INTEGRATED

WATER

CYCLE

MANAGEMENT

ISSUES AND RESPONSES

Prepared by
Woodlots & Wetlands Pty Ltd

for

Gunnedah Shire Council

Document Registration

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Glossary[1]

[1] Where possible definitions and abbreviations are from widely available industry sources

ABS Australian Bureau of Statistics
Acidity: The chemical activity of hydrogen ions in soil. Usually expressed in pH units.
ADWF Average volume of sewage arranging at the STP during dry weather (usually in ML/day)
AWWF Average volume of sewage arranging at the STP during wet weather (usually in ML/day)
AHD Australian Height Datum
Al: Aluminium
ANZECC Australian and New Zealand Environment and Conservation Council
ARI Average Recurrence Interval
Biological Oxygen Demand (BOD) is a measure of the extent of organic contamination in water.
C Carbon
Ca Calcium
Cation Exchange Capacity. The total quantity of exchangeable cations that the soil can absorb. Includes Ca, Mg, Na, K, H and Al.
Cl Chloride
cm centimetres
Coarse sediment. Gravel coarse sand and 50% of fine sand
Constructed wetland. An artificially created system that includes ponds and shallow vegetated areas
Continuous Deflective Separation (CDS). Compact gross pollutant traps that operate by deflecting stormwater in a centrifugal flow, separating out the litter.
Crusting (surface sealing). The nearly horizontal orientation and packing of dispersed soil particles on in the immediate surface layer of soil. This greatly reduces water penetration, encouraging runoff.
CRC Co-operative Research Centre
CSIRO Commonwealth Scientific and Industrial Research Organisation
DEC NSW Department of Environment and Conservation. A mixed department containing EPA, NPWS, SCA and other authorities
Denitrification. A process of anaerobic respiration whereby microbes use oxidised nitrogen (nitrate) in the absence of oxygen. The nitrogenous gases produced by this process escape to the atmosphere.
Detention time. The time it takes for a 'parcel' of water to flow from the inlet to the outlet of a system
DEUS NSW Department of Energy, Utilities and Sustainability
dS/m decisiemens/metre A measure of electrical conductivity (1 dS/m=1000 microsiemens/cm)
Dispersion. The breakdown of soil particles into constituents such as clay, silt and sand via the process of deflocculation. Dispersion can lead to erosion, high rainfall runoff and turbid waters.
DNR NSW Department of Natural Resources, formerly DIPNR, DLWC, CaLM, WC&IC, SCS, etc
DSS Decision Support System
EP Equivalent person
Erodability. The susceptibility of soil to detachment and transport by water and wind. (The K value in the Universal Soil Loss Equation).
Faecal coliforms. A group of bacteria common in faecal material. Their presence in large numbers indicates contamination
G gram
Gross pollutant trap (GPT). A device to trap debris>5 mm from stormwater. Normally it has a trash rack immediately upstream
ha hectare (1 ha=100m*100m)
IWCM Integrated Water Cycle Management
Infiltration basins. Relatively large shallow pond with pervious floors that enable filtration of stormwater into the underlying strata
K Potassium
Kg kilogram
KL Kilolitre (1000 L)
km kilometre
L litre
LEP Local Environment Plan
LGA Local Government Area

Litter basket. A basket installed below an inlet pit to collect rubbish directly entering the stormwater system from roads
Litter boom. A floating device placed in drainage lines to capture floating litter and oil
LWU Local Water Utility
m metre
mg milligrams (1/1000 g)
Mg magnesium
mL millilitres (10^{-3}L)
ML megalitres (10^{6}L)
mm millimetres
Na Sodium
Nitrogen (N) includes organic N plus mineral N forms such as nitrate, ammonia and nitrite.
Oil/ grit separators. Baffled chambers designed to separate both floating oils and coarse sediments from stormwater exiting roads and parking lots.
On site sewage management based on treatment and return of sewage to the environment in a decentralised system
OSD Onsite detention. Typically involves a vault to capture a portion of stormwater and release it a t a rate that does no cause down slope erosion.
P Phosphorus
Percentile The percentage
pH A measure of acidity
POEO Protection of the Environment Operations Act 1997, NSW
Porous pavement. Pavement that allows water to enter the underlying strata rather than runoff.
PRG Project Reference Group
Riparian zone Lands adjacent to streams that are directly influenced by the stream
SAR sodium adsorption ratio. A measure of the ratio of sodium to calcium plus magnesium. It is used in conjunction with salinity data to determine the stability of irrigation water.
Sediment trap. A structure placed within a drainage line to capture coarse sediment
Slaking. The partial breakdown of soil aggregates in water due to clay swelling and soil gas pressure.
Sodic soil. A soil whose structure is degraded due to excess exchangeable sodium. Usually applies to soils where more than 6% of exchangeable cations are sodium.
Stakeholder Persons, organisations and authorities who have an interest in or are likely to be impacted by an event or project outcome.
STP Sewage Treatment Plant
t Metric tonne
t/ha tonnes/ha
Trash rack. A series of vertical bars with 40 mm spaces between them. Extends the width of a drainage line and is designed to retain gross pollutants such as PET bottles.
TSS Total Suspended Solids (usually in mg/L)
WSUD Water Sensitive Urban Design
WTP Water Treatment Plan

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1. INTRODUCTION

Gunnedah Shire Council needs to demonstrate best-practice management in order to qualify for financial assistance under the CTWS&S Program. The DWE document Best-Practice Management of Water Supply and Sewerage guidelines (DWE, 2007) identifies six criteria that are used to gauge Best-Practice Management. These are:

1. Strategic Business Planning
2. Pricing (including Developer Charges, Liquid Trade Waste Policy and Approvals)
3. Water Conservation
4. Drought Management
5. Performance Reporting
6. Integrated Water Cycle Management

As part of the IWCM process Gunnedah Council arranged preparation of the Concept Plan. This IWCM study identified local issues including:

- Security of water supplies
- Raw water quality
- Leakage and blockage of sewers and potable water pipes.
- Lack of a trade waste policy
- Relatively high use of water on residential allotments
- Heavy use of water in some parks and gardens and in some commercial and industrial premises
- Stormwater management, especially peak flow rates

The current investigation examines these issues and assesses the inputs required to address them.

The DWE guidelines indicate different level of inputs required to address issues:

- Issues that can be addressed by 'Business as Usual' approach simply require identification of the criteria used to identify success.
- Issues that require improved management, to achieve local Best Management Practice require a more detailed plan which sets out how the local Best Management Practice will be achieved
- Issues that require major capital works need to be addressed by developing an IWCM Strategy Plan. This Strategy Plan would include the six criteria listed above.

It is noted that Gunnedah council already has completed some of all the components listed in the checklists for the six criteria. The current report assesses the extent to which Council is adequately addressing the issues raised in the IWCM Concept Report. It then identifies any necessary additional actions needed to ensure the issues are adequately addressed.

The next section contains background information on the Gunnedah Shire and its water cycle management.

2. GUNNEDAH-BACKGROUND INFORMATION

This section characterises conditions in Gunnedah and in the region.

2.1 CATCHMENT CONTEXT

Location

The Shire of Gunnedah is located within the Namoi River Catchment, some 470 km NW of Sydney. The shire covers an area of 5,092 square kilometres. Figure 2.1 shows the shire location within the Namoi Catchment. Figure 2.2 shows Gunnedah Shire is bordered by the Tamworth Regional Council and Shires of Liverpool Plains (Quirindi), Narrabri and Coonabarabran.

Gunnedah is the service hub of the Shire. Outlying villages include Curlewis and Breeza to the southeast, Carroll to the east and Tambar Springs and Mullaley to the southwest.

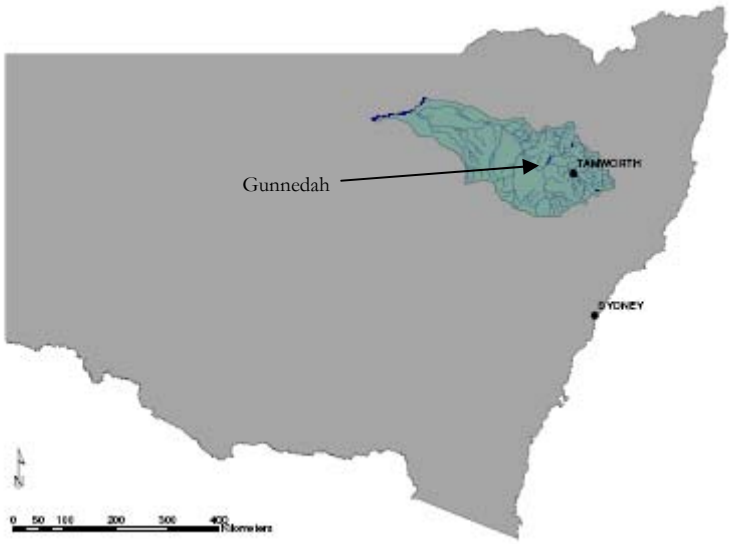


Figure 2.1. Gunnedah and its position within the Namoi Catchment (Source: River Styles Report for Namoi CMA).

This IWCMS is concerned all areas of the catchment related to the water supply, and all areas of the water utility business that impact on the catchment.

Population

Shire population in 1996 was 12,819 (ABS, 1997). This fell by 6.4% to 11,993 in 2001 (ABS, 2002). The non rural population has fluctuated considerably over the past few decades, having declined following closure of the Gunnedah abattoir and some coal mines. The proposed opening of new mines and other industries is likely to stabilise the population near its current numbers.

Rural industry employs 19% of the population. Other significant employers include retail (18%), manufacturing (11%) and community services (11%). Employment in mines can be significant at times (5% in 1996).

The populations supplied with reticulated water are: Gunnedah, Curlewis, Mullaley; and Tambar Springs.

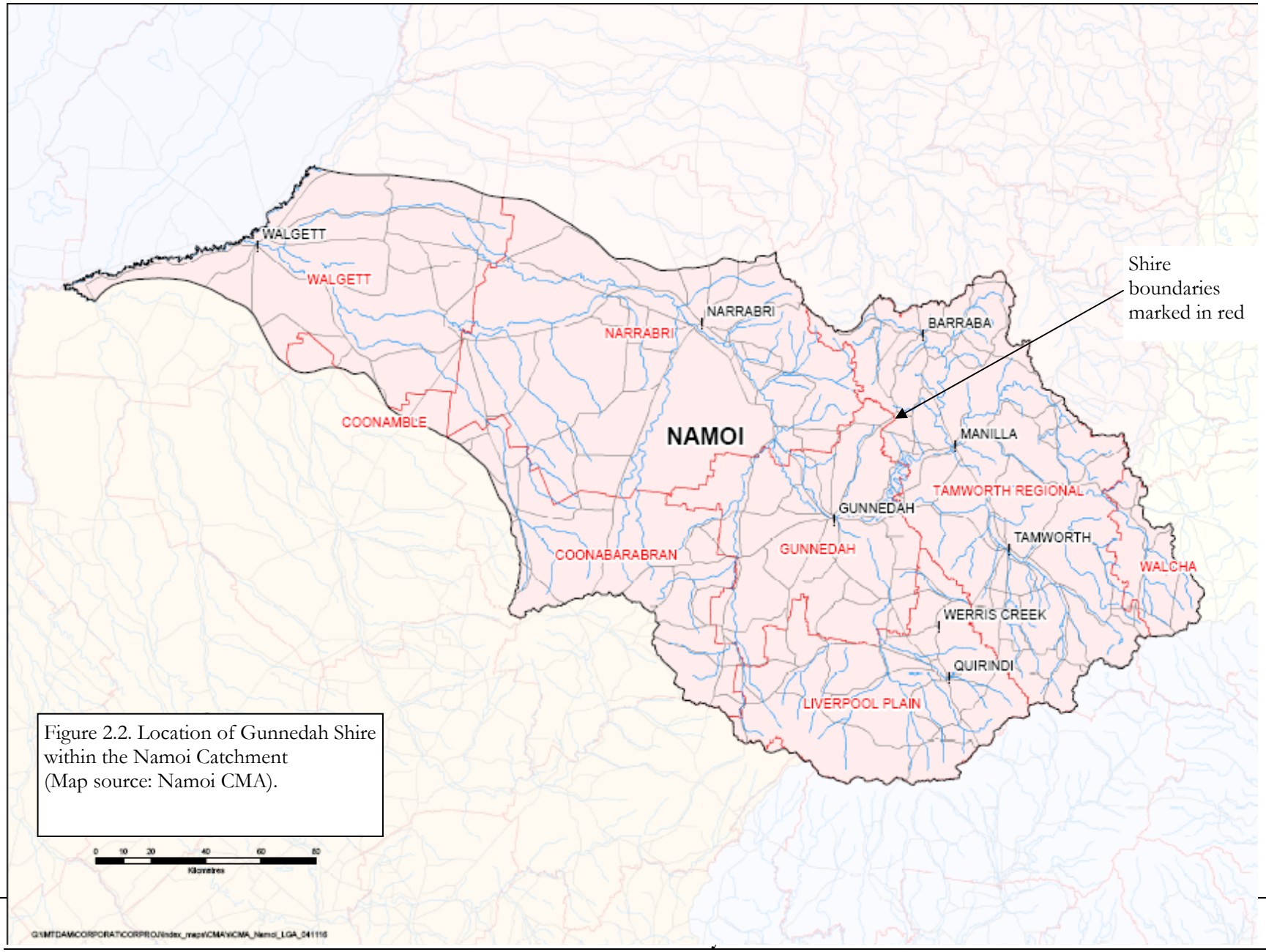


Figure 2.2. Location of Gunnedah Shire within the Namoi Catchment (Map source: Namoi CMA).

Economic environment

Agriculture is the major industry, generating some $220 million/year. Crop production contributes 78% of agricultural value, while livestock and livestock products contribute 18% and 4% respectively (ABS, 1997). Mining contributes $15 to $35 million/year. Other industries contribute $60m. However these figures are almost 10 years old and a combination of abattoir closure, increased coal mining and increased tourism is likely to have changed the relative contributions from different industries.

Landuse

Table 2.1 shows the area utilised by different rural production and the value of the output. Wheat is the major crop; however Cotton production is becoming increasingly important. Other summer crops such as sorghum are grown in response to anticipated market requirements.

Table 2.1. Crop production, area planted and gross value in the Gunnedah Shire (Source DPI).

Crop	Production		Gross Value ($'000)
	Hectares	Tonnes	($'000)
Wheat	51,647	105,428	26,122
Barley	16,972	29,888	6,447
Oats	3,276	4,197	509
Triticale	0	0	0
Chickpeas	186	148	47
Faba Beans	12	6	2
Field Peas	74	61	14
Lupins	0	0	0
Canola	238	106	38
Safflower	174	87	32
Soybean	332	548	217
Sunflower	7,897	6,725	231
Sorghum	14,232	45,912	9,129
Maize	854	6,728	1,547
Mungbeans	571	277	156
Cotton Seed	20,811	54,640	?
Vegetables	26	519	298
Total	117,302	255,270	44,789

EPA licenses

The licenses listed as current on the EPA website are shown below.

11222 CARROLL COTTON COMPANY PTY LTD licence summary CLIFTON ROAD CARROLL 2340

- Main issue: Largely concerned with air quality. Some contamination concentrations in water. No volume given).

Issued 11561 GUNNEDAH SHIRE COUNCIL licence summary KAMILAROI HIGHWAY GUNNEDAH 2380

- Saleyards. Issues include effluent disposal and ground water monitoring.

Issued 5940 GUNNEDAH SHIRE COUNCIL licence summary LOT 11 and Lot 12, QUIA ROAD GUNNEDAH 2380

- Landfill site. Leachate collection an issue.

Issued 831 GUNNEDAH SHIRE COUNCIL licence summary BOGGABRI ROAD GUNNEDAH 2380

- STP. LBL system in place. STP has exceeded N &P loads in the past.

Issued 1838 HANSON CONSTRUCTION MATERIALS PTY LTD licence summary RACECOURSE ROAD GUNNEDAH 2380

- Concrete batching. License refers to discharge of high pH, high TSS waters.

Issued 7193 HUNTER AND NEW ENGLAND AREA HEALTH SERVICE licence summary MARQUIS STREET GUNNEDAH 2380

- Main issue: Hospital waste.

Issued 1465 NAMOI FLOUR MILLS PTY LTD licence summary 91 - 93 BARBER ST GUNNEDAH 2380

- Largely concerned with dust and noise.

Issued 1863 NAMOI MINING PTY. LTD. licence summary BLACK JACK ROAD GUNNEDAH 2380

- Sedimentation pond discharges

Issued 2298 NAMOI MINING PTY. LTD. licence summary QUIA ROAD GUNNEDAH 2380

- Discharge to drain near coal loader

Issued 2634 NEW WAVE LEATHERS PTY LTD licence summary QUIA ROAD GUNNEDAH 2380

- Main issue: effluent discharge onto land.

Issued 3637 WHITEHAVEN COAL MINING LIMITED licence summary BOGGABRI ROAD GUNNEDAH 2380 Issued

- Main issue: dust

Effluent discharge from premises such as New Wave Leather Pty Ltd is typically as irrigation onto surrounding lands.

Climate

Climatic information is available from two stations in Gunnedah. Table 2.2 summarises key climate attributes. Gunnedah Shire has a warm continental climate with a typical daily range of 13 degrees. Average temperature varies from 25 degrees in summer to 10 degrees in winter.

Rainfall is highest in late summer. This often occurs within a series of thunderstorms, when the relatively intense rainfall of 12 mm/wet day can generate significant runoff and potential erosion. Average rainfall is lowest in late winter and an average of 6 mm falls each wet day. The 10 and

90%ile annual rainfalls are 74 and 174% of the mean annual rainfall. This suggests rainfall is moderately consistent among years.

Monthly pan evaporation ranges from 245 mm in December to less than 60 mm in winter. January evaporation is slightly less than December's reflecting higher humidity and rainfall in late summer. Moisture deficit was calculated by comparing rainfall less estimated runoff with 80% of pan evaporation. Table 2.2 shows there is an irrigation deficit under average conditions in each month. However there is also a very strong seasonal influence. Minimal irrigation is required in the average winter, while in summer over 100 mm of water is required each month.

Table 2.2. Climate conditions in the Gunnedah area (Source: BoM).

Attribute	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Daily Max Temp (deg C)	32	31	29	25	20	17	16	18	21	25	28	31	25
Mean Daily Min Temp (deg C)	19	19	17	13	9	6	5	6	8	12	15	17	12
Mean Daily Temp (deg C)	25	25	23	19	15	11	10	12	15	18	22	24	18
Mean Rainfall (mm)	89	72	42	41	47	37	43	36	38	61	66	65	636
Median (Decile 5) Rainfall (mm)	74	61	36	22	41	35	30	32	31	57	62	59	649
Decile 9 Rainfall (mm)	202	140	97	126	99	76	91	82	77	114	134	126	859
Decile 1 Rainfall (mm)	17	9	1	2	2	4	7	4	4	12	13	16	365
Mean no. of Raindays	7	6	5	4	5	6	6	6	6	7	7	7	72
Mean Monthly Evaporation (mm)	239	188	186	129	84	57	59	84	117	164	198	245	1752
Estimated irrigation deficit (mm/month)	111	85	111	66	25	12	8	34	59	77	99	138	829

The results above indicate Gunnedah has a moderately dry warm climate. Rainfall is reasonably reliable, at least on an annual basis. Irrigation is required every month in the average year.

Geology

The Shire is within the Gunnedah Basin. This basin extends from Bellata in the north to the Liverpool Ranges to the south (Harrington, 1977). The basin was formed in the late Carboniferous / Early Permian period and involved overlying a volcanic chain which supplied sediments to the region in the Devonian and Carboniferous periods.

According to Harrington (1977) a shallow sea covered the region in the early Permian period. Infilling of this sea with organic material created extensive peat deposits that have now been converted to coal. Widespread deposition of sandstone and mudstone occurred during the Triassic period.

There was intermittent volcanic activity between the late Triassic and the Tertiary periods. Sediments were eroded from the New England Tablelands and the Liverpool Ranges, and these have now been covered with Quaternary alluvium, creating the Liverpool Plains. The stratigraphy of the region is described in Packham (1969).

Figure 2.3 shows that much of the Shire is flat and covered with alluvium. There are isolated areas of steep metasediments to the south of Gunnedah township. Volcanic remnants occur near Mullaley. Figure 2.4 indicated that the bulk of the Shire is within the Liverpool Plains landscape.

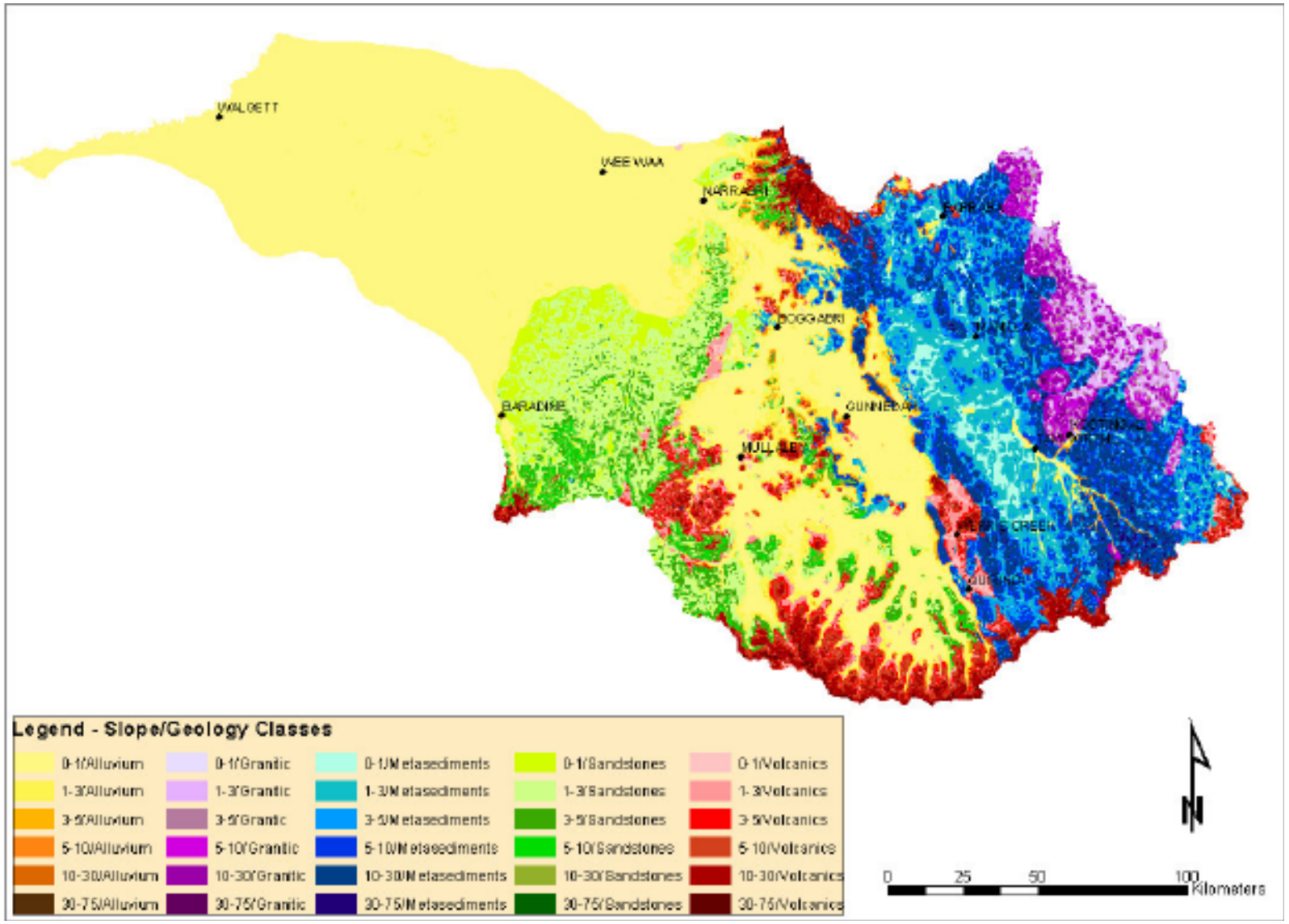


Figure 2.3. Slope and geology classes within the Namoi catchment. (Source: River Styles Report for Namoi CMA).

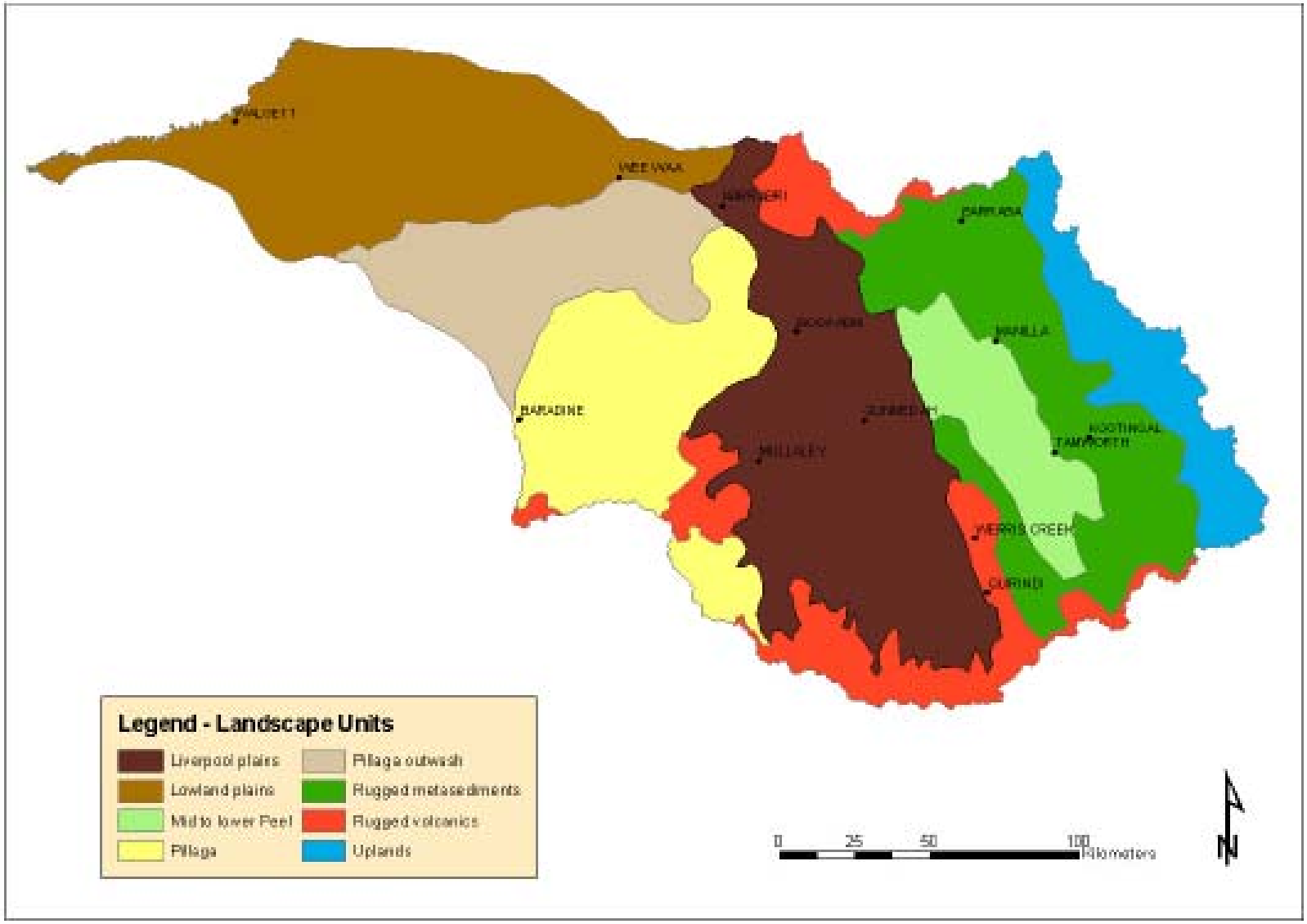


Figure 2.4. Landscape units within the Namoi Catchment (Source: River Styles Report for Namoi CMA).

Soils

Detailed soil landscape information is available for the southern portion of the shire in the Curlewis Soil Landscape book (Banks, 1995). Northern portions of the Shire are included in the unpublished Soil Landscape Book for the Boggabri area.

Soil types in the shire are summarised in table 2.3. Soils with uniform texture (vertosols and kandosols) cover 80% of the shire. The soils are usually relatively recently formed and can be fertile. Sketal soils such as the Pilliga Soil Landscape Group are common in the south west portion of the shire as figure 2.4 shows. These soils are usually infertile.

Table 2.3 Major soil types in the Gunnedah Shire. (Source: derived from Bailey, 1995)

Great soil group	Classification based on Isbell (1996)	Percentage of shire covered (%)
Black Earth	Vertosols	30
Brown and Grey Clays	Vertosols	18
Red Earth/Brown Earth	Kandosols	28
Gravelly Red Earths	Kandosols	4
Skeletal	Tenosols and Rudosols	9
Gravelly Solodics	Sodosols	3
Euchrozems	Ferrosols	5
Sandy Yellow Solodics	Sodosols	2
Disturbed and others	Various	1

Erosion

According to Bailey (1995), over 9000 ha of the Gunnedah Shire had severe to extreme sheet or rill erosion. This erosion would contribute to a significant sediment load reaching the Namoi and its tributaries. These sediments would contain nutrients that facilitate algal blooms. Table 2.4 shows that less than 1% of the Shire had salinisation in 1995. It is likely that this has increased appreciable in the past decade.

Changes in agricultural activity and more widespread use of conservation farming may have reduced the spread of erosion over the past decade; however areas of severe to extreme erosion will remains a threat to land utility and water resources for decades to come.

Bailey (pers comm) suggested that salinisation and waterlogging is likely to be more obvious now than in 1995.

Salinity is largely confined to the break of slope between the metasedimentary rock and the soils of the Liverpool Plain. These occur where the lower hill slopes intersect the Liverpool Plain.

Bailey (1995) also examined stream bank erosion. He reported that over 120 km of stream banks within the Shire had vertical banks in excess of 3m. Table 2.5 shows this is 26% of the total stream length examined. The result suggests stream bank collapse can be a major sediment management issue

Table 2.4 Erosion type and severity as a percentage of shire area (Source: derived from Bailey, 1995).

Erosion type and severity	Percentage of shire affected
No appreciable erosion	57
Minor sheet and rill erosion	34
Moderate sheet and rill erosion	7
Severe sheet and rill erosion	2
Extreme sheet and rill erosion	<1
Wind erosion	Nil
Salinisation	<1
Mass movement(slides, slumps, rock debris)	<1

Table 2.5. Stream bank heights in Gunnedah Shire. (Source: Based on investigations reported by Bailey, 1995).

Height of stream bank	Length of streams with this height class (km)	Percentage of stream banks with this height class.	
<1.5m	161	35	
1.5 to 3m	178	39	
3 to 6m	86	19	
>6m	34	7	

Gully erosion is another significant land management issue in Gunnedah Shire. Bailey (1995) reported there was almost 200 km of moderate to extreme erosion gullies over 1.5m deep in the Shire. All of these gullies were active at the time of the survey.

Topography

Much of the shire is associated with alluvial plains of the Namoi and Mooki River systems. The area is described in Greenwood (1982) as near level plains developed from deposition of alluvium during the Quaternary period. Table 2.4 shows 85% of the shire has slopes less than 5%. The lack of slope in much of the LGA is demonstrated in figure 2.3.

In some areas the Mesozoic surface protrudes as strongly weathered residual ridges of low isolated hills. The hill ridge systems are asymmetrical in form with steep to precipitous slopes on the eastern faces and relatively gentle western slopes. Table 2.6 shows over 4% of the shire has slopes exceeding 20%.

The major peaks of the Shire are Tulcumba (885m), Mount surprise (647m), King Jack Mountain (761m) and Tambar Mountain (805m) (Gunnedah Shire Council, SoE, 2003/04).

Highest points in the Gunnedah township area include Blackjack Mountain (670m), Porcupine Hill (450 m) to the south-east of Gunnedah, and Borethistles Hill (360 m) and Pensioners Hill (340 m) the west of Gunnedah (Planning Workshop, 1981).

Table 2.6. Slope classes in the Shire. (Source: Copied from Bailey, 1995).

Slope range	Percentage of shire
<2%	64
2 to 5%	21
5 to 10%	7
10 to 20%	4
20-33%	2
33-50%	2
>50%	<1%

Terrain

Bailey (1995) divided the terrain of the shire into various types. The main ones are shown in table 2.7. Over 95% of the Shire consists of plains, floodplains, footslopes and side slopes.

Table 2.7 Major types of terrain in Gunnedah Shire (derived from Bailey, 1995).

Terrain type	Percentage
Floodplain	37
Plain	3
Drainage plain	1
Footslope	35
Side slope	19
Water bodies	2
Other	3

Table 2.7 shows that floodplains are a major feature of the Gunnedah Shire. These plains extend up to 20 km on either site of the main stream lines.

Drainage systems

The Namoi and Mooki Rivers and Cox's Creek flow through the northern, south-eastern and western sections of the Shire respectively (Gunnedah Shire Council web site accessed 20.2.06).

The Namoi River rises as the MacDonald River in the New England Plateau and flows over the lower slopes of the Great Dividing and Liverpool Ranges to the Barwon floodplain at elevations of less than 150 metres. It is one of the main tributaries of the Barwon-Darling River System, draining an approximate area of 43,000 square kilometres (17,100 square kilometres at Gunnedah), starting near Walcha in the east and flowing in a north-westerly direction to Walgett in the west of NSW.

The Mooki River drains the south-eastern portion of the Shire, including the Liverpool Plain downstream of Breeza. It enters the Namoi River four kilometres upstream of Gunnedah.

Cox's Creek flows through the west of the Shire passing Tambar Springs, Mullaley and Boggabri, where it enters the Namoi River.

Impact of Keepit Dam

Keepit Dam is the major storage on the Namoi River and it lies partly within the Shire, upstream of Gunnedah. The 423,000 ML storage covers some 4,400 ha and is designed to regulate water supply to cotton farmers. Figure 2.5 shows the percentile distribution of flows in the river at Gunnedah before 1960 and since 1990. There has been a small decrease in flow over much of the curve. For example at the 50% flow (i.e. half the time the flow exceeded this rate), prior to the dam there was around 452 ML/day. Since 1990 the 50% flow is 347 ML/day.

Figure 2.5 . Percentile flow distribution in the Namoi River at Gunnedah for pre (1891 to 1960) and post dam (1990 to 2006) periods (Source: DNR).

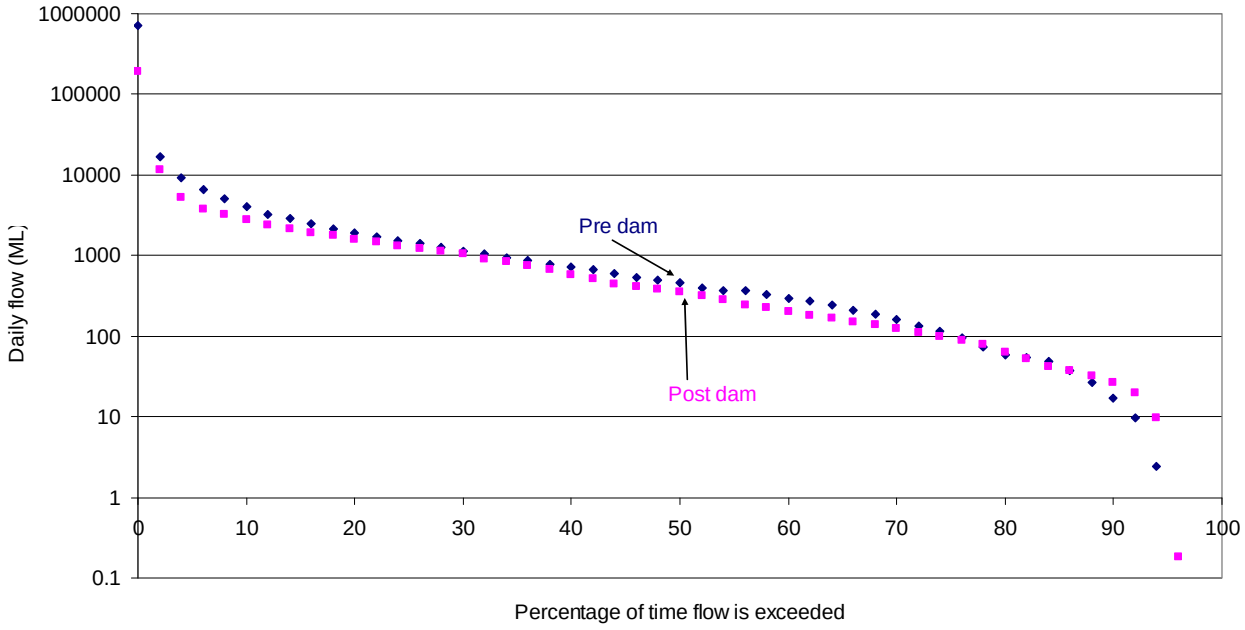
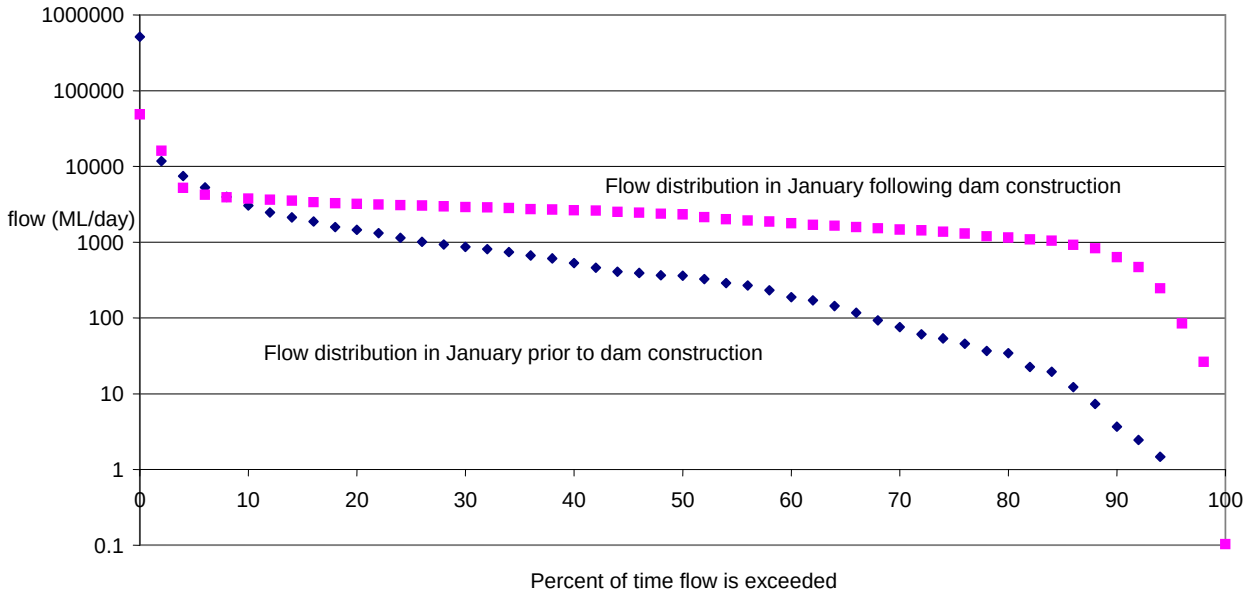


Figure 2.6 shows the effect of the dam management is very marked during the irrigation season. For example in January prior to 1906 median flow was 362 ML/day. Since 1990 it has been 2333 ML/day. Figure 2.6 also shows the flow is less variable since dam construction. For example the 10% exceedance for January flow pre 1960 was 3077 ML/day. This fell 34 fold to 34 ML/day for the 80% exceedance flow. In contrast the flow since 1990 is 3770 ML/day while the 80% flow rate is 1152 ML/day. That is, under natural conditions there is a 99% fall in rate between 10% and 80% flow exceedance. This is much greater than the 70% fall in rate between 10% and 80% flow in January since 1990. Continuous unseasonal high flows in January can result in marked changes in river ecology. For example it can increase habitat for European Carp.

Figure 2.6. Percentile flow distribution during January in the Namoi River at Gunnedah for pre (1891 to 1960) and post dam construction (1990 to 2006) periods (Source: DNR).



River styles

A river styles assessment was recently prepared for the Namoi CMA. This assessment is designed to identify stream conditions and assist in setting remediation priorities for the Namoi Catchment. Figure 2.7 shows the Namoi River within its catchment context.

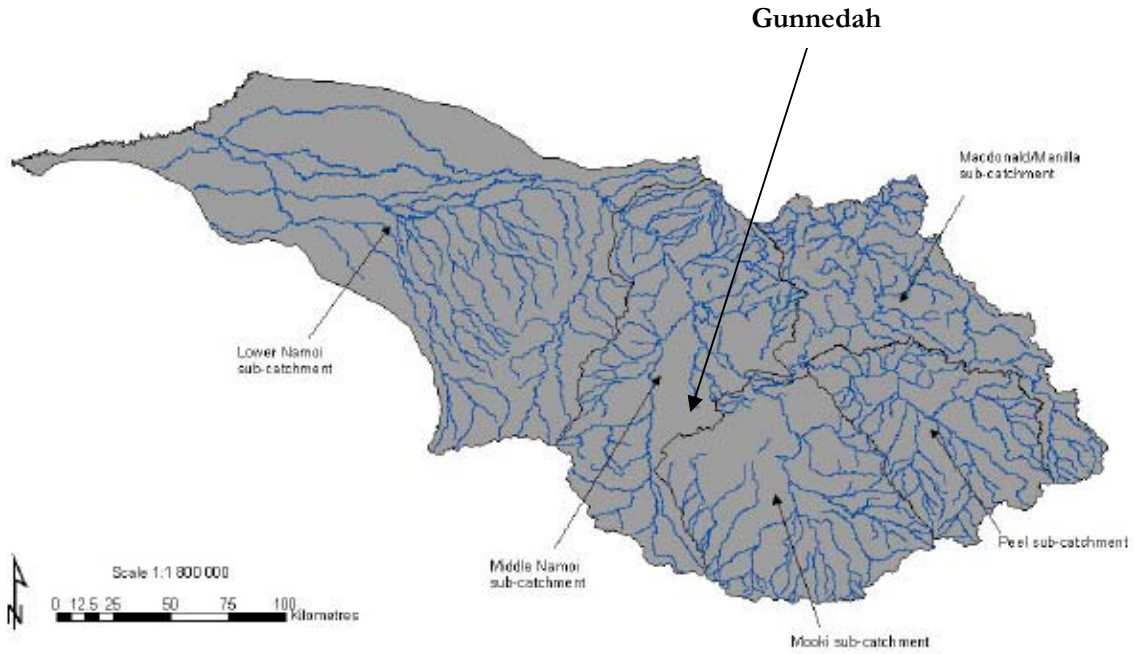


Figure 2.7. Namoi Catchment drainage system (Source: Namoi River Styles Report Namoi CMA).

Figure 2.8 shows the long profile of the Namoi River as well as that of Mooki River and Coxs Creek. Near Gunnedah township the Namoi River is a low slope, low sinuosity, gravel based river.

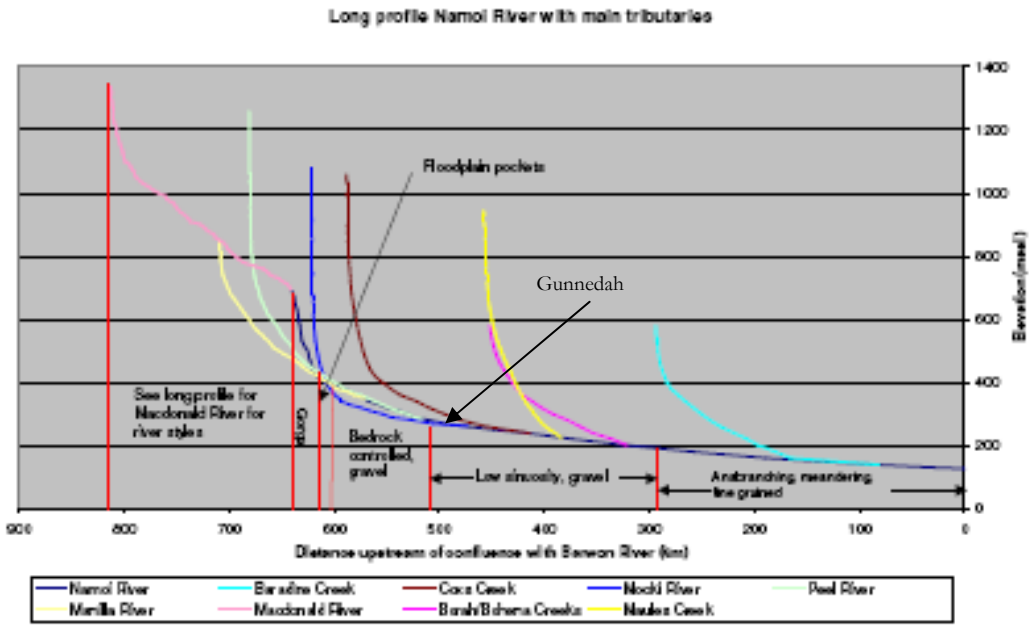


Figure 2.8. Long profiles of the Namoi and Mooki River and of Coxs Creek.
(Source: copied from Riverstyles Report for Namoi CMA.

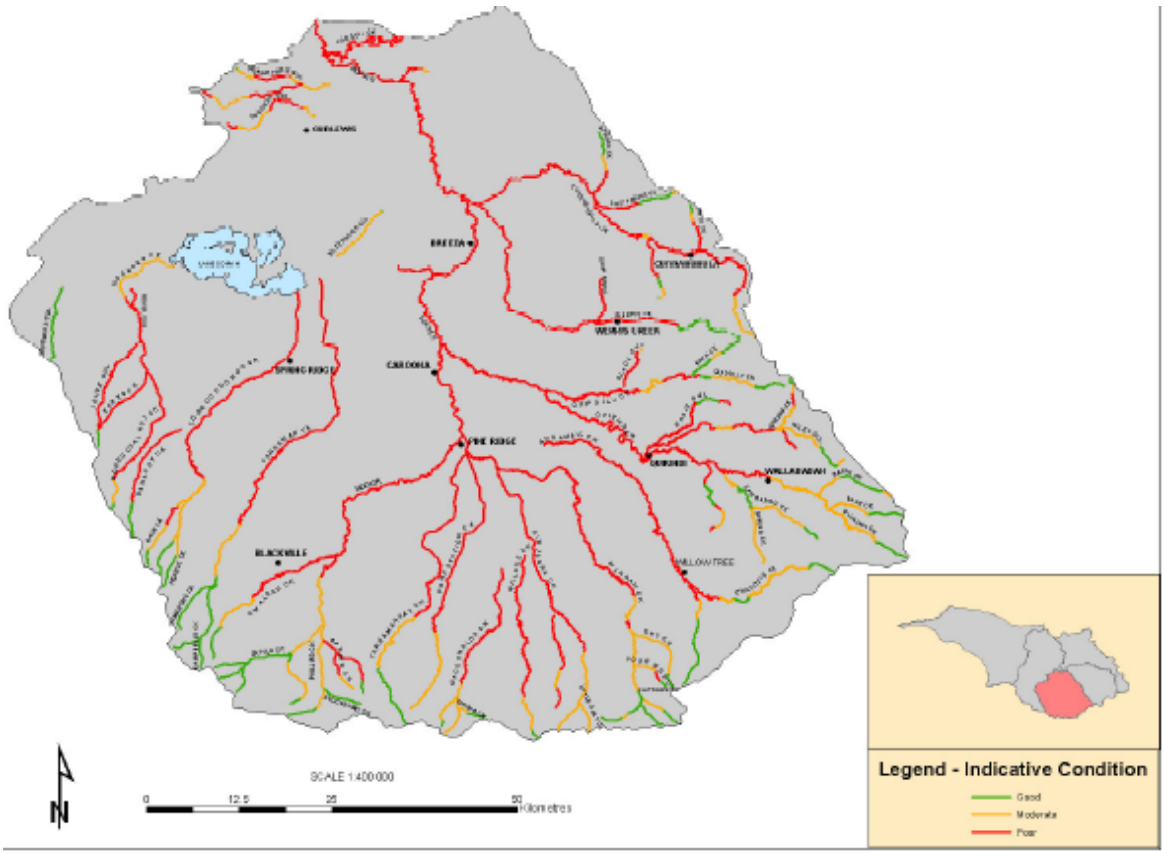


Figure 2.9. Indicative river conditions in the Mooki River subcatchment. (Source: Namoi River Styles Report for Namoi CMA).

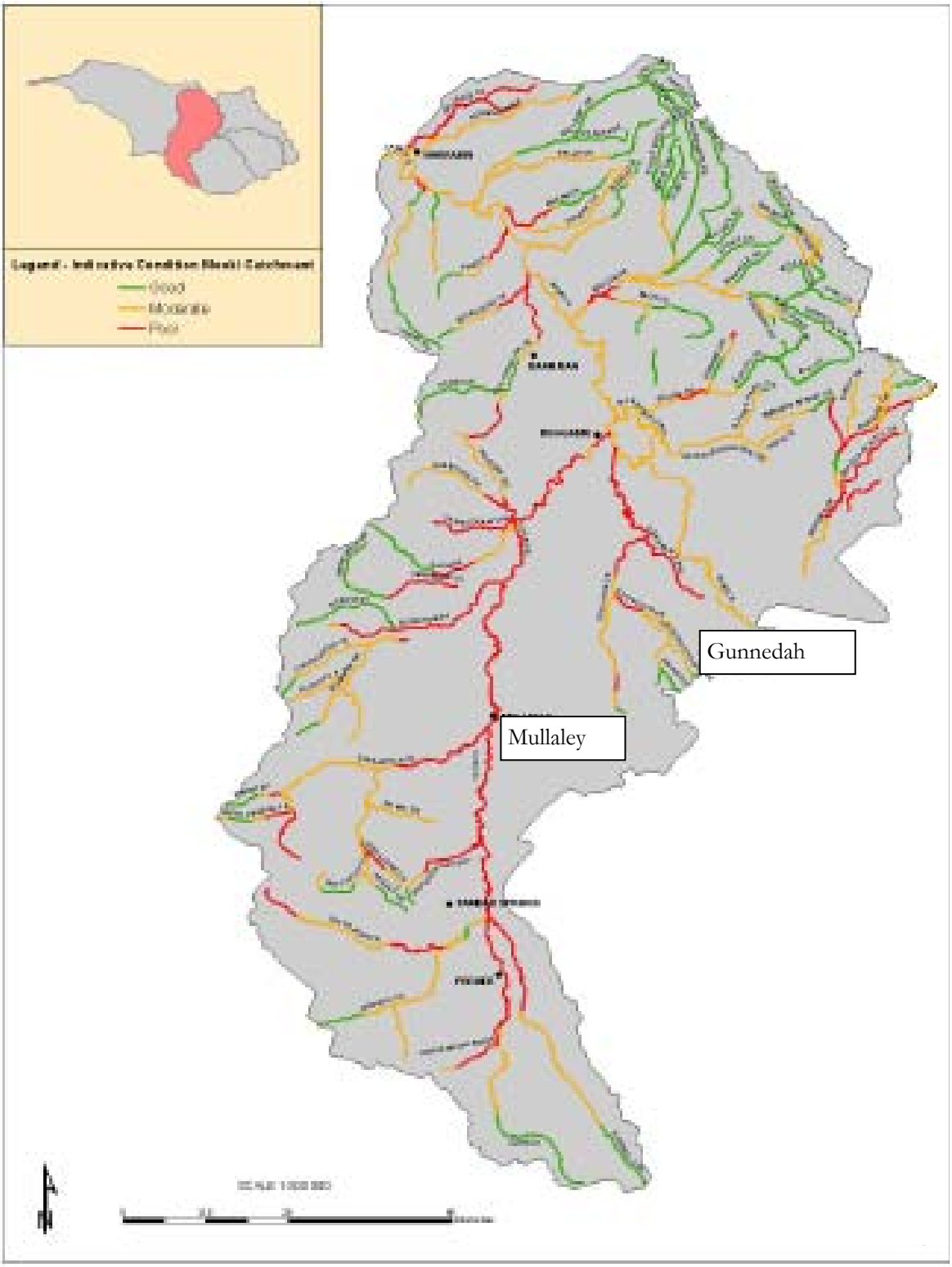


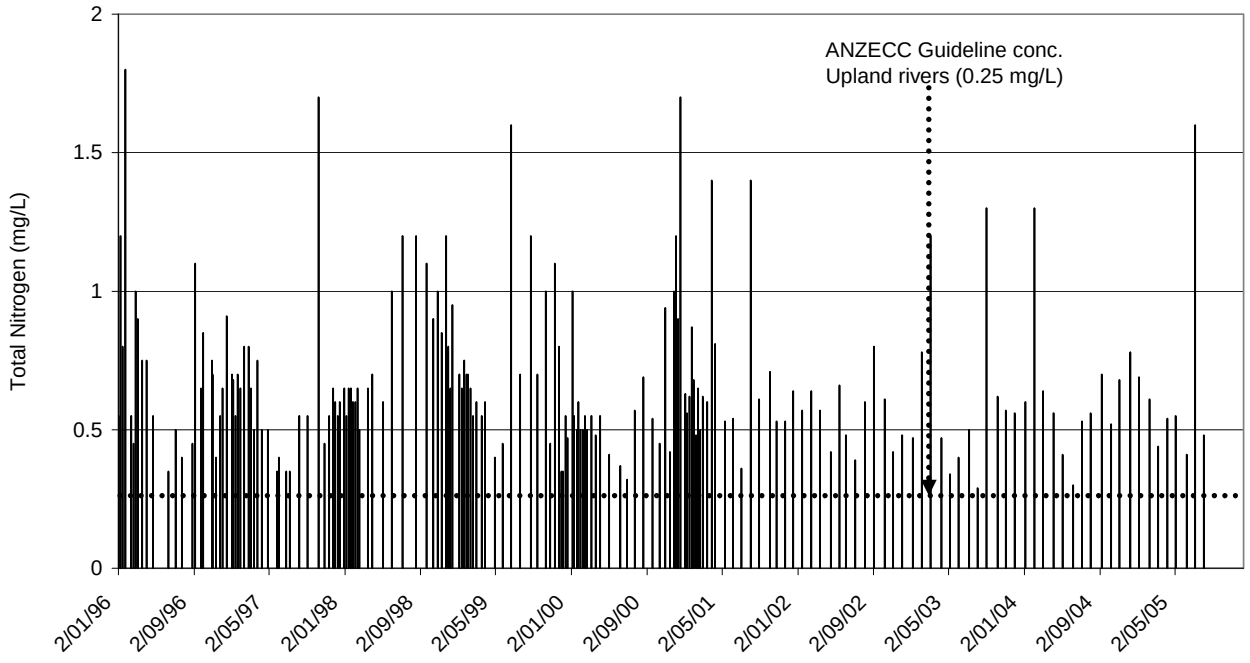
Figure 2.10. Indicative river conditions in the Mooki River subcatchment. (Source: Namoi River Styles Report for Namoi CMA).

Figure 2.9 shows the river condition in the Mooki subcatchment while figure 2.10 shows conditions downstream of Gunnedah. It is obvious that much of the stream length within the Liverpool Plains is in poor condition. This is correlated with loss of the stipa grasslands (Wallbrink, et al, 1998).

Water quality in the Namoi River

Figure 2.11 shows Nitrogen concentration in the Namoi River at Gunnedah virtually always exceeds the ANZECC Guideline for Aquatic Ecosystem Protection (ANZECC, 2000). The elevated nitrogen concentration is likely to reflect the intensive irrigation found in the catchment.

Figure 2.11. Total Nitrogen concentration in the Namoi River at Gunnedah.



Phosphorus concentration is also very high compared with the ANZECC Guideline concentration for aquatic ecosystem protection as figure 2.12 shows. The high phosphorus concentration can result in algal blooms. These blooms can make treatment of water for potable use difficult and expensive.

Figure 2.12. Phosphorus concentrations (mg/L) in the Namoi River at Gunnedah.

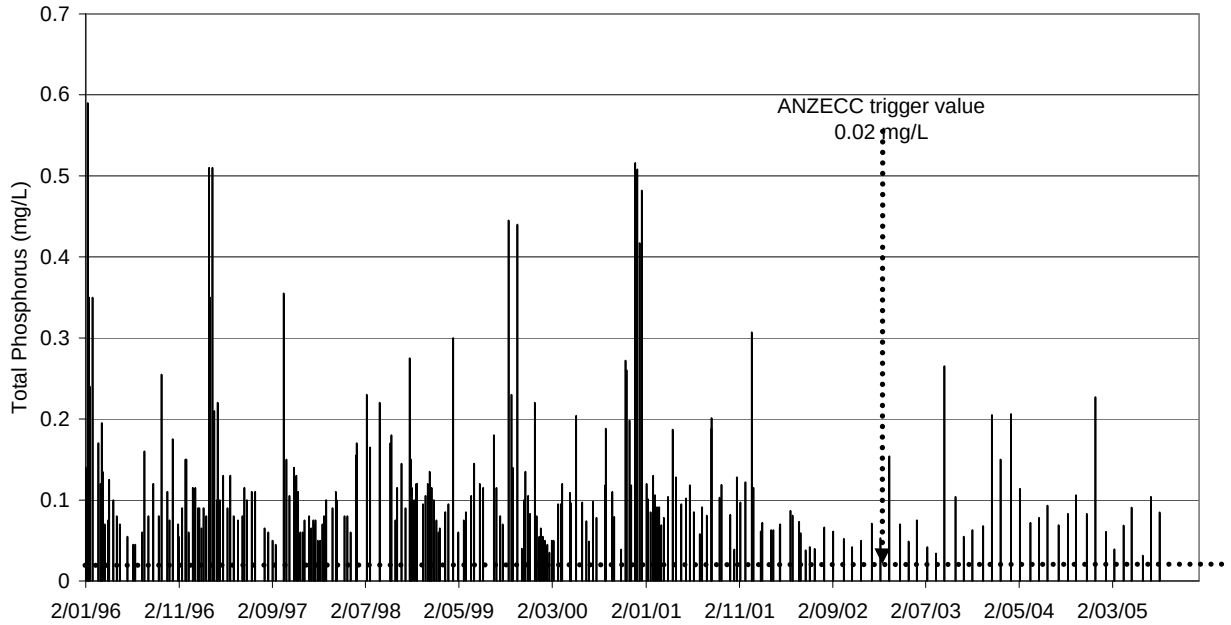
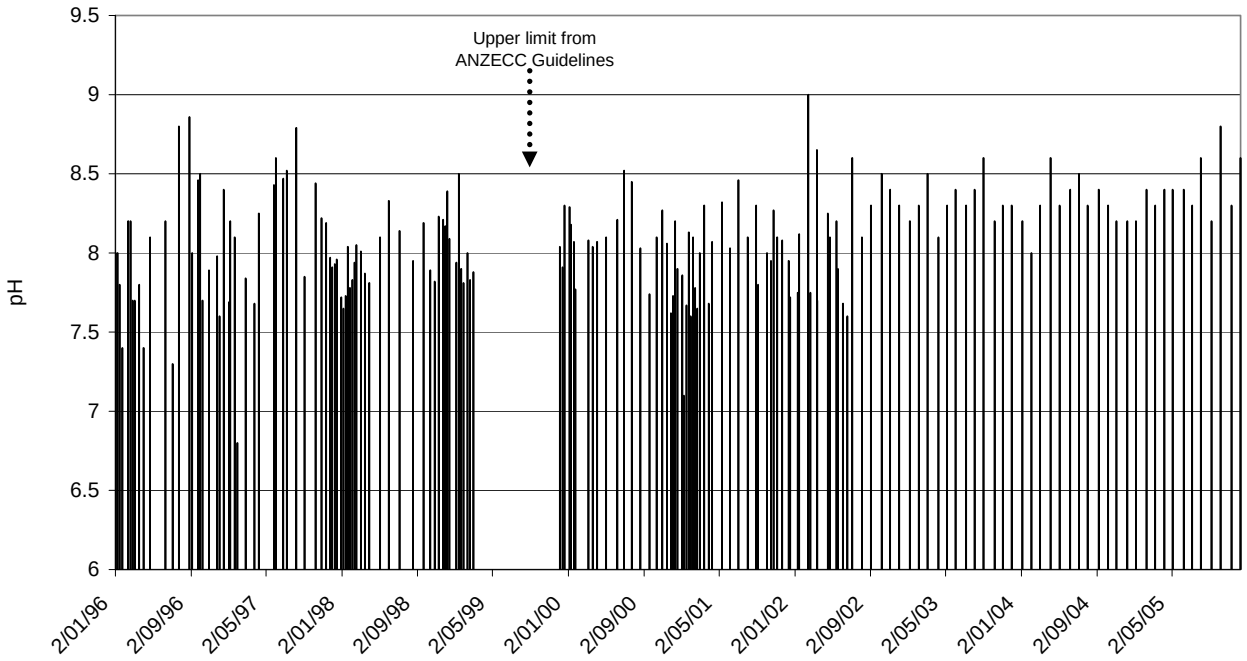


Figure 2.13. pH in the Namoi River at Gunnedah.



According to the ANZECC guidelines the pH should not exceed 8.5, however figure 2.13 shows the pH in the Namoi River exceeds this value on numerous occasions. Intermittent high pH is commonly associated with algal blooms.

Figure 2.14. Relationship between stream level (gauge height) and Phosphorus concentration at Gunnedah since 1996.

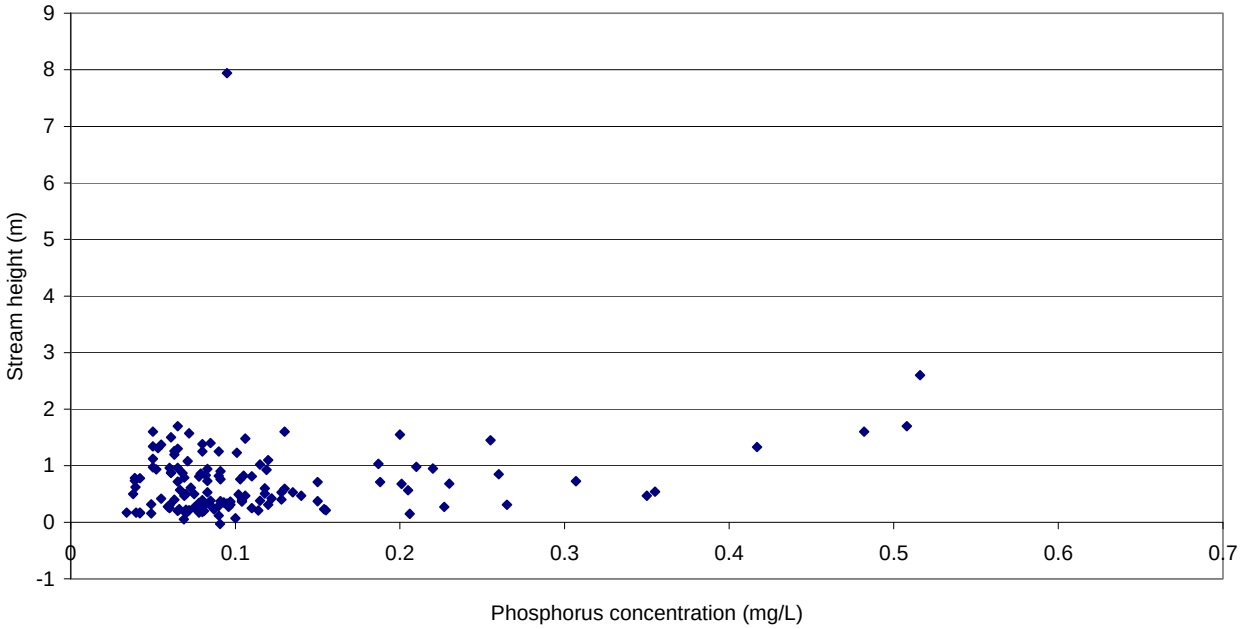


Figure 2.14 shows there is minimal relationship between river height and Phosphorus concentration in the Namoi River at Gunnedah. The river always contains elevated Phosphorus concentrations.

Catchment water quality objectives

Interim catchment water quality objectives were established by the EPA (now DEC) in 1997. These are shown in figure 2.15. Figure 2.16 shows the assessment of the Namoi catchment near Gunnedah in 1997.

Mooki River had moderate salinity and rarely met the water quality criteria for aquatic ecosystem protection. There was no information on Coxs Creek. There was a Namoi River sampling site within Gunnedah and one immediately downstream. The site within Gunnedah meets water quality criteria for primary contact recreation (e.g. swimming) and for aquatic ecosystem protection in less than 50% of samples. Downstream of Gunnedah the water quality improved slightly and it met quality criteria for swimming in over 75% of samples. Salinity was moderate at all sites.

The results indicate Gunnedah township has a minor impact on Namoi River water quality. This is likely to be due to a combination of urban stormwater and salt incursion.

Salinity is a regional issue that occurs naturally. However land clearing and irrigation will have increased its severity.

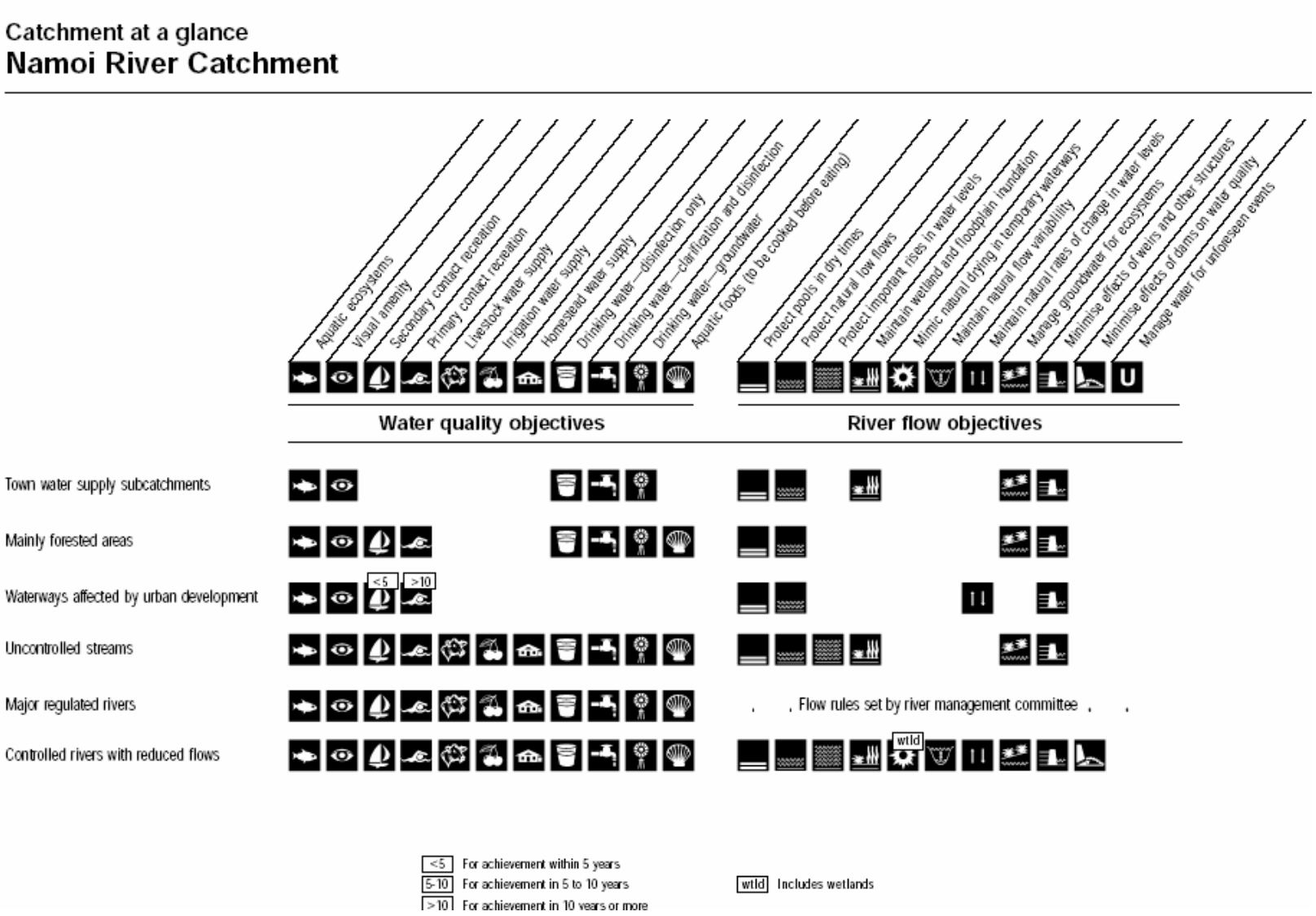


Figure 2.15. Namoi Water quality objectives for different end uses (Source: EPA, 1997).

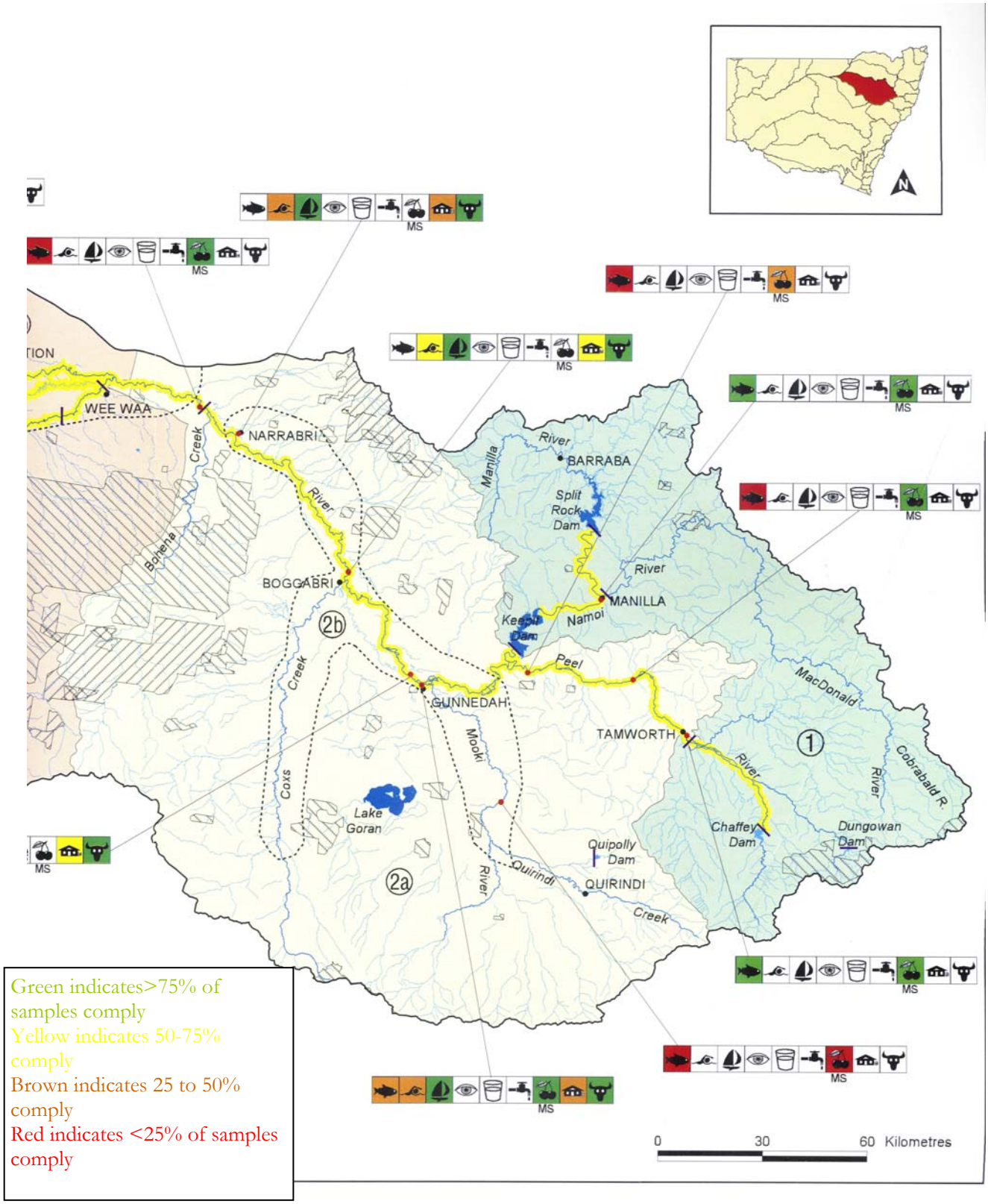
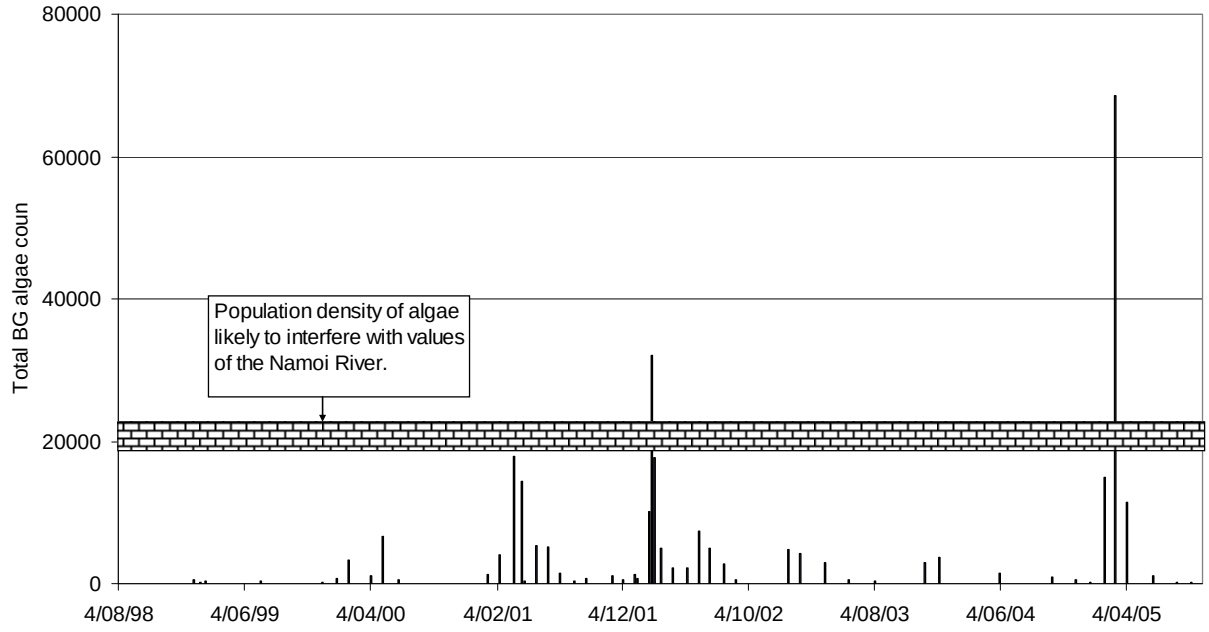


Figure 2.16. Extent of compliance with Interim Water Quality Objectives in streams in the Gunnedah region of the Namoi River Catchment (Source: EPA, 1997). .

Presence of algae in the Namoi River

Blue green algae population can increase to nuisance values in some rivers. Impacts of the algae include obstruction of waterways, clogging of filtration systems, reduction in fish habitat, odour production and the potential for releasing toxins into water supplies making them unfit for consumption (ANZECC, 2000). Figure 2.17 shows the algae count in the Namoi River downstream of Keepit Dam.

Figure 2.17. Total Blue-green algae count in water down stream of Keepit Dam since 1998.



There are periods in 2001, 2003 and 2005 when the indicative threshold of 15,000 to 20,000 cells/mL was exceeded. The presence of algae in the Namoi River is not a direct threat to Gunnedah water supply; however it can make the river less attractive for swimming and passive recreation (ANZECC, 2000).

Salinity hazard

Salinity hazard mapping has been carried out on a regional, 1:250,000 scale (Collins and Donaldson, 2002). The mapping utilised modelling that incorporated geological complexity, lithology, soil salt load, soil permeability, change in slope and rainfall. Anthropogenic impacts such as vegetation clearing, urbanisation, dam construction and irrigation are not considered. Figure 2. shows there is an area of moderate to very high salinity hazard land in the triangle between Breeza, Gunnedah and Mullaley. This result is consistent with the moderate salinity reported in Mooki River and Coxs Creek that flow on either side of the salinity hazard belt shown in figure 2.18.

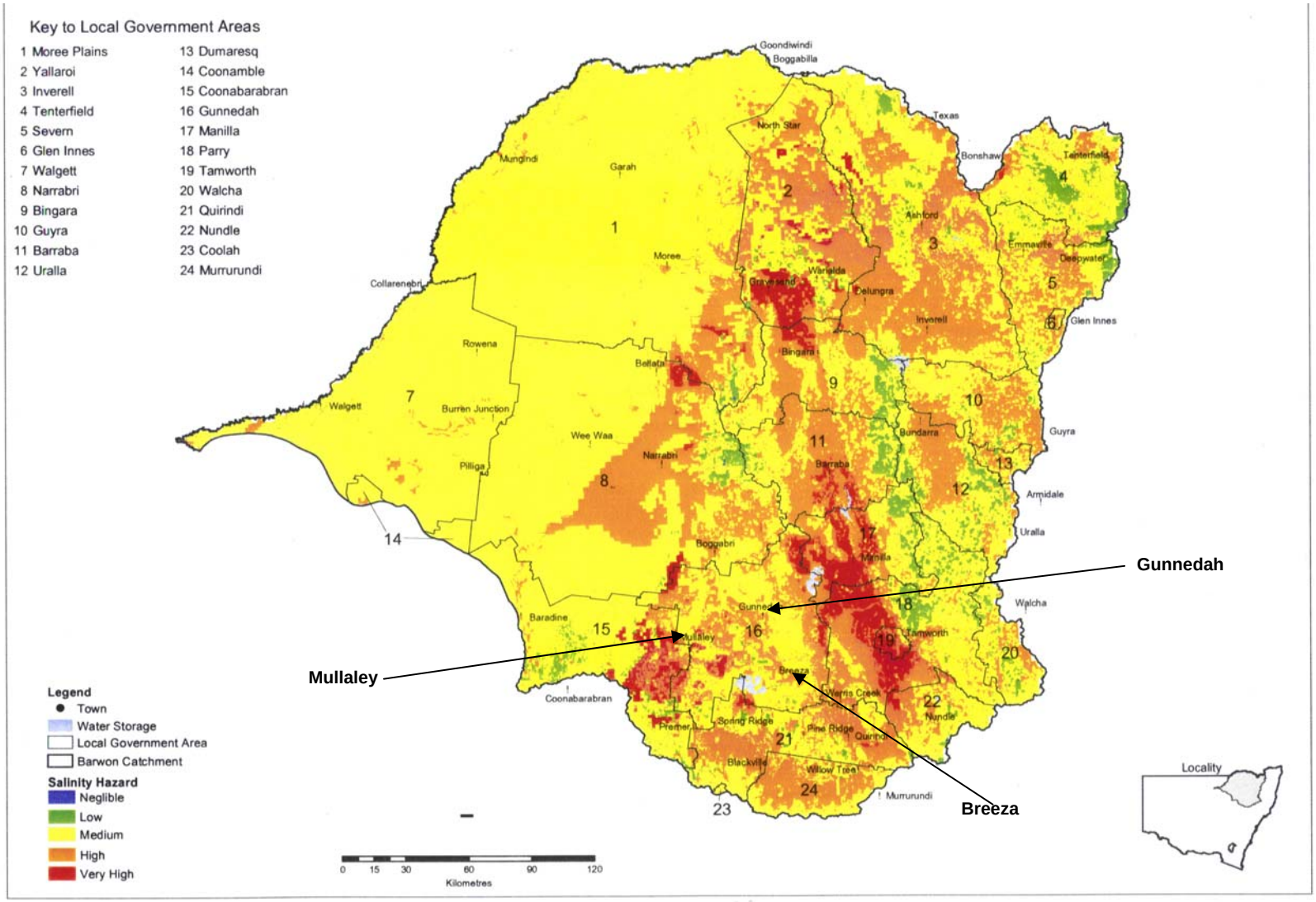


Figure 2.18. Regional salinity hazard map (Source: Collins and Donaldson, 2002).

Groundwater resources

Groundwater in the Namoi Catchment is vital for both agricultural and urban use. The 2003 Water Sharing Plan for the Upper and lower Namoi Groundwater Sources (DLWC, 2003) recognises the importance of the groundwater and the Plan identifies the very substantial fall in agricultural use of groundwater that is required to ensure long term resource sustainability. It is understood that the volume of water that can be extracted by individuals will be reduced to be consistent with the sustainable yield. The historic extraction rate will be used to adjust extraction allocations. Plan implementation has been suspended until July 2006 to allow stakeholder consultation (DNR, 2006). Table 2.8 shows the estimate recharge and the potential water extraction rate based on access licenses in different zones along the Namoi Catchment.

Table 2.8. Estimated water store recharge, licence allocation, volumes of water on town water licenses and the % reduction in access licence volume (DLWC, 2003).

Zone	Estimate recharge to each zone and proposed extraction limits. (ML/year)	Domestic and stock right (ML/year)	Water requirements based on access licenses (ML/year)	Town water access licenses and allocation volumes	Reduction in agricultural access license volume as given in the Namoi Groundwater Sharing Plan
1	2100	39	8510	1650 (Quirindi) and 66 (Willow Tree)	87%
2	7200	359	23801	59 Mullaley	70%
3	17300	470	56017	199 Curlewis	69%
4	27500	667	82590	3900 Gunnedah, 760 Boggabri	73%
5	16000	262	36042		45%
6	14000	272	11448		0%
7	3700	89	6321		41%
8	16000	166	48204	56 Caroona	67%
9	11400	187	11342	42 Tambar Springs, 55 Premer	0%
10	4500	36	1420		0%
11	2200	210	8740		75%
12	2000	73	7487		73%
Lower Namoi	86000	3304	172187	3500 Narrabri, 900 Wee Waa, 7 Rowena.	51%
Total	209900	6134	474109		

It is obvious from table 2.8 that allocations are more than twice the sustainable yield. Town use is less than 10% of sustainable yield, and is guaranteed under the Plan. . However town supply is put at risk when actual extraction exceeds recharge estimates. In the case of Zone 4 (the one containing Gunnedah township), the current extraction of around 35,000 ML/year exceeds the estimated sustainable yield of 25,700 ML by 30%. The Groundwater Sharing Plan has reduction in extraction rate to 100% of average annual recharge as its first target. This is considered critically important for the maintenance of town water quality in the long term.

Groundwater vulnerability

Groundwater vulnerability has been assessed in portions of the Gunnedah Shire. The results are shown below. Figure 2.19 shows groundwater resources near Gunnedah township is classified as having moderately low risk and groundwater contamination must be avoided.

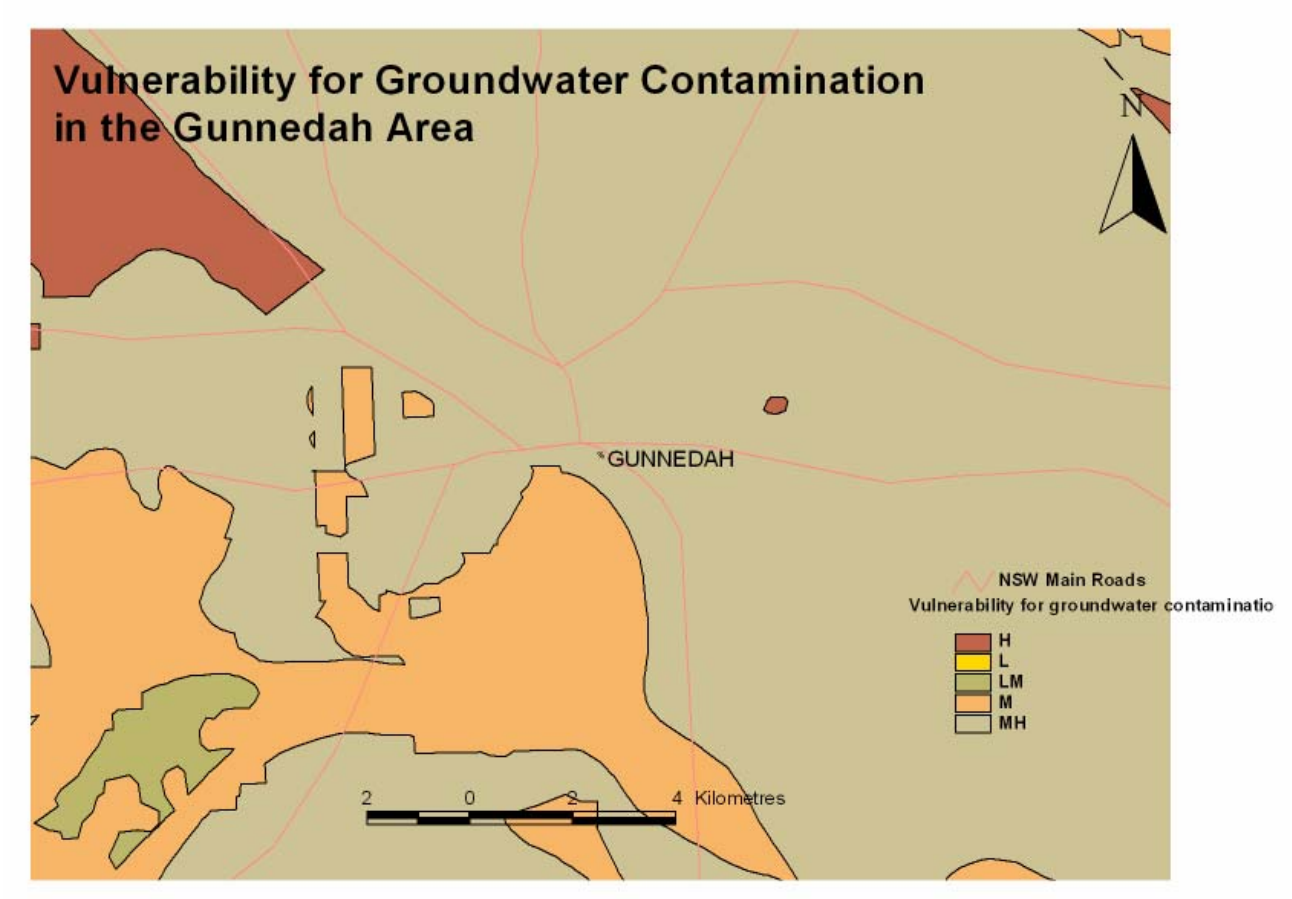


Figure 2.19. Groundwater vulnerability to contamination in area around Gunnedah township (Source: DNR).

Figure 2.20 shows the groundwater vulnerability to contamination in area around Mullaley is in the moderate range. While figure 2.21 shows the area around Tambar Springs has moderately low risk.

These results suggest the risk to groundwater resources near urban areas is low to moderate. The main concern is to reduce extraction rates so that water quality is maintained.

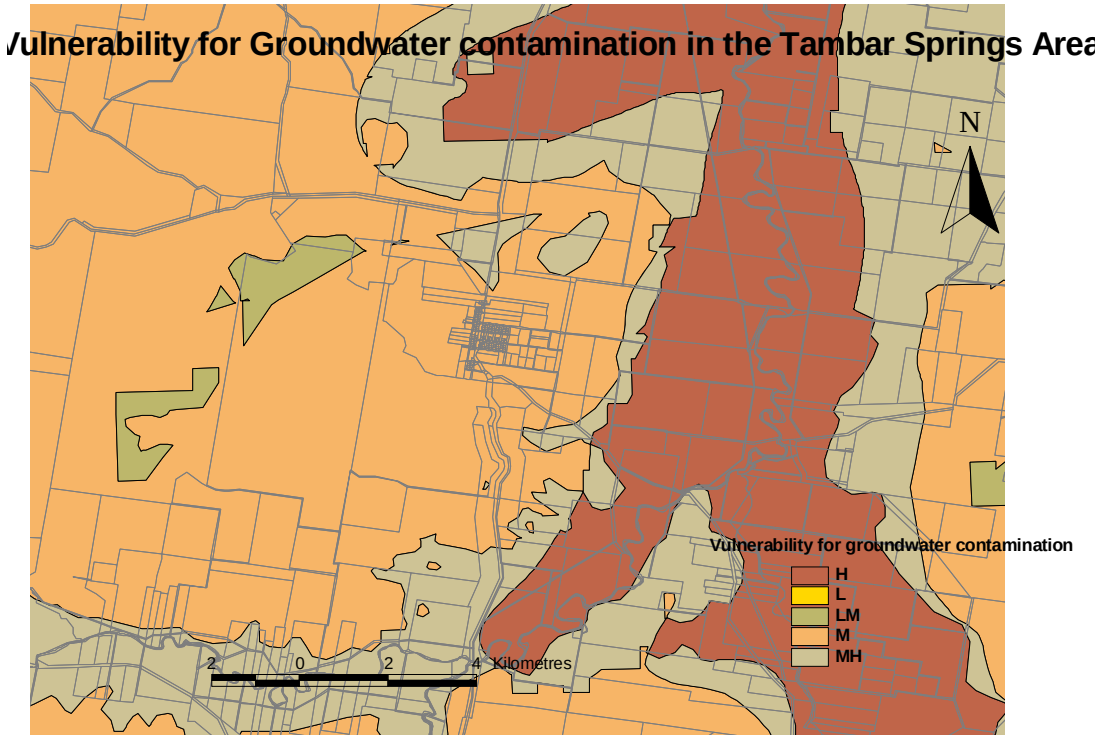


Figure 2.20. Groundwater vulnerability to contamination in area around Mullaley (Source : DNR)

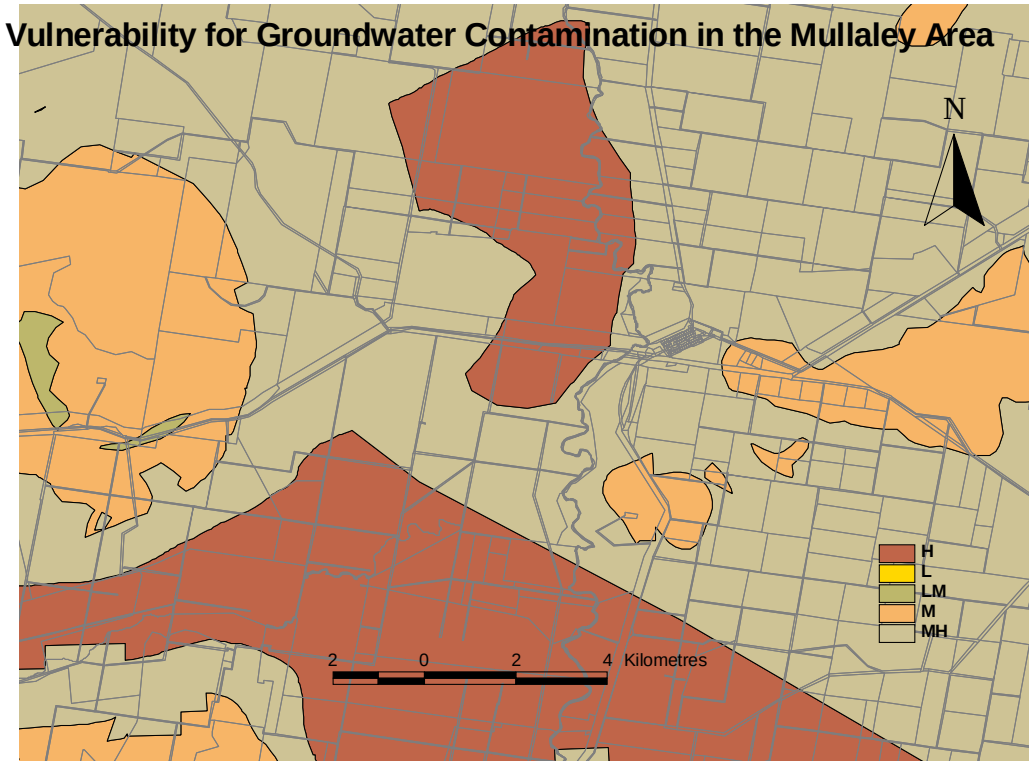


Figure 2.21. Groundwater vulnerability to contamination in area around Tambar Springs (Source: DNR).

Vegetation

General information on natural vegetation in Gunnedah Shire is largely derived from the standard Soil Conservation Service manual for the Gunnedah district (SCS, 1976). Four major plant communities were identified in 1976 by the Department of Conservation and Land Management. The four communities have distinctive on structural form and species composition.

These four categories are:

1. Plains Grasses (*Stipa aristiglumis*), Dry Tussock Grassland.-Largely located on the Liverpool Plains

2. White Box (*E. albens*), Tall Woodland and Savannah Woodland - elevated lands

3. White Cypress Pine (*C. hugelli*), Tall Woodland and Shrub Woodland – elevated lands with poorer soils

4. Yellow Box - White Box - Bimble Box (*E. melliodora - E. albens - E. populinea*), Tall Woodland and Savannah Woodland. - elevated lands

A 1971 grassland survey reported by the Planning Workshop (1981) indicated there were large areas of plains grass (Stipa spp.), within the Shire. By 1981 these areas had largely ceased to exist (Urwin, 1981). Remnants are now found in sites such as Mount Kaputar National Park and in isolated alluvial fans and flood prone lands that are unsuited to cropping (Caitechton, et al, 1999). Around 12% of this association is still intact (DLWC, 2003b). Loss of these grasslands is important for water management as they would have provided an effective mechanism for slowing floodwaters, facilitating infiltration into the soil (Wallbrink et al, 1999).

Table 2.9 summarises the results of an evaluation by Bailey (1995). Over half the Shire has no tree cover, while another 34% has scattered trees. Bailey estimated that only 10% of the shire is shaded by trees. This lack of trees is due to a combination of low rainfall, unsuitable soils, wildfire and deliberate clearing.

Table 2.9. Tree cover type and percent coverage in Gunnedah Shire (Source: Bailey, 1995).

Type of tree cover	Percentage of shire with this vegetation type
Undisturbed Dry Sclerophyll Forest	8
Undisturbed Native Pine Forest	<1
Undisturbed Heath or Scrub	<1
Tree lots	<1
Road Reserves	2
Scattered timber (typically 5% cover)	34
Mature trees in clumps (typically 25% cover)	3
No mature trees (approximately 50% of this area has some regenerating trees)	52

According to Bailey (1995) there was 45 km sq of native reserves, 33 km sq of recreation areas and 193 km sq of State forests in the Shire in 1995. Some of these reserves and State Forested may now be classified as part of the National Park system, however the area involved is likely to have increased rather than decreased. Rivers and other protected water bodies covered another 99 sq km. So the total protected area in the Shire was 371 km sq or some 7% of the shire area. This is consistent with the indicative 2 to 10% protected lands in zone BBS in figure 2.22.

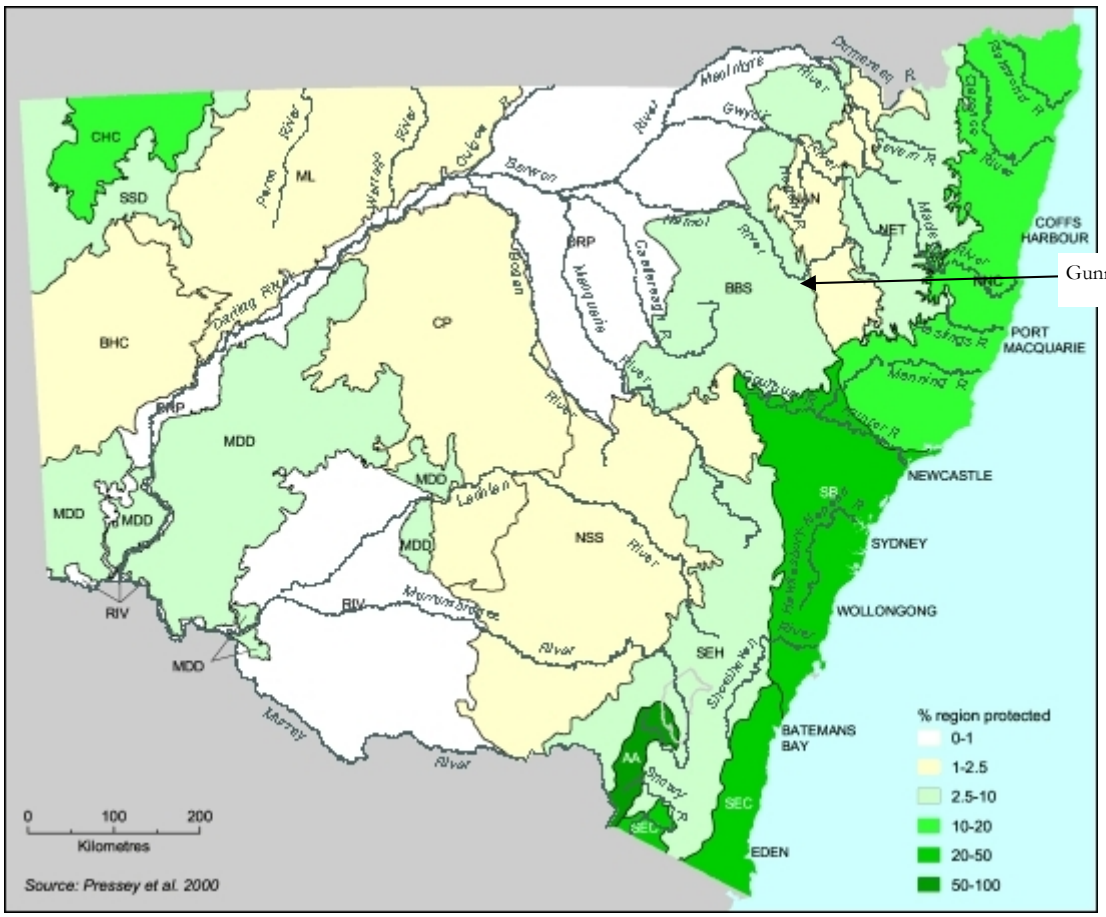


Figure 2.22. Extent of protected lands in the Namoi Catchment. (Zone BBS)

2.2 URBAN CONTEXT

Groundwater quality

Gunnedah, Curlewis, Mullaley and Tambar Springs water supplies are pumped from nearby aquifers. Consequently groundwater quality and quantity is a vital concern.

Gunnedah groundwater quality

Table 2.10 shows quality attributes of groundwater from near Gunnedah boreholes since 2000. The only attributes to exceed ADWG (NHMRC, 2004) were Chloride, TSS and Hardness. This occurred in early 2003 during a major drought. The results suggest susceptibility of Gunnedah Water quality to reduced quality during drought.

Curlewis groundwater quality

Table 2. 1 shows the quality attributes of groundwater from Curlewis since 2000. Nitrite-N exceeded ADWG (NHMRC, 2004) in 2000 and 2001. However the result is unusual, especially as Nitrate-N concentration was very low. (It may be due to transcription error).

Total Dissolved Solids (TDS) concentration has always exceeded the criteria. In some cases the difference is over 3 fold. Sodium and Chloride concentration also exceeds ADWG values. The results indicate a serious problem with the Curlewis water supply. Residents with severe hypertension or congestive heart failure may be at risk, if is this is their sole source of water. (It is noted that Curlewis residents largely rely on rainwater tanks for this potable water).

The hardness is also higher that the ADWG criteria. Concentrations in excesses of 500 mg/L results in severe scaling of pipes and valves, especially those associated with the hot water system.

Discussions with DNR hydrologeolists suggest the Curlewis bore is susceptible to saline water influx during drought periods.

Mullaley groundwater quality

Table 2.12 shows the quality attributes of groundwater from Mullaley bores since 2003. TDS and Total Hardness exceed guideline criteria. However the exceedance is relatively small. pH is close to the upper limit.

The results suggest the water will have a slight taste and there is a need to uses 'salt' resistant anodes in hot water services.

Tambar Springs groundwater quality

Table 2.13 shows the quality attributes of groundwater from Tambar Springs since 2003. Iron and lead concentrations have exceeded ADWG criteria on isolated occasions. According to ADWG iron is not a health issue, but lead is, especially for infants, foetuses and pregnant women. Lead concentration is close to the limit of detection, so there may be some doubt as to the accuracy of the results, but it is an element of concern at Tambar Springs. Use of rainwater tanks to supply drinking needs can be encouraged.

Hardness and turbidity also exceed the ADWG criteria, but the difference is small and is not a major issue.

Table 2.10 Groundwater quality supplied to Gunnedah since 2000 (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 17/9/00	Result 12/9/00	Result 18/9/01	Result 22/11/02	Result 18/2/03	Result 28/1/04	Result 11/5/04	Result 16/2/05	Result 1/6/05
Aluminium	mg/L	0.20		0.05			0.05	0.07	0.01	0.03	0.02
Antimony	mg/L	0.003	0.001			0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00			0.00	1.00	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.04			0.04	0.12	0.04	0.03	0.02	0.02
Boron	mg/L	4.00	0.10			0.10	0.10	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Calcium	mg/L	9999		42			141	42	35	27	34
Chloride	mg/L	250		35			**338**	45	35	21	39
Chromium	mg/L	0.05	0.01			0.01	0.03	0.01	0.01	0.01	0.01
Copper	mg/L	2.00	0.22	0.05	0.02	0.02	0.04	0.02	0.03	0.03	0.02
Cyanide	mg/L	0.08					0.01	0.01			
Fluoride	mg/L	1.50	0.15	0.10	0.10	0.15	0.16	0.10	0.15	0.18	0.17
Iodine	mg/L	0.10					0.03	0.02	0.02	0.02	0.02
Iron	mg/L	0.30		0.05			0.09	0.05	0.50	0.01	0.01
Lead	mg/L	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	mg/L	9999		21			79	23	19	14	18
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	mg/L	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Molybdenum	mg/L	0.05	0.01			0.01	0.01	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01			0.01	0.01	0.01	0.01	0.01	0.01
Nitrate	mg/L	50	10	2	8	10	31	10	5	5	10
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.3	7.5	7.4	7.0	7.0	7.0	7.2	7.1	7.2
Selenium	mg/L	0.01	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Silver	mg/L	0.10					0.00	0.00	0.00	0.00	0.00
Sodium	mg/L	180	44	29		53	109	34	35	25	29
Sulphate	mg/L	500	53	38		60	139	47	34	23	42
TDS	mg/L	500	362		294	416	**877**	278	238	193	233
Total Hardness	mg/L	200		190			**679**	197	167	126	161

True Colour	H U	15.00		3.00				1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.10	0.20	0.10	0.10	1.50	0.60	4.80	0.10	0.10
Zinc	mg/L	3.00		0.05			0.01	0.10	0.02	0.02	0.01

Table 2.11. Groundwater quality supplied to Curlewis since 2001 (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 18/9/01	Result 22/11/02	Result 18/02/03	Result 11/11/03	Result 28/1/04	Result 11/5/04	Result 16/2/05	Result 11/5/05
Aluminium	mg/L	0.20			0.03	0.03	0.08	0.01	0.03	0.02
Antimony	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.14	0.16	0.15	0.11	0.18	0.14	0.09	0.14
Boron	mg/L	4.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Calcium	mg/L	9999.00			124.30	85.58	145.00	122.60	70.05	123.50
Chloride	mg/L	250.00			**685.70**	**465.20**	**884.40**	**685.00**	**361.50**	**764.40**
Chromium	mg/L	0.05	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
Copper	mg/L	2.00	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.02
Cyanide	mg/L	0.08			0.01	0.01	0.01			
Fluoride	mg/L	1.50	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Iodine	mg/L	0.10			0.04	0.03	0.03	0.03	0.03	0.04
Iron	mg/L	0.30			0.01	0.01	0.01	0.01	0.01	0.02
Lead	mg/L	0.01	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002
Magnesium	mg/L	9999			82	51	96	83	45	80
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	mg/L	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.0	0.1	0.1	8.4	5.6	11.6	5.2	2.9	3.3
Nitrite	mg/L	3.00	**6.00**	**7.90**	0.10	0.10	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.60	7.20	7.40	7.60	7.90	7.80	7.60	7.90
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver	mg/L	0.10			0.00	0.00	0.00	0.00	0.00	0.00
Sodium	mg/L	180	**226**	**291**	**240**	178	**291**	**279**	163	**285**

Sulphate	mg/L	500	85	93	100	64	116	101	48	92
TDS	mg/L	500	**1263**	**1292**	**1227**	**916**	**1502**	**1259**	**784**	**1319**
Total Hardness	mg/L	200			**646**	**422**	**759**	**847**	**359**	**638**
True Colour	H U	15.00				1.00	1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.10	0.20	0.10	0.10	0.20	0.10	0.10	0.10
Zinc	mg/L	3.00			0.02	0.06	0.10	0.01	0.02	0.02

Table 2.12. Groundwater quality supplied to Mullaley since 2003. (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 11/11/03	Result 28/1/04	Result 16/2/05	Result 1/6/05
Aluminium	mg/L	0.20	0.04	0.09	0.03	0.01
Antimony	mg/L	0.003	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.08	0.09	0.08	0.10
Boron	mg/L	4.00	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.002	0.001	0.001	0.001	0.001
Calcium	mg/L	9999	38	40	40	40
Chloride	mg/L	250	114	110	107	107
Chromium	mg/L	0.05	0.02	0.03	0.03	0.04
Copper	mg/L	2.00	0.01	0.01	0.01	0.01
Cyanide	mg/L	0.08	0.01	0.01		
Fluoride	mg/L	1.50	0.11	0.10	0.13	0.11
Iodine	mg/L	0.10	0.03	0.04	0.03	0.04
Iron	mg/L	0.30	0.01	0.01	0.02	0.02
Lead	mg/L	0.01	0.00	0.00	0.00	0.00
Magnesium	mg/L	9999	46	52	52	46
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01
Mercury	mg/L	0.001	0.000	0.000	0.000	0.000
Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.00	3.30	3.10	3.20	3.30
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10

pH		6.5-8.5	7.70	7.80	8.20	8.30
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00
Silver	mg/L	0.10	0.00	0.00	0.00	0.00
Sodium	mg/L	180	135	145	142	147
Sulphate	mg/L	500	14	13	13	13
TDS	mg/L	500	**602**	**596**	**591**	**590**
Total Hardness	mg/L	200	**285**	**312**	**314**	**288**
True Colour	H U	15.00	1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.20	0.10	0.20	0.30
Zinc	mg/L	3.00	0.07	0.09	0.02	0.01

Table 2. 13. Groundwater quality supplied to Tambar Springs since 2003 (Source: Gunnedah Shire Council)

Test	Units	ADWG	Result 11/11/03	Result 28/1/04	Result 11/5/04	Result 1/6/05
Aluminium	mg/L	0.20	0.04	0.08	0.04	0.01
Antimony	mg/L	0.003	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.10	0.10	0.10	0.11
Boron	mg/L	4.00	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.002	0.001	0.001	0.001	0.001
Calcium	mg/L	9999	49	51	53	51
Chloride	mg/L	250	71	62	57	64
Chromium	mg/L	0.05	0.01	0.02	0.02	0.03
Copper	mg/L	2.00	0.17	0.04	0.02	0.11
Cyanide	mg/L	0.08	0.01	0.01	0.00	0.00
Fluoride	mg/L	1.50	0.12	0.12	0.11	0.13
Iodine	mg/L	0.10	0.03	0.04	0.03	0.04
Iron	mg/L	0.30	**2.30**	0.03	0.06	0.14
Lead	mg/L	0.01	**0.04**	0.00	0.01	**0.02**
Magnesium	mg/L	9999	38	40	38	38
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01
Mercury	mg/L	0.00	0.00	0.00	0.00	0.00

Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.00	1.00	1.00	1.00	1.00
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.50	7.80	7.80	7.80
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00
Silver	mg/L	0.10	0.00	0.00	0.00	0.00
Sodium	mg/L	180	71	76	79	79
Sulphate	mg/L	500	8	8	8	8
TDS	mg/L	500	446	434	437	439
Total Hardness	mg/L	200	**278**	**291**	**289**	**284**
True Colour	H U	15.00	1.00	1.00	1.00	1.10
Turbidity	NTU	5.00	**13.90**	0.30	0.50	1.20
Zinc	mg/L	3.00	1.51	0.23	0.06	0.66

Table 2.14. Static heights in water supply bores since 2002. The date used to compare current levels with past ones is shaded.

Date	G1	G2	G3	G4	G5	G6	G7	G8	G9	G11	Cur1	Cur2	Car1
11/12/02	8.9	0.0	11.5	11.2	0.0	10.4	12.0	16.2	16.1	9.5	16.0	26.1	0.0
11/02/03	9.0	10.5	11.8	11.8	12.2	11.7	14.0	21.0	20.0	9.9	23.7	26.1	0.0
17/03/03	9.1	10.3	11.4	10.7	11.3	11.5	11.6	13.2	13.6	9.7	22.0	22.2	15.6
1/07/03	9.0	9.0	10.9	10.9	10.9	10.7	10.7	13.6	13.2	9.7	23.1	23.7	14.6
15/09/03	8.9	10.7	11.0	10.9	11.0	10.6	10.5	12.1	12.1	9.7	24.2	25.1	14.7
29-Mar-2004	9.0	9.9	11.1	11.2	11.6	11.1	10.9	13.3	13.3	10.0	20.6	20.6	14.8
24-Sep-04	8.7	9.8	11.0	11.1	11.3	10.9	10.7	12.8	12.4	9.9	26.7	28.1	14.0
16.03.05	9.0	10.5	11.8	11.9	12.3	11.6	12.2	19.3	19.0	10.0	20.5	21.1	15.1
6.9.05	8.8	9.8	11.5	11.9	12.3	11.4	10.6	12.0	11.8	9.8	21.8	24.0	13.7
6.3.06	9.7	11.0	12.4	12.1	12.5	12.0	11.6	15.0	15.1	9.8	27.2	28.6	15.3
Trend 2002 to 3/2006	-0.8	-0.6	-0.9	-0.9	-0.4	-1.6	0.4	1.2	1.0	-0.3	-3.5	-2.5	0.3

Depth to groundwater

Depth to groundwater measurement and drawdown tests are conducted on the potable water supply bores twice each year.

Table 2.13 shows that while the depths vary markedly over time, static water levels have fallen in most sites since 2002. Levels in the Gunnedah bore field have fallen by 0.3m over the past 3.5 years. Static levels in the Curlewis bores have fallen by an average of 3.5m.

Potable water supply and infrastructure within the urban areas of Gunnedah Shire

Table 2.15 shows the water allocation and volume supplied each year since 1996. Water supplied is markedly less than allocation in all years.

Table 2.15 . Water allocation and potable water supplied to different urban centres in Gunnedah Shire (Source: Gunnedah Shire Council)

Urban area	Allocation	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Ave 2000-2005
Gunnedah	3900	3145	2632	1586	2324	2431	2522	2912	3159	834	2446	2384
Curlewis	198	228	216	124	153	84	75	142	171	42	112	104
Mullaley	59	31	36	29	27	35	19	33	36	7	25	26
Tambar Springs	42	20	20	14	18	18	15	21	22	6	21	17

Gunnedah

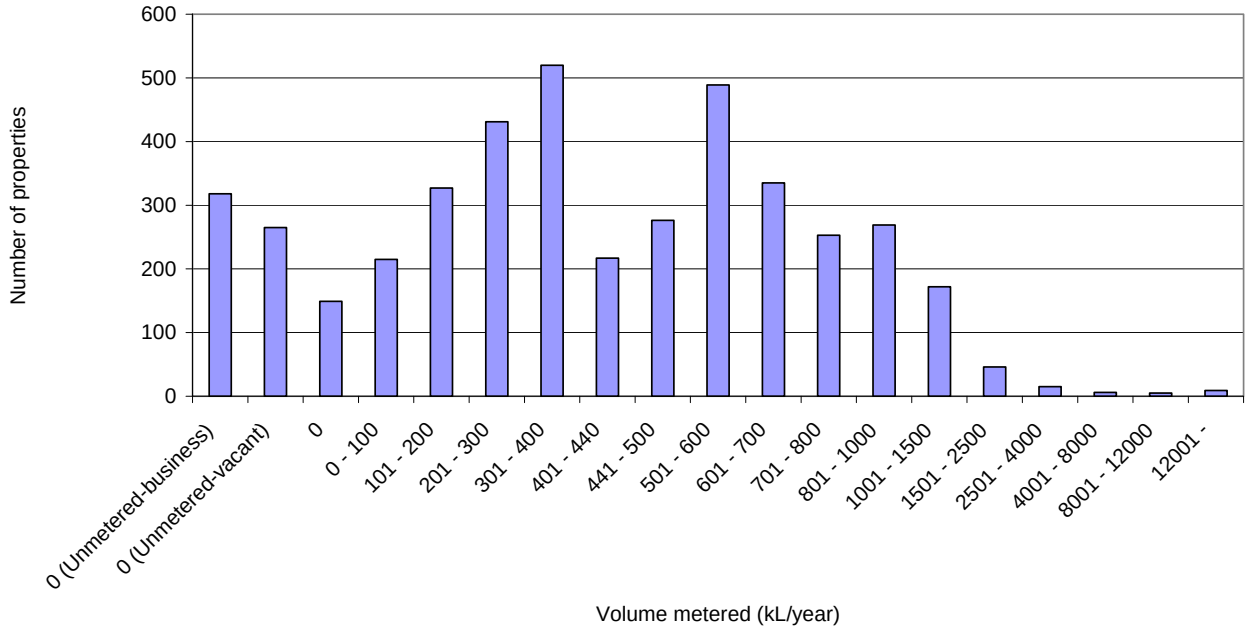
The Gunnedah scheme was established in 1900 (Gunnedah Shire Council Strategic Business Plan for Water Supply 2003/4). Council extracts groundwater using 11 bores. These bore have a capacity of 20 ML/day. Flow from the bores has recently been augmented by the installation of an additional 500 mm main. The water is transferred via three pump stations to 5 reservoirs. The reservoirs have a total capacity of 19.5 ML. Gunnedah has 140 km of mains with pipe sizes ranging from 80 to 500 mm. The water supplies are currently not chlorinated.

There are 2623 connections to the Gunnedah water supply system (Gunnedah Shire Council Management Plan 2005/06). Rating is two tiered, with $0.45/kL for water use less than 450 kL/y and $0.9/kL for water use in excess of 450 kL/year. Industrial companies and sporting bodies are charged $0.51/kL for use in excess of 440 kL. Figure 2.23 shows the distribution of water usage in Gunnedah in 2004/5. Council's aim is to cover costs plus anticipated inflation. Total metered usage in Gunnedah was 2181 ML so the unaccounted water was 265 ML or 11% of the estimated supply.

Some of the apparent fluctuation in Gunnedah water use since 2000 is due to shut down and start of various industries. It also reflects periods of incomplete data collection.

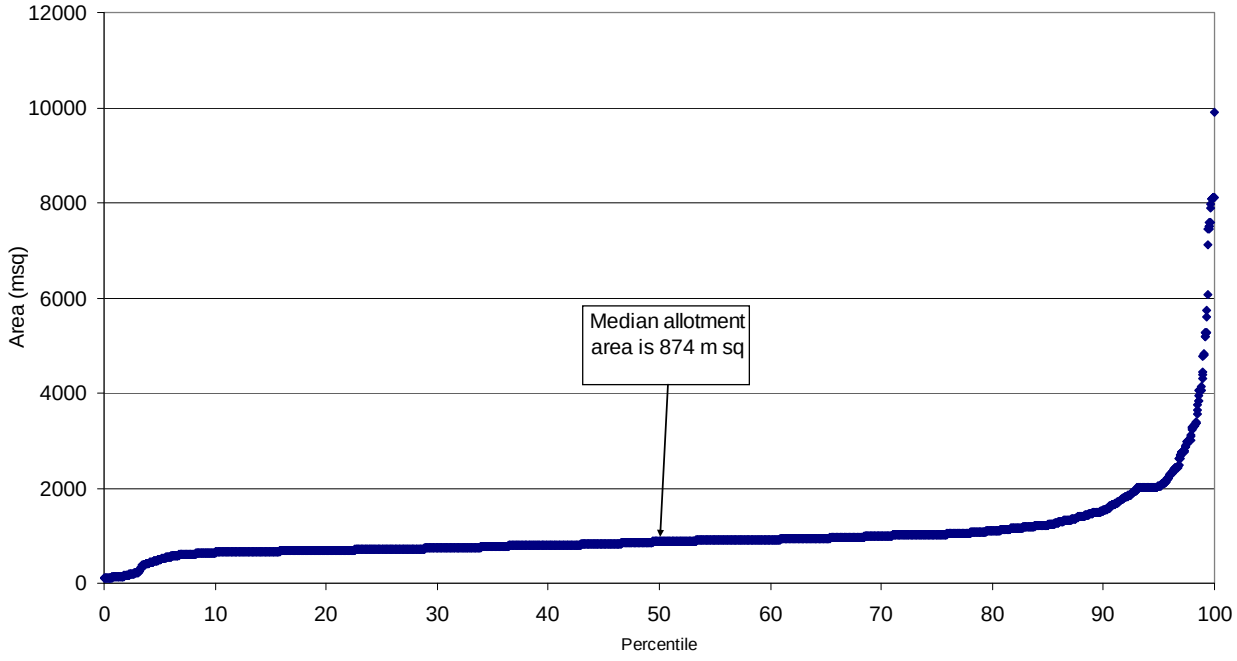
Figure 2.22 shows the distribution of water usage in Gunnedah. There are 308 businesses that pay water rates but do not have meters. There are some 103 sites/ activities in town that do not pay rates but have received a total of 100 ML/year of water. These include public facilities such as ovals and swimming pools. The lack of water meters on Gunnedah businesses is an issue. According to the Strategic Business Plan for Water Services (2003/04), meters were to be installed in the CBD by June 2005. This has not been done.

Figure 2.22. Distribution of metered water usage from Gunnedah town water supply in 2004/5.



Individual domestic premises have 20 mm connections and these consume the bulk of the potable water. However there are also premises with 50, 80 and 100 mm connections. Some of these premises consume many ML/year of potable water. Some 1917 ML was withdrawn via 20 mm connections, while another 54 ML was by 50 mm connections. A further 11 ML was via 80 mm to three properties, while another 4 sites with 100 mm connections utilised 200 ML. One site with a 100 mm connection utilised 153 ML. This site (Number 45008610005) paid $270 in water rates or $1.76/ML. In 2001/02 the leather factory used 233 ML.

Figure 2.23. Percentile distribution of rateable allotments in Gunnedah.



Council is currently investigating options to introduce a more equitable user pays system, consistent with reducing consumption where possible. Water supply charge rates to business is an issue.

The percentile distribution of rateable Gunnedah allotments in excess of 100 msq is shown in figure 2.24. The median property area is 873 msq. This is relatively large and assists in explaining the volume of potable water being used on Gunnedah properties. A combination of large property area and high evaporation can result in large volumes of water being irrigated.

The Strategic Business Plan for Water supply (Gunnedah Shire Council, 2003/04) identifies a program for mains replacement within Gunnedah. It also identified the need for a 5 ML reservoir at Borthistle. Figure 2.24 shows the layout of the Tambar Springs water distribution system.

Table 2.16 shows the quality of Gunnedah's raw water supply since 2001. The third column shows the percentage of samples that meet Australian Drinking Water Guidelines (NHMRC/ARMCANZ (2004)). Total dissolved solids, Chloride, Iron and hardness criteria were occasionally exceeded. However coliforms were present in 88% of the samples. This result emphasises the need for disinfection. It also raises concerns regarding the source of this contamination. Gunnedah water is sourced from deep bores so the groundwater is unlikely to be biologically contaminated. This indicates the contamination is occurring after extraction. This is a significant issue.

Curlewis

The Curlewis water supply system was established in 1972. Table 2.14 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 2 ML. The water is conveyed to three reservoirs which have a total capacity of 1.4 ML. The water is chlorinated. Curlewis has 19.3 km of pipes, with diameters ranging from 100 to 150 mm. Figure 2.25 shows the layout of the Curlewis water distribution system.

Table 2.17 shows quality attributes of the Curlewis water supply. It has significant microbial contamination. It also has elevated Na, Cl, TDS and Hardness values. This is consistent with the Council bore data in table 2.11 and emphasises the need for alternative potable water sources in Curlewis.

Mullaley

The Mullaley water supply system was established in 1972. Table 2.15 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 0.4 ML. The water is conveyed to a reservoir which has a capacity of 0.2 ML. Mullaley has 3.8 km of pipes. Pipe diameter is 100mm. Figure 2.26 shows the layout of the Mullaley water distribution system. The water is chlorinated.

Table 2.18 shows quality attributes of the Mullaley water supply. It has significant microbial contamination. It also has elevated TDS and Hardness values. This is consistent with the Council bore data in table 2.12.

Tambar Springs

The Tambar Springs water supply system was established in 1990. Table 2.14 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 4 ML. The water is conveyed to three reservoirs which have a capacity of 0.3 ML. Tambar Springs has 11.5 km of pipes. Pipe diameters range from 100 to 150 mm diameter. Figure 2.27 shows the layout of the Tambar Springs water distribution system.

Table 2.18 shows quality attributes of the Tambar Springs water supply. It has significant microbial contamination. It also has elevated lead and Hardness values compared with the ADWG. This is

consistent with the Council bore data in table 2.13. The elevated lead concentration is an immediate health risk that needs investigation.

Note that the consistancy between bore data and raw water results at all four urban centres suggests there is duplication of analysis. The need for a full analytical suite for both groundwater and town water is questioned.

The Gunnedah and Mullaley water supplies contain thermotolerant coliforms in 7 and 43% of samples respectively. The Mullaley and Tambar Springs water supplies contain thermotolerant coliforms in 14 and 13% of samples respectively. According to the ADWG (2004), there should be zero faecal coliforms. The presence of these microflora indicate faecal contamination. The source of this contamination should be determined and rectified as a matter of urgency.

Table 2.16. Results of Gunnedah township water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0429	0.03	0.0325	0.01	0.1	7	0	0.0962	0.0145
Antimony	0.0030 mg/L	100	0.001	0.001	0	0.001	0.001	9	0	0.001	0.001
Arsenic	0.0070 mg/L	100	0.001	0.001	0	0.001	0.001	9	0	0.001	0.001
Barium	0.7000 mg/L	100	0.0467	0.036	0.0378	0.013	0.116	9	0	0.1087	0.0182
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	9	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	9	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	62.24	35.43	49.5704	27.19	140.8	7	0	143.5355	32.8705
Chloride	250.0000 mg/L	71	112.157	38.6	137.96	20.9	337.6	7	2	338.4113	36.735
Chromium	0.0500 mg/L	100	0.0113	0.009	0.0076	0.006	0.031	9	0	0.0239	0.0073
Copper	2.0000 mg/L	100	0.0482	0.0245	0.0601	0.012	0.22	12	0	0.1467	0.0224
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	88	0.6324	0	2.5633	0	24	185	22	4.8363	1.2
Fluoride	1.5000 mg/L	100	0.1498	0.155	0.0337	0.099	0.2	12	0	0.205	0.1041
Iodine	0.1000 mg/L	100	0.022	0.0198	0.004	0.02	0.03	7	0	0.0286	0.0203
Iron	0.3000 mg/L	86	0.1	0.02	0.1787	0.01	0.5	7	1	0.3931	0.0344
Lead	0.0100 mg/L	100	0.0023	0.002	0.0009	0.002	0.005	12	0	0.0037	0.0022
Magnesium	9999.0000 mg/L	100	34.9471	18.98	29.8826	13.79	79.39	7	0	83.9546	17.07
Manganese	0.5000 mg/L	100	0.0063	0.005	0.0022	0.005	0.01	12	0	0.0099	0.0052
Mercury	0.0010 mg/L	100	0.0001	0.0001	0.0001	1E-04	5E-04	9	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	8	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	9	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	11.125	9.3	9.3804	3	31	12	0	26.5088	4.4
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	12	0	0.099	0.099

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
pH	6.5 - 8.5	100	7.1667	7.15	0.1557	7	7.4	12	0	7.422	7.02
Selenium	0.0100 mg/L	100	0.0023	0.002	0.0007	0.002	0.004	9	0	0.0035	0.0021
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	7	0	0.002	0.002
Sodium	180.0000 mg/L	100	50.9222	34.8	33.4401	23.2	109.1	9	0	105.764	27.495
Sulfate	500.0000 mg/L	100	62.2125	44.25	45.8874	23.4	139	8	0	137.4678	29.18
Thermotolerant Coliforms	0.0000 cfu/100 mL	93	0.1447	0	0.6262	0	4	76	5	1.1717	0.2
Total Coliforms	0.0000 cfu/100 mL	28	26.1611	5.5	46.9242	0	202	180	129	103.1168	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	82	384.182	294	249.166	179	877	11	2	792.8136	213.9
Total Hardness as CaCO3	200.0000 mg/L	71	299.329	166.6	246.727	126.1	678.5	7	2	703.9609	153.72
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.6829	0.15	1.3579	0.099	4.8	12	0	2.9099	0.334
Zinc	3.0000 mg/L	100	0.03	0.02	0.0316	0.01	0.1	7	0	0.0819	0.0145

Table 2.17. Results of Curlewis water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0333	0.03	0.0242	0.01	0.08	6	0	0.0731	0.0135
Antimony	0.0030 mg/L	100	0.001	0.001	0.0001	0.001	0.001	8	0	0.0011	0.001
Arsenic	0.0070 mg/L	100	0.0011	0.001	0.0004	0.001	0.002	8	0	0.0017	0.0011
Barium	0.7000 mg/L	100	0.137	0.14	0.0294	0.087	0.18	8	0	0.1853	0.0917
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	8	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	111.838	123.05	28.0805	70.05	145	6	0	157.8903	73.7975
Chloride	250.0000 mg/L	0	641.033	685.35	193.614	361.5	884.4	6	6	958.5596	387.645
Chromium	0.0500 mg/L	100	0.0113	0.0095	0.007	0.005	0.027	8	0	0.0227	0.0061
Copper	2.0000 mg/L	100	0.0121	0.0105	0.0054	0.006	0.02	8	0	0.021	0.0067
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	67	4.5	0	12.9361	0	101	164	54	25.7153	5.05
Fluoride	1.5000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
Iodine	0.1000 mg/L	100	0.033	0.0295	0.0083	0.025	0.044	6	0	0.0466	0.026
Iron	0.3000 mg/L	100	0.0116	0.01	0.0041	0.01	0.02	6	0	0.0184	0.0104
Lead	0.0100 mg/L	100	0.0021	0.002	0.0004	0.002	0.003	8	0	0.0027	0.0021
Magnesium	9999.0000 mg/L	100	72.6483	80.8	20.3433	44.7	96.4	6	0	106.0114	47.285
Manganese	0.5000 mg/L	100	0.0056	0.005	0.0017	0.005	0.01	8	0	0.0085	0.0052
Mercury	0.0010 mg/L	100	0.0002	0.0001	0.0001	1E-04	5E-04	8	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	7	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.01	0.01	0.0001	0.01	0.01	8	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	6.3625	5.8	2.863	2.9	11.6	8	0	11.0579	3.335

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
pH	6.5 - 8.5	100	7.625	7.6	0.2435	7.2	7.9	8	0	8.0243	7.235
Selenium	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	8	0	0.002	0.002
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Sodium	180.0000 mg/L	25	244	259	51	163	291	8	6	328.5356	169.42
Sulfate	500.0000 mg/L	100	87	93	23.3	48.4	115.5	7	0	125.8299	51.755
Thermotolerant Coliforms	0.0000 cfu/100 mL	57	7.5	0	17.5	0	101	72	31	36.2417	5.05
Total Coliforms	0.0000 cfu/100 mL	45	19.5	1	41.7	0	202	156	86	87.9468	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	0	1195	1261	231	784	1502	8	8	1575.109	819.9
Total Hardness as CaCO3	200.0000 mg/L	0	578	642.1	153	359	759	6	6	830.4699	379
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.1243	0.099	0.0468	0.099	0.2	8	0	0.2009	0.1041
Zinc	3.0000 mg/L	100	0.0383	0.02	0.0349	0.01	0.1	6	0	0.0955	0.0145

Table 2.18. Results of Mullaley water quality testing since 2001 (Source: Gunnedah Shire Council).

.Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.046	0.04	0.0305	0.01	0.09	5	0	0.096	0.014
Antimony	0.0030 mg/L	100	0.001	0.001	0	0.001	0.001	6	0	0.001	0.001
Arsenic	0.0070 mg/L	100	0.001	0.001	0	0.001	0.001	6	0	0.001	0.001
Barium	0.7000 mg/L	100	0.0875	0.086	0.0048	0.083	0.096	6	0	0.0955	0.0837
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	6	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	39.674	40.01	1.0951	37.74	40.39	5	0	41.47	37.8725
Chloride	250.0000 mg/L	100	109.78	109.6	3.0712	106.7	114.2	5	0	114.8167	107.075
Chromium	0.0500 mg/L	100	0.026	0.0255	0.0061	0.017	0.036	6	0	0.0359	0.018
Copper	2.0000 mg/L	100	0.0073	0.007	0.0024	0.005	0.011	6	0	0.0113	0.0053
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	83	3.3611	0	15.9341	0	95	36	6	29.493	4.75
Fluoride	1.5000 mg/L	100	0.1147	0.11	0.0168	0.099	0.14	6	0	0.1422	0.1011
Iodine	0.1000 mg/L	100	0.0348	0.036	0.0016	0.033	0.036	5	0	0.0375	0.0332
Iron	0.3000 mg/L	100	0.018	0.02	0.0084	0.01	0.03	5	0	0.0317	0.011
Lead	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Magnesium	9999.0000 mg/L	100	49.554	51.6	3.3249	45.55	52.59	5	0	55.0069	45.902
Manganese	0.5000 mg/L	100	0.005	0.005	0	0.005	0.005	6	0	0.005	0.005
Mercury	0.0010 mg/L	100	0.0002	0.0001	0.0002	1E-04	5E-04	6	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	6	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	6	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	3.4	3.25	0.4472	3.1	4.3	6	0	4.1334	3.16

.Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
pH	6.5 - 8.5	100	8.0833	8.2	0.2639	7.7	8.3	6	0	8.5162	7.73
Selenium	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	5	0	0.002	0.002
Sodium	180.0000 mg/L	100	142.3	143.4	4.502	134.8	146.9	6	0	149.6833	135.405
Sulfate	500.0000 mg/L	100	13.2	13	0.6928	12.6	14.4	6	0	14.3362	12.69
Thermotolerant Coliforms	0.0000 cfu/100 mL	86	0.3571	0	1.0818	0	4	14	2	2.1313	0.2
Total Coliforms	0.0000 cfu/100 mL	28	55.806	19.5	74.9086	0	202	36	26	178.6557	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	0	595.6	596	5.1284	590	602	5	5	604.0105	590.6
Total Hardness as CaCO3	200.0000 mg/L	0	303.14	312.3	15.2114	285.1	316.5	5	5	328.0868	286.67
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.2665	0.2	0.1753	0.099	0.6	6	0	0.554	0.1241
Zinc	3.0000 mg/L	100	0.056	0.07	0.0385	0.01	0.09	5	0	0.1191	0.014

Table 2.19. Results of Tambar Springs water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0425	0.04	0.029	0.01	0.08	4	0	0.0896	0.0135
Antimony	0.0030 mg/L	100	0.0013	0.001	8E-04	0.001	0.003	6	0	0.0027	0.0011
Arsenic	0.0070 mg/L	100	0.0017	0.001	0.002	0.001	0.005	6	0	0.0043	0.0012
Barium	0.7000 mg/L	100	0.1033	0.102	0.008	0.094	0.114	6	0	0.1156	0.095
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	0.0005	6	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	51.16	51.265	1.414	49.33	52.78	4	0	53.4792	49.5025
Chloride	250.0000 mg/L	100	63.5	62.9	5.859	57	71.2	4	0	73.1086	57.71
Chromium	0.0500 mg/L	100	0.0178	0.0195	0.008	0.005	0.028	6	0	0.0305	0.0062
Copper	2.0000 mg/L	100	0.0664	0.0443	0.061	0.014	0.168	6	0	0.1668	0.0217
Cyanide	0.0800 mg/L	100	0.0066	0.0099	0.006	0	0.0099	3	0	0.016	0.0005
E. coli	0.0000 cfu/100 mL	74	3.0263	0	14.88	0	92	38	10	27.4215	4.6
Fluoride	1.5000 mg/L	100	0.1295	0.12	0.035	0.099	0.198	6	0	0.1872	0.104
Iodine	0.1000 mg/L	100	0.0276	0.034	0.016	0	0.037	5	0	0.0531	0.0019
Iron	0.3000 mg/L	75	0.6325	0.1	1.113	0.03	2.3	4	1	2.4572	0.1435
Lead	0.0100 mg/L	50	0.0143	0.0115	0.014	0.002	0.04	6	3	0.0376	0.0039
Magnesium	9999.0000 mg/L	100	38.33	38.07	0.837	37.65	39.53	4	0	39.7029	37.744
Manganese	0.5000 mg/L	100	0.0108	0.005	0.014	0.005	0.04	6	0	0.0343	0.0068
Mercury	0.0010 mg/L	100	0.0002	0.0001	2E-04	1E-04	0.0005	6	0	0.0006	0.0001

	Guideline	% meeting			Standard			Number	Number	95th	5th
Molybdenum	0.0500 mg/L	100	0.0058	0.005	0.002	0.005	0.0099	6	0	0.0091	0.0052
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	5	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	0.9075	0.99	0.202	0.495	0.99	6	0	1.2389	0.5198
Nitrite	3.0000 mg/L	100	0.132	0.099	0.081	0.099	0.297	6	0	0.2646	0.1089
pH	6.5 - 8.5	100	7.7667	7.8	0.207	7.5	8.1	6	0	8.1054	7.53
Selenium	0.0100 mg/L	100	0.0025	0.002	0.001	0.002	0.005	6	0	0.0045	0.0022
Silver	0.1000 mg/L	100	0.0036	0.002	0.004	0.002	0.0099	5	0	0.0094	0.0024
Sodium	180.0000 mg/L	100	76.05	76.7	3.003	71.3	79.2	6	0	80.9741	71.695
Sulfate	500.0000 mg/L	100	7.85	7.8	0.217	7.6	8.2	6	0	8.2055	7.63
Thermotolerant Coliforms	0.0000 cfu/100 mL	87	6.4	0	23.7	0	92	15	2	45.2728	4.6
Total Coliforms	0.0000 cfu/100 mL	32	51.189	8	75.07	0	230	37	25	174.3044	11.5
Total Dissolved Solids (TDS)	500.0000 mg/L	100	435.8	437	8.408	423	446	5	0	449.5897	424.15
Total Hardness as CaCO3	200.0000 mg/L	0	285.58	286.6	5.757	278.2	290.9	4	4	295.0164	278.835
True Colour	15.0000 Hazen Units (HU)	100	1.0175	0.99	0.055	0.99	1.1	4	0	1.1077	0.9955
Turbidity	5.0000 NTU	83	2.95	0.85	5.392	0.2	13.9	6	1	11.7931	0.885
Zinc	3.0000 mg/L	100	0.615	0.445	0.648	0.06	1.51	4	0	1.6775	0.1325

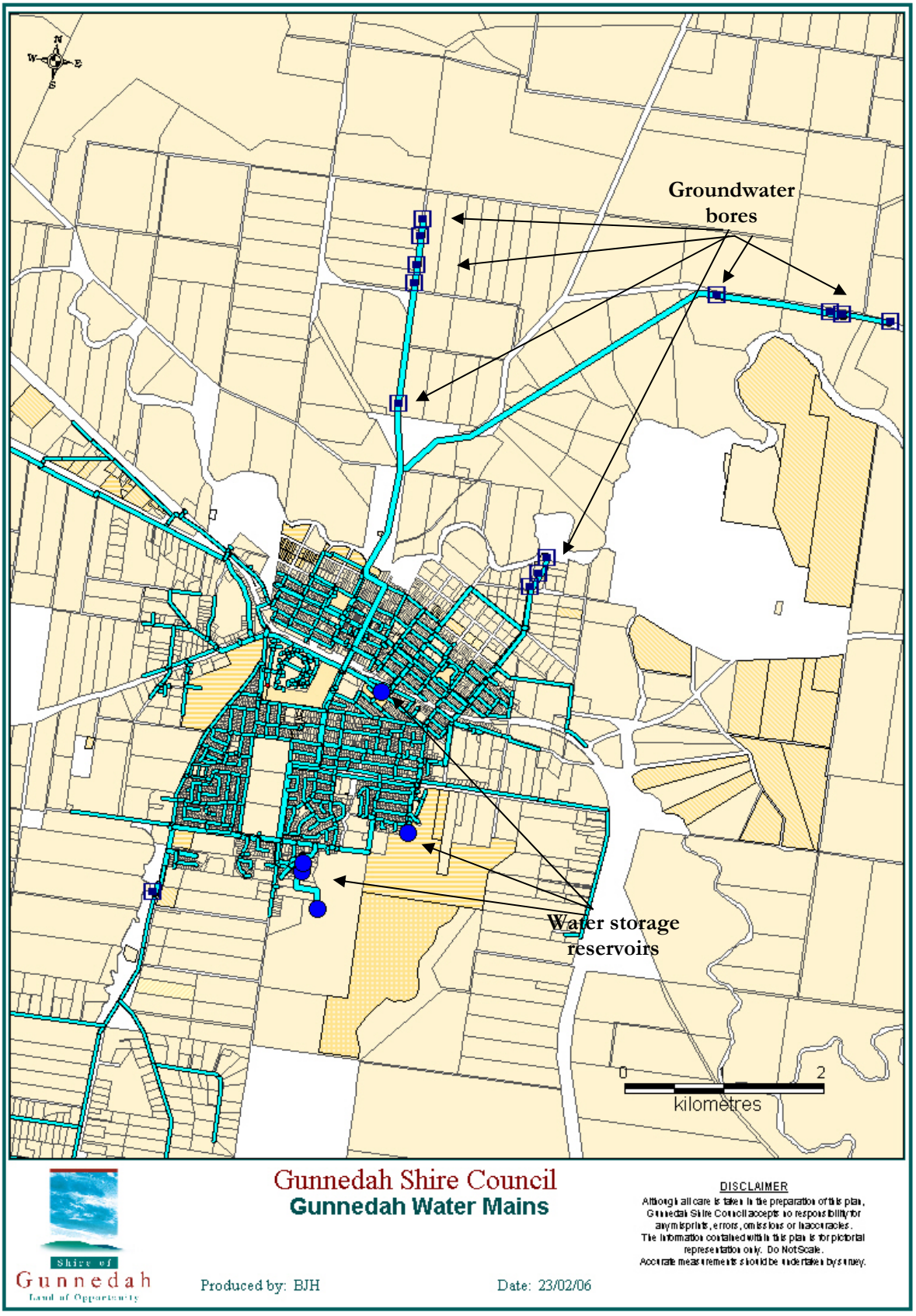


Figure 2.24. Gunnedah Water supply and distribution system (Source: Gunnedah Shire Council).

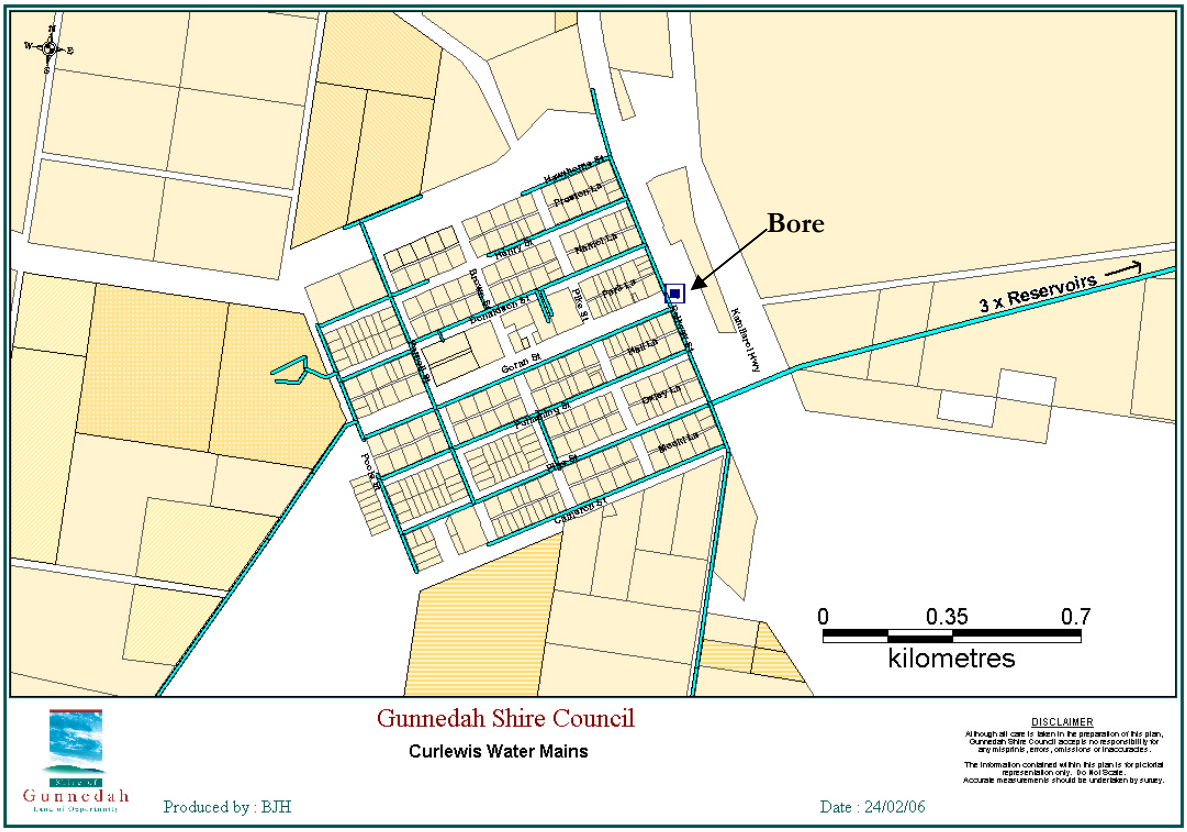


Figure 2.25. Curlewis water supply and distribution system.

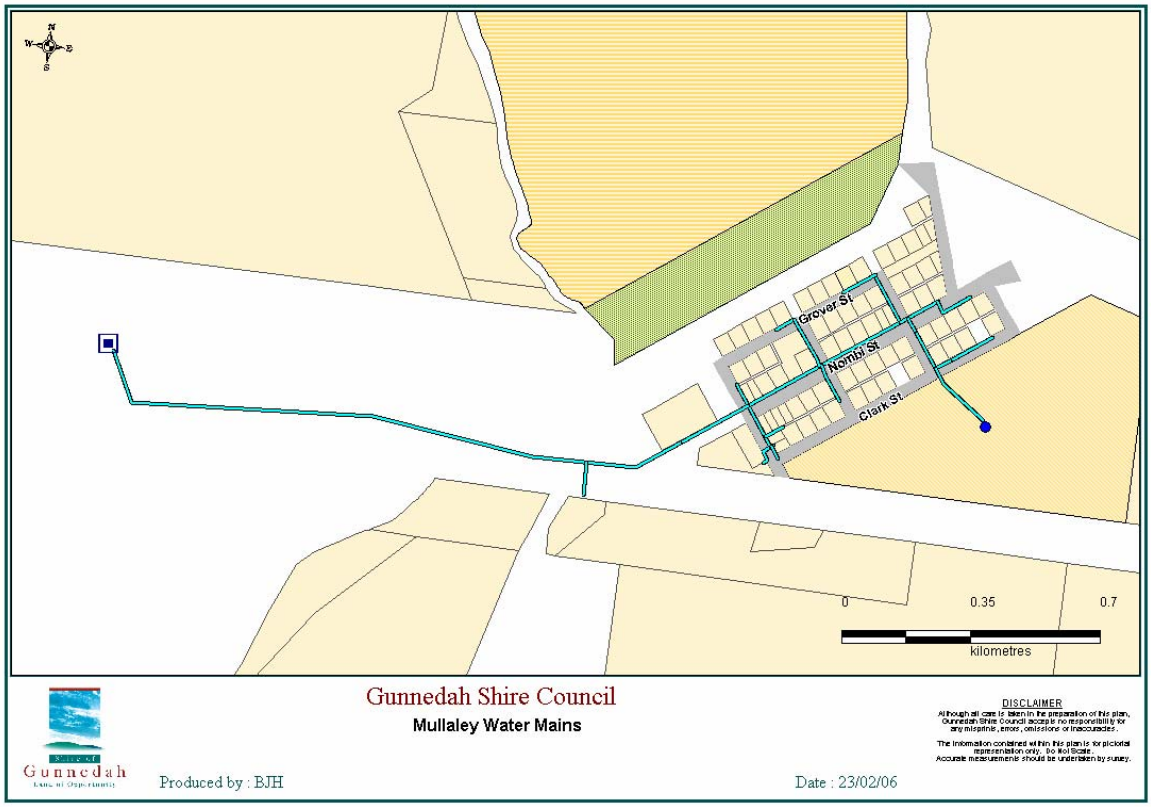


Figure 2.26. Mullaley water supply and distribution system.

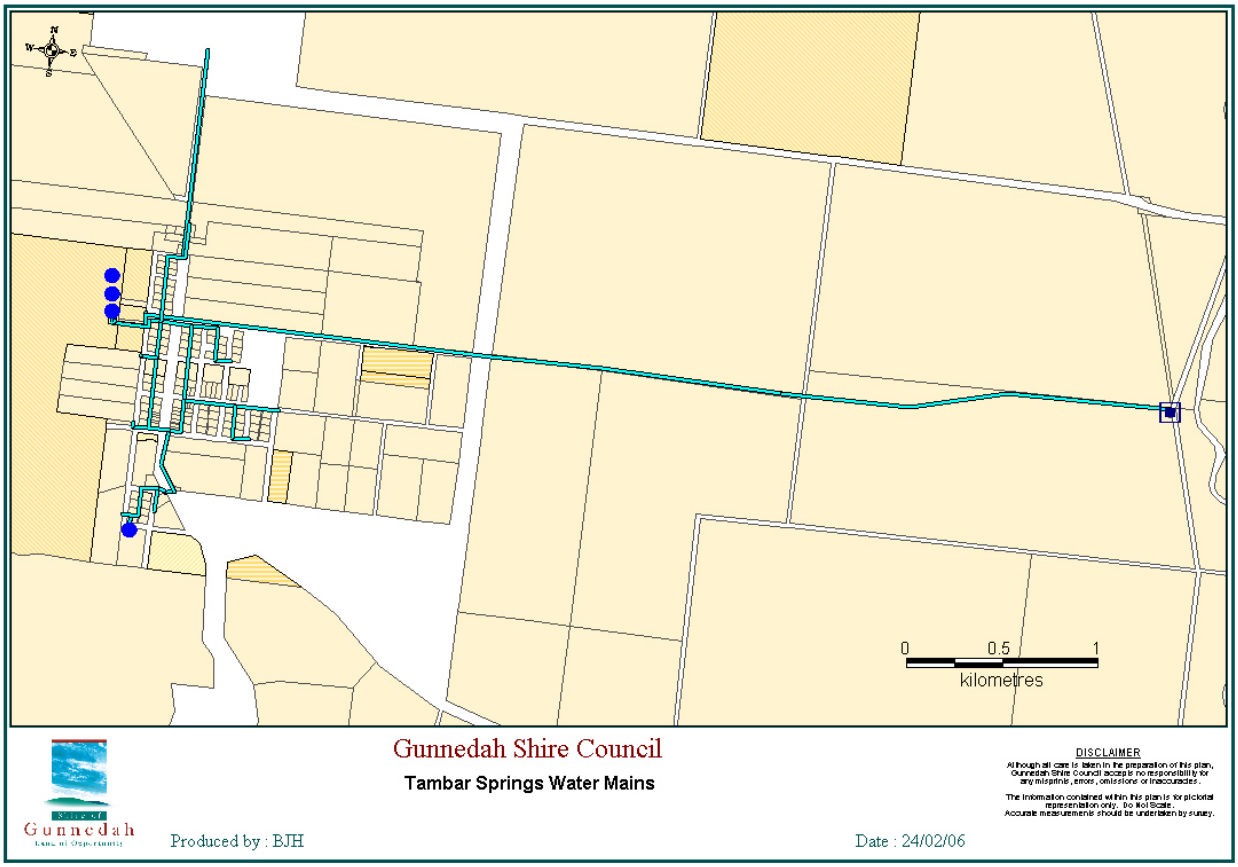


Figure 2.27. Tambar Springs water supply and distribution system.

System performance

The Strategic Business Plan for Water Services (Gunnedah Shire Council, 2003/04), compared actual and targeted performance. According to this Plan there is minimal interruption to services as Gunnedah has a ring main system that enables alternative water sourcing should a breakdown occur. There were a total of 7 interruptions in the 2003/04 year. In the period from Jan 2005 to Feb 2006 there were 28 line breaks, 17 leaks and 213 service breaks in Gunnedah. Curlewis has 7 repair incidents while Carroll had one.

The number of taste and odour complaints exceeded the target of less than five, with 24 being recorded in 2002.

The principal issues identified in the Strategic Business Plan were:

1. Reduce the number of mainbreaks
2. Upgrade selected water services
3. Reduce annual water consumptions
4. Implement new pricing structure
5. Develop asset management system and to value assets.

Table 2.20 compares the triple bottom line (TBL) performance of the Gunnedah Shire water supply system compared with the state median. The results identify the number of mainbreaks as being unsatisfactory. The introduction of a two tiered pricing system will help reduce water consumption per allotment.

Table 2.20. Triple bottom Line (TBL) performance of the Gunnedah Shire water supply system compared with the state median (LGA/ SANSW, 2003/2004).

Attribute	State median (most recently available data March 2000/01)	Gunnedah	Comment
Water quality complaints (27)	2.5	1.9	Better than median
Customer interruption frequency(29)	4	4	Similar to median
Mainbreaks (31)	18	36	Poor performance
Total days lost (33)	2.3	1.1	Better than median
Average residential consumption (34) kL	220	460	Poor performance. However consumption has fallen with introduction of 2 tiered pricing.
Operating cost (OMA) (51) $/assessment	200	182	Similar to median
Pumping cost (55) $/assessment	20	68	Poor performance, but cost is falling
Treatment cost (54) $/assessment	30	Nil	Minimal treatment required
Typical residential bill (15) $	315	255	Better than median
Typical developer charges (16) $	2350	2500	Similar to median
Economic real rate of return (47)	2.6%	3.66	Better than median
Management cost (53) $/assessment	80	47	Better than median

Sewerage services in Gunnedah Shire

The Sewerage Services in Gunnedah Shire are detailed in the document Strategic Business Plan for Sewerage Services 2003/04. Council operates schemes in Gunnedah and in Curlewis. Mullaley, Tambar Springs and other hamlets rely on on-site systems.

Gunnedah Sewerage System

The Gunnedah Sewerage System was constructed in 1938 and was augmented to an 11,000 EP capacity in 1968. The plant is based on a conventional trickling filter.

The town has 3510 sewerage connections. There are some 85 km of sewer mains ranging in size from 150 to 600 mm. The system is largely gravity feed and there is only one major pump station. Figure 2.28 shows the layout of the sewer system in Gunnedah.

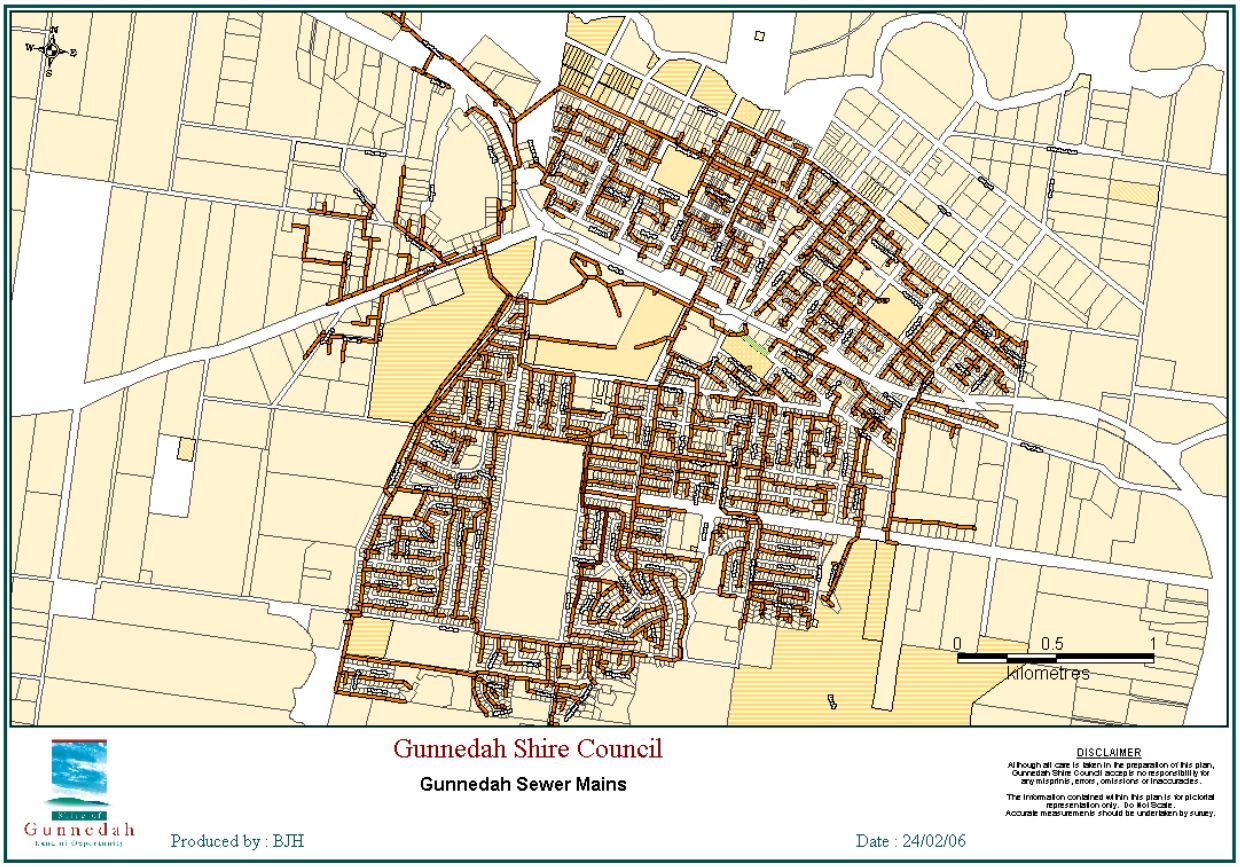


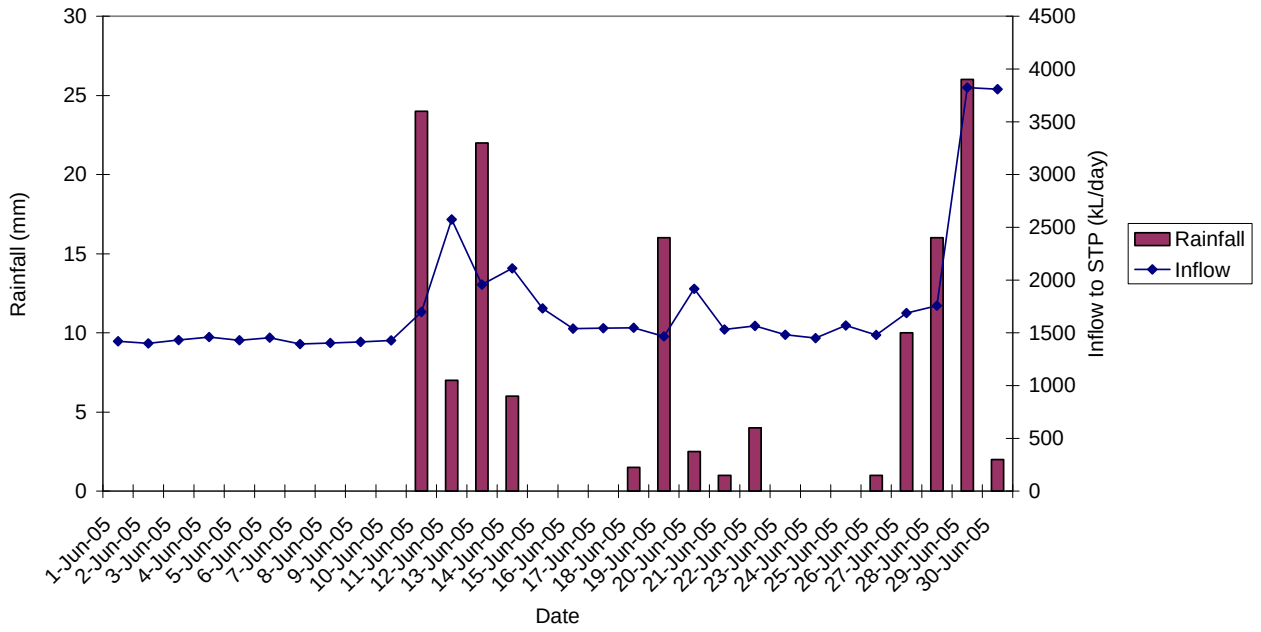
Figure 2.28. Sewer mains in Gunnedah. The system is clustered on the left bank of the Namoi River. (Source: Gunnedah Shire Council GIS).

Total flow between Feb 2005 to January 2006 was 573 ML or 1.7 ML/day. Average dry weather flow to the STP is 45 L/sec. Wet weather increases this over three fold to 130 L/sec.

Figure 2.29 shows the relationship between rainfall and total volume delivered to the STP each day. A series of wet days can more than double inflow. However there is often a delay of a day or more between rainfall and peak flow. This suggests there is slow infiltration into the system from the surrounding soil rather than simply direction connection of stormwater pipes, etc to the sewer.

Council does not have a trade waste policy. There is no monitoring of grease trap management. Large scale waste-producing industries such as the tannery are not connected to the town sewer system.

Figure 2.29. Rainfall and sewer inflows each day at Gunnedah STP in June 2005.



Effluent quality

Gunnedah Shire Council measures effluent quality monthly. The results for 2005 are shown below in table 2.21.

Table 2.21. Contaminant concentrations in Gunnedah effluent during 2005. (Units all mg/L) (Source: Gunnedah Shire Council)

Month:	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Mean	Annual load (kg)
BOD_5	5	10	4	8	7	6	4	4	5	6	9	*6*	*3047*
Suspended Solids	31	30	14	20	13	13	62	29	21	38	26	*25*	*15446*
Total Nitrogen	5	6	10	16	9	11	6	8	6	5	5	*7*	*3818*
Total Phosphorus	1	2	4	6	5	6	3	2	3	3	2	*3*	*1671*
Oil & Grease	2	2	5	5	5	5	5	5	5	5	5	*4*	*2440*

Suspended solids concentration exceeds the indicative 30 mg/L for secondary treated effluent in 4 months. The high concentration in August 2005 suggests an algal bloom.

Total Nitrogen and Phosphorous concentrations are low compared with many secondary treated effluents, and the results suggest the STP is well operated and/or there is a high inflow of uncontaminated water that dilutes the contaminant concentrations. Oil and Grease concentration is low suggesting the STP is not receiving unacceptably large loads of commercial waste.

The data in table 2.22 shows Gunnible farm received 3.8 t of Nitrogen and 1.7 t of Phosphorus in the 2005 effluent. The estimated value of this is around $3000. Table 2.21 also shows that in 2005

STP approached its licence load limits for Suspended Solids and exceeded the limit for oil and grease. Whilst the oil and grease loads were lower in previous years the results suggest the need for a combination of reduced inflowing contamination and improved treatment efficiency at the STP. A trade waste audit could assist in reducing the inflowing load.

The EPA license records indicate periods of non conformance in the past. These were related to high N, P and BOD loads. It is fortunate that the effluent is being beneficially utilised rather than discharged to the Namoi River.

Table 2.22. Comparison between calculated annual load since 2003 and the load limits given in Licence 831 L2.2.

Attribute	Annual load (kg) 2003	Annual load (kg) 2004	Annual load (kg) 2005	Load limit from EPA licence (No 831, Page 9)
BOD_5	3040	5008	3047	7104
Suspended Solids	6422	13459	15446	16824
Total Nitrogen	5381	5869	3818	7337
Total Phosphorus	2532	2283	1671	3165
Oil & Grease	942	993	2440	1750

Reuse

Council has a 5 year contract to supply all of its effluent to an irrigation farm owned by Savekemp Pty Ltd. The farm is some 10 km to the north of the town. Council is paid $55/ ML for the water, with the average annual volume being 600 ML. This covers pumping costs and avoids the obligation to pay DEC load based licensing fees.

Effluent is stored in Gunnedah for 28 days then pumped to Gunnible Farm. The farm then stores the water and utilises it to irrigate a variety of crops. There is formal Environmental Management Plan and a Monitoring program for the site (Gunnedah Shire Council, undated).

The soil monitoring results indicate soil physical stability is good and table 2.23 shows there is low salinity. There is minimal accumulation of phosphorous. Nitrate-N has accumulated in the soil, but there is minimal evidence of accumulation in groundwater. It is likely that crop uptake and denitrification have removed Nitrate from the soil before it can leach to the watertable.

Table 2.23. Results of 2005 monitoring program in effluent irrigated fields at Gunnible Farm (Source: Unpl. Data Gunnedah Shire Council, 2006).

Attribute	Units	Paddock 1 Sample depth 0.4 to 0.6m	Comments
Salinity as EC	dS/m (5:1, Water: soil)	0.13	Low and OK
Cation Exchange	Cmol(+)/kg	43	High and good

Capacity (CEC)			
Exchangeable Sodium Percentage	% of CEC	4	Slightly elevated, check next year
Available P (Bray)	mg/kg	1	Low. P in effluent will provide needed nutrients (note sample depth)
P sorption capacity	mg/kg	182	Medium, suggests long term ability to retain and supply P to plants
Nitrate-N	mg/kg	9	Medium. There could be some leaching of Nitrate to the water table.

System performance

The Strategic Business Plan for Sewerage Services (Gunnedah Shire Council 2003/04) indicates the number of failures due to rainfall and insufficient capacity was 3 per year. This is 50% higher than the 2/year target and is consistent with the high inflows that occur after significant rainfall events. There were some 150 failures/year due to blockages. This is well in excess of the <100 target for Gunnedah. In the 12 months to end of February 2006 there were 34 sideline chokes, 116 mains chokes, 48 boundary shaft blockages and 7 other types of chokes.

Table 2.24. Triple bottom Line (TBL) performance of the Gunnedah Shire sewerage system compared with the state median (LGA/ SANSW, 2003/2004)

Attribute	State median (most recently available data in March 2006)	Gunnedah	Comment
Employees /1000 properties	1.5	1.5	Median performance
Typical residential bill $/assessment	380	220	Better than median performance
Typical developer charges$/assessment	2800	200	Better than median performance
Odour complaints/1000 properties	0.4	0.2	Better than median performance
Days lost (%)	2.9	1.2	Better than median performance
Compliance with BOD licence % of samples	100	100	Good

Compliance with SS licence % of samples	99	90	Lower than median
Sewer chokes/100 km of mains	20	55	Markedly worse than median
Sewer overflow to the environment/100 km of mains	2	25	Markedly worse than median
Economic real rate of return (%)	1.9	1.7	Worse than median
Operating cost ($/property)	260	120	Better than median performance
Management cost ($/property)	96	22	Better than median performance
Treatment cost	90	42	Better than median performance
Pumping cost	36	15	Better than median performance

The results in table 2.24 show economic performance of the Gunnedah Shire sewerage system was better then the NSW median. However sewer chokes and quality of discharged effluent were below the median. Sewer chokes are being addressed, while the 100% reuse of the effluent means the occasional elevated suspended solids concentration is not creating an environmental issue in the receiving waters.

Response times, odour complaints and contaminant concentrations in discharges were within target values.

Key sewerage issues identified in the Business Plan

The key issues identified in the Strategic Businesses Plan are shown in table 2.25.

Table 2.25. Key issues identified for the Gunnedah sewerage system (Source: Gunnedah Strategic Business Plan for Sewerage Services 2003/04).

Issue	Response so far
Extension of sewerage services to industrial area	Forecast for 2005 to 2010 period. No action so far (March 2006)
Reduction in area flows and illegal connections	CCTV used to identify blockages. Council spending $250,000/year on a program expected to last 10 years. Individual home connections not yet tested
Development of asset management system and value	Required strategic maintenance plan (Page 54 of Strategy) partly implemented.

assets	Review and update asset management plan annually.
Update plans and policies including trade waste	Council has approved policy in principle (Jul 2003). No further development (See page 36 of Strategy report for proposed sequences).

Curlewis

The Curlewis sewerage scheme was constructed in 1990. It has a capacity of 1650 EP and serves a population of 610. Total length of the mains is 9.2 km. Figure 2.30 shows the sewer mains in Curlewis. This is a simple gravity feed system.

Sewage is directed to evaporation ponds. Overtopping is extremely infrequent except during periods of prolonged wet weather. Consequently there is effectively no water available for irrigation.

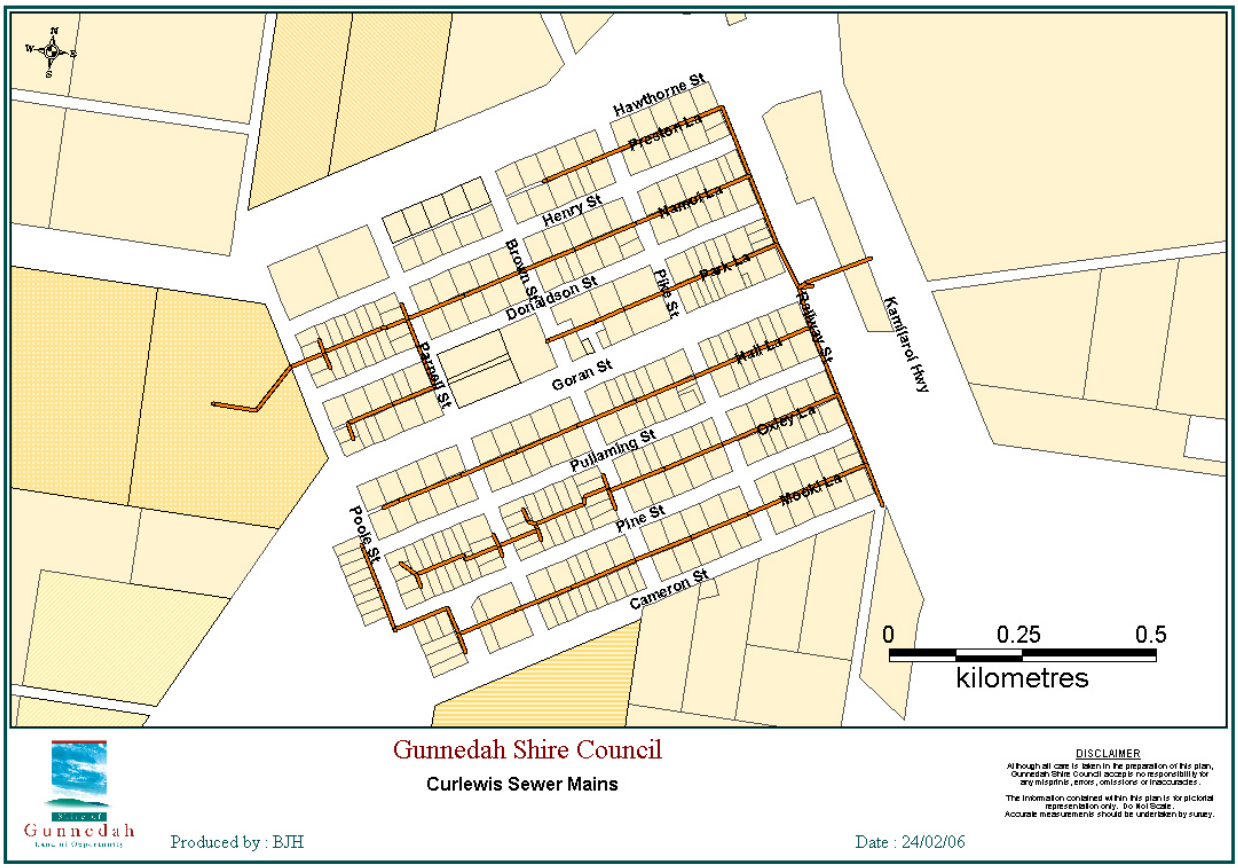


Figure 2.30. The Curlewis sewer main system. (Source: Gunnedah Shire Council GIS).

Onsite sewage management

Council does not have an onsite sewage management strategy. Most of the septic tanks in the Shire have been registered. However, they are not inspected unless the property is sold and a certificate on the septic is requested or there is a complaint.

There is no evidence that the Gunnedah water supply has had a problem from septic contamination. Mullaley and Curlewis water supplies are chlorinated as E. coli has been detected. This contamination may be from rural land use more than sewerage as the supplies are not located near any on site septics.

Stormwater within Gunnedah urban area

Runoff rate

The NSW Farm Dams Assessment Guide (DLWC, 1999) can be used to estimate natural runoff According to this guide Gunnedah Shire has a typical annual runoff of 65 mm or 0.65 ML/ha/y/year. Runoff in urban areas will be almost 10 times this figure.

Drainage systems within Gunnedah

The drainage systems in and around Gunnedah township are described in the Planning Workshop (1981). All the catchment systems drain to the Namoi River. Blackjack Creek Catchment is the largest local system. It arises in Blackjack State forest and extends to the north. Portions of west Gunnedah lie on relatively flat lands near the northern edge of this catchment.

Flooding is an issue in the lower, northern part of the township, and inundation of the CBD can occur in heavy flooding. Figure 2.31 shows the flooded areas in response to different river heights. During heavy rainfall there are major increases in sewage flow rate. Manhole surcharge can also occur. General inundation of the lower parts of Gunnedah would increase wet weather flows.

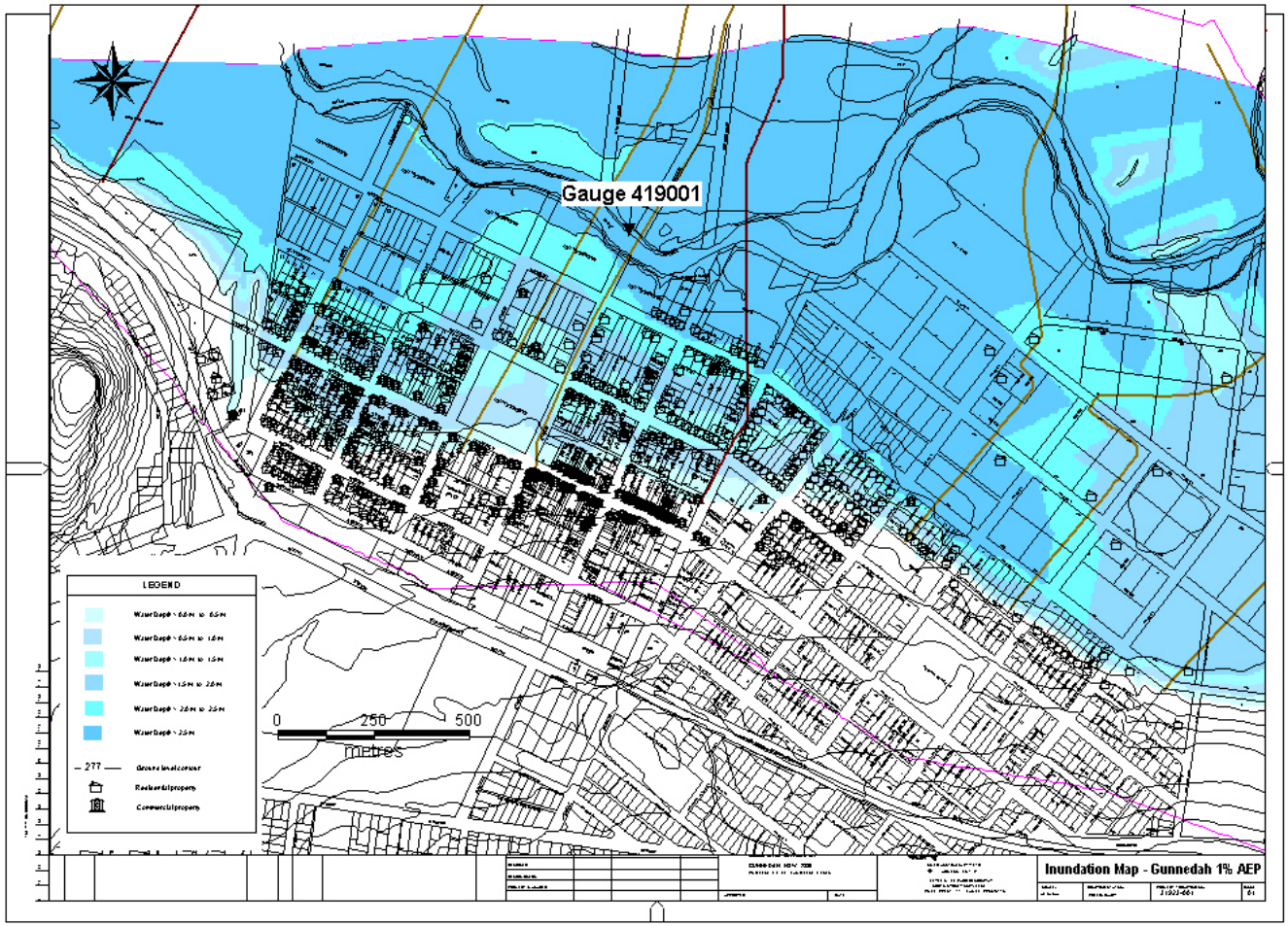


Figure 2.31. Flood inundation map of Gunnedah (Source: Gunnedah Shire Council).

Ashford Catchment covers some 330 ha and is bounded by hills to the south of Gunnedah. Ashford Creek flows through Gunnedah to the east of Links Road via a series of channels, pipes and box culverts. Eventually the creek joins Blackjack Creek and then proceeds to the Namoi River. Flooding with runoff from Ashford Creek is an issue in the lower part of the catchment.

Osric Street Catchment covers some 240 ha. It rises in hills south east of Gunnedah. As with the other catchments there is a marked reduction in slope towards within the township. South of the railway culvert the catchment includes some residential areas as far as Maitland Street. The area downslope of Maitland Street is floodplain. An isolated meander was augmented in 1999 to provide stormwater detention and treatment prior to discharge into the Namoi River. This wetland is known as Mullibah Lagoon.

Stock Road Catchment arises on Porcupine Hill. This catchment drains the eastern edge of Gunnedah and covers some 200 ha. There is only limited urban development in this catchment.
There is limited information on stormwater quality within Gunnedah township. Table 2.26 shows Phosphorus concentration is unusually high and may be due to sampling equipment error.

Table 2.26 Stormwater quality as measured by St Mary School students in 1995. Data is compared with ANZECC Guidelines for aquatic ecosystem protection (ANZECC, 2000) and with Duncan (1999).

Attribute	Oxygen (% sat)	pH	Total P (mg/L)	Nitrate-N (mg/L)	Turbidity (NTU)	Total SS (mg/L)	BOD (mg/L)
Median at Osric St drain Oct- Nov 1995.	68	7	1	0.1	68	251	20
ANZECC Guidelines for aquatic ecosystem protection (ANZECC, 2000).	>90%	<7.5	0.02	0.015	<25	Not given	Not given
Urban runoff (Duncan, 1999) median values	Not given	6.7	0.39	Not given	68	110	3
Comments	Below optimal	OK	High	High	OK	High	High

The results in table 2.26 show the stormwater has low oxygen saturation. This is consistent with the high BOD concentration. Total suspended solids load is higher than many urban areas, however the turbidity is lower. This suggests much of the TSS consists of relatively coarse particles. Total Phosphorus concentration is very high compared with other urban sites (Duncan, 1999).

The high BOD would make water storage a challenge as it would tend to become anaerobic.

Stormwater reuse and substitution

DCP 14 (Gunnedah Shire Council, 2005) aims to conserve water supplies and to complement the provisions of the BASIX Code. It requires every new home or homes undergoing significant extensions to have a 5,000 to 10,000 L rainwater tank. The tank can be connected to toilets and washing machines. Additionally an outdoor supply point is needed. The DCP applies to the entire shire, but is especially important for the urban areas where the reticulated groundwater has significant contamination issues. Note that BASIX is implemented through a SEPP and so overrides local planning instruments. As such, it should form key elements of the Gunnedah Shire urban water management strategy.

The Gunnedah golf course lies downslope of developing residential lands. It currently irrigates with bore water. However, runoff from the area will increase as the number of homes in the catchment

increase. Therefore there is an opportunity to capture urban runoff on the golf course. This would assist in reducing urban stormwater impacts on the lower parts of the town.

Urban salinity

Gunnedah township has a small but significant urban salinity issue (Heath, 2003). The main areas of concern are around Gunnedah High School, within the Wandobah Reserve and in the CBD.

Salinisation is related to shallow aquifers, and is the result of a combination of natural and anthropogenic processes. Groundwater salinity ranges from a low 1 dS/m to a very high 29 dS/m.

The recharge to the groundwater that is driving the salinisation is estimated to be 60% from rainfall, 30% from leakage of water and sewer pipes and 10% over irrigation (Berhane, et al, 2000). Improved water management is required to reduce the recharge rate.

2.3 Adequacy of data

Population assessment

Population growth rate estimates for Gunnedah Shire vary from a predicted decline to virtually static. Between 1981 and 1986 it increased by 1.92%. However it fell by 1.96% over the next 5 years and by another 3.2% between 1991 and 1996. NSWPlanning suggests a shire population of around 10,700 by 2021 (Cited in Strategic business Plan for Sewerage, 2003/04). This represents a 15% fall on current population figures. Gunnedah Shire Council predicts minimal change in population. The projections both suggest there will not be a significant increase in population.

Conclusion

There is no need for major augmentation of services to meet increased demand.

Groundwater supply security

Gunnedah urban water supply is completely reliant on groundwater sources. Increased salinity and reduced bore water heights during the recent drought highlighted the need to maximise supply security.

Recommendations

Council make continued representations to the DNR, Tamworth regarding the proposed reduction in water extraction rate to sustainable volumes.

Council make representations to the DNR to ensure the estimate of sustainable extraction rate is as accurate as possible. This may require more sophisticated analysis; for example use mathematical modelling rather than the 'hill' method.

Groundwater quality

Groundwater extracted for Curlewis is not meeting ADWG for sodium, Chloride TDS or Total Hardness. The reasons for this need investigation.

Groundwater at Tambar Springs has elevated concentrations of Lead. This is a health issue that needs to be investigated.

Recommendations

Council make continued representations to the DNR Tamworth regarding water quality at Curlewis.

Council make representations to the Department of Health regarding water quality at Tambar Springs.

Use of rainwater tanks

The introduction of DCP14 will gradually increase the number of rainwater tanks, however tank use is already widespread in Curlewis and other small urban centres. This is important as it means there is less reliance on subsurface supplies for drinking water.

There is a need to establish the extent of tank use and its likely implications for stormwater management as well as for human health.

Recommendation

Council identify the use of rainwater tanks in the urban areas of the shire.

Urban Stormwater information

The Gunnedah Stormwater Management Plan is a generic document that contains minimal data specific to Gunnedah. For example there is no information on flows in the major catchment within the town. Nor is there any estimate of benefits that could arise is various stormwater management systems were installed.

There is minimal stormwater quality information, and the information collected shows entirely high contamination with Phosphorus.

Recommendations

Council identify the value of installing stormwater management devices and policies before resource allocation. For example, what is the value of requiring on-site detention systems for new large buildings? Is there a need to require new developments to demonstrate that peak runoff will not be increased as a result of increased impervious surfaces?

Council should introduce a simple stormwater data collection system. This would be designed to measure any change in quality as different devices and policies are introduced.

Trade waste management audit

The concentration of Oil and Grease at the Gunnedah SPT exceeded the licence limit in 2005. This may be due to trade waste dumping.

Recommendation

Council to institute a trade waste audit and develop a trade waste agreement

2.4 Audit of data

DUES Guidelines (2004) Appendix provides a series of audit questions. The response to them is given in table 2.27

Table 2.27. Responses to questions in the DEUS Audit list (Appendix I DEUS, 2004).

Ref	Factor	Information	Information source
		Landscape characteristics	
1.1	What is the forested area of your catchment	371 km sq or some 7% of the shire area. Is protected. 34% has scattered trees	Bailey (1995)
1.2	Is catchment area currently subject to clearing	Yes, but relatively small and scattered as most of the catchment is already cleared	Bailey pers comm 2006.
1.3	What is the upstream extent of your estuary (tidal and saline)	Not applicable	
1.4	Are there wetlands in your catchment	Yes. Goran Lake is the largest wetland within the Shire It covers some 6000 ha	Bacon and Briggs (1995)
1.5	What are the predominant vegetation types in your catchment	Liverpool Plains were largely covered with Stipa spp grasslands. These have been cleared for agriculture. Scattered Eucalypts (E alba and E melliodora) occur on medium to heavy soil while pine occurs on sandy elevated sites.	SCS (1976)
1.6	Does your catchment have potential acid sulphate soils	No	
1.7	Are there acid impacts in your catchment waters	No	
1.8	Are urban areas located in areas of potential acid soil	No	
1.9	Are there acid impacts in your urban areas	No	
1.10	Does either dryland or irrigation salinity occur in your catchment	Yes. Salinity occurs naturally at the break of slope between hills overlying sedimentary rock and the Liverpool Plain. Bailey (1995) identified salinity from irrigation as a potential issue in 1995. Urban salinity in Gunnedah is considered to be 60% due to natural processes, 30% to leaking pipes and 10% to overwatering	Bailey (1995) Berhane et al (2000)
1.11	What is the area of catchment salt affected	Not available	CMA
1.12	Are urban areas salt affected	Yes. A small area near Gunnedah High School	Berhane et al (2000)
1.13	Are there salinity targets for waterways	Not known	DIPNR
1.14	What are predominant soil types in your catchment	See Section 2.1.7	Bailey (1995)
1.15	Are there national parks in your catchment	Yes, see section 2.1.16	Bailey (1995)

Ref	Factor	Information	Information source
1.16	Are there protected areas (including water supply catchments, aquifers and marine areas) in your catchment	Yes, approximately was 371 km sq or some 7% of the shire area.	Bailey (1995)
1.17	Are there any threatened species or critical habitats in your catchment	Stipa grass plains are considered threatened	DEC (NPWS)
1.18	What is the topography of your catchment	See Section 2.1.9. More than 80% has slopes <5%. 4% has slopes>20%	Bailey (1995)
1.19	What is the average catchment runoff	0.65 ML/ha/y or around 10% of median rainfall	DLWC (1999)
2.0 Urban and Agriculture			
2.1	Are there STPs in your catchment	Yes, see Section 2.2.3. One in Gunnedah, one in Curlewis	Gunnedah Shire Council. (2003/04) Strategic Business Plan for Sewerage Services.
2.2	Is STP effluent quality monitored	Yes. See section 2.2.3. STPs produce secondary treatment quality effluent	Council records
2.3	Is the STP discharge volume monitored	Yes. See section 2.2.3.	Council records
2.4	Where are the STP discharge locations	There is NO discharge. Gunnedah effluent is 100% utilised on north Gunnible Farm. Curlewis effluent is evaporated	Council records
2.5	What is the load of nutrients and any other monitored contaminants from the STP discharge	No discharge occurs. See section 2.2.3.	Council records
2.6	What is the expected effluent flow (total and dry weather only) in 25 years time	See section 2.2.3. 573 ML/year in 2005. Likely to be similar in 2030.	Council records
2.7	What is the expected load of nutrients and any other monitored contaminants in 25 years time	See section 2.2.3. 573 ML/year in 2005. Likely to be similar in 2030: BOD: 3T, TSS :16T, N: 4T, P 1.7T and O&G 2T	Council records assuming zero population change and no new treatment technology

Ref	Factor	Information	Information source
2.8	Are there WTPs in your catchment	No (see Section 2.2.2). Water is obtained from bores.	Gunnedah Shire Council
2.9	Is WTP final water quality monitored	Yes. See Section 2.2.2	Council records and Dept of Health
2.10	What is the WTP treatment capacity	See Section 2.2.2. Peak day flow in Gunnedah is 2,800 L/dwelling	Gunnedah Shire Council. (2003/04) Strategic Business Plan for Water Services.
Ref	Factor	Information	Information source
2.11	Size and location of aquaculture	NA	DPI
2.12	What is the urban area in your catchment	See Section 2.2.4	Gunnedah Shire Council
2.13	What types of agriculture are there in your catchment	See section 2.1.4. Irrigated cropping is the most valuable enterprise. Some dryland cropping and pasture usage occurs	DPI
2.14	What is the location and area of this agriculture	See section 2.1.4.	Dept of Primary Industries (Agriculture)
2.15	Is there modified or contaminated runoff or wastewater generated from this agriculture	No the main concern is salinisation and over use of groundwater resources.	CMA
2.16	What is the catchment population	See Section 2.1.2. Gunnedah Shire had 12819 in 2001.	ABS
2.17	What is the urban population	Gunnedah: 9000, Curlewis: 600, Mullaley: 80, Tambar Springs: 100.	Gunnedah Shire Council
2.18	What is the expected urban population growth	Zero to decline of around 1%/year	ABS, Gunnedah Shire Council
2.19	What is the expected rural (non-urban)population growth	Zero to decline of around 1%/year	ABS, Gunnedah Shire Council
2.20	How many on-site sewage systems (septic) operate in the catchment	Not known	
2.21	What types of industry operate within the catchment	There are two operating coal mines and a tannery.	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.22	Where is this industry located	Mines are to the North and West of Gunnedah township. The tannery is on the edge of Gunnedah.	Gunnedah Shire Council
2.23	Is the volume of industry waste discharge monitored	No monitoring of industrial waste discharge in undertaken by council	Gunnedah Shire Council
2.24	Where is industry wastewater discharged	Typically discharged as irrigation onto surrounding lands	DEC website
2.25	Is there wastewater/reclaimed water use in the catchment	Yes. See Section 2.3.3	Gunnedah Shire Council
2.26	Is reuse water monitored	Yes. 600 ML is produced from Gunnedah in the average year. Table 2.20 shows the contaminant load	Gunnedah Shire Council
2.27	What is the volume of urban stormwater generated by each urban centre	Not known. Runoff from 'natural' lands is estimated at 0.65 ML/ha/y. Urban runoff could be up to 6ML/ha/y from sites with 100% imperviousness.	DLWC (1999)
2.28	Is stormwater quality monitored	No. Indicative low urban median contaminant concentrations are: TSS 110 mg/L, P 0.39 mg/L, N 2.5 mg/L, BOD 3 gm/L, O&G 9 mg/L, Faecal coliforms 17,000 CFU/100 mL.	Duncan (1999)
2.29	What is the expected stormwater flow volume in 25 years time	No change	Gunnedah Shire Council
2.30	What is the expected stormwater load of nutrients and any other monitored contaminants in 25 years time	No change	Gunnedah Shire Council
2.31	Are there any contaminated sites in your Catchment?	No sites are listed in the DEC Contaminated Lands Register	DEC
2.32	Does flooding occur in urban areas?	Figure 2.31 shows the extent of flooding. The 100Y ARI flood will result in extensive shallow flooding in the business district.	Gunnedah Shire Council
2.33	Have algal blooms been recorded in your Catchment?	Yes, see section 2.1.13	DNR
2.34	What are your water demands?	Demand estimate is based on pump run times. Results for each urban area are given in Section 2.2.2	Gunnedah Shire Council
2.35	What is your water consumption?	See section 2.2.2	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.36	What is your energy consumption (kWh/ML) for your water and wastewater facilities and what is your bill for each?	Water costs = $254,346 (2004/05) Sewerage costs = $38,933 Pump energy costs for water averages 2.3 kW/kL	Gunnedah Shire Council
2.37	What is your sewerage and water supply operating cost per 100 km of mains?	Total costs Water $1.564 m ($894,000/100 km) Total sewer costs $1.037m ($1.09m/100 km of mains)	Gunnedah Shire Council
2.38	What is your sewerage and water supply operating cost per property?	2623 water connections in Gunnedah township. Operating cost is $97/ connection. Sewer operating cost is $110/ connection.	LGA (1002/03
2.39	Sewerage and water supply service complaints	Separate totals for sewerage and water supply complaints. 25 complaints per 1000 properties for water supply and 3 complaints per 1000 properties for sewerage	Local Government or LWU
2.40	Water supply quality complaints	5 complaints per 1000 properties for water supply	Local Government or LWU
2.41	Number of supply main breaks	21 per 100 km of main	Local Government or LWU
2.42	Sewer chokes and collapses	34 per 100 km of main	Local Government or LWU
2.43	Sewer overflows to the environment	16 per 100 km of main	Local Government or LWU
2.44	Are sewer overflows monitored	Individually records are kept of all incidents	Local Government or LWU
2.45	Typical developer charges for sewerage and water supply	Water $3392 Sewer $1343.5	Local Government or LWU
2.46	Average residential bill for sewerage services	$245/connected property	Local Government or LWU
2.47	Volume of sewage treated per property	157 kL/year. See Appendix 1 for spreadsheet of daily treated water production volumes for last 3-5 yrs	Local Government or LWU

Ref	Factor	Information	Information source
2.48	Urban properties without reticulated public sewerage and water supply	None	Gunnedah Shire Council
2.49	Water usage charge	45 cents/kL	Gunnedah Shire Council
2.50	Annual water allowance (if given)	450 KL/assessment	Gunnedah Shire Council
2.51	Access charge	$270/assessment	Gunnedah Shire Council
2.52	Drinking water quality tests	See section 2.2.2	Gunnedah Shire Council
2.53	Raw water quality data at extraction point	See section 2.2.1	Gunnedah Shire Council
2.54	STP effluent quality licence monitoring results	See section 2.2.3	Gunnedah Shire Council
2.55	Water quality monitoring results for local waterways	See section 2.1.12	Gunnedah Shire Council
2.56	Water supply, sewerage & stormwater system maps	See sections 2.2.2 and 2.2.3	Gunnedah Shire Council
2.57	Number of residential dwellings	2632 based on water use in Gunnedah township	Gunnedah Shire Council
2.58	Range of typical residential block sizes	See figure in section 2.2.2 Median area is 872 msq.	Gunnedah Shire Council
2.59	Number and size of rainwater tanks	Not known. DCP only recently introduced requiring 5 kL tanks	Gunnedah Shire Council
2.60	Number of tanks commented to the potable system for top up	Not known	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.61	Rainwater Tank rebate	Nil	Gunnedah Shire Council
2.62	Is there polluted atmospheric fallout over the urban area	No	Gunnedah Shire Council
2.63	Is there an on site detention policy (OSD)	No	Gunnedah Shire Council
3.0 Climate			
3.1	What is the mean annual rainfall for the catchment or catchment regions	636 mm	Bureau of Meteorology (BOM)
3.2	What is the mean annual evaporation for the catchment or catchment regions	1752 mm	BOM, DIPNR
3.3	What is the seasonality of the rainfall	See Table 2.2. Highest in late summer.	BOM
3.4	What is the maximum temperature and annual temperature range	January 19-32 degrees, July 5-16 degrees	BOM
4.0 River and groundwater			
4.1	What is the water quality of dry weather river flows	Figures in section 2.1.12 show water quality was less than the ANZECC Guideline values for aquatic ecosystem protection at virtually all samplings.	DIPNR
4.2	What is the total annual dry weather discharge volume	See section 2.1.12 for discussion of river flows	DIPNR
4.3	What is the annual dry weather contaminant load	Not relevant as flows adjusted to meet irrigation demand	DIPNR
4.4	What is the water quality of wet weather river flows	See section 2.1.12	DIPNR

Ref	Factor	Information	Information source
4.5	What is the wet weather mean annual discharge	Depends on irrigation demand	DIPNR
4.6	What is the annual wet weather contaminant load	Depends on irrigation demand	DIPNR
4.7	Have environmental flow requirements been identified for catchment streams	No but water quality objectives have been determined	DIPNR
4.8	What is the location of all catchment dams	Keepit is the main dam. It is located on the NE boundary of Gunnedah Shire.	DIPNR
4.9	What is the capacity of each catchment dam	Volume is 436,000 ML	State Water (SW)
4.10	What is the secure yield of each catchment dam	Not known	DIPNR
4.11	What is the water quality in each dam	Algae have been an issue in 3 out of the 5 past years	DIPNR
4.12	What is the location of all catchment weirs	Not known	DIPNR
4.13	What is the capacity of all catchment weirs	Not known	DIPNR,
4.14	What is the secure yield of all catchment weirs	Not known	DIPNR
4.15	What is the water quality in each weir	Not known	DIPNR
4.16	Are returned flows provided from, or intended to be provided from catchment storage/s or weirs	No	DIPNR

Ref	Factor	Information	Information source
4.17	Is the water quality of the return flows expected to be the same as the water quality in dam or weir	No	DIPNR
4.18	What is the extent and nature of groundwater resources within the catchment	Based on Namoi Groundwater sharing Plan indicates a recharge rate of 209,900 ML/y. This is less than half the 474,109 ML/y in allocated licenses	DIPNR
4.19	Does catchment include one or more estuary habitats	No	Gunnedah Shire Council
4.2	Are there licensed extractions in the catchment	474,109 ML in total. 2% for urban use (11194ML)	DIPNR
4.21	Are there licensed town water extractions in the catchment	Yes 11194 ML	DIPNR
2.22	What is the projected town water demand over the next 25 years?	No change from the current rate of 2531 ML	Gunnedah Shire Council

3 GUNNEDAH SHIRE PERFORMANCE IN 2005/06 BENCHMARKING REPORT

The 2005/06 NSW Benchmarking report (DWE, 2007) provides an opportunity to examine the performance of the LWU against other LWUs and against itself over time. The tables below are taken from the 2005/06 NSW Benchmarking report (DWE, 2007)

Table 3.1. Best-Practice compliance for Water Supply for Gunnedah Shire Council (from table 3, 2005/06 NSW Benchmarking report (DWE, 2007)

Component	Compliance (Y/N)	% of LWU with 3000 to 10000 properties that comply
Complete Current SBP & FP *(Yes/No)*	Yes	89
Pricing with full cost recovery, Without significant cross subsidies *(Yes/No)*	Yes	49
Complying Residential Charges *(Yes/No)*	Yes	95
Residential Charges >=50% in 2006/07, 60% in 2007/08, and 75% in 2008/09 *(Yes/No)*	Yes	58
Complying non- Residential Charges *(Yes/No)*	Yes	74
DSP with Commercial Developer Charges *(Yes/No)*	Yes	79
Complete performance Reporting Form by 15 September *(Yes/No)*	Yes	89
Sound Water Conservation implemented *(Yes/No)*	Yes	47
Sound Drought Management implemented *(Yes/No)*		53
Integrated Water Cycle Management Strategy Commenced (Yes/No)	Has commenced	26
Compliance with required Criteria 5 *(Yes/No)*	Yes	
Proposed Dividend from Surplus $'000	Nil	

The results above show that Gunnedah Shire Council is meeting almost all the Best-Practice Management Compliance criteria for water supply.

Table 3.2. Best-Practice compliance for Sewerage for Gunnedah Shire Council (from table 3, 2005/06 NSW Benchmarking report (DWE, 2007)

Component	Compliance (Y/N)	% of LWU with 3000 to 10000 properties that comply
Complete Current SBP & FP *(Yes/No)*	Yes	77
Pricing with full cost recovery, without significant cross subsidies *(Yes/No)*	Yes	77
Complying Residential Charges *(Yes/No)*		50
Complying non- Residential Charges *(Yes/No)*		38
Complying Trade Waster Fees and Charges *(Yes/No)*		42
DSP with Commercial Developer Charges *(Yes/No)*	Yes	77
Liquid trade waste approvals & policy (Yes/No)		54
Complete performance Reporting Form by 15 September *(Yes/No)*	Yes	92
Integrated Water Cycle Management Strategy Commenced *(Yes/No)*	Yes	35
Compliance with required Criteria *(Yes/No)*		Overall 60%
Proposed Dividend from Surplus $'000		

The areas of non-compliance are:

1. Charges for residential and non residential customers
2. The lack of a trade waste policy (Note that table 7D of DWE (2007) suggests that Gunnedah does have a complying liquid Trade Waste Policy. However no further information is provided. .

Both these issues should be addressed.

Table 3.3. Water losses for Gunnedah Shire Council (from table 8A, 2005/06 NSW Benchmarking report (DWE, 2007).

Component	%	Median % for LWUs with 3,000 to 10,000 properties
Apparent losses as a % of the total supplied	2%	4%
Real losses as a % of the total supplied	6% (but not recorded in data)	6%
Water loss as % of total potable	8%	10%

Total water loss is calculated as 8% of supplied volume. This is slightly less than the 10% median value of this group of LWUs.

The results suggest water loss is not a significant issue.

Table 3.4. Water conservation initiatives for Gunnedah Shire Council (from table 8C, 2005/06 NSW Benchmarking report (DWE, 2007).

Component	**Yes/ No**
Customer Education Program	No
Retrofit Program	No
Rebates for Water Efficient Appliances	No
Rebates for Water Tanks	No
Effluent or Stormwater Reuse	No
Leakage Reduction Program	No
Customer Billing Periods	3
Other Demand Management Measures	Full pay-for-use pricing, member of Waterwise, restrictions, public education program.
Sound Water Conservation Implemented?	Yes
Sound Drought Management Implemented?	Yes
Average annual residential consumption of water (kL/y)	336

The results in the table above suggest that Council could consider doing more customer and business focussed water conservation activities

Table 3.5. Water supply- Asset Management, Water resource Management for Gunnedah Shire Council (from table 10, 2005/06 NSW Benchmarking report (DWE, 2007).

Component	Result	Comment
Leakage-L/day/connection- (2003/2004)	133	22% fall in loss over 3 years. Median is 89. So still significantly higher than comparable LWUs.
Leakage-L/day/connection- (2004/2005)	112	
Leakage-L/day/connection- (2005/2006)	104	
Leakage –kL/km/day	2.3	Median is 2. So higher than comparable LWUs.
Main breaks/100 km of main-(2003/2004)	6	Median is 13. So Gunnedah is similar to comparable LWUs.
Main breaks/100 km of main-(2004/2005)	15	
Main breaks/100 km of main-(2005/2006)	11	
Unplanned interruptions to supply/ 1000 properties (2003/2004)	5	Median is 23. So Gunnedah is substantially better than comparable LWUs.
Unplanned interruptions to supply/ 1000 properties (2004/2005)	4	
Unplanned interruptions to supply/ 1000 properties (2005/2006)	3	
Rehabilitations (km/100 km)	0.5	Median is 3.1. So Gunnedah is substantially lower than comparable LWUs.
% recycled	20	Median is 8. So Gunnedah is substantially better than comparable LWUs.
Drought Management Policy in place	No	Policy has been prepared
Demand Management Policy in place	Yes	
Water consumption (kL/property/y) (2005/06)	336	Median is 318. So Gunnedah is substantially better than comparable LWUs.

The results indicate:

1. Leakage is higher than comparable LWUs. Rehabilitations are also low, so some additional work may be necessary.
2. Unplanned interruptions to services are very low, suggesting that customer satisfaction should be OK.
3. The recycled % is much higher than the median, suggesting that Gunnedah is performing satisfactorily in this area.
4. The Drought Management Plan has been prepared, but there has been no need to implement it at this stage.
5. Water consumption/ property is higher than the median. This is a reflection of the high supply security and the minimal water conservation initiatives in place.

Table 3.6. Water supply- Financial, Efficiency for Gunnedah Shire Council (from table 11, 2005/06 NSW Benchmarking report (DWE, 2007).

Component	Result	Comment
Debt to equity (%) 2005/06	-13.6	Median is -14.8%. So Gunnedah is similar to comparable LWUs.
Economic Real Rate of Return (ERRR)- % -(2003/04)	3.6	Median is 3.3%. So Gunnedah is similar to comparable LWUs.
Economic Real Rate of Return (ERRR)- % -(2004/05)	2.5	
Economic Real Rate of Return (ERRR)- % -(2005/06)	3.5	
Operating result $/property, 2005/06	152	Median is 139. So Gunnedah is slightly better than comparable LWUs.
Operating costs $/property 2002/03	213	Median is 347. So Gunnedah is substantially better than comparable LWUs.
Operating costs $/property 2005/06	232	
Total cost (Operation + Depreciation 2002/03	284	Median is 459. So Gunnedah is substantially better than comparable LWUs.
Total cost (Operation + Depreciation 2002/03	314	
Management Cost $/property, 2002/03	52	Median is 119. So Gunnedah is better than comparable LWUs.
Management Cost $/property, 2005/06	71	

The results indicate:

3. Equity to debt ratio is satisfactory
4. The ERRR is positive and satisfactory
5. The operating result, the operating costs and the management costs are better than comparable LWUs.

These favourable comparisons with similarly sized LWUs suggest Gunnedah is well managed for a financial viewpoint. Some of this may be due the relatively simply supply system. However it also reflects relatively efficient and cheap delivery of water.

Table 3.7. Water supply- Health, Levels of Service for Gunnedah Shire Council (from table 12, 2005/06 NSW Benchmarking report (DWE, 2007).

Component	Result	Comment
Council has a risk based water management plan	No	Few LWUs of comparable size have a risk based plan
Physical quality of water complies with NHMRC/ARMCANZ 1996 guidelines	40%	Median is 100. So Gunnedah is very much lower than comparable LWUs.
Chemical quality of water complies with NHMRC/ARMCANZ 1996 guidelines	100%	Median is 100. So Gunnedah is the same as comparable LWUs.
Microbiological quality of water complies with NHMRC/ARMCANZ 1996 guidelines	87%	Median is 100. So Gunnedah is very much lower than comparable LWUs.
Number of water supply zones that are compliant with microbiological guidelines	1/4	This is low and needs attention
Water service complaints/1000 properties (2005/06)	3	Median is 7. So Gunnedah is very much lower than comparable LWUs.
Total water complaints (2005/06)	8	Median is 16. So Gunnedah is very much lower than comparable LWUs.
Average customer outage time (minutes)	0	Median is 3. So Gunnedah is very much lower than comparable LWUs.
Customer interruption frequency/1000 properties 2005/06	3	Median is 23. So Gunnedah is very much lower than comparable LWUs.
Average duration of interruption (hours)	2	Median is 2. So Gunnedah is similar to comparable LWUs.
Drought restrictions (% of time since 2002/03)	0	Median is 0. So Gunnedah is similar to comparable LWUs.

The results indicate:

1. Physical water quality is low. This is largely related to salinity and reflects groundwater quality. Council may consider encouraging greater use of rainwater tanks
2. Microbiological quality is low. This is a significant issue that needs to be addressed.
3. Water supply criteria indicate there are few interruptions
4. Drought restrictions are not an issue in Gunnedah. A more water conservation attitude would be more consistent with public attitude elsewhere in NSW.

Table 3.8. Water supply- Benchmarking Cost Data for Gunnedah Shire Council (from table 13, 2005/06 NSW Benchmarking report (DWE, 2007).

Component (all 2005/06 unless specified)	**Result**	**Comment**
Operating cost ($/property)	113	Median is 56. So Gunnedah is very much higher than comparable LWUs.
Energy costs ($/property)	48	Median is 22. So Gunnedah is very much higher than comparable LWUs.
O&M costs mains ($/property)	81	Median is 57. So Gunnedah is much higher than comparable LWUs.
O&M costs reservoirs($/property)	7	Median is 5. So Gunnedah is slightly higher than comparable LWUs.
O&M costs pump stations($/property)	73	Median is 29. So Gunnedah is much higher than comparable LWUs.
Management/ admin costs ($/property)	36	Median is 65. So Gunnedah is very much lower than comparable LWUs.
Engineering costs ($/property)	34	Median is 35. So Gunnedah is similar to comparable LWUs.
Total management cost/kL	11	Median is 24. So Gunnedah is very much lower than comparable LWUs.
Wholesale water component ($/property)	58	Median is 121. So Gunnedah is very much lower than comparable LWUs
Retail water component ($/property)	174	Median is 157. So Gunnedah is slightly higher than comparable LWUs
Total O&M cost for pump stations (c/kL)	12	Median is 7. So Gunnedah is much higher than comparable LWUs.
Energy cost for pump stations ($/property)	48	Median is 22. So Gunnedah is much higher than comparable LWUs.
Total O&M cost for mains (c/kL)	13	Median is 11. So Gunnedah is similar to comparable LWUs.
Total O&M cost for mains ($/100 km)	181	Median is 125. So Gunnedah is much higher than comparable LWUs.

The results indicate:

1. Relatively high operating and energy costs.
2. Pump stations have especially high O&M costs compared with similar LWUs.
3. Mains also have a relative high operational cost
4. Management costs are relatively low, and this reduces the cost of supply/property.
5. Energy cost for pump stations is relatively high. This may reflect the relatively small size of the individual station.

Table 3.9. Sewerage-Asset Management, Resource Management characteristics for Gunnedah Shire Council (from table 15, 2005/06 NSW Benchmarking report (DWE, 2007).

Component (all 2005/06 unless specified)	**Result**	**Comment**
Infiltration (ML/100 km of mains)	69	Median is 50. So Gunnedah is worse than comparable LWUs.
Chokes and collapses/100 km of mains	123	Median is 61. So Gunnedah is worse than comparable LWUs.
Overflows/100 km of mains	63	Median is 16. So Gunnedah is worse than comparable LWUs.
Interruptions to services /100 properties	1	Median is 12. So Gunnedah is better than comparable LWUs.
Rehabilitation as a % of total length	2.1	Median is 0.5%. So Gunnedah is much more active in this area than comparable LWUs.
% of sewage treated that was compliant	75	This is not an issue if the effluent is reused on a sustainable agricultural enterprise.
Volume of sewage collected/kL/property	144	Median is 228. So Gunnedah is better than comparable LWUs.
Biosolids reused	75%	Median is 100%. So Gunnedah is worse than comparable LWUs.
% of effluent reused	90%	Median is 21. So Gunnedah is much better than comparable LWUs.

The results indicate:

1. Sewer performance measured as infiltration rate, chokes and collapses and overflows are much worse than other comparable LWUs. However Council recognises this and has undertake a small but steady sewer lining plan
2. Interruptions to services are relatively few, so the sewer performance issue is at the mains scale rather than individual residences.
3. The sewerage volume/ property is low. Possibly because at least some is lost via overflows and percolation from pipes.
4. Biosolids use is low, but the effluent reuse scheme is very effective

Table 3.10. Sewerage-Financial, Efficiency characteristics for Gunnedah Shire Council (from table 16, 2005/06 NSW Benchmarking report (DWE, 2007).

Component (all 2005/06 unless specified)	**Result**	**Comment**
Net debt to equity ratio	-29.8%	Indicates a reasonably healthy funding situation
Economic Real Rate of Return (ERRR)	2.2	Median is 2.6. So Gunnedah is slightly lower than comparable LWUs.
Operating result ($/property)	62	Median is 78. So Gunnedah is slightly lower than comparable LWUs.
Operating costs ($/property)	123	Median is 285. So Gunnedah is much better than comparable LWUs.
Total cost ($/property)	204	Median is 425. So Gunnedah is much better than comparable LWUs.
Management cost ($/property)	143	Median is 102. So Gunnedah is worse than comparable LWUs.

The results indicate:

1. The sewerage system is providing a modest ERRR.
2. Operating costs are lower than the median, except for management costs. The higher management costs reflect remedial activity.
3. The total cost/property is less than half the median, indicating the Gunnedah system is relatively cheap to operate.

Table 3.11. Sewerage-Environmental, Levels of Service characteristics for Gunnedah Shire Council (from table 17, 2005/06 NSW Benchmarking report (DWE, 2007).

Component (all 2005/06 unless specified)	**Result**	**Comment**
BOD –DECC license discharge compliance	100%	Median is 100. So Gunnedah is similar to comparable LWUs.
TSS –DECC license discharge compliance (2004/05)	78%	Median is 92. So Gunnedah is lower than comparable LWUs.
Compliance with environmental register	Yes	Satisfactory
Odour complaints/ 1000 properties	0	Median is 0.6. So Gunnedah is better than comparable LWUs
Service complaints / 1000 properties	46	Median is 18. So Gunnedah is worse than comparable LWUs.
Total complaints /1000 properties	47	Median is 17. So Gunnedah is much better than comparable LWUs.
Average customer outage time (minutes/ property unplanned)	0	Median is 1. So Gunnedah is better than comparable LWUs.
Customer interruption frequency /1000 properties	1	Median is 1. So Gunnedah is similar to comparable LWUs.
Average duration of interruption (hours)	1	Median is 2. So Gunnedah is better than comparable LWUs.

The results indicate:

1. The quality of effluent generally meets license criteria
2. Service complaints are higher than the median, indicating the need to continue improvement of the sewer mains.
3. The average duration of disruption is low. This suggests that impact on customers' ability to discharge wastewater is very low.

4 ISSUES AND OBJECTIVES

Issues influencing the IWCM within Gunnedah Shire can be considered in three components:

- Catchment
- Water resources
- Urban Area.

4.1 CATCHMENT

Namoi CMA released its Catchment Action Plan Part B-Natural Resources Management Plan in January 2006. This plan identifies a series of impacts as well as management actions to address these issues. A key issue relating to Gunnedah Shire IWCM is that management of water quality and flows within the Namoi River is at a catchment level and therefore outside the control of mid catchment LGAs such as Gunnedah.

Secondly catchment landuse is outside Council's control. Activities such as land clearing, irrigation, over cultivation or overstocking can all impact on Gunnedah Shire water resources yet the Shire has no control over the activities.

As an organisation with a vital interest in the well being of its constituents, Gunnedah Shire Council should ensure it participates in the decision making and prioritisation processes of the CMA.

The catchment based issues, targets and proposed management activities are summarised below. These focus on the catchment based actions upon which Gunnedah Shire Council could have some impact.

Table 4.1 Catchment based issues, targets and management actions to achieve the targets (Source: Namoi CMA, 2006).

Issues	Targets	CMA Management Actions	Potential actions for Gunnedah Shire Council
Poor management of soil resources including Over irrigation Over stocking Salinisation Soil sodicity Soil acidification Loss of soil structure Erosion Soil contamination	Adoption of BMP (Best Management Practices)	Develop/extend BMP in industry based partnerships Provide technical support to adopt BMP	Ensure active participation of appropriately qualified staff at stakeholder meetings. This can be via NROC or by requesting participation in stakeholder discussions. Ensure mining and construction industry follow appropriate BMPs

Issues	Targets	CMA Management Actions	Potential actions for Gunnedah Shire Council
Land is not being utilised within its capability	Increase percentage of land being utilised within its capability	Assist property planning Change landuse to suit capability	Encourage CMA activity in Gunnedah Shire. Involve CMA in IWCM and application of urban BMPs including environmentally sustainable urban development. Develop LEPs that reflect CMA issues, for example addressing urban salinity.
Water quality commonly does not meet ANZECC guideline criteria for salinity, P and N	Increase the proportion of time that surface waters meet ANZECC criteria	Rehabilitate and protect riparian zones Undertake some structural works Reduce both point and non point pollution Improve river flow	Actively manage council lands adjacent to waterbodies. Ensure Mullibah Lagoon is functioning adequately Adopt BMP for urban areas. For example use of OSD for commercial developments. (designed to reduce local flooding and downslope scour due to high flow rates) Develop maintenance plan to ensure adequate performance of stormwater assets such as GPTs.
Hydrological stress due to extraction and altered stream flows	Ensure groundwater extraction rate is similar to recharge rate Set salinity targets in line with MDBC salinity audit	Encourage rapid adoption of the Namoi Groundwater Sharing Plan (DLWC, 2003). Request improved dam discharges to allow for environmental flows, flushing and minimal thermal pollution.	Actively lobby CMA and DNR to accelerate the rate of adoption of the Namoi Groundwater Sharing Plan. Ensure residents understand where town water comes from. (The Namoi CMA is implementing a community based water eduction plan in July 2006. Council should cooperate with this). Publicise BMPs such as use of rainwater tanks, garden mulching and avoidance of overwatering. Limit water supplies to rural residential areas

Outcomes

Gunnedah Shire Council has little control over catchment activities outside its boundaries. However it can lobby the CMA to ensure the Groundwater Sharing Plan is implemented in full.

Within shire boundaries Council can ensure stormwater impacts are minimised. For example runoff from rural roads can be dispersed to minimise sediment yield to streams. Stormwater reuse can be encouraged, for example on the golf course.

Recommended B-PMs to address catchment based issues at LGA scale

1. Council to actively promote adoption of the Namoi Groundwater Sharing Plan
2. Council to actively promote residents' understanding of the need for conservative use of water
3. Council to enure its activities do not adversely impact on Namoi River water quality. e.g by ensuring Mullibah Lagoon is not contaminated by Council activities
4. Council to ensure urban development does not overload stormwater system or result in scouring outflows. For example adopt an on-site detention policy for developments exceeding 2500 msq that have in excess of 70% imperviousness.

4.2 WATER RESOURCES

Water quality in streams

Figures 2.11, 2.12, 2.13 and 2.17 all indicate surface water rarely meets ANZECC guidelines. Similarly the Interim Water Quality Objectives for various end uses are not always met as figure 2.17 shows. Issues include: elevated salinity, Phosphorus, Nitrogen, Total Suspended Solids and algal blooms.

Elevated salinity is due to a combination of natural salinisation plus accelerated movement of salt as it is flushed from the soil during irrigation. Dryland salinity has increased following clearing of deep rooted perennial vegetation. Elevated Phosphorus and Nitrogen concentrations appear to be largely due to erosion and inefficient use of fertiliser. The Nitrogen and Phosphorus is lost from the farms and eventually reaches surface waters.

Total suspended solids load arises from two major sources. There are substantial areas of erosion and some of this material reaches surface waters. Secondly there is erosion of stream banks and beds. A high proportion of this material is directly added to surface waters.

Erosion of stream banks is facilitated by the elevated sodium content in the water. The sodium encourages dispersion of the soil particles, and the fine particles are easier to transport.

Algal blooms occur in response to a wide range of environmental parameters including warm weather, sunlight and an excess of Phosphorus.

Outcomes

Gunnedah Shire Council has little control over water quality in the surface waters. However Gunnedah can reduce its impact by ensuring council owned lands are adequately vegetated and that excessive irrigation does not occur. .

Recommended B-PMs to address catchment based water quality issues at LGA scale

1. Council to actively maintain at least 70% ground cover of grass/ leaf litter in Council controlled reserves.
2. Council irrigation practices to meet but not exceed plant water demand
3. Council fertilisation practices to meet but not exceed plant nutrient demand

Water quality in aquifers

Section 2.2.1 discusses groundwater quality for each of the urban centres. The results are summarised in table 3.2

Table 4.2. Instances where groundwater attributes that exceed ADWG (2004) criteria.

Urban centre	Table in IWCM report	Issues	Objectives
Gunnedah	2.10	Occasionally elevated Hardness, TDS and Cl compared with ADWG. Appears related to drought.	To provide each urban centre with water that meets ADWG for as high a proportion of time as practical. An efficient disinfection system may be required. To ensure residents know and understand what is happening to their water supplies To encourage use of rainwater tanks throughout the shire, but, especially in Curlewis and Tambar Springs
Curlewis	2.11	Values of Cl, Na TDS and Total Hardness always exceed ADWG.	
Mullaley	2.12	TDS and Total Hardness occasionally exceed ADWG criteria. Appears related to drought.	
Tambar Springs	2.13	Total Hardness exceeds ADWG criteria. Lead concentration exceeds ADWG in 2 out of 4 samples	

Elevated total Hardness and TDS occur at all sites, especially during drought. There is evidence, especially at Curlewis, that saline water incursion is affecting bore water quality. The incursion is likely to be most severe during drought when demand is high and there is minimal recharge.

Elevated lead concentration may be an issue at Tambar Springs.

Outcomes

Gunnedah Shire Council has little control over water quality in the aquifers. However, the quality of this water is critical to the existence of the urban centres in the Shire. Council needs to actively lobby the CMA to ensure water quality is maintained.

Council should also consider keeping residents informed regarding potable water quality issues. It should consider improved disinfection, and the use of rainwater tanks to reduce reliance on bores for drinking water.

Recommended B-PMs to address catchment based water quality issues at LGA scale

1. Council to actively lobby the Namoi CMA regarding the essential need to maintain groundwater quality.
2. Council to keep residents informed regarding the quality of water within reticulated services.

Water volume in streams

Keepit Dam is operated to satisfy irrigation demand. Consequently flows during the irrigation season are typically elevated above natural flows and are maintained at these levels for long periods figure 26 shows.

The impacts of prolonged unseasonal high flows is not discussed in detail in the Catchment Action Plan, but it can include drowning of native riparian species such as River Red gum (*E camaldulensis*), increased bank erosion

and increased presence of European Carp. The release of large qualities of cold water can also inhibit breeding of native aquatic fauna.

Outcomes

Gunnedah Shire Council has no control over water volumes in the Namoi River. However the river can be an important resource for recreation and tourism. Council should actively participate in CMA stakeholder groups especially those that are concerned with continued health of the river.

Recommended B-PMs to address catchment based Namoi river flow issues at LGA scale

1. Council to actively lobby the Namoi CMA regarding the essential need to maintain adequate environmental flows in the Namoi River.

Water volume in aquifers

According to the Namoi Groundwater Sharing Plan the extraction rate from the aquifer is more than double the recharge rate. Table 2.8 shows the allocated volume and the estimated recharge rates. The table also shows the reduction in allocation to sustainable rates. Near Gunnedah, Curlewis and Mullaley around 70% reduction is required to match allocation and recharge rate. Council's water abstraction is small compared with the total removal rate. However improved demand management within urban areas would demonstrate its commitment to sustainable use of water resources.

Over extraction lowers the water table and encourages incursion of surrounding groundwater. This water can be saline or even contain trace metal contaminants.

There is an obvious imperative to ensure potable supplies do not deteriorate any further.

Outcomes

Gunnedah Shire Council has no control over groundwater yet it is totally dependant on a secure supply. Active participation in the CMA is essential to ensure Council's concerns are noted and acted upon. Council is undertaking demand management as part of its contribution to ensuring sustainable water supplies

Recommended B-PMs to address catchment based issues at LGA scale

Refer to section 3.1

Town water allocation

Section 2.2.2 discusses water supplies for the four urban areas with reticulated supplies. Annual water use is markedly lower than the allocated volumes: Even during 2003, in the middle of the drought water use in Gunnedah was only 81% of the allocated volume. The anticipated development of an ethanol plant will increase water demand by up to 400 ML/year. The actual volume required is currently being determined. It is suggested that the EIS demonstrate the development with use BMPs to ensure minimum water use/ML of effluent produced.

Even with the ethanol plant in full production, the total water use is likely to be less than 3600 ML or 92% of allocation.

Town water allocations are 'secure' under the Namoi Water Sharing Plan. However this simply means the towns can extract up to a specific volume/year. It does not guarantee that the water will be present to enable extraction or that the water is safe to drink.

While supplies are likely to remain adequate, there is still a need for the urban community to play its role in sustainable management of natural resources.

Outcomes

Assuming the Namoi Groundwater Sharing Plan is implemented there will always be sufficient water available for the urban areas of Gunnedah Shire. Water quality is likely to remain an issue unless extraction near council bores can be reduced.

The Demand Management Plan should assist Council in reducing water consumption without negatively impacting on its revenue base.

Recommended B-PMs to address demand management

1. Council to fully implement the recommendations of the Demand Management Plan

4.3 URBAN AREAS

Issue identification is based on the assessment of impacts the existing urban areas have on water resources and a comparison between the performance of Council's water supply and sewerage against state and other agreed benchmarks.

Urban impacts on water resources

Volume

Table 4.3 shows the water allocation to the towns compared with the anticipated sustainable yield for this specific catchment zone. The allocation varies from 1 to 14% of the recharge volume. This suggests extraction of groundwater for urban use has limited effect on resource sustainability. However equity suggests both urban and non urban stakeholders should be concerned with sustainable use of natural resources.

Table 4.3 also shows the area of crops that cannot be irrigated because the water is allocated to the urban centres (Note that 560 ML/y of effluent is utilised for irrigation). The urban centres have a net water utilisation equivalent to some 700 ha of cropping. There are over 100,000 ha of cropping in the area, so the impact of the urban water removal is less than 1% of the cropping area.

Table 4.3. Relationship between estimated recharge and volume of water utilised within urban centres. The number of ha of irrigation that is forgone is also shown (Source: Namoi Groundwater Sharing Plan, DLWC, 2003).

Urban centre	Estimated annual recharge (ML/y)	Town water allocation	% of recharge	No. of ha of cropping forgone (assume 5 ML/ha of irrigation)
Gunnedah	27500	3900	14%	780 ha (net is 668 ha as 560 ML/y is used for irrigated agriculture)
Curlewis	17300	199	1%	40 ha
Mullaley	7200	59	1%	12 ha
Tambar Springs	11400	42	1%	8 ha

Contaminant loads

The median flow in the Namoi River at Gunnedah since 1990 is 347 ML/day, while the median Nitrogen and Phosphorous concentrations are 0.60 and 0.095 mg/L respectively. So the annual load 'passing' Gunnedah is 76 T of Nitrogen and 12 T of Phosphorus.

Table 2.20 shows the reuse scheme diverts some 560 ML/year containing 4 T of Nitrogen and 1.7 T of Phosphorus from being added to the Namoi River. This is equivalent to an additional 5% of the Nitrogen load and 14% of the Phosphorus loads.

Table 4.4 shows the estimated mass of Nitrogen and Phosphorus in town stormwater. The town is estimated to add 6% of Nitrogen and 8% of the current nutrient loads to the Namoi River.

Table 4.4. Estimated mass of Nitrogen and Phosphorus in town stormwater assuming 50% runoff coefficient in the urban area.

Town area (ha)	Rainfall (mm/y)	Rainfall coeff	Runoff (ML/y)	N (mg/L)	P (mg/L)	N (T/y)	P (T/Y)
700	663	0.5	2320.5	2	0.4	4.6	0.93

The results above demonstrate the importance of recycling of effluent to reducing contaminant load in the Namoi River. The results also indicate the potential contribution of the town stormwater. Systems such as swales and wetlands that retain runoff allowing contaminant removal will assist in reducing contaminant loads. Options to reuse stormwater and reduce stormwater yield could also be considered.

Outcomes

Sewage effluent is not returned to the river except when a major sewer overflow event occurs. While these overflows occur more frequently than expected, the volume involved is small compared with the total load.

Diversion of effluent to irrigated cropping plays a significant role in reducing impacts of Gunnedah on quality in the Namoi River.

Conversely the urban runoff is adding substantial loads to the river. Council should consider introduction of BMPs to reduce total loads in the runoff. Components could include golf course irrigation, rainwater tanks and encouraging maximum grass cover

Recommended B-PMs to address stormwater impacts on waterways

1. Council to encourage all existing homes to install rainwater tanks of at least 5,000 L capacity
2. Council to require all new residences to install rainwater tanks at least 5,000 L capacity AND to connect the tanks to supply toilets and garden watering systems
3. Council to facilitate the golf course in a feasibility study to capture and reuse stormwater (CMA involvement could also be sought).

4.4 URBAN PERFORMANCE ASSESSMENT

The Strategic Business Plan for Water and for Sewerage Services includes an assessment of Council's performance against agreed targets. Similarly the NSW Water Supply and Sewerage Performance Monitoring reports (LGA, SA, 2002/03) enable comparison between Gunnedah Shire Council's performance and those of similar shires. The business plans for water and sewerage are discussed in Sections 2.2.2 and 2.2.3 respectively.

Water supply

The principal issues identified in the Strategic Business Plan for Water Services are shown in table 4.5.

Table 4.5. Issues identified in the Strategic Business Plan for Water Services (LGA/SA 2002/03).

Issue	Response as at March 2006
Reduce the number of mainbreaks	No change
Upgrade selected water services	No change
Reduce annual water consumption/ allotment	Some reduction following introduction of tiered pricing. But still high
Implement new pricing structure	As above
Develop asset management system and to value assets.	Currently underway.

The additional issues identified in the current document that were not commented upon in the business plan are:

1 Security of groundwater supplies

2 Quality of groundwater especially in areas where ADWG criteria are not being met

3 Urban salinity

4 Aging infrastructure

5 Adequacy of pressure to new subdivision in more elevated portions of Gunnedah

6 Water use is high despite the drought

7 Water loss as a % of volume pumped

Potential solutions to each of these issues are discussed in Section 4 of this IWCM report.

Recommended B-PMs to address water supply issues

1. Encourage all existing homes to install rainwater tanks of at least 5,000 L capacity
2. Maintain the recently restrictions on use as per the Water Conservation Plan

Sewage

The principal issues identified in the Strategic Business Plan for Sewerage Services are shown in table 4.6.

Table 4.6. Issues identified in the Strategic Business Plan for Sewerage Services (LGA/SA 2002/03).

Issue	Response as at March 2006
Chokes and overflows	Council has commenced a 10 year program to reline leaking sewers
Extension of sewerage services to industrial area	Forecast for 2005 to 2010 period. No action so far (March 2006)
Reduce illegal connections	Individual home connections not yet tested
Update plans and policies including trade waste	Council has approved policy in principle (Jul 2003). No further development (See page 36 of Strategy report for proposed sequences).
Development of asset management system and value assets	Required strategic maintenance plan (Page 54 of Strategy) partly implemented.

	Review and update asset management plan annually. Plan currently being implemented

The additional issues identified in the current document that were not commented upon in the business plan are:

1 Aging infrastructure

2 Security of the reuse scheme

3 Impacts of infiltration and leaks on the environment

4 Design of new subdivisions to ensure adequacy of services

Recommended B-PMs to address sewage issues

1. Council to continue sewer lining project
2. Council to develop and implement a trade waste policy for liquids

Stormwater

There is minimal information of stormwater despite Council commissioning an Urban Stormwater Management Plan. This lack of knowledge is a serious issue as information on catchment sizes, runoff coefficients and contaminant concentrations are needed to ensure all structural improvements are adequately sized.

The issues can be itemised as:

1 Almost no data on runoff volumes or contaminant loads, yet initial calculations suggest urban stormwater runoff is adding significant contaminant loads to the Namoi River.

2 No On Site Detention (OSD) Policy yet local flooding occurs during moderate rainfall events

3 Urban salinity is a highly significant issue in parts of Gunnedah. Urban stormwater can contribute to this problem

4 Rainwater tanks need to be more widely used and to be connected to toilets and washing machines as well as to garden taps in Gunnedah. This is considered an important way to reduce peak flows during storms. Their use to provide potable water in urban areas where bore water does not meet ADWG criteria should be actively encouraged. BASIX addresses rainwater tanks for new development, but Council should encourage shire wide adoption.

5 Subdivisions need to be designed using WSUD principles

6 Opportunities for stormwater capture and reuse need to be explored (eg the Golf Club).

Recommended B-PMs to address stormwater issues

1. Develop and implement an on-site detention policy for developments exceeding 2500 msq.
2. Examine options to reduce salinisation
3. Encourage installation of rainwater tanks
4. Encourage the golf course to harvest and reuse stormwater.

5 RECOMMENDATIONS

Recommendations have been developed based on identifying the extent to which the water cycle management issues in Gunnedah Shire can be addressed by a Business As Usual approach.

Where this is not realistic then the introduction of local best practice management is required.

The 2005/06 NSW Benchmarking Report has been extensively used to compare Gunnedah's performance against comparably sized LWU

The key findings are recommendations are given below

Table 5.1. Key findings, recommendations and extent of input required to achieve desired effect.

Key finding	Reference in report	Recommendation	Level of input required
Gunnedah Shire Council is meeting almost all the Best-Practice Management Compliance criteria for water supply.	Table 3.1	Continue as is	Business as usual
Charges to customers are not compliant	Table 3.2	Adjust as needed	Local B-MPs required
Lack of a complying liquid trade waste	Table 3.2	Introduce one	Local B-MPs required
Water loss is similar to other comparable LWUs	Table 3.3	Continue as is	Business as usual
There is a lack of customer orientated water conservation initiatives	Table 3.4	Council to promote conservative use of water. For example by introducing a range of actions, including rain water tanks rebates	Local B-MPs required
Potable water leakage rate is high	Table 3.5	Investigate and develop remediation plan	Local B-MPs required
Water consumption/ property is high	Table 3.5	Encourage more conservation methods (e.g similar to the timers being given away at Council)	Local B-MPs required
Operating and management costs of the water supply system as better than the median	Table 3.6	Continue as is	Business as usual
Physical and microbial quality of the water is less than similar LWUs.	Table 3.7	This is a significant issue: Examine options and develop plan to reduce customer health risks. For example install rainwater tanks.	Local B-MPs required
Customer s are being given a reliable supply of water	Table 3.7	Continue as is	Business as usual
Water supply O&M and energy costs are comparatively high. However management costs are relatively low.	Table 3.8	Assess reasons for higher costs. Look for improved efficiencies	Local B-MPs required
Sewer performance measured as infiltration rate, chokes and collapses and overflows are much	Table 3.8	Council is already addressing this issue. However the rate of improvement is slow	Local B-MPs required

Key finding	Reference in report	Recommendation	Level of input required
worse than other comparable LWUs			
Effluent reuse scheme is efficient	Table 3.8	Continue as is	Business as usual
A biosolids reuse strategy is needed	Table 3.8	Develop reuse scheme	Local B-MPs required
The sewerage scheme is relatively low cost	Table 3.9	Continue as is (BUT consider using some of the sewerage funds to speed up the sewer lining process).	Business as usual
Sewer complaints are relatively frequent	Table 3.10	Speed up the relining process	Local B-MPs required
Gunnedah is highly dependant on groundwater volume and quality	Section 4.1	Council to advocate full compliance with the Namoi Groundwater Sharing Plan	Local B-MPs required
Gunnedah does not have an OSD policy to reduce runoff from large developments	Section 4.1	Council to develop an OSD policy. For example adopt an on-site detention policy for developments exceeding 2500 msq that have in excess of 70% imperviousness.	Local B-MPs required
Council activities may impact on water quality	Section 4.1	Council to introduce water conservation work practices and ensure adequate ground cover in its reserves	Local B-MPs required
There is little reuse of stormwater	Section 4.3	Council should assist organisations such as the golf club to obtain funding for stormwater capture and reuse schemes.	Local B-MPs required
Salinisation may spread over time	Section 4.4	Council to encourage more Salt Action activities. This could include other stakeholders such as the Namoi CMA, Health NSW and the Department of Education	Local B-MPs required

Note that these recommended actions are yet to be agreed upon by stakeholders.

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