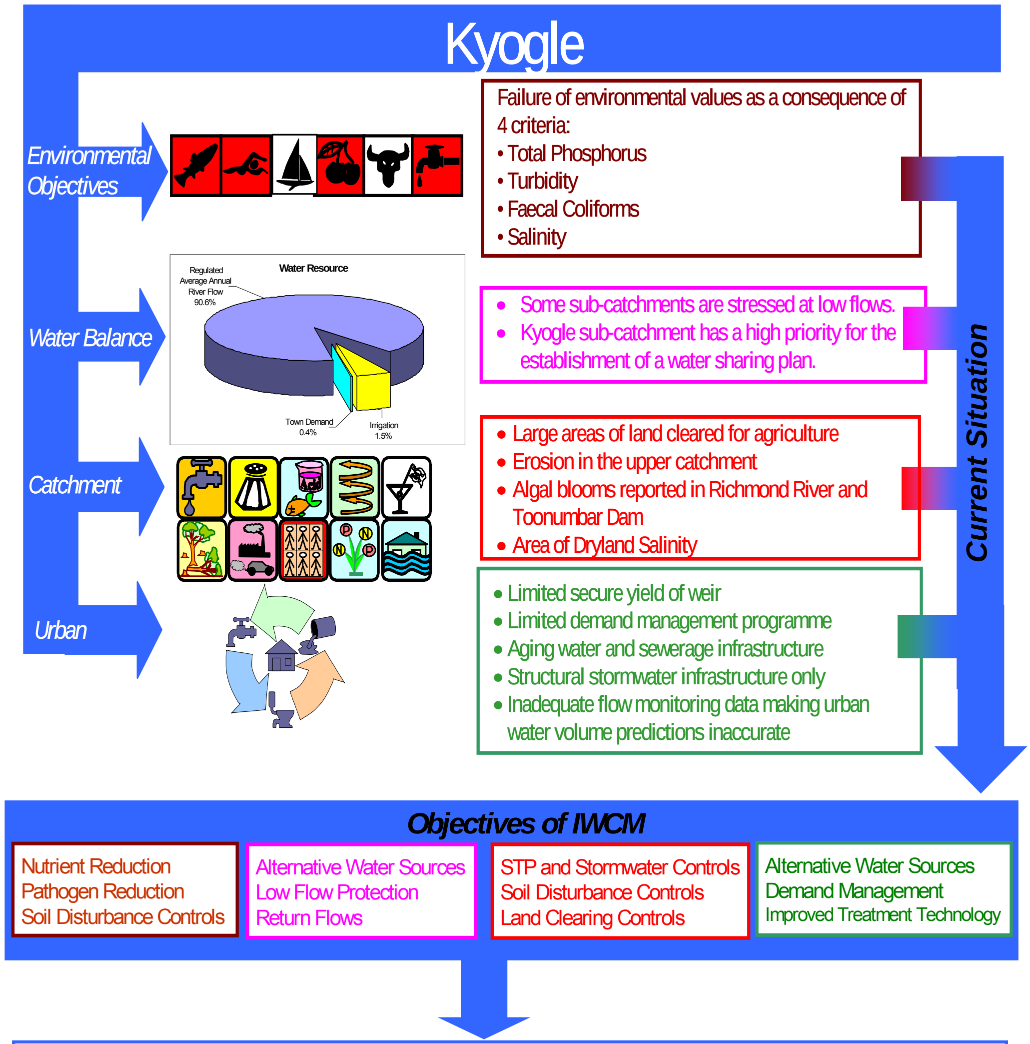
Many of the identified management options have the capacity to help mitigate or control more than one of the identified issues. For instance, improving the treatment of sewage and utilisation of recycled water will reduce nutrient loads to the catchment as well as reducing water stress. Conversely, activities which improve land management practices, will also result in improvements in the services delivered to urban areas. Because of this overlap, a shared responsibility will exist between local government, landholders, state agencies and commercial interests for achievement of many of the objectives and these responsibilities need to be taken into account when identifying and deciding on management options (**Table 14**).

Table 15: Management Objectives and Responsibilities for the Richmond River Catchment

Issue	Objectives	Responsibility
Water Stress	Returned flows Reduced extraction Water use efficiencies	Council, MEU, DSNR, EPA, Fisheries WMC, Irrigators, Council Irrigators, Council, Industry, WMC
Salinity	Improved land management	Landholders, CMB, Council, DSNR
Soil Erosion	Improved farm and land management	Landholders, CMB, Council, WMC, State Forests
Algal Blooms & Nutrients	Improved farm management Improved technology Improved Urban Management	Landholders, CMB Council, MEU, DSNR, EPA Council, MEU, EPA
Deforestation	Clearing limitation Replanting Improved farm management	Landholders, CMB, DSNR CMB, Landholders, Landcare groups, State Forests Landholders, CMB
Greenhouse Gases	Reduced greenhouse gases production Increase levels of replanting for carbon adsorption	Landholders, Council, industry, governments Landholders, Council, industry, State Forests
Monodiversity	Improved farm management – river riparian zones Improved treatment technology Improved Urban Management	Landholders, CMBLandcare Groups, WMC Council, MEU, EPA Council, MEU, EPA
Flooding	Improved stormwater management Improved urban planning	Council Council

As noted above (**Table 14**) only some of the management objectives fall within the partial or total responsibility of Council/ the local water utility. A number, while not the responsibility of Council, have consequences that will impact on Council's service delivery. These consequences include issues such as deforestation (clearing) and erosion, which ultimately impact on the level of treatment required by town water supplies. For these objectives and for others where Council will be a relatively minor contributor to an objective, Council will need to pursue a more active representation on the local Water Management Committee and Catchment Management Board. It may also be appropriate for Council to have direct dialogue with local landholders and act in a coordination role where the local Water Management Committee and Catchment Management Board agree to such a role.

Figure 26: Summary of Kyogle IWCM issues and objectives.



Potential Integrated Water Cycle Management Outcomes

- **Review Strategic Business Plan in line with NSW Performance Comparison reporting**
- **Adopt pro-active approach to the implementation of the Water Management Act 2000**
- **Development of a strategic demand management program**
- **STP upgrades to reduce nutrient and faecal loads to the environment**
- **Consider effluent and stormwater reuse to provide other water sources for town and irrigators**
- **Develop data collection and management programs for water demands, sewage flows, and water quality**
- **Improve surveillance, and implement auditing of on-site sewage systems, to improve user knowledge**
- **Explore further alternative water supply sources, including supply of water from Casino, off-stream storages and the purchase of competing licences**
- **Consider rainwater tanks to supplement potable water supply usage**
- **Infiltration/Exfiltration management plan**

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Appendix A – Audit

1.0 Landscape characteristics								
Ref.	Factor	Information required	Yes/ No?	Information				Location of available information*
1.1	What is the forested area of your catchment?	Give number and percentage cover of catchment		**Description (State Forests within LGA)**	**Area within LGA (sq. km)**	**% of the sub-catchment**		Stressed Rivers Report
				Roseberry Creek State Forest	87.78	22		
				Roseberry Creek Nation Park	135.66	34		
				Gradys Creek Nation Park	142.20	45		
				Kyogle Area State Forest	4.56	1		
				Kyogle Area Nation Park	18.24	4		
1.2	Is catchment area currently subject to clearing?	Yes/No, if yes provide percentage annual removal of existing cover		Yes				Stressed Rivers Reports
1.3	What is the upstream extent of your estuary (tidal and saline)?	Describe location, and where or how this may vary	No	**Location**	**Upstream Extent of Estuary (km)**			EPA WQO Maps
				N/A				
1.4	Are there wetlands in your catchment?	Yes/No, if yes describe location and percentage cover of catchment	No	**Location**	**Area (sq. km)**	**Area Within Catchment Within LGA (sq. km)**	**% Within LGA**	DLWC
				N/A				
1.5	What are the predominant vegetation types in your catchment?	Describe location and cover		**Type**	**Area (ha)**	**Cover (%)**		Supplementary SoE Report 1998/99
				Native Forests				
				Exotic and Native Grass				
				Crops				
1.6	Does your catchment have potential acid sulphate soils?	Yes/No, if yes describe location of soils and proportion of catchment affected	No	**Location**	**Proportion of Catchment Affected**			Refer to Potential acid sulphate soil maps
				N/A				
1.7	Are there acid impacts in your catchment waters?	Yes/No, if yes describe	No					River Management Committee
				N/A				
1.8	Are urban areas located in areas of potential acid soil?	Yes/No, if yes what proportion	No					Acid sulphate soil maps
				N/A				
1.9	Are there acid impacts in your urban areas?	Yes/No	No					Local Government
				N/A				
1.10	Does either dryland or irrigation salinity occur in your catchment?	Yes/No, if yes what type and where?		**Location**	**Type**			Catchment Management Board
				Roseberry Sub-catchment				
1.11	What is the area of catchment salt affected?	Give number		**Location**	**Area (ha)**			Catchment Management Board
1.12	Are urban areas salt affected?	Yes/No, if yes what proportion?		**Location**	**Proportion**			Local Government
				No				
1.13	Are there salinity targets for waterways?	Yes/No, if yes describe						DLWC
				No				
1.14	What are the predominant soil types in your catchment?	Describe						Supplementary SoE Report 1998/99
				Alluvial - sedimentary				
				Basalt				
1.15	Are there national parks (NP) in your catchment?	Yes/No, if yes describe		**Description**	**Area within LGA (sq. km)**	**Area within C, B, D & T catchments (sq. km)**	**Percentage within LGA**	NPWS
				Rosebery Creek National Park	135.66	34.00		
				Gradys Creek National Park	142.20	45.00		
				Kyogle Area National Park	18.24	4.00		
1.16	Are there protected areas (including water supply catchments and aquifers) in your catchment?	Yes/No, if yes describe		**Description**				Local Government River Management Committee
				Only National Parks				
1.17	What is the topography of your catchment?	Describe, provide GIS image if available						DLWC
				Refer to Map				
1.18	What is the average catchment runoff?	Give number		**Catchment**	**Catchment Runoff (%)**			DLWC
				Upper Richmond	0.28			

2.0	**Urban and Agriculture**								
Ref.	**Factor**	**Information required**	**Yes/ No?**	**Information**					**Reference**
2.1	Are there STPs in your catchment?	Yes/No, if yes give number, type and location		**Name**	**Location**	**Description**	**EP**		Local Government
				Kyogle		Trickling Filter	**3400.00**		
2.2	Is STP effluent quality monitored?	Yes/No, if yes describe effluent quality (mean values sufficient)		**Name**	**TN (mg/L)**	**TP (mg/L)**			DLWC Inspectors; OWRU Report
				Kyogle	21.8	7.50			
2.3	Is the STP discharge volume monitored?	Yes/No, if yes give total annual discharge and daily average dry weather discharge volumes		**Name**	**Annual Discharge (ML/year)**	**ADWF (ML/day)**	**Holidays? (ML/day)**		Local Government
				Kyogle		**0.65**			
2.4	Where are the STP discharge locations?	Describe location		**Name**	**Description**				
				Richmond River downstream of Kyogle					
2.5	What is the load of nutrients and any other monitored contaminants from the STP discharge?	Give number		**Name**	**Annual TN Load (tonnes)**	**Annual TP Load (tonnes)**			Local Government
				Kyogle	5.2	1.80			
2.6	What is the expected effluent flow (total and dry weather only) in 25 years time?	Give number based on pro-rata population increase/decrease estimates for this period	Based on 2020 predictions	**STP**	**Expected Total Effluent Flow (ML/year)**	**Expected Dry Weather Effluent Flow (ML/day)**			OWRU Report
				Presently no growth in Kyogle					
2.7	What is the expected load of nutrients and any other monitored contaminants in 25 years time?	Give number based on pro-rata population increase/decrease estimates for this period	Based on 2020 predictions	**STP**	**Annual TN Load (tonnes)**	**Annual TP Load (tonnes)**	**Increased TN Load (%)**	**Increased TP Load (%)**	DLWC Inspectors; OWRU Report
				as above					
2.8	Are there WTPs in your catchment?	Yes/No, if yes give number, type and location (if No, go to 2.11)		**Name**	**Type**				Local Government or water supply utility
				Kyogle	gravity sand filtration and pressure filtration				
2.9	Is WTP final water quality monitored?	Yes/No, if yes describe final water quality (mean values sufficient)							Local Government, Water supply utility, Dept of Health
				zero FC					
2.10	What is the WTP treatment capacity?	Give total annual capacity and peak daily capacity		**Total Annual Capacity (ML)**	**Peak Daily Capacity (ML)**				Local Government or water supply utility
				3 ML/day					
2.11	Size and location of aquaculture?	Give number, type and size		**Location**	**Type**	**Size (Approximate % of Foreshore Area)**			State Fisheries
				N/A					
2.12	What is the urban area in your catchment?	Describe boundaries and give size		**Name**	**Size (sq. km)**				Local Government
				407.6 Ha					
2.13	What types of agriculture are there in your catchment?	Describe (grazing, dairy, cropping, horticulture, intensive, etc.,)		**Description**	**Location**	**Area (ha)**			Local Government
				Beef					
				Dairy					
2.14	What is the location and area of this agriculture?	Describe location and size							Dept of Agriculture
				2512 Km2					
2.15	Is there modified or contaminated runoff or wastewater generated from this agriculture?	Yes/No, if yes estimate load of contaminants in runoff		**Contaminant Load (units?)**					Catchment Management Board River Management Committee
				N/A					

2.16	What is the catchment population?	Give number							Local Government, DUAP
				9716					
2.17	What is the urban population?	Give number		**Location (in LGA)**	**Population (1996 census)**				Local Government, DUAP
				3937					
2.18	What is the expected urban population growth?	Give number							DLWC Estimate
				0%					
2.19	What is the expected rural population growth?	Give number							DLWC Estimate
				1%					
2.20	How many on-site sewage systems operate in the catchment?	Give number and location							DLWC Estimate; OWRU Report
				2200					
2.21	What types of industry operate within the catchment?	Give number and describe		**Industry**	**Type of Waste**	**Pretreatment (if required)**	**Volume (kL/d)**	**Monitoring**	DLWC Trade Waste Register; Local Government
2.22	Where is this industry located?	Describe		See 2.21					Local Government
2.23	Is the volume of industry waste discharge monitored?	Yes/No, if yes give discharge volume, quality and contaminant load							Local Government
2.24	Where is industry wastewater discharged	Describe							Local Government
2.25	Is there wastewater/reclaimed water use in the catchment?	Yes/No, if yes describe and give volume and location of reuse		**Location**	**Volume**				OWRU Report
				No					
2.26	Is reuse water monitored?	Yes/No, if yes give discharge volume, quality and contaminant load		**Location**	**Wastewater Source**	**Parameters Monitored**			Local Government, DLWC, EPA, Dept of Health
				No					
2.27	What is the annual volume of urban stormwater generated by each urban centre?	Give number based on estimated urban runoff, urban area and local precipitation		**Urban Centre**	**Volume (ML)**	**TN (tonnes)**	**TP (tonnes)**		DLWC estimates
				Kyogle	5444.0	5.44	1.63		
2.28	Is stormwater quality monitored?	Yes/No, if yes give estimate of quality and contaminant load using previous volume estimate. If no use DLWC water quality estimate for rural towns and previous volume estimate	See 2.27						Local Government
				No					
2.29	What is the expected stormwater flow volume in 25 years time?	Give number based on pro-rata population increase/decrease estimates for this period	Based on answer to 2.18	**Urban Centre**	**Predicted Volume (ML)**	**Predicted TN (tonnes)**	**Predicted TP (tonnes)**		Local Government
				As above					
2.30	What is the expected stormwater load of nutrients and any other monitored contaminants in 25 years time?	Give number based on pro-rata population increase/decrease estimates for this period		See 2.29 above.					Local Government
				As above					
2.31 (new)	Are there landfills in your catchment?	Yes/No, give number and location		**Location**					
2.32 (new)	Are there contaminated sites in your catchment?	Yes/No, give number and location		**Location**					
2.33	What is the number of irrigators in the area	Give number		Roseberry Creek - 48 Graddys Creek - 36 Kyogle Area - 131					
2.34	What is the irrigation area	Give area in Ha		Roseberry Creek - 475 Graddys Creek - 422 Kyogle Area - 2121					

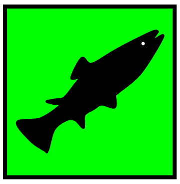
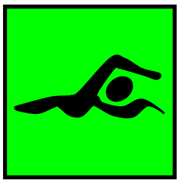
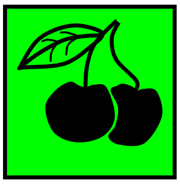
3.0 Climatic

Ref.	Factor	Infomation required	Yes/ No?	Infomation		Location of available infomation*
3.1	What is the mean annual rainfall for the catchment or catchment regions?	Give number/s		**Location**	**Mean Annual Rainfall (mm)**	Bureau of meteorology, DLWC
				Kyogle	1196	
3.2	What is the mean annual evaporation for the catchment or catchment regions?	Give number/s		**Location**	**Mean Annual Evaporation (mm)**	Bureau of meteorology, DLWC
				Kyogle	1200	

4.0 River and groundwater

Ref.	Factor	Information required	Yes/ No?	Information	Location of available information*
4.1	What is the water quality of dry weather river flows ?	Give mean values	Based on median values	Roseberry Creek - TP -0.07 TN - 0.3 Gradys Creek TP - 0.05 TN -0.25 Kyogle Area TP- 0.08 TN- 0.26	River Management Committee
4.2	What is the total annual dry weather discharge volume?	Give mean value		Roseberry Creek 2 GL Gradys Creek11.8 GL Kyogle Area 30.6 GL Toonumbar 1.8 GL Eden Creek 1.8 GL Doubtful Creek 5.3 GL	River Management Committee
4.3	What is the annual dry weather contaminant load?	Give numbers calculated from quality and volume above		Roseberry Creek -140 Kg/TP- 602 Kg/TN Gradys Creek - 739 Kg/TP 3695 Kg/TN Kyogle Area	Local Government
4.4	What is the water quality of wet weather river flows ?	Give mean values	Based on 90% values	Roseberry Creek - TP -0.2 TN -0.97 Gradys Creek TP -0.217 TN -0.58 Kyogle Area TP- 0.321 TN- 1.11	Local Government, DLWC, EPA
4.5	What is the wet weather mean annual discharge?	Give volume		Roseberry Creek - 75 GL	DLWC, River Management Committee
				Gradys Creek - 190 Gl	
				Kyogle Area - 539 GL	
				Toonumbar Area - 28 GL	
				Eden Creek - 74 GL	
				Doubtful Creek - 202 GL	
4.6	What is the annual wet weather contaminant load?	Give numbers calculated from quality and volume above			Local Government
4.7	Have environmental flow requirements been identified for catchment streams?	Yes/No, if yes have they been implemented or are they planned for future implementation		No	DLWC, River Management Committee
4.8	What is the location of all catchment dams?	Give number, location and storage type (on-stream or off-stream)		Onstream weir at Kyogle Onstream weir at casino Toonumbar Dam on Iron Pot Creek	DLWC, River Management Committee
4.9	What is the capacity of each catchment dam?	Give number for each dam		Kyogle 20 ML Casino 700 ML Toomumbar 11000 ML	DLWC, River Management Committee
4.10	What is the secure yield of each catchment dam?	Give number for each dam			DLWC, River Management Committee
4.11	What is the water quality in each dam?	Give mean values for each dam			DLWC, Dept of Health, EPA, Local Government
4.12	What is the location of all catchment weirs?	Give number, location and type			DLWC, River Management Committee
4.13	What is the capacity of all catchment weirs?	Give number for each weir			DLWC, Local Government
4.14	What is the secure yield of all catchment weirs?	Give number for each weir			DLWC, Local Government
4.15	What is the water quality in each weir?	Give mean values for each			DLWC, Dept of Health, EPA, Local Government
4.16	Are returned flows provided from, or intended to be provided from catchment storage/s or weirs?	Yes/No, if yes give volume for each storage or weir			DLWC, River Management Committee
4.17	Is the water quality of the return flows expected to be the same as the water quality in dam or weir?	Yes/No, if no give mean values			River Management Committee
4.18	What is the extent and nature of groundwater resources within the catchment?	Give estimated volume (for specific aquifers if available) and annual recharge (as a percentage of average annual rainfall)		Refer to Report	DLWC, River Management Committee
4.19	Does catchment include one or more estuary habitats?	Yes/No, if yes what is the ambient water quality of the estuary, provide mean values		No	Local Government
4.2	Are there licenced extractions in the catchment?	Yes/No, if yes give source, location, extraction purpose and volume		Yes	DLWC, Water Management Committee
4.21	Are there licenced town water extractions in the catchment?	Yes/No, if yes give source, location and volume		Yes	DLWC, Water Management Committee
4.22	What is the projected town water demand for the next 25 years?	Give number based on current population usage		Refer to Report	Local Government

Appendix B – Environmental Values and Criteria for Richmond River Catchment

Environmental Value	Symbol	Criteria
Aquatic Ecosystem Protection		Total Phosphorus (TP) <0.05mg/L Total Nitrogen (TN) <0.75mg/L Dissolved Oxygen >6.0mg/L (or > 80% sat.) pH 6.5-9.0 Salinity < 1 500 µS/cm Turbidity 5-20 NTU, with <5 NTU in Upper Richmond River subcatchments
Primary Contact Recreation		Faecal Coliforms < 150 cfu/100mL Enterococci < 35 eu/100mL Algae & blue green algae <15 000 cells/ml pH 5.0-9.0 Turbidity <6 NTU
Secondary Contact Recreation		Faecal Coliforms < 1 000 cfu/100mL Enterococci < 230 eu/100mL Algae & blue green algae < 15 000 cells/ml
Edible Seafood - Shellfish		Faecal Coliforms < 14 cfu/100mL
Agriculture - Irrigation		Faecal Coliforms < 1 000 cfu/100mL Chloride < 100mg/L pH 4.5-9.0 Salinity <280 µS/cm
Agriculture - Livestock		Faecal Coliforms < 1 000 cfu/100mL Calcium < 1 000 mg/L Sulphate < 1 000 mg/L Chloride < 1 600 mg/L pH 6.5-9.0 Algae & blue green algae < 10 000 cells/ml
Drinking Water – Clarification and Disinfection		Faecal Coliforms 0 cfu/100mL Salinity <1 500 µS/cm Dissolved Oxygen >6.5 mg/L (>80% sat.) pH 6.5-8.5

Appendix C – Performance Comparison & Strategic Business Plan Audit

Appendix includes:

- Strategic Business Plan Audit
- Summary Report of Performance Comparisons for Kyogle Local Water Utility

Kyogle Council — TBL Water Supply Performance — 2000/01

Water is drawn from the Clarence River to supply Kyogle, Bonalbo and Woodenbong. Council has 1 dam with a total storage capacity of 45 ML. The Kyogle system comprises 1 gravity and pressure water treatment works (3 ML/d), 5 service reservoirs (6.4 ML), 3 pumping stations (8.1 ML/d), 1 weir (20 ML), 5 ML/d delivery capacity into the reticulation, 23 km of trunk mains and 42 km of reticulation. 82% of the water supply is fully treated and the remainder is a disinfected non-potable supply for outdoor uses. The number of microbiological test samples was 150 and the number of physical/chemical samples was 1. There was 100% compliance with faecal coliform water quality, 100% compliance with total coliform quality and 100% compliance with physical/chemical quality. There were no failures of the chlorination system. The treatment system failed to operate on 1 day The current replacement cost of system assets was $12M ($6,800/assessment), cash and investments were $1.3M, debt was $0.1M and turnover was $0.7M (excluding capital works grants.)

Business Planning

Strategic Business Plan (SBP)	*Year Prepared*	1995/96	*Year Updated:*	1999/00	*Is Further Development Required[4]?*	YES
Financial Sustainability of Business	*Demonstrated?*	NO	*Year Updated:*	1999/00	*Is Further Development Required[4]?*	YES

Triple Bottom Line (TBL) Performance Indicators

		No.	Indicator	Council Result	Ranking[1] 801 to 2,000 Properties	Ranking[2] All Councils	Statewide Median[3]
UTILITY CHARACTERISTICS		1	***Population Served:*** 3,700 (0.95 connected properties per assessment)				
		2	***Number of Assessments*** 1,700 ***Number of Connected Properties*** 1,620				
		3	***Residential Assessments*** (% of total)	88		5	92
		4	***New Residential Dwellings Connected to Water Supply*** (%)	0.2	5	5	1.0
		5	***Properties Served per km*** (properties/km of main)	25		3	33
		6	***Rainfall*** (% of average annual rainfall)				100
		7	***Annual Total Consumption*** (at Master Meters - ML)	650		4	7,500
		8	***Peak Week to Average Consumption*** (%)	145		2	145
		9	***Renewals Expenditure*** (% of current replacement cost of system assets)	0.0		2	0.0
		10	***Employees*** (employees/1000 properties)	2.5	4	4	1.3
		11	***Employees Undergoing 2 or more Days of Training*** (number of employees)				
SOCIAL	Charges/Bills	12	***Description of Residential[5] Tariff Structure 2001/02:*** *Two Part ; Independent of Land Value*				
		13	***Residential Water Usage Charge 2001/02[5]*** (c/kL) *All Usage*	63		3	65
		14	***Residential Access Charge 2001/02*** ($/assessment)	242		3	195
		15	***Typical Residential Bill 2001/02*** ($/assessment)	395		4	310
		16	***Typical Developer Charge 2001/02*** ($/equivalent tenement)	1,000		4	2,300
		17	***Average Residential Bill 2000/01*** ($/connected property)	311	1	2	325
		18	***Bill for Residential Customer using 200kL/a (2000/01)*** ($/assessment)	314	2	3	255
		19	***Real increase over previous year's Bill for Residential Customer using 200kL/a*** (%)	0.3	5	5	-3.0
	Health	20	***Urban Population without Reticulated Water Supply*** (%)	16.1	5	5	0.7
		21	***Physical and Chemical Water Quality Compliance*** (%) *Water Quality Compliance on basis of*	100	1	1	100
		22	***Microbiological Water Quality Compliance*** (%) *1996 NHMRC/ARMCANZ Guidelines*	100	1	1	99
		23	***Category 1 Public Health incidents - Minor*** (per 1000 properties)				0
		24	***Category 2 Public Health incidents - Limited Effects*** (per 1000 properties)				0.0
		25	***Category 3 Public Health incidents - Major*** (per 1000 properties)				0.0
		26	***Capital Expenditure on Improving Public Health Performance*** ($ per property)				3
	Levels of Service	27	***Water Quality Complaints*** (per 1000 properties)	4	3	3	8
		28	***Water Service Complaints*** (per 1000 properties)	22	4	4	9
		29	***Customer Interruption Frequency*** (per 1000 properties)	25	4	4	20
		30	***Average customer outage time*** (min)	3	3	4	2
		31	***Number of Main breaks*** (per 100km)	14	3	2	18
		32	***Drought Water Restrictions*** (% of time)	0	1	1	0
		33	***Total Days Lost*** (%)	4.2	5	5	2.5
ENVIRONMENTAL	Natural Resource Management	34	***Average Annual Residential Consumption*** (kL/property, potable)	243	3	3	230
		35	***Unaccounted for water*** (including system water loss) (%)	31		5	10
		36	***Energy Consumption*** (kWh/ML)	341		2	500
		37	***Energy Consumption*** (kWh/property)	110		2	400
		38	***Renewable Energy Consumption*** (kWh/property)				
		39	***% Progress towards ISO 14001 Certification*** (100% is certified)				0
		40	***Category 1 Environmental incidents - Minor*** (per 1000 properties)				0
		41	***Category 2 Environmental incidents - Limited Effects*** (per 1000 properties)				0.0
		42	***Category 3 Environmental incidents - Major*** (per 1000 properties)				0.0
		43	***Capital Expenditure on Improving Environmental Performance*** ($ per property)				0
ECONOMIC	Financial	44	***Revenue from Usage Charges*** (% of total)	31		2	35
		45	***Revenue from Access Charges*** (% of total)	55		3	35
		46	***Revenue from Other*** (% of total)	14		3	20
		47	***Economic Real Rate of Return*** (%)	-0.9	1	5	2.6
		48	***Debt to Equity*** (%)	1	1	4	3
		49	***Interest Cover*** (%)				520
	Efficiency	50	***Operating Cost (OMA) per 100km of main*** ($'000)	542	3	3	680
		51	***Operating Cost (OMA) per property[6]*** ($/property)	218	2	2	200
		52	***Operating Cost (OMA) per kL*** (c/kL)	54	3	3	59
		53	***Management Cost*** ($/property)	105	5	4	80
		54	***Treatment Cost*** ($/property)	27	1	2	30
		55	***Pumping Cost*** ($/property)	14	1	2	20
		56	***Energy Cost*** ($/property)	9	1	1	15
		57	***Water Main Cost*** ($/property)	61	4	4	40

Notes:

1. *Ranking for each performance indicator is based on dividing the results for councils in the 801 to 2,000 connected properties group into 5 equal divisions of 20%, ie:*
   . a ranking of 1 indicates the Council is in the top 20% of Councils; a ranking of 5 indicates the Council is in the bottom 20% of Councils.
2. *Ranking (1 to 5) for all councils.*
3. *The Statewide Median is on a percentage of connected properties basis as indicated in Tables 1 and 3 of the 2000/01 NSW Performance Comparisons Report.*
4. *Annual review of the key projections and actions in Council's SBP are required, together with annual updating of Council's financial plan. The Business Plan should be updated after 3 years.*
5. *Non-residential Tariff: Uniform Access Charge ($242); Two Part Tariff: All usage 63 c/kL.*
   Water consumption by non-residential customers was 25% of potable water consumption excluding unaccounted-for-water.
   Revenue from non-residential customers was 28% of annual rates and charges, including water sales.
6. *The operating cost (OMA)/property was $218.The components of operating cost/property were: management ($105), operation ($32), maintenance ($72), energy ($9) and chemical ($1).*

Kyogle Council - TBL Water Supply Performance - 2000/01

(Results shown for 7 years together with 2000/01 Statewide Median and Top 20%)

1 *Costs are in Jan 2001$.*
2 *Microbiological water quality compliance for 1998/99 to 2000/01 was on the basis of the 1996 NHMRC/ARMCANZ Australian Drinking Water Guidelines. Compliance prior to 1998/99 was on the basis of the 1987 NHMRC/AWRC Guidelines.*

LEGEND
2000/01 State Median
2000/01 Top 20%

Kyogle Council — TBL Sewerage Performance — 2000/01

The area sewered is 552 ha, serving Kyogle, Bonalbo and Woodenbong. Council has 3 sewage treatment works providing secondary treatment. The system comprises 4,100 EP treatment capacity (comprising 2 pasveer channel and ponds and 1 trickling filter and ponds), 7 pumping stations (9.1 ML/d), 3 km of rising mains, 34 km of reticulation, and 1 river and 2 land discharges. The total number of sampling days at the treatment works was 46. There were no major malfunctions of the treatment processes. Peak wet weather flow was 66 L/s and average dry weather flow was 5 L/s. The current replacement cost of system assets was $12M ($7,600/assessment), cash and investments were $0.8M, debt was $0.5M and turnover was $0.6M (excluding capital works grants).

Business Planning

Strategic Business Plan (SBP)	*Year Prepared* 1995/96	*Year Updated:*	1999/00	*Is Further Development Required[4]?*	YES
Financial Sustainability of Business	*Demonstrated?* NO	*Year Updated:*	1999/00	*Is Further Development Required[4]?*	YES

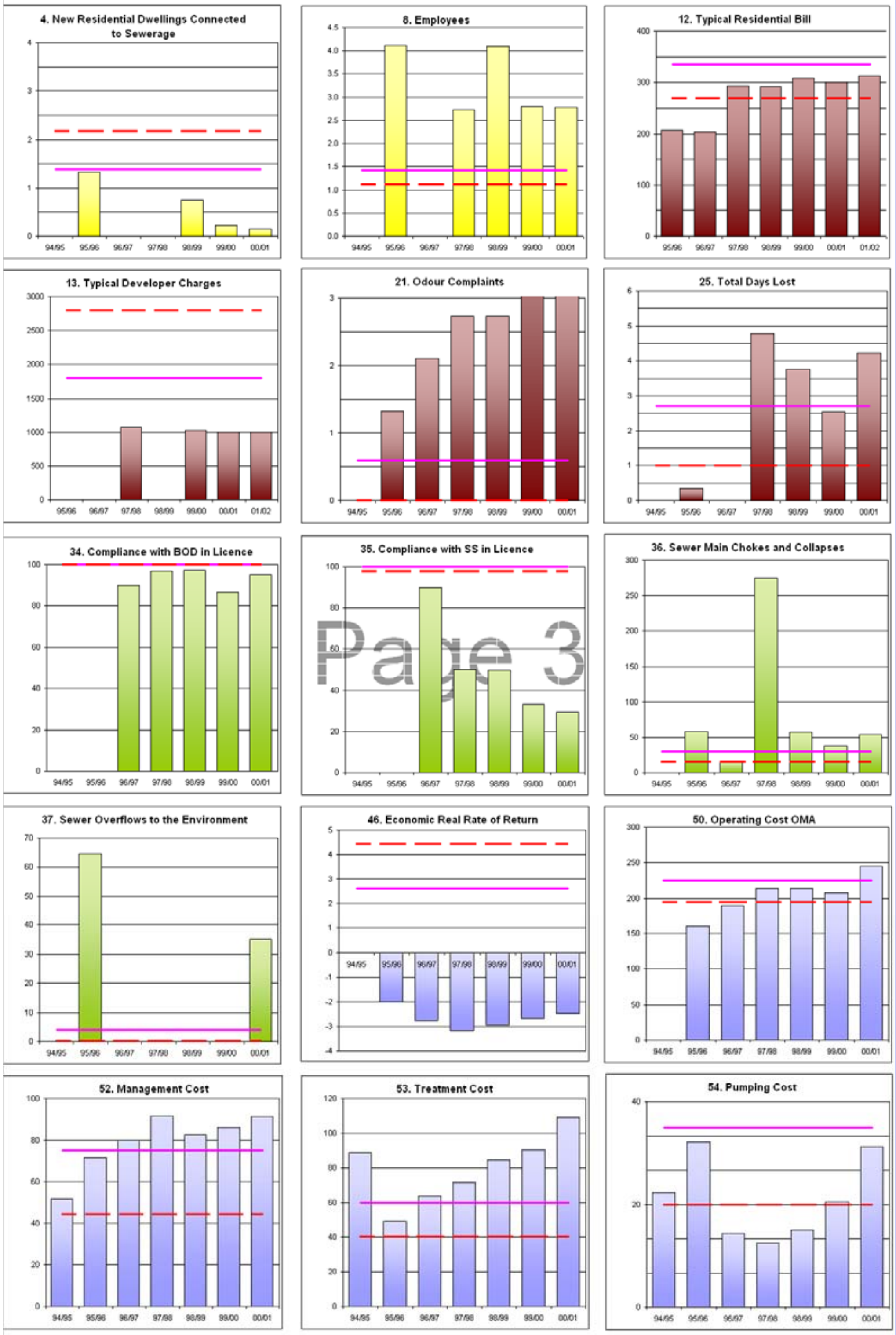
Triple Bottom Line (TBL) Performance Indicators

Category	Group	No.	Indicator	Council Result	Ranking[1] 801 to 2,000 Properties	Ranking[2] All Councils	Statewide Median[3]
UTILITY CHARACTERISTICS		1	***Population Served:*** 3,600 (0.95 connected properties per assessment)				
		2	***Number of Assessments:*** 1,600 ***Number of Connected Properties:*** 1,520				
		3	***Residential Assessments*** (% of total)	92		5	92
		4	***New Residential Dwellings Connected to Sewerage*** (%)	0.1	1	5	1.4
		5	***Properties Served per km of Main***	40		2	40
		6	***Volume of Sewage Collected*** (ML)	252		5	3,700
		7	***Renewals Expenditure*** (% of current replacement cost of system assets)	0.0		1	0.0
		8	***Employees*** (per 1000 properties)	2.8	5	5	1.4
		9	***Employees Undergoing 2 or more Days of Training*** (%)				
SOCIAL	Charges/Bills	10	***Description of Residential[5] Tariff Structure:*** *Access Charge/property with 126 c/kL Usage Charge (discharge factor = 40%), Independent of Land Value*				
		11	***Residential Access Charge 2001/02[5]*** ($/assessment)	242		2	345
		12	***Typical Residential Bill 2001/02*** ($/assessment)	313		4	335
		13	***Typical Developer Charge 2001/02*** ($/equivalent tenement)	1,000		5	1,800
		14	***Average Residential Bill 2000/01*** ($/connected property)	201	2	1	335
		15	***Real Increase over Previous Year's Average Residential Bill*** (%)	7.5	4	5	-1.7
	Health	16	***Urban Properties without Reticulated Sewerage Service*** (%)	13.1	4	5	2.7
		17	***Category 1 Public Health Incidents - Minor*** (per 1000 properties)				0
		18	***Category 2 Public Health Incidents - Limited Effects*** (per 1000 properties)				0.0
		19	***Category 3 Public Health Incidents - Major*** (per 1000 properties)				0.0
		20	***Capital Expenditure on Improving Public Health*** ($/property)				0
	Levels of Service	21	***Odour Complaints*** (per 1000 properties)	4.1	5	5	0.6
		22	***Service Complaints*** (per 1000 properties)	14	3	3	11
		23	***Customer Interruption Frequency*** (per 1000 properties)	0	1	1	2
		24	***Average Customer Outage Time*** (min)				1
		25	***Total Days Lost*** (%)	4.2	5	5	2.7
ENVIRONMENTAL	Natural Resource Management	26	***Volume of Sewage Treated per property*** (kL/a)	170	1	1	260
		27	***Reclaimed Water*** (% of effluent reclaimed)	14	1	3	1
		28	***Biosolids Reuse*** (%)				80
		29	***Treated Sewage*** (% of sewage collected)	100			
		30	***Energy Consumption*** (kWh/ML)	307		2	500
		31	***Energy Consumption*** (kWh/property)	52		2	130
		32	***Renewable Energy Consumption*** (kWh/property)				0
		33	***90 Percentile Licence Limits for Effluent Discharge:*** *BOD 20 mg/L; SS 30 mg/L*				
		34	***Compliance with BOD in Licence*** (%)	95	1	5	100
		35	***Compliance with SS in Licence*** (%)	29	5	5	98
		36	***Sewer Main Chokes and Collapses*** (per 100 km of main)	54	4	5	30
		37	***Sewer Overflows to the Environment*** (per 100 km of main)	35	5	5	4
		38	***% Progress towards ISO 14001 Certification*** (100% is certified)				0
		39	***Category 1 Environmental Incidents - Minor*** (per 1000 properties)				0
		40	***Category 2 Environmental Incidents - Limited Effects*** (per 1000 properties)				0.0
		41	***Category 3 Environmental Incidents - Major*** (per 1000 properties)				0.0
		42	***Capital Expenditure on Improving Environmental Performance*** ($/property)				0
ECONOMIC	Financial	43	***Revenue from Access Charges*** (% of total)	59		5	75
		44	***Revenue from Trade Waste Charges*** (% of total)	0.0		2	0.4
		45	***Revenue from Other*** (% of total)	41		1	25
		46	***Economic Real Rate of Return*** (%)	-2.5	1	5	2.6
		47	***Debt to Equity*** (%)	9	1	2	9
		48	***Interest Cover*** (%)				530
	Efficiency	49	***Operating Cost (OMA) per 100 km of Main*** ($'000)	981	5	5	900
		50	***Operating Cost (OMA) per property*** ($/property)	245	4	5	225
		51	***Operating Cost (OMA) per kL*** (c/kL)	144	5	5	82
		52	***Management Cost*** ($/property)	91	4	5	75
		53	***Treatment Cost*** ($/property)	109	4	5	60
		54	***Pumping Cost*** ($/property)	31	3	3	35
		55	***Energy Cost*** ($/property)	7		4	8
		56	***Sewer Main Operation & Maintenance Cost*** ($/property)	14	3	2	27

Notes: 1 *Ranking for each performance indicator is based on dividing the results for councils in the 801 to 2,000 connected properties group into 5 equal divisions of 20%, ie: a ranking of 1 indicates the Council is in the top 20% of Councils; a ranking of 5 indicates the Council is in the bottom 20% of Councils.*
2 *Ranking (1 to 5) for all councils.*
3 *The Statewide Median is on a percentage of connected properties basis as indicated in Tables 2 and 3 of the 2000/01 NSW Performance Comparisons Report.*
4 *Annual review of the key projections and actions in Council's Business Plan are required, together with annual updating of Council's Financial Plan. The business plan should be updated after 3 years.*
5 *Non-residential: Uniform Access Charge($242); Usage charge - 126c/kL (discharge factor = 40%).*
6 *Trade waste and non-residential rates and charges provided 42% of the annual rates and charges revenue, including usage and trade waste charges.*
7 *The operating cost (OMA)/property was $245 The components of operating cost/property were: management ($91), operation ($112), maintenance ($24), energy ($11) and chemical ($7).*

Kyogle Council - TBL Sewerage Performance - 2000/01

(Results shown for 7 years together with 2000/01 Statewide Median and Top 20%)



Note: Costs are in Jan 2001$.

LEGEND
2000/01 State Median
2000/01 Top 20%

Appendix F – Demand Management Options

Demand Forecasts and Preliminary Assessment of Cost Effectiveness of Demand Management Options

Introduction

Goal of Analysis

The purpose of this component of the Integrated Water Cycle Management Strategy is to:

- Determine preliminary water demand forecasts for Kyogle using an "end-use" forecasting methodology; and
- Use these forecasts as a basis for assessing the cost-effectiveness of demand management options through cost benefit analysis.

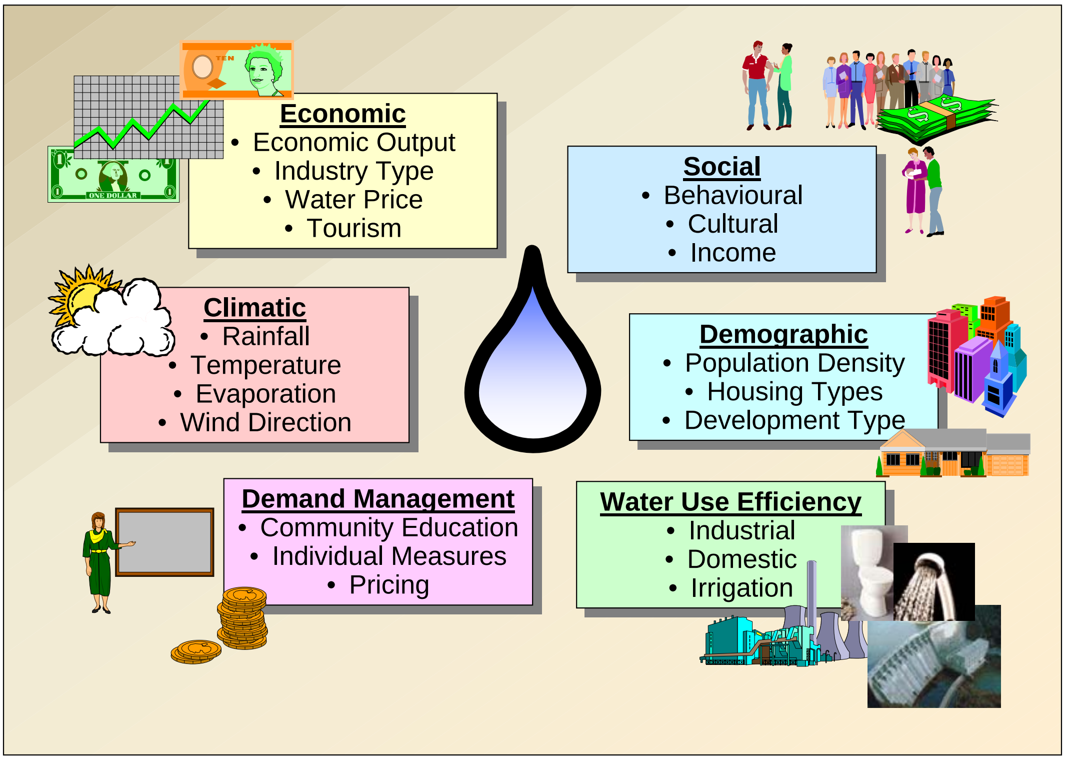
Both the end-use forecasts and cost benefit analysis have been undertaken using the Demand Management Decision-Support System (DSS) developed by MEU as part of the Integrated Water Cycle Management Process.

At this stage of the planning process, the costs and assumptions used in the analysis are approximate, and hence, modelled results serve only to demonstrate the potential of demand management for Kyogle. It is anticipated that as the planning process proceeds and the preferred options begin to emerge, that more accurate figures will lead to greater clarification of the role of demand management in the future development of the water resource. The goal of this first phase of the analysis is to demonstrate the methodology behind the process and the likely cost-effectiveness of demand management options.

What is Demand Management?

There are a large number of factors influencing water demand. The impact of a number of these such as climate, demographic trends and demand management impacts, have significant and measurable short run and cross-sectional impact on demand and can be accurately estimated. Others, such as economic and water efficiency trends, have a relatively minor impact in the short run and, as such, are more difficult to gauge. Fundamental to active demand management is the development of a detailed understanding of the factors influencing demand which can then be used to balance supply and demand side options in arriving at a preferred urban water supply solution (**Figure 1**).

Figure 1. Factors Influencing Water Demand



The management of demands is an ongoing process. While many NSW water utilities, such as Kyogle, will be embarking on a demand management program for the first time, it should not be thought of as a "one-off" occurrence, but rather as an integral part of the ongoing urban water cycle planning process.

Correctly implemented, a demand management program results in a least cost investment stream that will balance a community's economic and environmental goals. It provides a framework for examining options and trade-offs in deciding on the most efficient allocation of resources to meet those goals. After the initial implementation of a demand management program, it is tempting to take the attitude that demand management has been accomplished. However, it is important to recognise that with population growth and expensive water supply and wastewater amplifications continually required, demand management needs to be constantly on the planning agenda.

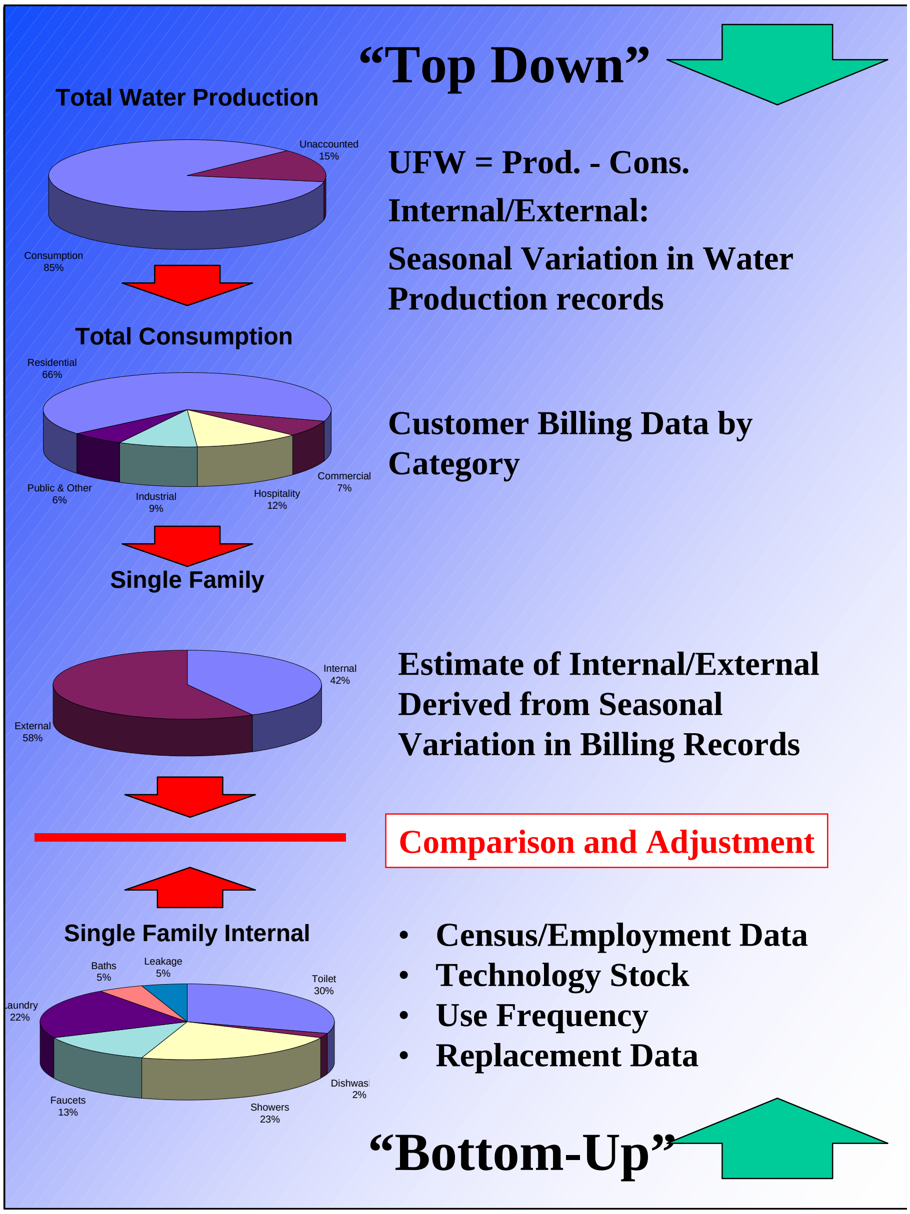
End-Use Based Forecasts

Overview

Simply put, "end-use" modelling is undertaken by examining the volume and frequency of all the potential uses of water by individual consumers within a particular community. Combining this breakdown of uses with the demographic characteristics of the community (eg. population growth, dwelling growth), estimates of total water use can be generated. The end-use based forecasts use this known data on water use to develop a model of both current and future water use.

The end-use approach utilises known water consumption information coupled with water use characteristics such as use volumes and frequency of use in a trial and error adjustment process to develop the end use model. The approach is illustrated in **Figure 2**. The commencement of this end-use modelling process requires an analysis of total water production by a utility, which is discussed further in the next section.

Figure 2. End Use Model Development Approach



Water Production Analysis

The total water produced by a utility is equal to the amount of water consumed by its customers plus the amount of water lost in distribution. Water lost in distribution includes system leakage, but also use that is not metered at the consumer, or cannot be otherwise traced to point of consumption.

Climate is a driver for overall customer demand for water, and hence impacts upon the changes in total water production over time. In order to gain a good understanding of total water production by Kyogle Council, it is necessary to adjust existing production records for seasonal variation. To this end, daily water demand data taken from Council records was climate corrected by MEU.

Climate Correction of Water Demands

The climate correction analysis was undertaken using purpose-built multi-variable regression analysis software. The software is a programmed spreadsheet that uses a spreadsheet for the storage of data and visual basic code for the calculations. The program provides the user with detailed information about the climate influences on daily water demand or sewer flows. The particular analysis conducted for this study considered the influence of climate on per capita water production records for Kyogle.

The analysis uses 3 basic steps:

1) *Calibration* where the model is calibrated over a short time series to provide a baseline;
2) *Hindcasting* where the available climate record is used to project the calibrated model through the full climate record to obtain a statistical understanding of the mean or climate normalised baseline year consumption; and
3) *Trend Tracking* where the observed demands are compared with those predicted by the baseline-calibrated model and changes in both the level of fixed and seasonal demand relative to the baseline are estimated.

Analysis Results

Calibration

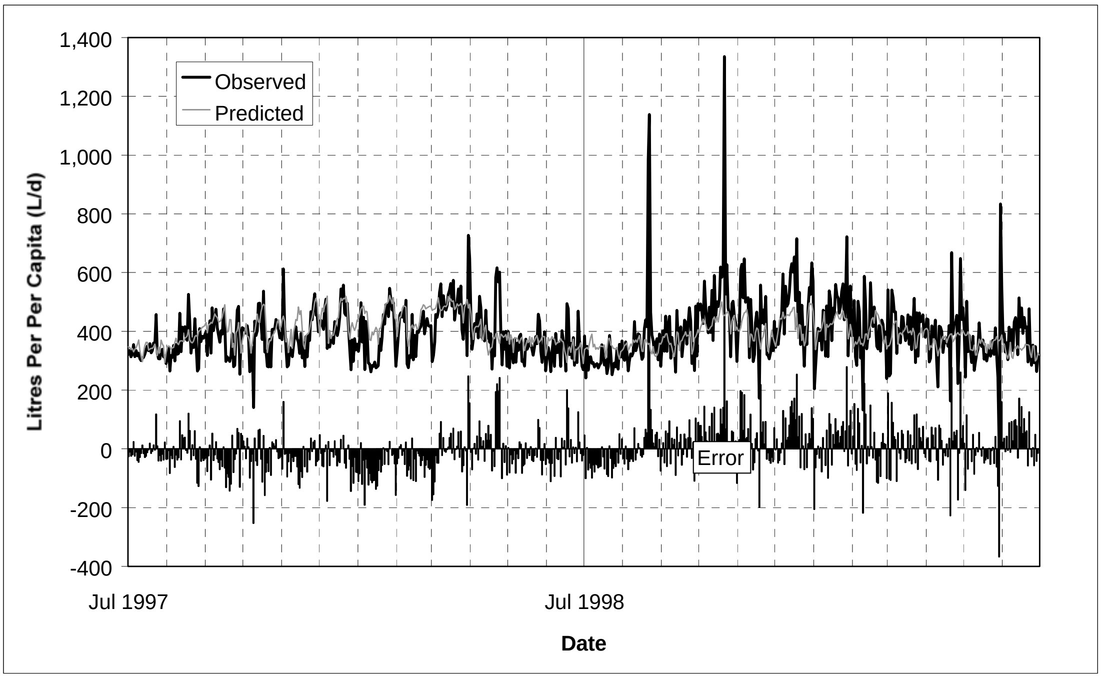
Calibration of the model was carried out over the two year period 1 July 1997 to 30 June 1999 (**Figure 3**). This period was considered the most reliable period of record in more recent years. The calibration produced an R^2 statistic of 0.24, which is to say that only 24% of the variations in daily per capita water production could be explained by the fitted model. Three variables were found to be significant in explaining the daily water production during the calibration period:

1) A soil moisture index, which combines rainfall and evaporation data to provide an index of soil moisture that models the underlying demand pressure associated with antecedent rainfall and evaporation;
2) Average maximum daily temperature; and
3) Daily rainfall.

All climate data was sourced from the SILO Data Drill climate information service which uses observed climate data from multiple stations to provide estimates of daily records at any point in Australia. Water production data was provided by Kyogle Council, and population data was taken from ABS Census information. Population for Kyogle since the 1996 census is assumed to be constant at 2,866 persons (See discussion below).

The calibration exercise clearly shows that although the general trend in observed and predicted data is similar, the recorded peak demands cannot be well explained by the climate-based model during the calibration period, particularly the very high peak demands recorded in August and October 1998. Although the calibration results are at the lower end of the correlation spectrum for analyses of this type, the number of very high demand days which cannot be explained by climate drivers, suggest that there may be a need for investigation of possible meter errors, operational procedures or other influences. It is important to recognise too, that any errors in measurements of treated water volumes leaving the plant will also impact on the estimate of unaccounted for water in the system.

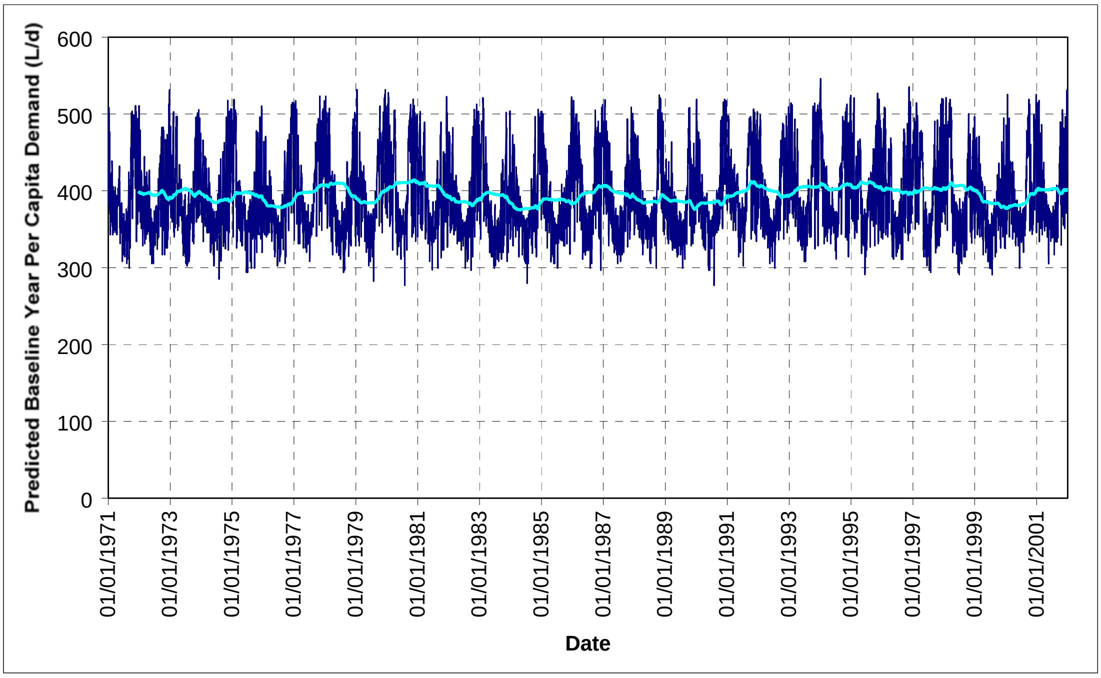
Figure 3: Model Calibration



Hindcasting

While the SILO Data Drill provides estimates of many climate parameters back to 1857, reliable evaporation data is only available from 1970 onwards. For this reason, the model hindcast was conducted over the 30 years since 1970 (**Figure 4**). The hindcast represents the demand that would have occurred in the calibration (baseline) under the full climate time series. Also shown is the 365-day trend in predicted daily production levels.

Figure 4: Baseline Model Hindcast



The hindcast demonstrates that the annual demands of Kyogle are influenced by climate conditions. With a mean of 395 Litres per day, the hindcast shows that the hottest/driest 365 days in the climate record will result in a demand of 414 Litres/person/day (6% above average) whilst the coolest/wettest period will result in a demand of 375 Litres/person/day (5% below average).

The hindcast also provides an estimate of the hottest/driest day (541 Litres/person/day - 37% above average) and the coolest/wettest day (277 Litres/person/day - 29% below average). This result is interesting in that it means that the climate influence can account for a 37% increase in demand on the peak day. This amount is much lower than the observed peak day in the water production records.

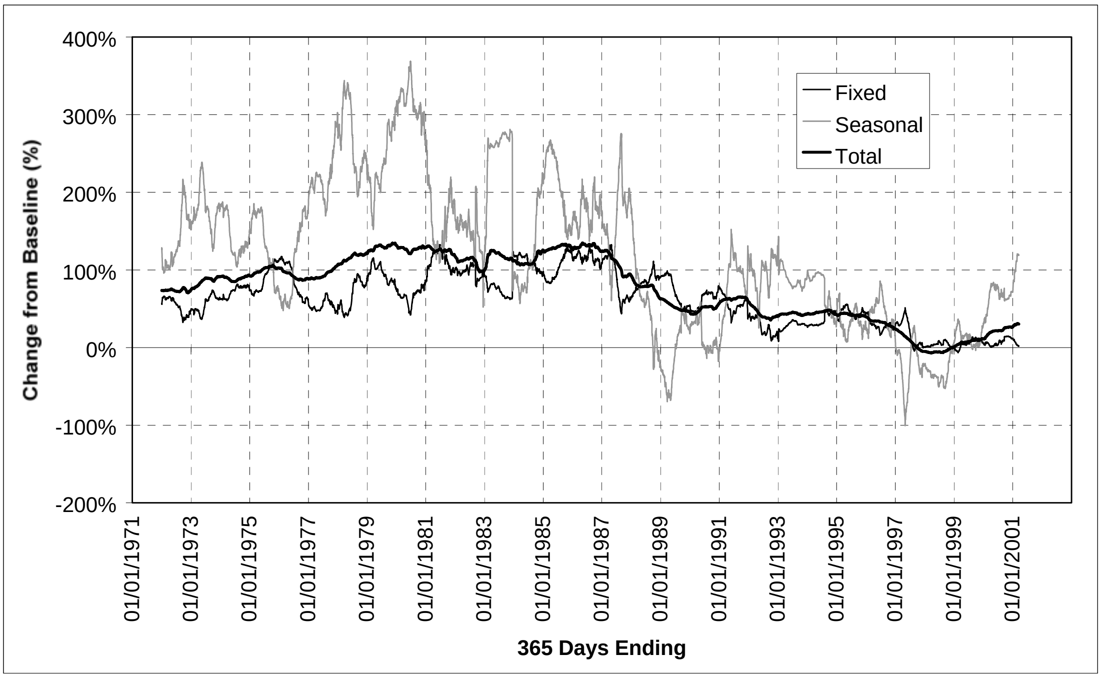
Trend Tracking

The trend tracking procedure utilises a simple polynomial curve fit on observed and predicted baseline data to provide an estimate of the change in both the fixed and seasonal demands. Trend tracking was carried out on a

365 day moving average basis since 1972, when daily water production records were available. Note that due to the technique used there is a tendency for changes in seasonal demand to be negatively correlated with changes in fixed demand, resulting in the "mirror image" effect shown in **Figure 5**. As such, the overall trends in the change parameters should be used a guide to changes in the demand regime rather than the individual observations.

The trend tracking exercise suggests that while there has not been significant change in the fixed demand relative to the baseline period in recent times, the seasonal demand appears to have been increasing. Such a rapid change tends to imply some type of metering error rather than a significant change in the demand regime.

Figure 5: Estimated Changes in Fixed and Seasonal Demands Relative to Baseline



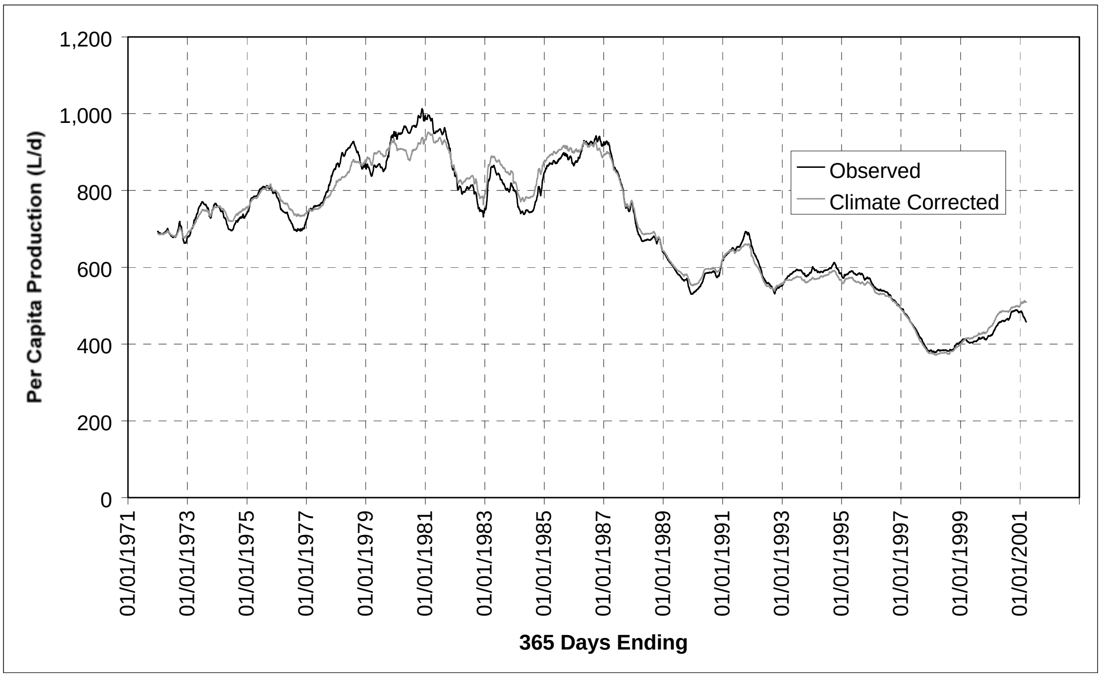
Climate Correction

By coupling the estimates of the change in seasonal demand with the total climate influence in the baseline year, it is possible to correct the observed demand for the influence of climate to show the underlying trends (**Figure 6**).

Overall, the water demands of Kyogle are not particularly responsive to climate influences. The record shows a very large downturn in per capita demand since the late 1970's and early 1980's and a significant increase in demand in 1999. The more recent increase in demand is a cause for concern. This increase is accompanied by a noticeable deterioration in the quality of the metering data that suggests that the meter may be reading high

– particularly in the higher flow ranges. Further evidence of this is the high levels of unaccounted for water recently reported in the NSW Water Supply and Sewerage Performance Comparisons.

Figure 6: Observed and Climate Corrected Per Capita Water Production



Peak Day Demand Estimates

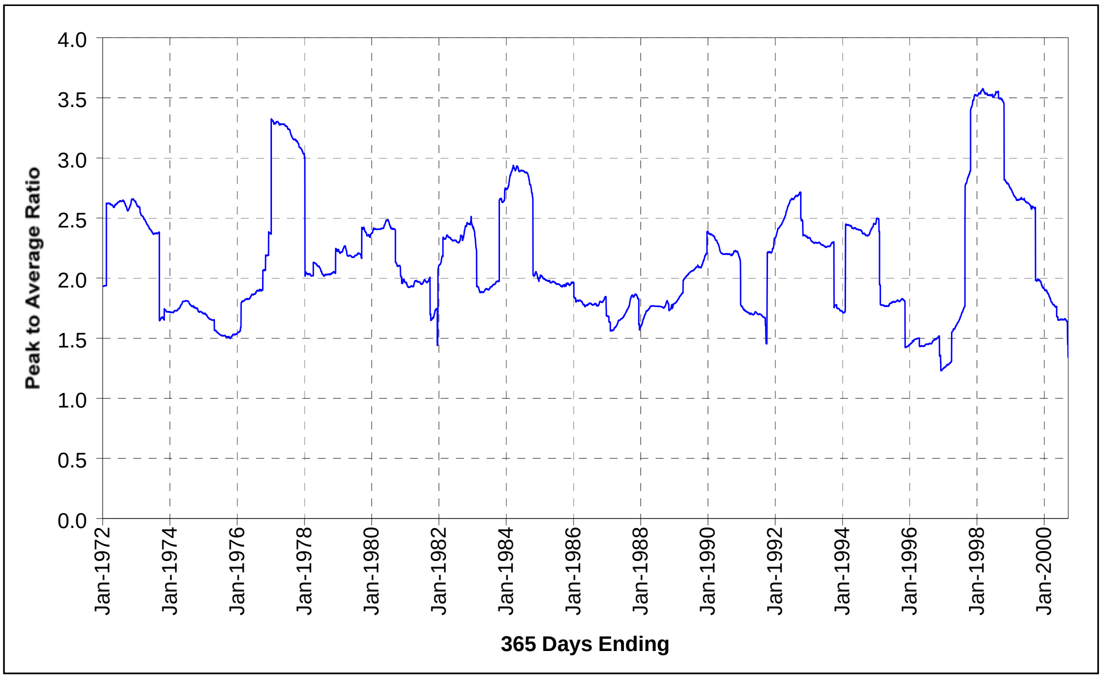
The time series analysis of the climate factors affecting the daily water demand showed that the climate influence can only explain a 37% increase in demand from the average to the peak day. As illustrated in **Figure 7**, the peak to climate-corrected average day ratio varies between 1.5 and 3.5. Clearly there are factors other than climate that are generating peak day demand records. The doubts about the quality of the more recent bulk meter data suggest that the peak day of approximately 3.5 times the peak recorded recently is more likely to have been caused by metering error or operational issues than by hot/dry weather.

If the most recent peak day event is ignored, the inability to find a climatic explanation for high demand days in the model calibration period suggests that operational factors may be contributing to high demand estimates. Fluctuations in the service reservoirs will almost certainly be having a damping effect on the flow records at the treatment plant.

Better estimates of the design peak to average ratio will be able to be made when better quality bulk metering data including corrections for fluctuations in service reservoir levels is available. **At this stage it would be irresponsible to proceed with the design of key infrastructure with so much uncertainty surrounding the estimates of demand**. The use of existing demand figures are likely to have adverse financial or operational consequences well in excess of the cost of improving the quality of metering data.

For the purposes of this study, a peak to average day ratio of 2.0 has been adopted. It will however, be necessary to revise this estimate when improved information on peak flows becomes available.

Figure 7 - 365 Day Rolling Average Peak to Climate Corrected Average Day Demand



Water Production Analysis Conclusions

Contrary to common expectation, climate correction of the daily water demand data provided by Kyogle Council was not able to explain much of the driving influence on the peak day demand recorded. In this light, it would seem reasonable to question the reliability of the plant flow meter in the high flow range, and it is suggested that perhaps the calibration of the meter needs to be checked or the meter replaced to improve the reliability of future records. Further consideration should be given to obtaining telemetry data on service reservoir fluctuations to allow a truer picture of the daily demand record to be obtained.

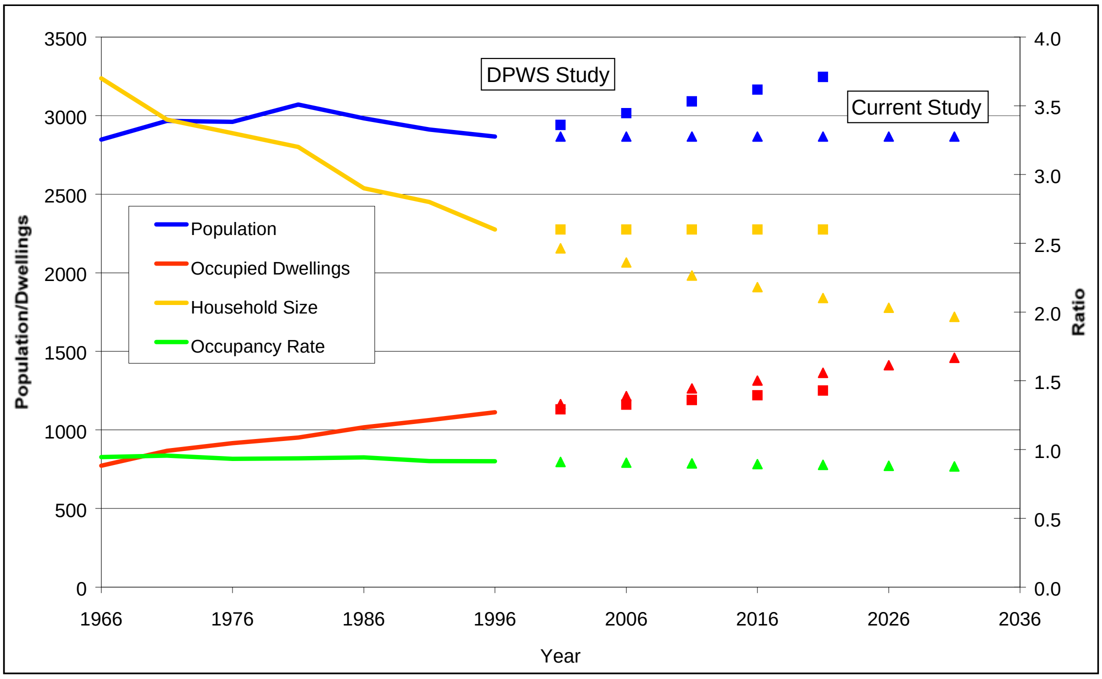
End Use Model Development

Demographics

In spite of a falling population in recent years, continued demand for new housing has seen household sizes decline significantly (Figure 8). For the purposes of this study, it has been assumed that population will remain at

1996 levels and that continued growth in occupied dwellings will see further falls in household sizes. These assumptions will be verified when the results of the 2001 census are released. At this point in time there is little evidence for the growth in population anticipated in the recent DPWS report. A more detailed assessment of future population should include an examination of the drivers of population growth in the region and an assessment of the likely impact on Kyogle.

Figure 8: Kyogle Demographics

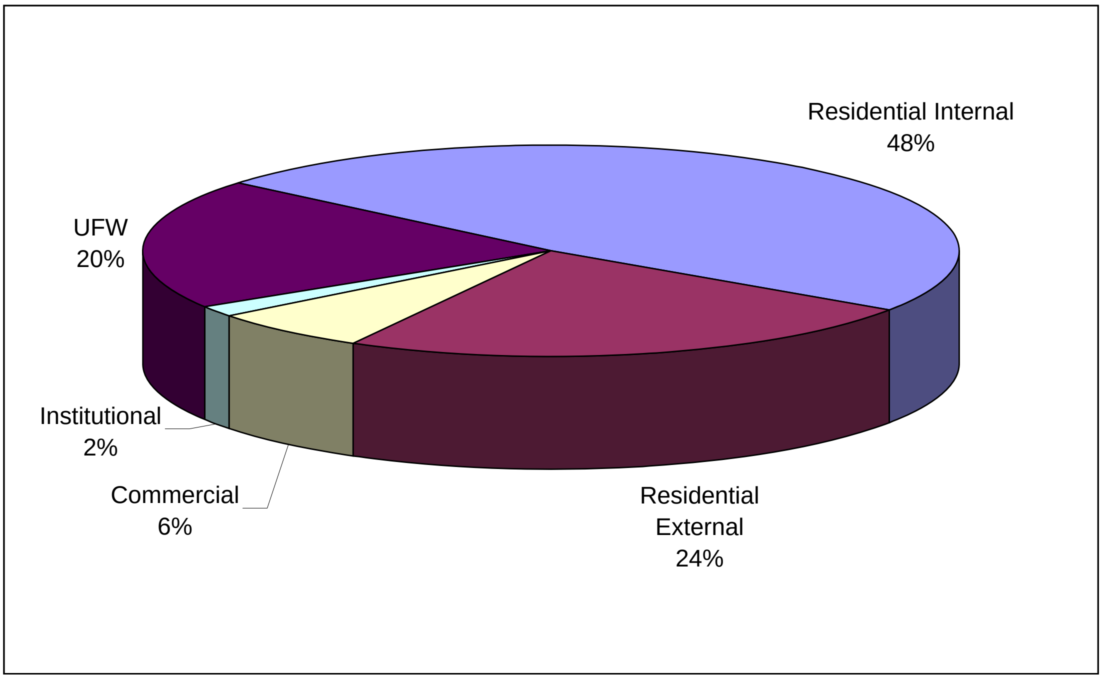


Current Water Demands

For the purposes of developing the end use model – it has been assumed that the demand in the calibration period of the model is truly representative of current levels. This equates to a current demand in a climatically average year of 410 ML/annum. In addition, it has also been assumed that 20% of total production is unaccounted for water in line with recent reports prepared for Council.

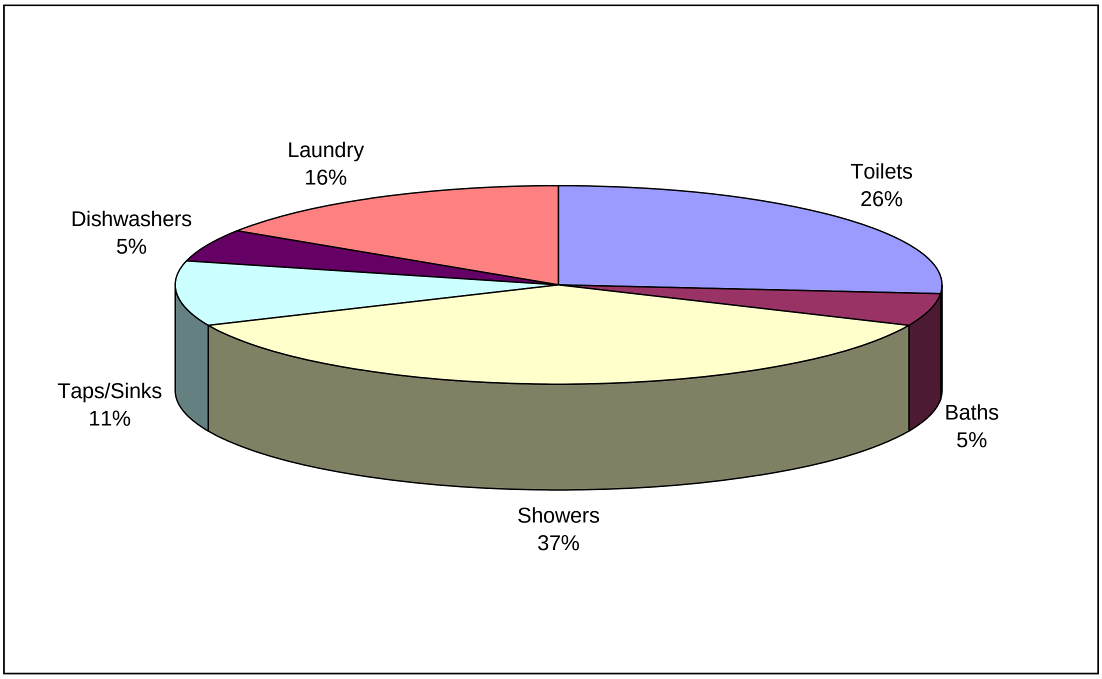
The available customer billing information provided for the 2000/01 Performance Comparison Reports has been used to divide the total consumption into consumer categories. The assumed current breakdown in total consumption (production less unaccounted for water) is shown in Figure 9.

Figure 9. Assumed Breakdown in Current Water Production



In order to approximate the demands of single families, the estimates of the breakdown of uses within the residential sector shown in Figure 10 were adopted for this study.

Figure 10. Assumed Breakdown in Internal Use - Residential



The initial assumptions made on the breakdown of internal and external residential use, and the distribution of internal water consumption across various activities were based on the results of studies of typical residential areas in Australia. However, the breakdowns given above were also adjusted by building up a profile of internal use based on available demographic data and fixture modelling (technology stock, replacement data, and use frequency), as discussed in the following section.

Forecasting Future Water Demands

Expected Changes in Water Use Efficiency

For this study, natural changes in water efficiency have been assumed to occur only in residential consumption on the basis of improvements in toilet and shower technology. Water efficient appliances will be installed in new dwellings and in the renovation of existing dwellings. Efficiency changes in other categories of consumers are expected to have a much more minor influence on future demands and have been ignored in this preliminary analysis.

The expected change in the stock of toilets and showers in residential houses is shown in Figure 11 and Figure 12. The impact of the changes in water use per account is also shown.

Figure 11. Impact of Natural Changes in the Stock of Residential Toilets

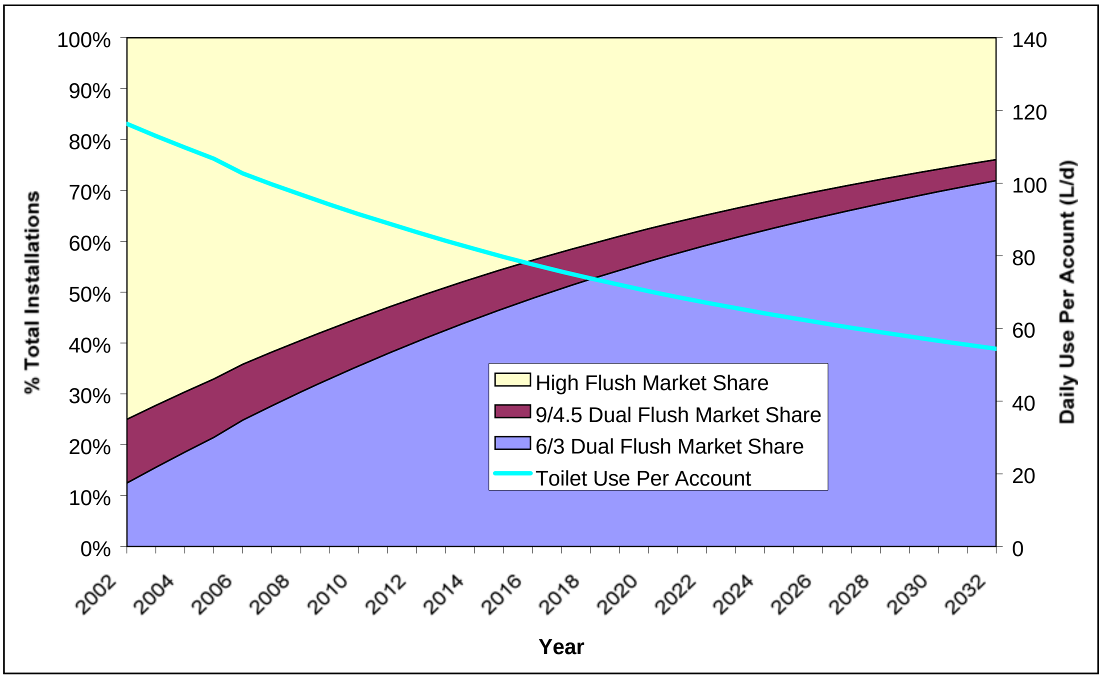
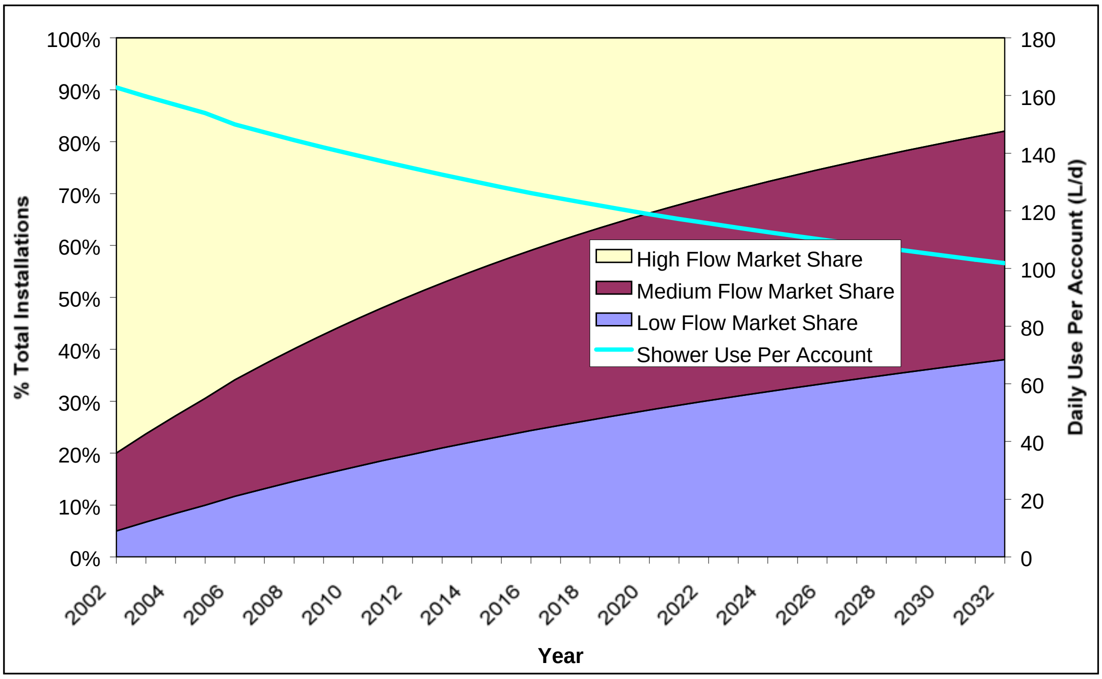


Figure 12. Impact of Natural Changes in the Stock of Residential Showerheads



Demand Management Benefit Cost Analysis.

Overview

The Planning, Implementation and Monitoring Cycle

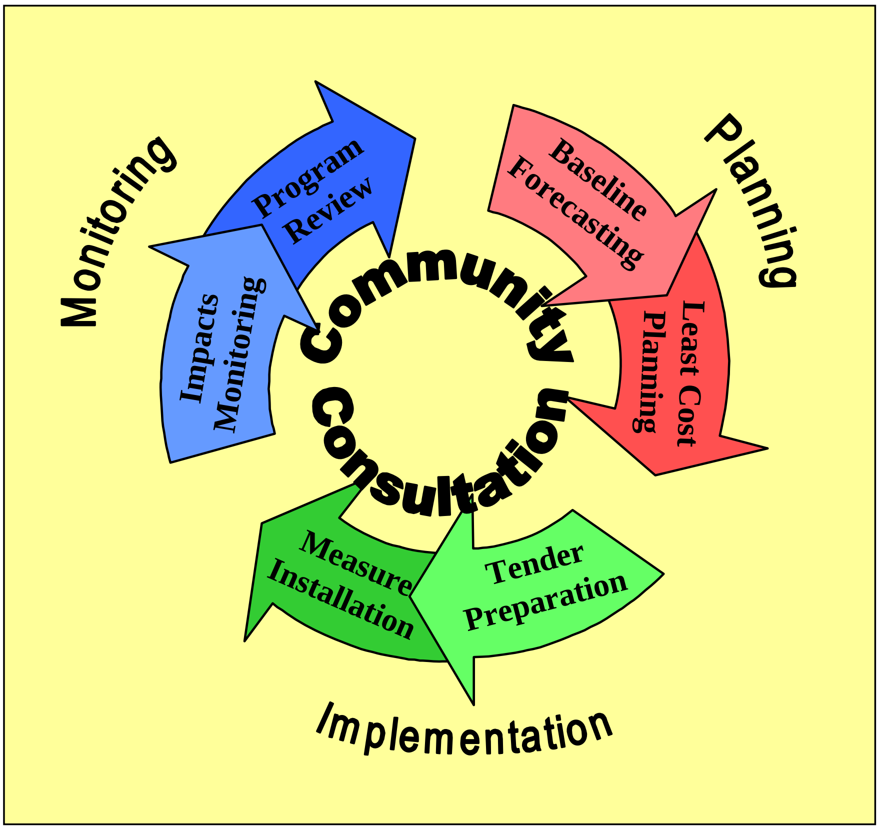
The use of a systematic approach to demand management provides a transparent framework for examining both demand and supply side management options. It provides detailed answers on the impact of different measures and assists in giving the community a feel for the trade-offs required. It also allows the results of the program to be published and adjustments made to the investment schedule as the timing of supply side infrastructure approaches.

Demand management requires three steps as shown in Figure 13. These are:

- *Planning*, where baseline or “do nothing” forecasts of demand are prepared and Least Cost Planning analysis is used to decide on the preferred program.
- *Implementation,* where the preferred program is implemented; and
- *Monitoring,* where the results of the program are assessed and adjustments made.

This process is continually repeated as part of the routine strategic planning work of water utilities.

Figure 13. The Demand Management Planning, Implementation and Monitoring Cycle



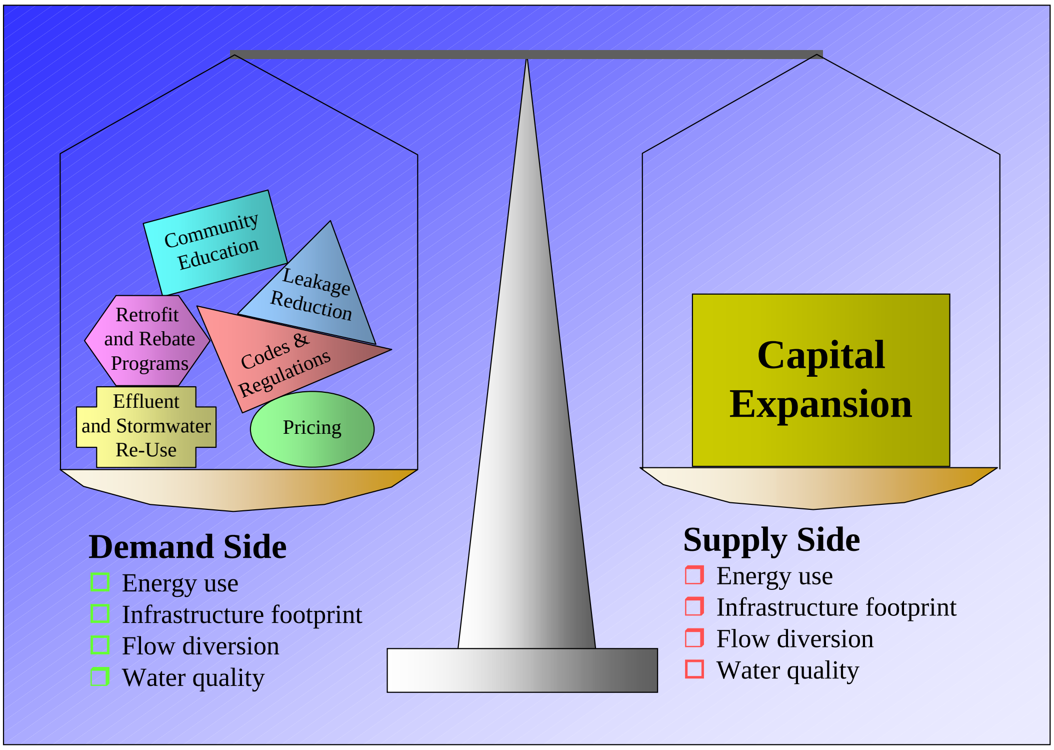
Why Manage Demands?

Financial and Environmental Benefits

In traditional urban water cycle planning, the problem of the balance between supply and demand has been met with capital investment on the supply side of the problem (Figure 14). Increasing per capita demands were seen as an inevitable consequence of economic development and the supply side of the equation was increased to balance the increasing demand. This type of thinking led to an era of burgeoning growth in demands and escalating infrastructure costs. The environmental impacts of infrastructure and resource over-allocation were rarely considered.

In recent years, the focus has begun to shift to the demand side of the equation. Investment on the demand side of the equation in items such as community education, rebate programs and better distribution management have led to more cost effective outcomes. Demand side management also provides additional social and environmental benefits such as reduced energy consumption and flow diversion, smaller infrastructure footprints and increased water quality.

Figure 14. Balance Between Supply and Demand Side Management



Key Focus Areas for Demand Reduction

There are a wide variety of individual measures that can be brought to bear when attempting to reduce demand. These can be grouped into 5 broad categories:

1) Active Intervention – retrofit and rebate programs
2) Community Education
3) Water Pricing
4) Unaccounted for Water Reduction
5) Effluent and Stormwater Re-use

A comprehensive demand management program will assess a wide variety of measures in each category before arriving at a preferred program.

Cost Savings Assumptions

Omissions

There are a number of costs that have not been considered in the analysis. Specifically, the impact of water distribution and reticulation system infrastructure has not been included. Although the impact of these costs are significant, it is beyond the scope of this initial analysis to include a comprehensive assessment of these costs. This will make the current analysis conservative.

The impact of future sewerage amplification has also been ignored, simply due to the fact that the current DSS does not allow benefit cost analysis on the basis of multiple sources and discharge points. The inclusion of sewerage amplification costs would require separate end-use models and would need to be set up for each sewage catchment. The gains from deferral of sewage infrastructure from demand management programs are generally small in comparison to the water supply infrastructure.

Energy Use

A number of assumptions have been made regarding energy usage.

- Incoming water service temperature: 16^{o}C
- Shower water temperature: 70^{o}C
- Bath temperature: 60^{o}C
- 81% of connections serviced by electric hot water systems at a cost of $0.12 per kWhr
- 19% of connection serviced by electric boosted solar hot water at a cost of $0.12 per kWhr

Treatment and Transfer Costs

These costs have been adopted on the assumption that for compliance purposes, the treatment works needs to be fully upgraded. Treatment and transfer costs for water and wastewater are:

- Current water transfer: $25/ML
- Current water treatment: $25/ML
- Current wastewater transfer: $25/ML
- Current wastewater treatment: $25/ML
- Increase in water treatment costs associated with new water treatment facilities: $3 650/ML

Capital Works

As an initial estimate, it has been assumed that the full upgrade (in order to comply with present standards) of both the water supply headworks and water treatment facilities will be in the order of $2.6m and $2m respectively. This is a deliberately conservative estimate, which will be refined at a later date when better information becomes available. For the purpose of calculating the marginal cost of downsizing, 50% of the costs are assumed to be fixed with the remaining costs linearly dependent on the infrastructure capacity.

Water Utility Revenue Impacts

When preparing benefit cost analyses for water utilities, many people question if the loss of revenue by the water utility should be taken into account. In a well-managed water utility, the rate levels are continually adjusted to reflect the cost of provision of services. If investment in demand management reduces the future capital works budget of the utility, this will be reflected in reduced rates. To include the reduction in revenue for the water utility hence would be double counting and is excluded from considerations.

Control Measures Considered

In the preliminary development of a demand management program, only a small number of measures were considered. This list of measures should be expanded using input from the community as a guide before a final analysis is undertaken. A brief description of each of the measures included in the preliminary analysis can be found below.

Shower Head Retrofit Program. In this measure, retrofits of low-flow shower roses would be offered to all residential customers.

Community Education Targeting External Use. This measure involves specifically targeting external residential water use. As one of the drivers of the peak day demand, external use is a key target in any conservation program. Preliminary assessment shows that a campaign with annual expenditure of $20,000 that achieves a 3.5% reduction in external use will have a benefit cost ratio of approximately 1.2. Such a campaign would emphasise the importance of correct irrigation practice and the potential for water efficient garden design and plant choice to reduce external use.

Dual Flush Toilet Retrofit. This measure is one targeted at residential dwellings where water use per toilet is high.

Rainwater Tank Retrofit. Under this option, 10,000 litre rainwater tanks are retrofitted to existing occupied houses for use for garden watering, washing machine and toilet flushing. The tank size is designed to provide the majority of this water use with a mains top-up as required. Water from the tank is supplied via a small pump. The cost of the tank to Council ($2,000) is offset by the tank's dual role as On-Site-Detention (OSD) ($600).

Water and Sewerage Price Changes. In 2001/02 Kyogle has a water usage charge of $0.63 per kL in addition to a sewerage usage charge of $1.26 per kL levied on 40% of the water consumption. The net effect is a marginal water usage cost to consumers of $1.13 per kL.

In a recent review of Kyogle's Stategic Business plans for water supply and sewerage, MEU has recommended a water usage charge of $1.20 to more accurately reflect the long-run marginal cost Council's water supply and encourage demand management efforts.

In addition, to comply with IPART's recommendation in its Pricing Principles for Local Water Authorities, MEU has recommended that Council replace its present sewerage two-part tariff for residential customers with a fixed sewerage charge per residential property. The reasons for recommending removal of the sewerage usage charge for residential customers are:

- the lack of net benefits from such pricing; and
- such usage charges are not cost-reflective (refer to the bottom of page 4 of the MEU brochure on best-practice pricing for water supply, sewerage and trade waste).

In future annual reviews of its water pricing structure, in order to retain the demand management benefits, Council should ensure that the water usage is maintained at least $1.20/kL in $2002/03.

This specific pricing measure involves dropping the link between water consumption and sewerage charges and increasing the water usage charge from $0.63 to $1.20 in 2002/03 and maintaining the charge at that level in real terms.

Reduction in Unaccounted for Water. This option requires an initial investment by Council of $200,000 over five years from 2002, and an ongoing maintenance budget of $10,000 pa in a program to reduce the UFW by 7.6L/c/d.

Results

Overview

The results of the preliminary analysis show that a number of water conservation options have the potential to be cost effective. Table 1 below shows the results of the analysis for the measures implemented on a stand-alone basis. Note that the end use methodology means that measures effecting more that one consumer group (such as the showerhead retrofit program) need to be listed as multiple measures.

Table 1. Benefits and Costs of Demand Management Measures on a Stand-Alone Basis

Control Measure Name	Estimated Water Savings (ML/d):	Potential Cost Effectiveness
Real Price Increase 2003	0.003	Very High
UFW Measure Model	0.021	High
House Shower Retrofit	0.017	High
House Toilet Retrofit	0.020	Medium
Rainwater Tank Retrofit	0.047	Medium
External Use Education	0.012	Low

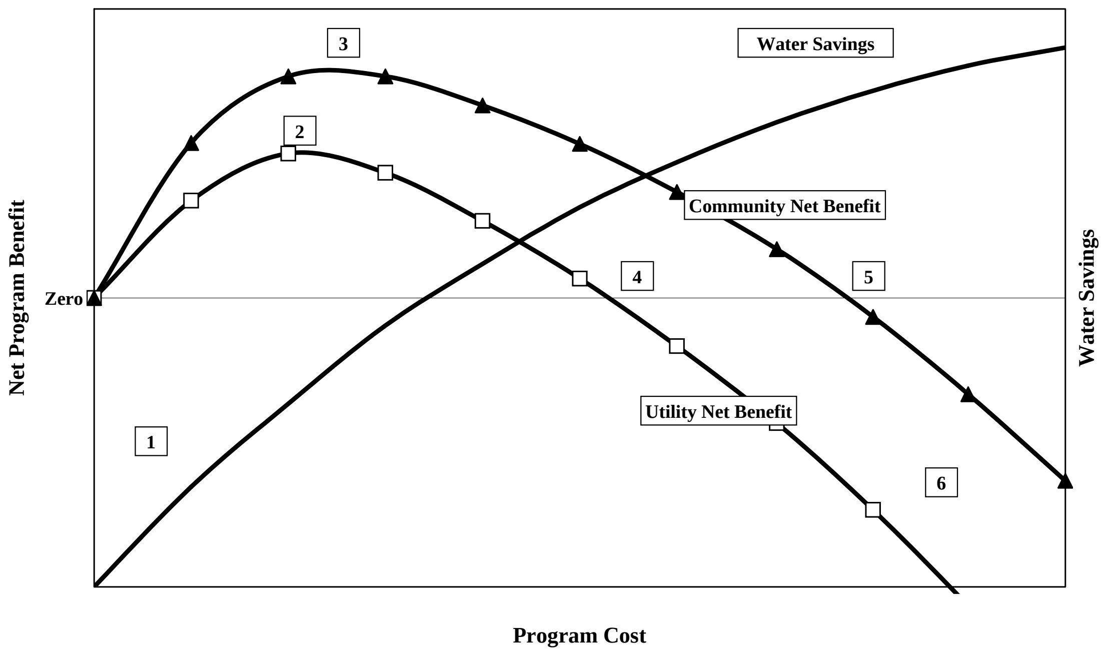
Deciding on the Level of Investment

To examine the question of the appropriate level of investment it is best to look at the alternative conservation programs in terms of their net benefit to both the water utility and the total community. Net benefit is the benefits minus the costs. Figure 15 shows the net return from both the utility and total community perspectives against the level of water utility investment and the six financial goals that can be adopted for the conservation program:

1. *Do nothing*. Some communities may feel that they like their present level of water use and are willing to pay for it. In this case no investment in demand management takes place.
2. *Maximising customer water bill savings*. If this perspective is taken the maximisation of the utility's net benefit is required. This allows the utility to pass on the savings to customers through lower rates and/or water usage charges.
3. *Maximising customer combined water and energy bill savings*. This result will be achieved with a maximisation of the community's net benefit. A less than optimal water bill saving will be more than compensated for with increased energy bill savings.
4. *Maximising water savings with no increase in water bill*. If this goal is to be achieved, a program is required with the utility's net benefit equal to zero.
5. *Maximising water savings with no overall increase in water and energy bills*. This result will be achieved with a program with the community net benefit equal to zero. In this situation the utility will lose money on the program. This loss will be passed on to consumers in the form of higher water charges. Hot water savings will offset the higher water charges incurred by the community.
6. *Water savings goal*. With a specific water savings goal, the net benefit can be any number. Each water-saving goal will have a different impact on customer costs. The net benefit in this case may be negative if the community is willing to live with higher water and energy bills to meet some environmental goal.

The final choice for Kyogle will be dependent on the interaction of the water and wastewater upgrades with the demand management measures.

Figure 15: Level of Investment in Demand Managment



Note: numbers on graph refer to discussions points on page LXIV.

Impact on Future Demands

The water conservation programs identified have considerable potential to reduce future demands. This is illustrated for both annual and peak day demands as shown in Figure 16 and Figure 17.

Benefit Cost Analysis

Many of the numbers used in the benefit cost analysis are estimates in the absence of current information. These estimates include:

- The safe yield of the existing system and the cost of future headworks amplification.
- The cost of future water treatment facilities; and
- Treatment and transfer costs for water and wastewater.

These estimates will have to should be refined or replaced with actual databefore a final decision is made with regard to the combination of demand and supply side measures.

Other Conservation Measures That Could be Considered

In integrating demand management into the strategic planning of the water resources for Kyogle, this current analysis has focussed mainly on common measures in the residential sector. In the final analysis, there are a number of other options that could be considered. These include:

- *Commercial Toilet Retrofit*
- *Conservation-oriented inclining block tariffs*
- *Fill and Flush Urinal Removal.* Many commercial premises use fill and flush urinals. This type of unit flushes automatically upon filling and extremely wasteful form of technology.
- *Building Code Measures.* Kyogle is in the advantageous position of having control of both the local government regulations and the water business. Building code measures for all new development are an extremely cost effective method of increasing the propagation of more water efficient appliances. Many NSW councils are now mandating the installation of rainwater tanks for new development.

Demand Forecasts

The planning period adopted for the demand forecasts made as part of this study was from 2002 to 2032.

The resulting forecasts of demand are shown in Figure 16 and Figure 17. The impact of the propagation of water-using appliances can be clearly seen, when compared with the forecasts provided by the DPWS study.

Falling household sizes have resulted in predictions of an increased level of external use, thus offsetting some of the expected savings in internal use. This has resulted in a predicted increase in the peak day demand when average day demand could reasonably be expected to fall. This result should be tempered in the final analysis with acknowledgment of urban consolidation trends that will reduce lot sizes for residential dwellings and also impact on long term irrigation levels.

Figure 16. Revised Annual Demand Forecasts

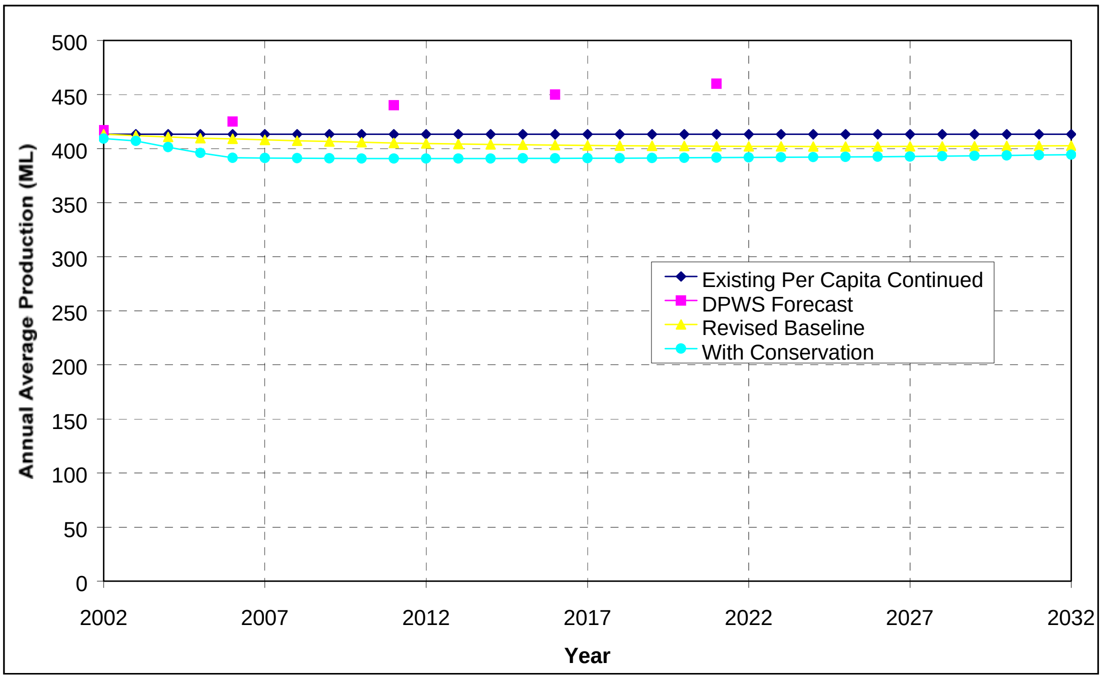
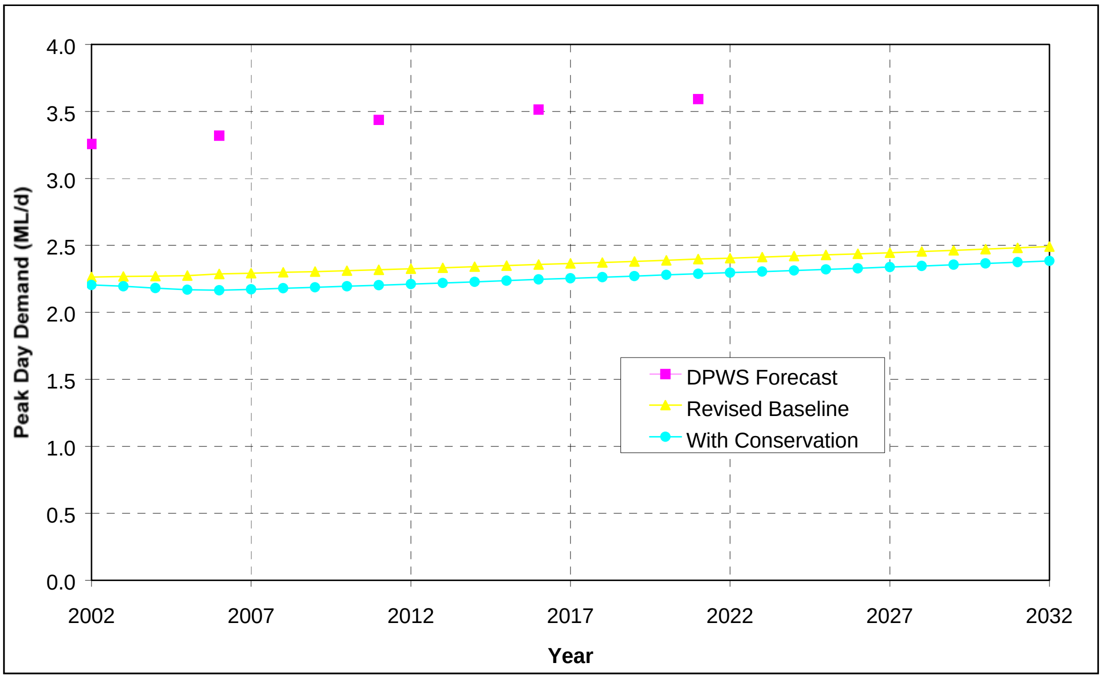


Figure 17. Revised Peak Day Demand Forecasts



The revised forecasts of peak day demand presented in **Figure 17** are considerably different to those estimated by DPWS. As noted earlier, it is apparent that the recent peak days recorded in the raw data provided by Kyogle Council cannot be adequately explained by climate changes, and hence it has been suggested that there may be inaccuracies in the metering of high flows.

Conclusions

The revised demand projections prepared for this report show that there are compelling reasons for future water demands to fall below existing per capita levels in the future. By factoring in expected changes in water efficient appliance stock, a significant reduction in the future capital works budget can be achieved.

The results of the preliminary benefit cost analysis show that it is highly likely that demand-side management measures can be actively employed in a cost effective manner in Kyogle to reduce the size and cost of supply-side infrastructure.

Additional work is required to:

- Refine the assumptions used in the end-use water demand projections;
- Refine the assumptions used in the assessment of water conservation options; and
- Expand the set of measures considered in the analysis.

References

DPWS (1996) *Water Supply Augmentation Strategy Report*

DLWC (2000) *1999/00 NSW Water Supply and Sewerage Performance Comparisons*

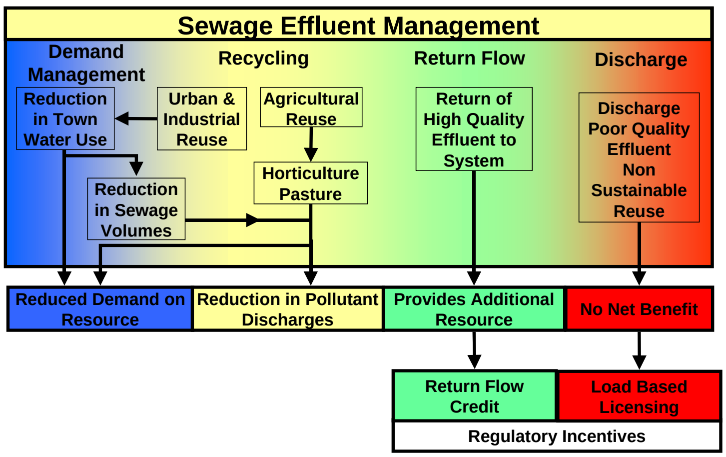
Appendix G – Effluent Modelling

Effluent Management Opportunities for Kyogle

Introduction

There are a number of potential sewage management options which should be considered for Kyogle. These management options include demand management (to reduce the amount of effluent generated), effluent reuse and return flows. Figure 1 shows the benefits from the range of options available.

Figure 1 Sewage Effluent Management Options



At present the NSW EPA has issued a Pollution Reduction Programme for the Kyogle sewage treatment plant in relation to a reduction in the load of nutrients (nitrogen and phosphorus) being discharged to the Richmond River. A number of options have been considered to provide for this outcome. In analysing these options climatic conditions, urban and agricultural activities in the local area, the flow regime of the river and the impact of the pollutant load from the Kyogle STP has been considered.

Climatic Data

The general climatic conditions in Kyogle are warm and humid summers with mild winters. Although rain can occurs throughout the year, the North Coast is a predominantly a summer rainfall area. Summer months average from two to four times the rainfall of winter months, while springtime is usually the driest period.

Figure 2 Annual rainfall in Kyogle compared with long term average

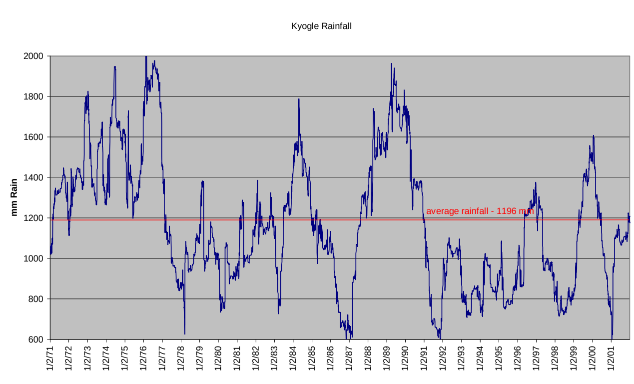


Figure 2 shows the total rainfall over the last year (365 days), for the past 30 years. In this figure distinct periods of wet and dry weather in the region can be seen. In the early 70's and late 80's there were periods of above average rainfall, while periods of below average rainfall occurred between 1978 – 83 and from 1991-99.

Daily climatic data of rainfall and evaporation has been acquired for the local area for the period between 1st January 1970 to the 28th February 2002. This information has been used to determine the soil moisture deficits, irrigation volumes and storage volumes for the area over this period.

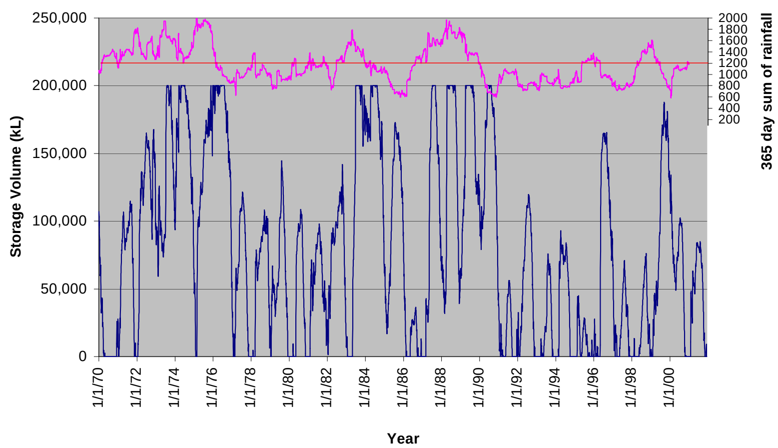
Potential Reuse Schemes

The last 3 years of sewage volume data has been used to simulate sewage flows over the past 30 years to determine land area and storage volume requirements. Irrigation requirements have been based on daily rainfall and evaporation measurements, while allowing for a 10-mm soil moisture deficit to be maintained to prevent nutrient runoff from the site.

Lucerne

The growing and cropping of lucerne is a potential reuse option for the Upper Richmond River catchment as supplementary foods crop for the local cattle. To date no landholder has been identified as a potential receiver of the effluent from the Kyogle STP. The preferred option would be the transfer of effluent to a neighbouring property, were the water and nutrients could be used within a viable agricultural business to replace present extraction requirements.

Figure 3 Effluent storage volumes for lucerne production in the Kyogle area



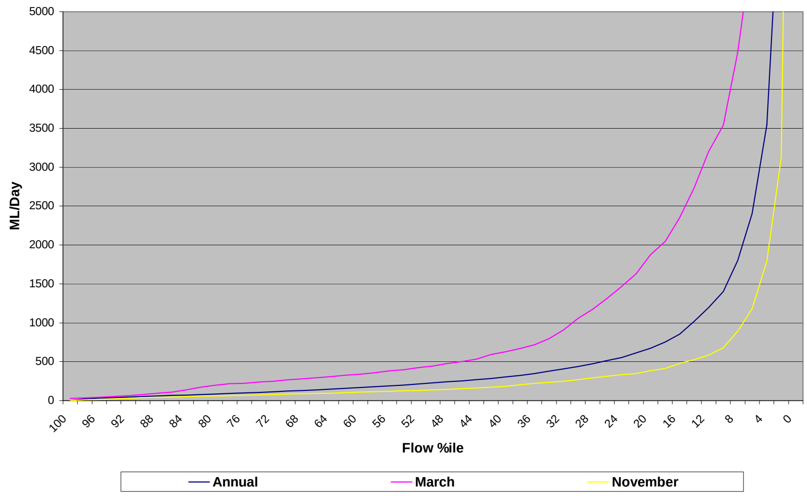
The present volume of sewage generated within Kyogle would result in a required irrigation area of between 50-60 hectares and storage of about 200 ML. Figure 3 shows how the effluent storage volume behaves over a period of 30 years for this system. It can be seen from this scenario that overflows from this storage would occur during years of above average rainfall.

Effluent Return Flows

The Water Management Act 2000 provides for the establishment of return flow rules, whereby water allocations that have been used by the holder of an access licence, may be regained. To gain this credit the access holder needs to demonstrate that the return of effluent to the system provides a net benefit. To achieve this the return will need to have minimal impact on the environment and provide a resource to other water users downstream of the release point.

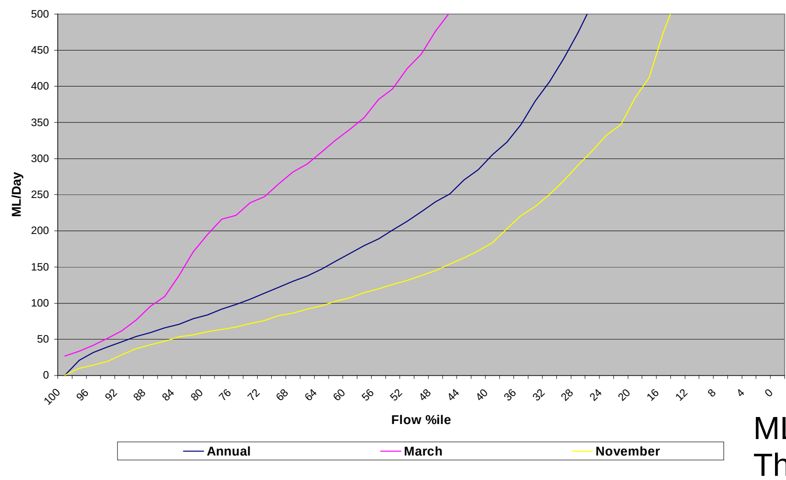
The *Kyogle Area* subcatchment has been identified as being hydraulically stressed, with all of the low flow in the river during the months of August to November being allocated. Presently there is an embargo on any new licence extractions from this section of the river. The area has also been identified as a high priority for the development of a water sharing plan which my have future impacts on extraction requirements.

Figure 4 Flow Duration Curve for Richmond River at Kyogle



A flow duration curve (Figure 4) has been derived form DIPNR data for the Richmond River at Kyogle based on data collected from 1/5/69 – 9/8/2000. The flows in the Richmond River generally exceed 20 ML/day with peak flows above 50 000 ML/day being recorded. The flow in the system is impacted by the seasonal climatic variation.

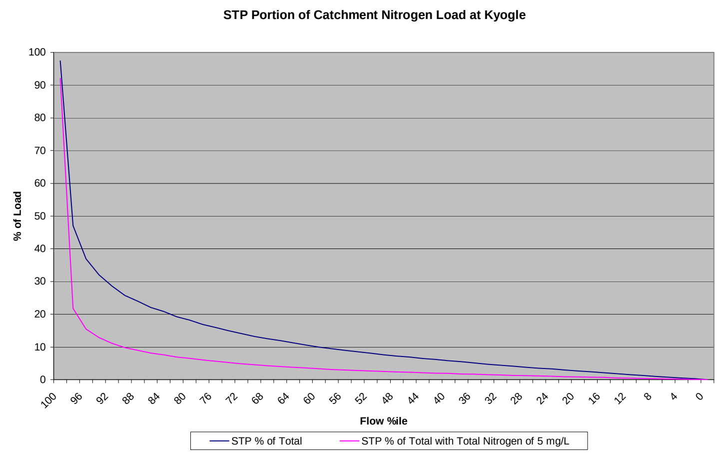
Figure 5 Flow duration Curve for Richmond River at Kyogle showing low flows



This seasonal variation becomes evident when the flow duration curves for March and November are compared (Figure 4). Kyogle sewage treatment plant discharges approximately 0.5 ML/day during dry weather but due to infrastructure issues the treatment plant discharges greater than 5 ML/day during wet weather. These volumes however are small compared with the flows in the Richmond River.

Nitrogen Loading

Figure 6 Total nitrogen % of total catchment Load various flows.

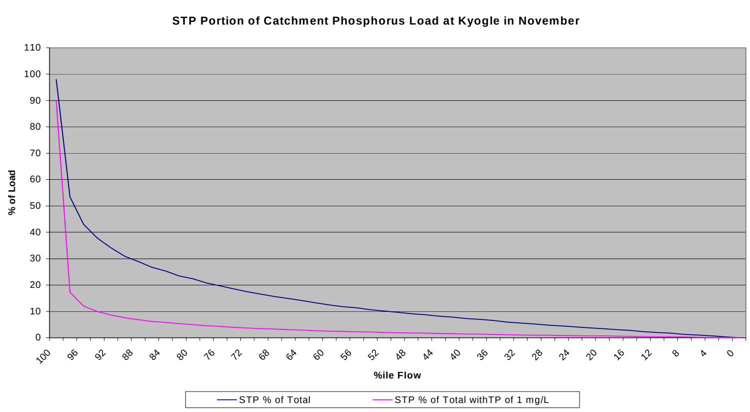


Based on the annual flow duration curve and the total nitrogen concentration in the river in dry weather, the impact of the Kyogle sewage treatment plant has been estimated (Figure 5). This approach is only intended to provide an estimate of loads based on a mass balance approach. It is worth noting that water quality in the Richmond River deteriorates during high flow events and may be slightly low after storm events. Despite this, the graph gives a good indication of the percentage of the total load of nitrogen in the river being sourced from the Kyogle effluent.

Under present conditions the effluent from the Kyogle treatment plant accounts for greater than 10% of the total nitrogen load in the system for flows less than the 60th percentile flow. If the treatment plant was improved to provide best management practices (median TN value of 5 mg/L) the plant would only account for greater than 10 % of the total nitrogen load in the system at flows of less than the 90th percentile flow. The need to improve nitrogen removal at the plant may be questionable ion the basis that total nitrogen concentration in the Richmond River does not exceed the water quality guidelines objectives for the Richmond River.

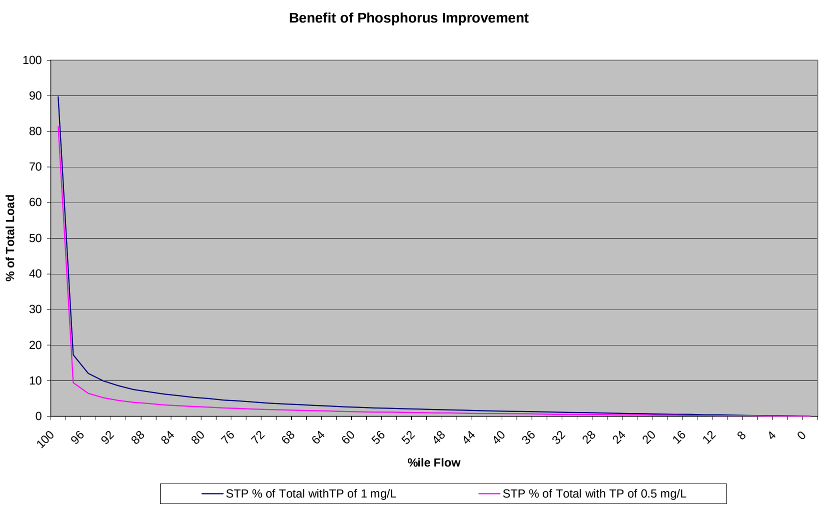
Total Phosphorus

Figure 7 Total Phosphorus % of Total Catchment Load various flows.



The load of phosphorus attributed to Kyogle STP effluent was calculated as for total nitrogen above. As can be seen from Figure 7 the phosphorus load from the STP is greater than 10% for all flows less than the 50th percentile flow. If the treatment plant was upgraded to reduce phosphorus concentration to 1 mg/L of TP, the STP would only contribute greater than 10% or more of the total river phosphorus load when the flows in the Richmond River were less than the 94th percentile flow (Figure 6).

Figure 8 Impact of improving phosphorus removal to 0.5 mg/L at Kyogle.



If the Kyogle sewage treatment plant phosphorus removal potential was increased to deliver an effluent total phosphorus concentration of 0.5 mg/L, the STP would only contribute 10% or more of the total phosphorus load in the Richmond River when the flows were less than the 98th percentile flow (Figure 7).

Conclusion

The Richmond River subcatchment adjacent to Kyogle has been identified as being hydrologically stressed with an embargo issued on any new licensed extractions for the river. As a consequence, sewage management options should not be focusing on creating new demands for water, but look at replacing or replenishing present extractions.

The Kyogle sewage treatment plant has been identified as being a significant source of nutrients within the Richmond River at Kyogle and work needs to be carried out on reducing the plant's impact. As total phosphorus and not total nitrogen has been identified as an issue for the Richmond River, the priority for Kyogle council should be to reduce the phosphorus load leaving the plant.

At present there are two management options available for Kyogle STP that need to be considered further. They are:

1. Reuse of the sewage effluent on an adjacent agricultural property in place of river extraction. At present no property has been identified, but expressions of interest should be sort.
2. Improve the level of treatment at the Kyogle STP to reduce the total phosphorus load in the effluent. A number of techniques are commercially available for reducing phosphorus levels to a point where the STP impact on the total load will be minimal. As the cost of any upgrade is a significant issue for council, there seems to be little benefit associated with improving phosphorus removal below 1 mg/L.

As a priority a number of further investigations need to be undertaken to ensure the best outcome can be achieved. These include:

1. Infiltration/exfiltration in the Kyogle sewerage system has been identified as a major issue. The causes of infiltration need to be investigated and repairs to sewage mains progressed in order to reduce infiltration/exfiltration to acceptable levels. This will provide significant improvement in relation to plant capacity and reduce costs associated with treatment and sizing of reuse areas and storages.
2. Investigation into any viable reuse options, were effluent could replace river water extractions. Interest will need to be sort from landholders.

Appendix H – IWCM the Broader Context

Having completed the IWCM context study, which will feed directly into Phase two of the overall IWCM planning process for Kyogle's urban water service, it is important to consider how this planning process links with other planning instruments.

Catchment Blueprints

In December 2001, the DLWC (now DIPNR) published the Catchment Blueprints developed by the Catchment Management Boards as long term plans for management of river basins. Each plan identifies the natural resource management issues faced by particular catchments, as well as a series of objectives and targets to manage these issues into the future.

The Northern Rivers Catchment Management Board, which applies to the Kyogle area, identifies a range of catchment and water management actions and responsibilities for local government. Specific Catchment Blueprint targets to which an IWCM will directly contribute include:

- 50% of HCV riparian vegetation under active management by 2006;
- Aquatic habitat management and rehabilitation plans implemented in all priority HCV subcatchments by 2006;
- Water sharing plans established in 18 priority subcatchments by 2006;
  'water sharing plans' to include environmental share/flow, basic rights and extraction.
- A minimum of 10% reduction in 2001 per capita reticulated water usage achieved by 2011.
- All treated effluent discharged from municipal sewerage treatment plants(STP) to have either:
  - 50% reuse of dry weather flow by 2011, or
  - be of a reuse standard by 2011.

Further, there is a series of prioritised management actions included in the Catchment Blueprint towards which the outcomes of the IWCM planning process will help Kyogle Council move. These management actions are summarised in **Table 14** below.

Table 14: Prioritised management actions for Kyogle Council within the Northern Rivers Catchment Blueprint

Priority	Action Number	Action
33	3.6.1	Identify sustainable treated effluent end uses and develop innovative reuse programmes
34	3.6.2	Upgrade STPs in accordance with integrated urban water management plans by utilising the financial and planning support from the Country Town Water Supply and Sewerage Programme and Small Town Sewer Programme and monitor and review STPs operation
38	3.3.3	Develop Integrated Urban Water Management Plans to optimise the use of water, stormwater and sewage effluent

Council Planning Instruments

The IWCM planning process may also impact on the local environment plan (LEP and development control policies (DCP) which council has in place. While at this stage in the process, specific alterations needed to these instruments for IWCM have not been identified, Council may wish to consider now how this will be dealt with in Phase two of this process.

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