The State of the Shire- Year 2000 Benchmark

Chapter 4 - Water and Atmospheric Management Technical Paper

April 2001

Chapter 4 Water and Atmospheric Management

CHAPTER 4 – WATER AND ATMOSPHERIC MANAGEMENT

4.1. Introduction

This paper aims to assess and report on the condition of water and atmospheric assets in the Shire. Water is an abundant resource in the Shire and is present as groundwater, freshwater, tidal and estuarine water and coastal (off-shire) water. Surface waters play an important role in providing urban water supply, irrigation, industrial needs, in-stream needs and river health. The main threats to water quality are nutrients and suspended solid and pesticide contamination from use of land in the catchments.

The quality of these surface waters is also important to the quality of coastal waters. Studies which are presently being conducted include long-term chlorophyll monitoring, long term flood monitoring, temporal trends, assessing the effect of surface water runoff to these areas and detailing the implications of changed land use for the Great Barrier Reef. Groundwater yield, supply, and quality are also included in this report.

Atmospheric management is also discussed although little data exists. This paper identified point sources of pollution only, however, it is hoped that the lack of atmospheric data will be an issue addressed in the preparation of future reports.

4.2. Water Demand and Needs

4.2.1. Quantity

4.2.1.1. Surface Water

Estimated mean annual discharge from the Johnstone Basin is some 4.7 million megalitres per annum. This amounts to an average runoff of about 2020 millimetres per year. The catchments of the Johnstone and South Johnstone Rivers contribute some 2.7 million megalitres (approximately 70%) to the total discharge.

Streamflow records and water quality records are available from five gauging stations in the Johnstone Shire. Figure 4.1 shows the location of the streamflow gauging stations in the Johnstone Basin. There are no major water conservation initiatives undertaken in the basin, although a number of small storages have been constructed outside the Johnstone Shire for urban water supplies, irrigation and industrial purposes.

The major industrial water extraction sites in the Johnstone Shire are the South Johnstone and Mourilyan Sugar Mills located on the South Johnstone River. A milk processing factory at Malanda in the Eacham Shire is also a significant water user from the North Johnstone River.

Some 5160 hectares of crops have been licensed to be irrigated from surface water resources. Some 90% of this area is made up of tree crops (3000 hectares) and pasture and fodder crops (1700 hectares). Other crops that require licensing to be irrigated with surface water include sugar cane, tea and vegetables.

Supplies for urban, irrigation and industrial purposes are generally obtained from unregulated streamflow. Small weirs however have been constructed by the Eacham Shire Council on the Johnstone and North Beatrice Rivers for the purpose of providing urban supplies to the towns of Malanda and Millaa Millaa respectively. The capacities of these storages are very small and do not measurably increase the supplies available from the natural streamflow. The limited coverage of streamflow data across the basin makes estimating the total supplies available from natural streamflow difficult.

Licences have been issued for 190 privately owned surface water storages. Of these 123 are utilised for irrigation purposes and five for industrial purposes. These storages are generally small, with only three having a capacity greater than 100 megalitres. While the supply available from these storages is unknown, it is thought to be small.

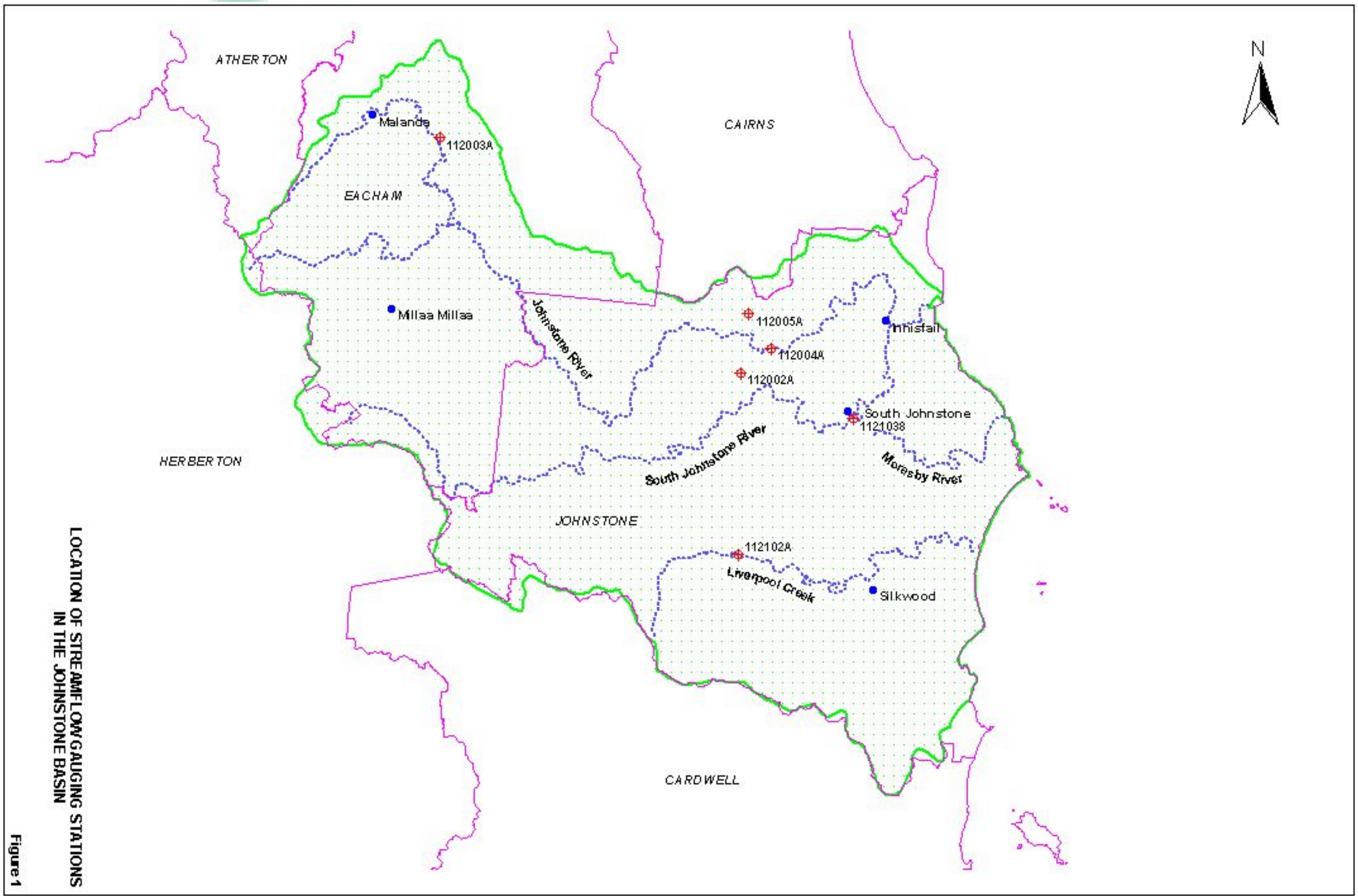


Figure 4.1 Gauging Stations in the Johnstone Shire

4.2.1.2. Water Demand

Total demand for water supplies in the basin in 1991/92 was 27 900 megalitres. Individual demands for urban, industrial and irrigation purposes are shown in Table 4.1 over page. Demands have been considered in terms of those adjacent to the major streams, the Johnstone and South Johnstone Rivers and those in the remainder of the area. This provides some indication of the demands, which are met by the predominant water resources of the Basin. Demands for supplies for stock and domestic purposes have not been considered since each of these point sources of demand is small.

Source	Irrigation Ml	Urban Ml	Industrial Ml	Total Ml
Adjacent to Johnstone River and South Johnstone River				
Surface Water	910	4 310	16 100	21 320
Ground Water	30	0	0	0
Remainder of Catchment Area				
Surface Water	3 970	1 250	0	5 220
Ground Water	230	0	0	230
TOTAL	**5 140**	**5 560**	**16 100**	**26 800**

Table 4.1 Johnstone Basin Water Demand 1991/92

4.2.1.3. Urban Supply

Demand for reticulated urban water supplies in the Basin amounted to about 5560 megalitres in 1991/92. Centres provided with reticulated supplies include Innisfail, South Johnstone, Flying Fish Point, Silkwood, El Arish, Kurrimine, Mission Beach and Bingil Bay in the Johnstone Shire and Malanda and Millaa Millaa in the Eacham Shire. All supplies in the Johnstone Shire are provided from unregulated streamflow, while as previously described, small weirs have been constructed at Millaa Millaa and Malanda to provide urban supplies.

4.2.1.4. Irrigation

Estimated demand for irrigation supplies in 1991/92 was 6250 megalitres. Almost all of this demand was satisfied from unregulated streamflow, with a small amount being obtained from groundwater. As such, no accurate quantitative data are available on irrigation use.

An assessment has been made, based on licensing data and industry information, of the areas of each crop type actually irrigated in 1991/92. In turn, an estimate of the portion of full irrigation requirements generally applies to the respective crops has also been made. In this case, it is assumed that tree crops and vegetables generally receive their full irrigation requirement, while sugar cane and pasture would be irrigated on a supplementary basis using up to 50% of their full requirement.

4.2.1.5. Industrial

Industrial supplies are required by three major processing installations in the Basin Area; Mourilyan and South Johnstone sugar mills and the Atherton Tablelands Dairy Association milk factory at Malanda. In total, they require 16 100 megalitres of water each year. In each case, demand is met from unregulated streamflow.

4.2.1.6. Instream Needs

Instream use of water resources encompasses use by wetlands, river systems and estuaries. Importantly, it must be recognised that often there will be conflict between different types of instream use and that these should essentially be able to be sustained over time without degradation of the resource, loss of riverine values or loss of essential ecological processes.

Streams in the Basin are essentially unregulated with water being diverted from streams to meet urban, industrial and irrigation demands. Instream allowances in the case of unregulated watercourses takes the form of a volume of water allowed to pass through the catchment without being extracted from the stream for consumptive purposes. There have been several methodologies proposed for the determination of required instream flow volumes, eg 25% of low flow. These however are preliminary and a detailed assessment of the stream, including location within the catchment, flow patterns, flood volumes, contributions of tributaries etc., would be required to satisfactorily determine instream needs.

4.2.1.7. River Health

Two biological studies of river health have been undertaken in the Johnstone Basin. These studies are the Monitoring River Health Initiative and the First National Assessment of River Health. These studies assess the ecological condition of streams using macroinvertebrates as indicators. Macroinvertebrates are present in a whole range of water systems and they can be affected by a range of impacts including pollution, lack of suitable habitats and changes in flow conditions. The diversity, composition and abundance of macroinvertebrates can be used to indicate the health of the whole ecosystem.

Overall the in-stream health of the Johnstone Basin seems to be in generally good to moderate condition. Some sites, particularly the smaller tributaries, were assessed to be in poor condition. Those assessed to be in good condition are generally in rainforest areas which have good riparian vegetation and diverse in-stream habitats. Sites assessed to be in poor condition are generally the smaller tributaries which run through intensive grazing or agricultural land and have poor riparian vegetation, high infestation of exotic bank vegetation, poor in-stream habitat and poor water quality.

Many sites in the North and South Johnstone River channels, which were downstream of intensive agriculture, did not show up as being in poor condition. The in-stream channel does not seem to be very impacted by cleared vegetation and infestation by exotic plants in the riparian zone. In these channels the in-stream habitats are good, water flows continuously and flow rates are generally high. As a result, not too much siltation occurs and the residence time of potential pollutants may be too short to have significant impact on the in-stream fauna. However, low biodegradable effluent could end up in the coastal and marine area and it is here that the impacts are expected to be significant. Exotocicological studies into acute and chronic toxicity and bioaccumulation in selected freshwater and coastal molluscs, arthropods and fish would be highly desirable.

4.2.2. Water Quality

4.2.2.1. Surface Water Quality

Industrial and urban development on the floodplain has been minimal. Except for the Mourilyan and South Johnstone sugar mills, the Consolidated Meat Group, and small townships there are few point sources of pollution in the Basin. The most significant point source of nutrient discharge in the Shire emanates from the Innisfail Sewage Treatment Plant into Ninds Creek near the mouth of the Johnstone River. This nutrient concentration is also contributed to from runoff from the cane, banana, and dairy industries.

Another source of pollution is decreased pH caused by the exposure of acid sulfate soils in drainage excavation. Whilst the vast majority of drainage excavation has been completed the cumulative impact of past activity of this nature still persists. Past landfill waste disposal practices also contribute a point source of pollution though this has been partly offset by the capping of some of these sites.

There are many examples of direct deposition of waste on riverbanks in the form of old machinery, car bodies and various other items having been deposited mainly as part of past attempts to stabilise erosion or as indiscriminate dumping. With increased environmental awareness in the Shire, examples of this are now quite rare but accumulations of rubbish on riverbanks from past practice still exist.

A study on Water Quality in the Johnstone Catchment titled 'From Land to River to Reef Lagoon: Land Use Impacts on Water Quality in the Johnstone River Catchment' (1997) produced the following key findings.

- There is widespread community concern that discharges of nutrients and sediment from many Queensland coastal rivers may be harming the GBR. To date however, a balanced assessment of the nature, extent and causes of the problem has been limited by a lack of reliable data and quantitative information.
- The Johnstone River Catchment Co-ordinating Committee, in its Management Strategy has identified a priority need for a Water Management Plan for the catchment. Such a plan will rely heavily on access to contemporary information on the quality of surface waters and groundwaters in the catchment, in order to determine important issues and to provide a basis for establishing an on-going monitoring program to detect future trends. Nutrients, sediment and pesticides are key water quality indicators for the Johnstone catchment.
- An understanding is needed of the sources of contaminants, the processes by which they reach waterbodies and the consequent effects on water quality. This knowledge

can then be used to assist development of land and water management strategies for the catchment to minimise adverse impacts on downstream water quality.

Nutrients and Suspended Solids: During dry weather conditions, concentrations of nitrogen, phosphorous and suspended solids are generally low at most of the 16 stream monitoring sites in the catchment, indicating high water quality suitable for protection of aquatic ecosystems, for drinking and other uses such as agriculture. There are exceptions, however. For example, nitrate concentrates at the Scheu Creek site are typically higher (usually < 0.5mg/L) than elsewhere in the catchment and are occasionally as high as 1-2 mg/L nitrate-N. These concentrations are still well below the upper limit of 10 mg/L recommended for drinking water. Come groundwater samples from the lower catchment also have elevated nitrate-N concentrations (1-5 mg/L).

Suspended solids (sediment) concentrations increase markedly when stream flows increase following rainfall and runoff events. Nutrient concentrations also increase since much of the nutrient load transported during these events is attached to the suspended sediment. During cyclone Sadie, for example, 200,000 tonnes of sediment were discharged from the river system into the GBR lagoon, carrying 85% of the total nitrogen load discharged (858 tonnes). The evidence indicated that major flood events account for most of the nutrient and sediment exported annually from the catchment. There is some evidence to suggest that sediments from the catchment may travel at least 10km offshore.

Clearly, strategies to minimise nutrient and sediment discharge to the Great Barrier Reef lagoon should focus on reducing soil and sediment movement in the catchment. Sources of sediment during flood events are likely to include soil erosion from rural lands, roadsides and stream banks, as well as the remobilisation of streambed sediments. However, it is not yet clear to what extent these different sources have contributed to the suspended sediment loads measured in the Johnstone catchment.

Pesticides: Prior to undertaking a 'snapshot' survey of pesticides in streams and groundwaters in the catchment, pesticide usage by major industries in the catchment was evaluated to determine products used, the time of year of predominant usage and their likely environmental fate. The sampling time (December 1995) was selected as representing a time of major pesticide use, when periodic rainfall would increase the potential for pesticide movement in the catchment. Coincidentally, it was also the time of heavy applications of insecticides used in conjunction with the papaya fruit fly outbreak.

Samples from 23 stream sites and 16 bores were tested for a wide range of pesticide residues, including diuron, glyphosphate and the triazine and phenoxyacid herbicides and a selection of organophosphate , organochlorine and pyrethroid insecticides. Overall results were very encouraging, with very few pesticide residues detected. Seven samples (3 stream 4 groundwater) contained very low concentrations of atrazine, while 20 samples (12 stream and 8 groundwater) contained low levels of 2,4-D.

Contaminants in Fauna: between 1990 and 1992, a variety of aquatic fauna from freshwater and estuarine sites were analysed for pesticide residues and heavy metals. Again, results indicated little evidence of significant pesticide contamination, although several samples contained trace levels of organochlorine, phenoxyacid or atrazine residues. Similarly, most heavy metals detected were well below the maximum permitted concentrations set by the Australian Food Standards Code.

On-going investigations will help resolve outstanding issues, such as the sources of nutrients and sediment and the loads transported over a range of seasonal conditions. A computer modelling approach is being used which will provide the basis of a management tool to aid decision making on catchment planning and resource management issues. Catchment scale modelling will link to similar work at the paddock or farm scale.

Community input will be a vital component of planning and implementing a strategy in the catchment, with community-based group such as Waterwatch playing an important role. Decisions are needed on what environmental values should be placed on catchment water resources and what amelioration projects (if any) should be undertaken to improve water quality. Other issues not yet investigated (for example, levels of microbiological contaminants) may warrant attention.

4.2.2.2. Coastal Water Quality

The Great Barrier Reef Water Quality and Coastal Development Unit manages two monitoring and assessment programs designed to document the status of water quality and catchment activity in and adjacent to the Great Barrier Reef (GBR). These water quality programs are the Long term Chlorophyll Monitoring Program (the Chlorophyll Program) and the Flood Monitoring Program. These programs are designed to define the nutrient status of the GBR, quantify increases in nutrients due to anthropogenic changes and determine the extent and actual influence that river waters have on the GBR. Concurrent information from these programs, documenting the ambient and episodic water quality concentrations and potential links with land-use changes is used to guide management direction in dealing with the complex and multi-governmental issue of water quality in the GBR. This report will deal principally with the results from the Long term Chlorophyll Monitoring Program.

Long term chlorophyll monitoring program

The Great Barrier Reef Marine Park Authority (GBRMPA) initiated the Chlorophyll Program in 1992 in response to the need to have comprehensive reporting of the water quality status of the GBR (Brodie and Furnas, 1994). The Chlorophyll Program aims to document the nutrient status of regional waters within the Great Barrier Reef (GBR) lagoon using chlorophyll *a* concentration as a proxy nutrient bioindicator. The objectives, design and sampling protocols of the Chlorophyll Program and the results from the eight years of data collection will be presented in a GBRMPA publication by June 2001

The Chlorophyll Program involves regular sampling at fixed sampling stations within seven, discrete, regional cross-shelf transects, namely; Far Northern Section, Lizard Island, Port Douglas, Cairns, Townsville, Whitsundays and Keppel Bay and Capricorn. Chlorophyll *a* is representative of the amount of algae in the water column. . As phytoplankton stocks respond quickly to changes in nutrient availability, measurement of chlorophyll *a* concentration was chosen as a proxy indicator of nutrient status.

Data presented in this attachment is for the central section of the GBR. This data demonstrates a difference in inshore and offshore waters in the central section most likely related to terrestrial discharge from the Herbert, Tully, Johnstone and Russell-Mulgrave Rivers. There is also a persistent and upward trend of increasing chlorophyll concentrations for this central section, which again is most likely related to the expanding of fertilised agriculture.

The regional cross-shelf transects were grouped into three sections, North (Cooktown Osprey, Far Northern and Lizard Island), Central –(Wet Tropics (Port Douglas, Cairns) and Dry Tropics (Townsville)) and South –(Wet Tropics (Whitsundays) and Dry Tropics (Keppel Bay and Capricorn Bunker)) to further illustrate the regional differences in chlorophyll *a* concentrations.

These regional differences are a consequence of the diverse geological structure of the GBR shelf as well as the diverse nature of, and land-use activities within, the adjacent GBR river catchments. Central and Southern regions have significantly higher inshore chlorophyll *a* concentrations than the Northern region. The GBR river catchment area of the Northern regional cross-shelf transects (north of Cooktown) is typically an undisturbed area with limited cropping activities and cattle grazing characterised by low stocking rates. The GBR river catchment areas of the Central and Southern regional cross-shelf transects include the Wet and Dry Tropics. These river catchments are characterised by high stocking rates for cattle grazing and intensive cropping activities in the lower catchment areas. The cropping activities, primarily sugar cane cultivation, are concomitant with high fertiliser application rates. The higher chlorophyll *a* concentrations in the GBR lagoon adjacent to these catchments may be the result of significantly elevated nutrient levels in the water derived from fertiliser application in these catchments.

Temporal Trends

The chlorophyll *a* concentration data has been collected over a period of approximately seven years therefore temporal trends are difficult to ascertain and are too short to resolve long-term trends in phytoplankton biomass as a proxy for nutrient loading. There are no significant changes in the data over time when the data for all the regional cross-shelf transects are grouped. However when the data is separated into Northern, Central and Southern sections temporal trends are evident. At the inner sampling stations in the Central section, there is a slight increase in chlorophyll *a* concentrations over time. This data needs to be considered in the context of large variability between transects and sampling sites, but it does raise some interesting questions about the direction of change for the nutrient status in the coastal area of the Central section.

Long term flood monitoring program

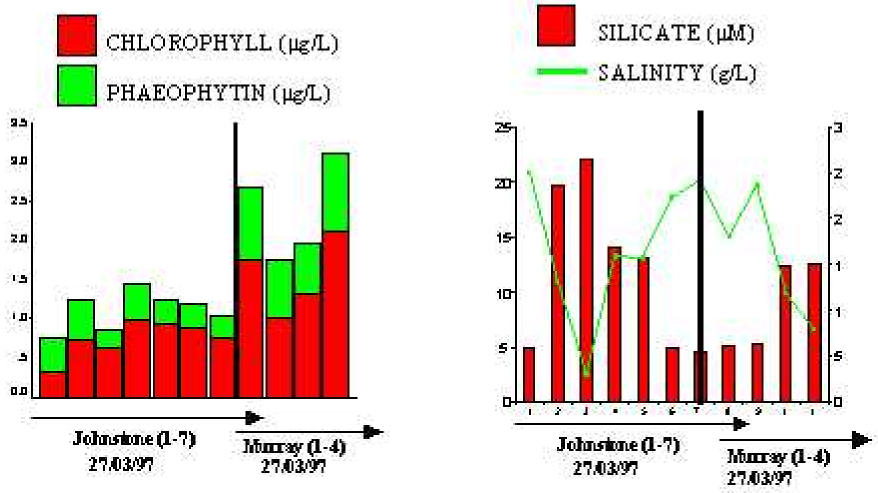
One of the most important processes directly impacting the Great Barrier Reef (GBR) is the input of terrestrially derived nutrients and sediments to near shore regions. This mainly occurs via river runoff, especially during periods of intense rainfall typically associated with tropical cyclones. Flood plumes occur at a time when the majority of inputs into the Great Barrier Reef lagoon are at peak concentrations, and reefs and other inshore marine ecosystems then experience the highest concentrations of pollutants. The principal threat to the water quality of the reef arises from changes to the composition of the riverine discharge due to changed land use on coastal catchments. The characteristics of the plume water, including salinity, nutrients, sediment and toxicants pose a range of potential threats to the health of inshore ecosystems.

One of the key research areas of the Great Barrier Reef Marine Park Authority (GBRMPA) is the assessment of riverine input into the Great Barrier Reef lagoon, the importance of flood plumes as a source of nutrients and sediments and the impact of flood plumes on nearshore reef and seagrass communities. GBRMPA, in conjunction with other agencies, runs a multi-institutional research and monitoring program on the discharge properties, composition and spatial dynamics of river plumes entering the Great Barrier Reef. This work forms a component of a larger research and monitoring program to understand the sources, transport and effects of terrestrial pollution on the GBR. This study has monitored and measured flood plumes associated with cyclones from 1991 to 1999. The sampling events were Cyclone Joy (1991), Sadie (1994), Violet (1995), Ethel (1996), Justin (1997), Sid (1998) and Rona (1999).

Table 4.2 presents data collected in flood plumes adjacent and north of Wet Tropics catchments (primarily between Herbert and Russell –Mulgrave). Concentrations of water quality parameters measured in the plume surface waters are almost always elevated in comparison to ambient water quality concentrations measured throughout the dry season. Figure 4.2 presents water quality data collected from one event, in Cyclone Justin (1997) for inshore reef areas off the Johnstone.

Cyclone	Sadie	Violet	Ethel	Justin	Sid	Rona	Ambient* (non-flood)
Date	**Feb-94**	**Mar-95**	**Mar-96**	**Mar-97**	**Jan-98**	**Feb 99**	
Shelf region sampled	Central Lagoon	Central Lagoon	Northern Inshore	Central Inshore	Central Inshore	Central Inshore	**Cairns**
Salinity	6.4	2.2	12.5	0	0	6.3	**34.18± 0.11**
NH_4	3.6	12.8		3.6	9.3	3.13	**0.03± 0.04**
NO_2	0.3	1.2	1.1	.3	.5	0.31	**0.03± 0.09**
NO_3	6.9	14.3	1.3	9.1	4.5	5.27	**0.08± 0.36**
DON	18.4	40.4	9.65	27.1	16.7	12.9	**4.9**
PN		10.0	10.3	20.3	19.1	17.8	**1.6± 0.9**
DIP	0.5	.31	0.6	2.5	0.6	0.33	**0.07± 0.27**
DOP	0.3	2.8	2.7	0.8	1.6	0.36	**0.30**
PP		1.3	0.96	0.9		0.96	**0.13± 0.08**
$Si(OH)_4$	27	112		221	112	167	**12.7± 11.9**
Chlorophyll a	2.2	4.6	2.0	4.6	2.5	2.2	**0.56± 0.44**
Phaeophytin	4.2	2.6	1.0	3.0	1.4		**0.26± 0.21**
Suspended solids	150	49	62		39		**3.0± 0.1**

Table 4.2 Minimum salinities and maximum nutrients, chlorophyll and suspended particulate matter concentrations in the Wet Tropics sampled in GBR waters following cyclonic events.



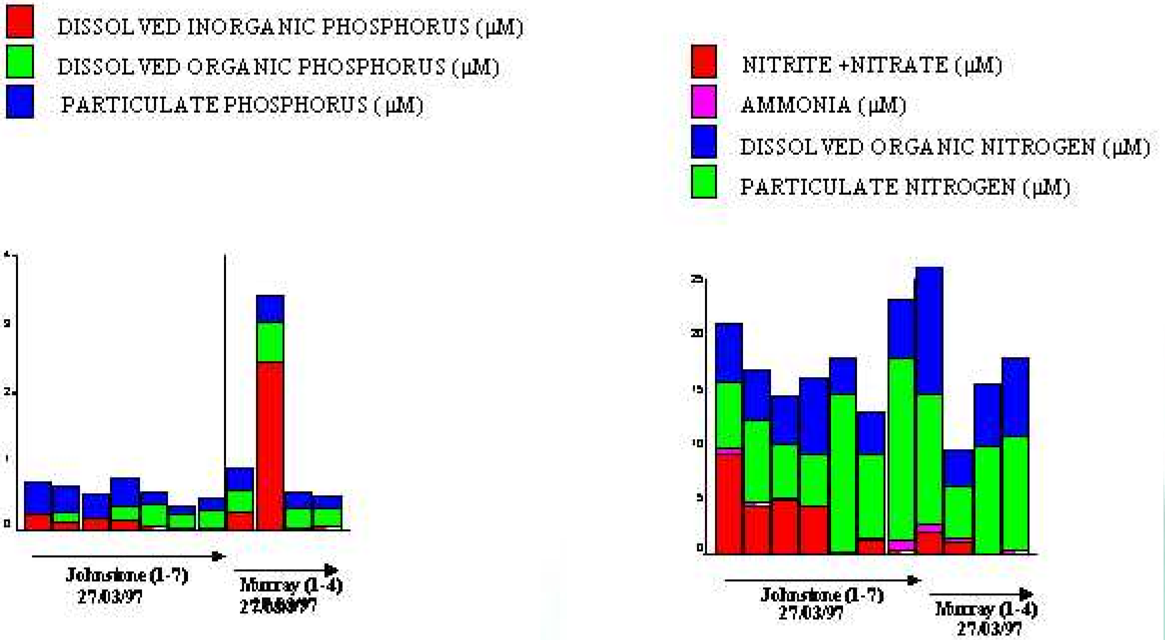


Figure 4.2 Concentrations of water quality parameters adjacent to the Johnstone Rivers in the flood plume associated with Cyclone Justin (1997).

<u>Implications of changed land use for the Great Barrier Reef</u>

There has been concern for some time about increasing nutrient loading to the GBR (Bennell, 1979; Bell, 1991; Kinsey, 1991). Some published material claims that the system is already eutrophic (Bell, 1991, 1992) and other work demonstrates increases in the nutrient discharge to the GBR from rivers over the last 150 years (Moss *et al.*, 1992). While increasing nutrient loads have been recognised as a major threat to reefs, the actual ways in which reefs respond to these increases is still being elucidated (Hatcher *et al.*, 1989; Koop et al, 2000). Monitoring of point source discharges and changes in the ecosystem (Smith *et al.*, 1981), defining eutrophication and pollution gradients (Tomascik and Sander, 1987a, 1987b; Hunte and Wittenburg, 1992; van Woesik *et al.*, 1999) and infield and laboratory experimental studies (Koop et al, 2000; Kinsey and Davies, 1979; Schaeffelke, 1999, Ferrier-Pages et al, 2000; Marubini and Davies, 1996) have shown that increased nutrient levels profoundly affect corals and coral reef ecosystems.

Important marine communities along the GBR coast, such as coral reefs and seagrass beds have recruited, grown and evolved in the presence of natural land run-off. However, numerous studies (Smith *et al.*, 1981; Rogers, 1990; van Woesik, 1992; Jokiel *et al.*, 1993; Preen *et al.*, 1995) have demonstrated that freshwater inundation or high sediment and nutrient loads can damage coral reefs and seagrass beds. This can be part of a natural cycle for inshore reefs, but to the extent that a recovery will occur over time is debatable if the biological processes are altered/affected by high nutrient and sediment concentrations.

Nutrient concentrations measured near these inshore reefs may not necessarily be representative of a particular river as the Wet Tropics river plume merged into one continuous plume. However, river waters from a particular river or catchment are likely to move in a northerly direction over reefs that lie in a northern direction away from the mouth.

Coral reef systems are complex and it is difficult to assess how a particular variable, such as high concentrations of dissolved nutrients, can impact on the "health" of the system. Assessment is hindered by the (nearly always)-simultaneous impact of coincident high seawater temperatures and of low salinity and high turbidity caused by flood plumes. There has been tentative guidelines developed for trigger nutrient values for inshore marine waters. Trigger values are concentrations (loads) of key performance indicators, below which there is a low risk of adverse biological effects occurring (ANZECC, in press).

NH_4, NO_3 and DIP concentrations measured in waters surrounding inshore reefs in the central section during plume conditions ranged from 1-8µM, 2-9µM and 0.1–2.5µM. The long term ambient concentrations of these nutrient species in these areas are 0–0.01 µM, 0.1–0.4µM and 0.1–0.15µM respectively (Furnas and Brodie, 1996). Concentrations measured in close proximity to reefs are 2 to 20 fold higher than ambient concentrations and above the trigger values

Implications of these higher concentrations reaching inshore ecosystems are that inshore reef and seagrass beds off the developed Wet Tropic catchments (Port Douglas to Ingham) are now seeing above effect levels of nitrogen and phosphorus species for periods of days to several weeks in the wet season. There is considerable evidence to support that inshore areas, both coral reefs and seagrass beds are being negatively impacted by changes in the plume water composition.

ENCORE results have shown reef organisms and processes investigated *in situ* were impacted by elevated nutrients, even at relatively low dosages, including coral reproduction, coral mortality and stunted coral growth. Long term increases in phytoplankton can lead to a higher abundance of non-reef building filter feeders, such as tubeworms, sponges and bivalves. Excessive phosphorus concentrations can weaken the skeleton of reef builders (hard coral, coralline algae) and make the reef structure more susceptible to damage from storm action

While there has been considerable debate regarding the current nutrient status and the actual potential impacts on the GBR ecosystems, there is evidence that eutrophication has occurred in some inshore areas of the GBRWHA. Increases in local and/or regional nutrient levels have led to increased seagrass biomass and distribution at Green Island (Cairns regions) (Udy *et al.*, 1999) and around Palm Island (Klumpp, 1997). Anecdotal evidence suggests that some nearshore fringing reefs in the central section of the GBRWHA are now muddier and have less coral and more algal cover. The comparison of historical photographs of reef flats prior to 1950, with the current status, revealed signs of degradation on some reefs (Wachenfeld, 1997).

Multiple stressors often have significant effects on recruitment and regenerative processes of assemblages. These impacts are much less obvious than catastrophic or chronic mortality, but they play a crucial role in community dynamics over longer time scales. Importantly, chronic anthropogenic impacts can impede the ability of coral assemblages to recover from natural disasters, even when there is little detectable effect on rates of adult mortality. Once a reef has been degraded, it is usually impossible to ascertain retrospectively the precise mechanisms that were involved or the relative importance of different events.

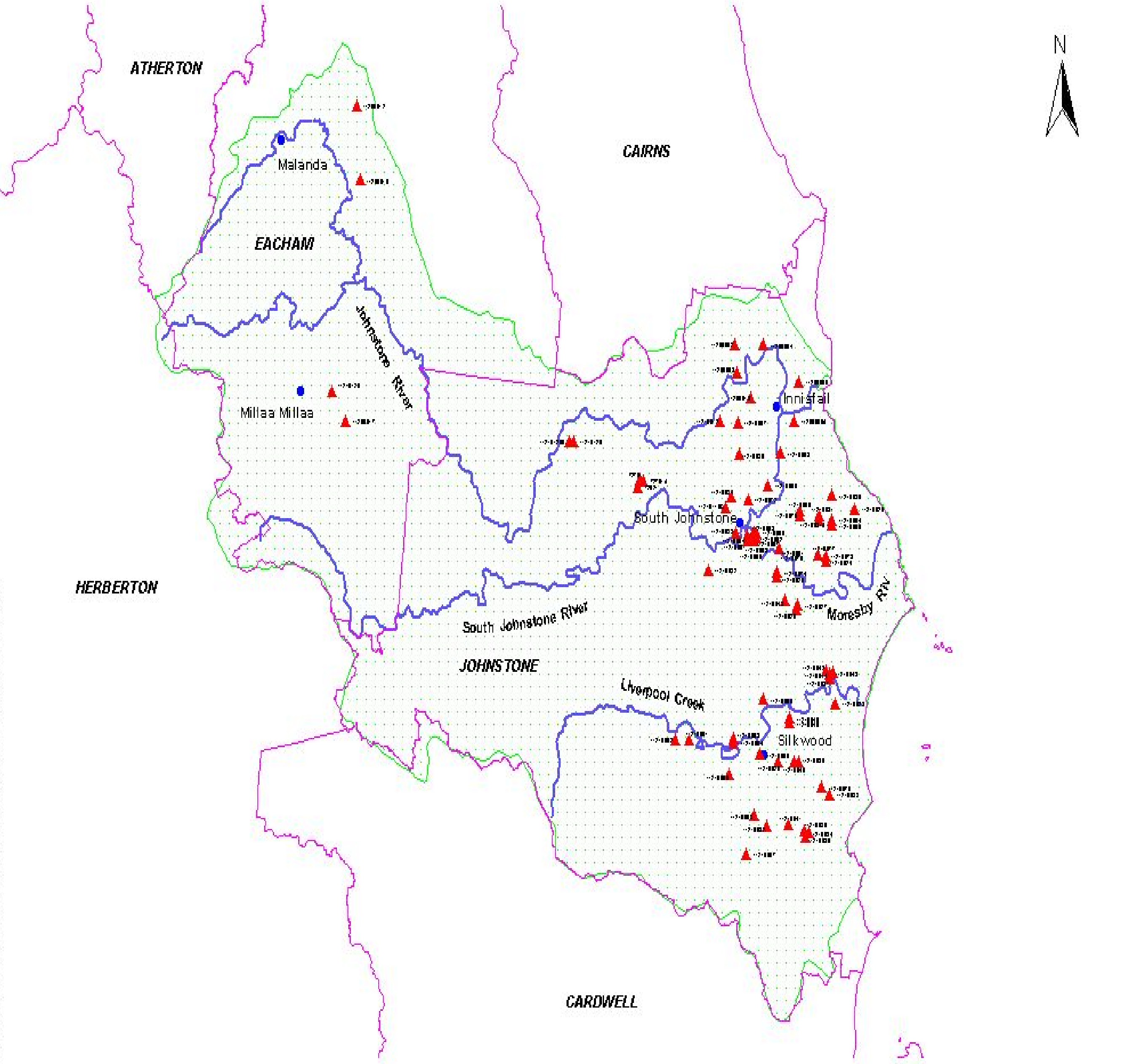
High concentrations of nutrients and sediments are being measured in our river catchments, and through the movement of floodwaters, these pollutants are moving into the inshore areas of the GBR. High concentrations (effect levels) of nitrogen and phosphorus are being measured at inshore reefs for a period of days and weeks. While high nutrient concentrations in river plumes are transient and quickly reduced by biological uptake, it is probable that long-term increased nutrient availability in inshore waters of the GBR from increased terrestrial fluxes may have occurred. Diffuse source pollutants, specifically high levels of nitrogen, originating from agricultural lands are considered to be the greatest chronic pollutant source to the GBRWHA, and management of these inputs, both point source and diffuse, are essential in the long term management and sustainability of the GBR.

4.3. Groundwater

The Department of Mines in 1980 initiated an investigation of the groundwater resources of the alluvial and coastal plains associated with the Russell and Johnstone Rivers and Liverpool Creek.

A number of groundwater observation bores exist in the Johnstone Basin. Figure 4.5 shows the location of the observation bores in the Johnstone Basin. Height and water quality data from five representative groundwater observation bores is available. The total groundwater yield in the Johnstone Basin is estimated to be some 122 000 megalitres per annum, of which some 50% is available for alluvial aquifers and some 40% from basalt aquifers.

Water quality is generally very good, with only very minor supplies within the metamorphic fractured rocks having total dissolved solids of over 3000 milligrams per litre. Some saltwater intrusion has occurred in the inlets of Liverpool Creek, Maria Creek, Johnstone River and Mourilyan Harbour.



LOCATION OF GROUNDWATER OBSERVATION BORES IN THE JOHNSTONE BASIN

Figure 2

Figure 4.5 Location of the observation bores in the Johnstone Basin

Supply rates are generally low, rarely being greater than eight litres per second. The majority of bores yield supplies at less than three litres per second, making them suitable only for small-scale irrigation and stock and rural domestic supplies. This relatively low rate of supply in the alluvium is due to the claybound nature and lack of lateral extent of the sediments. A few bores in the basalts supply at rates greater than 17 litres per second, but these are found only where the basalts subcrop within alluvial sequences in very limited areas and where the basalts are highly vesicular. However, some bores in the alluvial sequences yield supplies at rates up to 15 litres per second. Table 4.3 shows the estimated yields available form each of the aquifer types.

Aquifer Type		**Estimated Yield (1)**	**ML/a**	
	<1 000mg/l	**1 000 – 3 000 mg/l**	**> 3 000mg/l**	**Total**
Alluvium	63 500 (2)	Min	Min	63 500
Sand Dune	5 200	Min	Min	5 200
Fractured Basalt	48 600	Min	Min	48 600
Other Fractured Rock	4 750	Min	Min	4 750
Total	**122 050**	**Min**	**min**	**122 050**

(1) - based on regional geological interpretation except where noted
(2) - based on data from investigation drilling
Min - minimal

Table 4.3 Johnstone Basin Groundwater Yields

A similar study on groundwater in the Johnstone Shire was also conducted as part of the Shire's environmental audit undertaken in 1992. The major findings of this study are summarised in the tables below.

Area	Number of Bores	Minimum depth (m)	Maximum depth (m)	Average depth (m)	Minimum supply (l/s)	Maximum supply (l/s)	Average supply (l/s)	Main Hydrogeological unit
Coquette Pt	6	9.45	57.91	41.45	0.30	2.53	0.96	Metamorphics
Cowley Beach	11	6.10	46.63	27.54	0.63	7.58	2.77	Unconsolidated sediments
Daradgee	6	13.70	60.96	37.89	0.60	3.79	2.10	Basaltic volcanics
East Palmerston	27	27.43	122.00	55.60	0.50	3.16	1.27	Basaltic volcanics
Flying Fish Point	1	9.15	9.15	9.15	0.45	0.45	0.45	Unconsolidated sediments
Garradunga	12	29.20	91.46	49.43	0.55	4.42	1.44	Basaltic volcanics
Innisfail	17	15.70	92.96	41.95	0.37	7.32	2.70	Unconsolidated sediments
Japoonvale	2	13.72	21.30	17.51	1.89	12.6	7.25	Unconsolidated sediments
Kurrimine	4	21.00	32.00	27.88	2.80	6.31	4.65	Unconsolidated sediments
Mena Creek	22	16.50	72.54	41.75	0.50	10.00	2.29	Basaltic Volcanics
Moresby	4	21.30	56.39	41.84	1.00	12.62	4.64	Unconsolidated sediments
Mourilyan	19	15.50	38.10	21.83	2.53	15.00	6.45	Unconsolidated sediments
Mundoo	2	32.00	59.44	45.72	2.53	4.42	3.48	Basaltic volcanics
Silkwood	13	12.80	38.01	21.22	1.00	6.70	3.22	Unconsolidated sediments
South Johnstone	2	32.00	110.00	71.00	3.70	3.79	3.75	Basaltic volcanics
Wangan	1	31.70	31.70	31.70	3.79	3.79	3.79	Basaltic volcanics

Table 4.4 Water Bore Statistics for the Johnstone Shire

Hydrogeological Unit	Depth range of Bores (m)	Expected Supply (l/s)	Expected chemical quality	Potential for contamination	Potential for further development	Other Comments
Metamorphics	40-60	0.5-1.0	Good – suitable for Domestic, irrigation, stockwater	Low – owing to thick clay sequences above aquifers	Low – supplies are small and insufficient for irrigation Would be adequate for housing provided. No likelihood of contamination	Subject to saline intrusion adjacent to saline estuaries and close to shorelines.
Basaltic Volcanics	35-70	2.0-2.5	Good – suitable for domestic, irrigation, stockwater	Moderate – basalt soils are reasonable permeable; care needed with septic systems, refuse tips, industrial waste	Moderate – unit will supply small scale irrigation Unit should provide adequate housing supplies	Bores adjacent to major drainage features may experience reduction in supplies at end of dry season
Unconsolidated sediments	10-50	4.0-6.0 depending on depth drilled	Good – suitable for domestic, irrigation, stockwater	High – very permeable soils; care needed with septic systems, refuse tips, industrial waste	High – unit is apparently under-utilised but coincides with productive cane lands – scope for greater irrigation	Very susceptible to saline intrusion adjacent to saline estuaries and close to shorelines

Table 4.5 Summary of Groundwater conditions in Johnstone Shire

4.4. Complaints

In the year 2000, Council received complaints regarding water management in the Shire. These are summarised in the table below.

Nature of Complaint	Number of Complaints
Drainage	128
Oil Spill	5
Pollution - Water	3

Table 4.6 Complaints Received by Council

4.5. Atmospheric Management

There is limited information recorded and therefore reported in the Johnstone Shire. The only sampling points are located at point sources such as the sugar mills, abattoir and foundry. This sampling monitors material released from stacks to determine if they are within the licence limits set by the EPA.

	South Johnstone Mill Release Point A1	South Johnstone Mill Release Point A2	Mourilyan Mill Release Point A1	Mourilyan Mill Release Point A2
Boiler Served by Release Point	Boiler Number 2	Boiler Number 3	Riley Dodds	ABB
Stack Height (metres)	63	64	55	35
Minimum Discharge Velocity (metres/second)	15	15	12	10
Maximum Particle Mass Discharge Rate (grams per second)	t.b.s	t.b.s	1510	10
Maximum Particulate Concentration (milligrams per cubic metre)	250	800	700	250
Maximum Ringelmann Number	3	3	4	3

Table 4.7 Licensed Limits for Atmospheric Releases by Point Source Sugar Mills

Release Point	Source Description	Minimum Release Height (metres)[1]	Minimum Efflux Velocity (metres/second)
A1	Furnace No 3	18m	10 m/sec
A2	Green Sand Dust Extractor	17.5m	10 m/sec
A3	Dust Extractor Fettling	13m	10 m/sec
A4	Cold Box	12m	10 m/sec
A5	Sand Drier	16m	5 m/sec
A6	Cold Box – leampe	11.3m	Not specified
A7	Cold Box – w.e.s	11.3m	Not specified
A8	Conveyorised Oven	11.8 m	Not specified
A9	Batch Oven	12m	Not specified
A10	New Spray Booth	11.9m	10 m/sec
A11	Spray booth # 2	12m	10 m/sec

Table 4.8 Licensed Limits for Atmospheric Releases by Point Source Foundry

Release Point	Source Description	Minimum Release Height (metres above ground level)	Minimum Efflux Velocity (metres/second)
A1	Render Afterburner	8.4	8
A2	Render Chemical Scrubber	12	8
A3	Boiler Stack 1 Abattoir	12	8
A4	Boiler Stack 2	12	8

Table 4.9 Licensed Limits for Atmospheric Releases by Point Source Abattoir

The only other information is anecdotal from complaints received by Council and the Environmental Protection Agency in relation to noise, odour and smoke.

In the year 2000, the Environmental Protection Agency received 7 noise complaints regarding operations in the Johnstone Shire. Of these complaints, 2 sources could be identified, with the remaining 5 incidents occurring from unknown/unidentified sources. Only 1 complaint was unable to be resolved in the year 2000.

The Environmental Protection Agency also received a total of 6 odour complaints and 1 smoke complaint regarding operations in the Johnstone Shire. Only 1 odour complaint was unable to be resolved along with the only smoke complaint from an unknown/unidentified source. All 6 odour complaints were identified as originating from known sources, with four incidents coming from the one source.

In addition to noise, smoke and odour complaints, the Environmental Protection Agency also received an additional 5 complaints of incidents of dust in the year 2000. One of these complaints was not resolved in the year 2000. All 5 other complaints received were from identified sources, with one source being responsible for two complaints.

In the year 2000, Council received complaints of air pollution and the nature of these complaints and the number of complaints are summarised in the table below.

Nature of Complaint	Number of Complaints
Pollution – Air	1
Pollution – Noise	5
Pollution – Other	3
Smells	7
Smoke	0

Table 4.10 Atmospheric Related Complaints Received by Council

[1] The height above ground level at which the release point is located

The State of the Atmosphere in the Shire is at present unknown due to a lack of atmospheric monitoring. The majority of people believe that atmospheric pollution is not an issue in the Shire and that it is not anticipated that any further monitoring needs to occur.

4.6. Deficiencies in Data.

Numerous studies on coastal water quality have been conducted in the Johnstone Region, however, most data has been collected on a regional basis. The following water and atmospheric data should be collected:

- Streamflow data across the Johnstone Basin.
- Storage capacity and present levels of private water resources.
- Further information on the volume of flow required to satisfy instream needs.
- More reliable and quantitative information on the effects of nutrient and sediment discharges on the Great Barrier Reef.
- Levels of microbiological contaminants in receiving waters.
- Further assessment of contributors to sediment loads.
- Greater identification of sources of water contaminants, investigation of how they reach waterbodies, and the assessment of effects on water quality.
- Information on atmospheric quality as it comes to hand and details of point sources of atmospheric 'pollution'.

4.7. Recommendations – Water Management

- That exotoxicological studies into acute and chronic toxicity and bioaccumulation in selected freshwater and coastal molluscs, arthropods and fish be conducted.
- That a balanced assessment of the nature, extent and causes of discharges of nutrients and sediment be undertaken to obtain reliable data and quantitative information.
- That instream flow volumes be calculated for the major creeks and rivers in the Shire to allow better management of water extraction permits.
- Regular monitoring and analysis of the key indicators for the major river systems and streams in the Johnstone Basin must occur so that effective water and land management strategies can be developed.
- That investigation be undertaken to identify projects to be undertaken to improve water quality in the Johnstone River Basin.
- Community input will be a vital component of planning and implementing a strategy in the catchment, with community-based groups such as Waterwatch playing an important role. Decisions are needed on what environmental values should be placed on catchment water resources and what amelioration projects (if any) should be undertaken to improve water quality. Other issues not yet investigated (for example, levels of microbiological contaminants) may warrant attention.

4.8. Bibliography and Further Reading

Bertocchi, S., 2001, *Personal Communication*, January, Innisfail.

Buchanski, N., 2001, *Personal Communication*, January, Cairns

Devlin, M., 2001, *Personal Communication*, January 29, Innisfail.

Water Resources Commission, 1992, *Assessment of Groundwater Conditions: Johnstone Shire*, Department of Primary Industries.