DEPARTMENT *of*
PRIMARY INDUSTRIES,
WATER *and* ENVIRONMENT
Tasmania

Water Quality of Rivers in the Jordan Catchment

A Report Forming Part of the Requirements for State of Rivers Reporting

PART 1

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The Department of Primary Industries, Water and Environment

The Department of Primary Industries, Water and Environment provides leadership in the sustainable management and development of Tasmania's resources. The Mission of the Department is to advance Tasmania's prosperity through the sustainable development of our natural resources and the conservation of our natural and cultural heritage for the future.

The Water Resources Division provides a focus for water management and water development in Tasmania through a diverse range of functions including the design of policy and regulatory frameworks to ensure sustainable use of the surface water and groundwater resources; monitoring, assessment and reporting on the condition of the State's freshwater resources; facilitation of infrastructure development projects to ensure the efficient and sustainable supply of water; and implementation of the *Water Management Act 1999*, related legislation and the State Water Development Plan.

SUMMARY

The information contained in this report should be viewed together with the reports on aquatic ecology and hydrology. These three reports combine to form the 'Sate of River' report for the Jordan River catchment.

The Jordan River is located in southeast Tasmania, which is the driest region in the State. The Jordan catchment has a long history of pastoral activity, and large areas of the catchment have been cleared for grazing and cropping. Current land uses in the Jordan catchment include primarily pasture (sheep) in the upper catchment with the middle and lower catchment consisting of a mixture of pasture, dairy, cropping, industrial and urban development.

Water quality monitoring commenced in January 1999 and was completed in December 2001. While the main strategy was monthly sampling at a number of sites throughout the catchment, 'snapshot surveys' of the catchment, diurnal water quality investigations and some event-based sampling was also undertaken. The major findings from the study are;

- Surface water salinity throughout much of the catchment is high, with median values at most sites greater than the guideline for upland rivers (350 $\mu S/cm^{-1}$) that has been suggested by ANZECC (2000). Although surface water salinity in the Jordan is likely to be heavily influenced by local geology (high sodium and calcium), the elevated levels that were recorded at some sites are likely to be significantly exacerbated by the loss of vegetation that is a characteristic of this catchment.

- Monthly sampling of dissolved oxygen revealed that some sites recorded concentrations below the 90% default trigger value for slightly disturbed streams (ANZECC, 2000). At some locations, short-term intensive monitoring of this parameter showed that dissolved oxygen fell below 5mg/L, which is likely to adversely affect aquatic biota (Koehn and O'Connor, 1990) and may impact on river health. This is also likely to be influenced by the ephemeral nature of the river and in some areas may be affected by agricultural activities.

- Snapshot data for bacteria illustrated that those sites that are subject to stock access or are substantially urbanised are subject to higher faecal contamination.

- Analysis of hourly changes in various water quality parameters at Jordan River at Elderslie Road (J6) exhibited characteristics of a significantly modified and eutrophic system. Very low dissolved oxygen concentrations were generally recorded (2-5 mg/L) during all deployments. These low concentrations appear to be the result of high levels of primary productivity that have been brought about by eutrophication of the river at this site (see next point).

- Monthly sampling showed that nutrient concentrations at the majority of sites are in excess of the recommended ANZECC (2000) trigger values for upland rivers. Highest concentrations of nitrogen and phosphorus were found at Jordan River at Elderslie Road (J6) and Jordan River upstream of tidal limit (J1). Both of these sites exhibit characteristics of eutrophication and contribute to degraded water quality downstream.

- The very low flows that occur in the Jordan River are likely to contribute indirectly to degraded water quality, however this is exacerbated by further reductions in flow that occur as a result of water extraction and dam construction. The scarcity of surface water in the catchment means that impacts from such factors as fertiliser application, unrestricted stock access, riparian vegetation removal and instream works are all likely to be magnified.

- Nutrient loads and export coefficients for TN and TP in the Jordan River are approximately within the top 30% for those catchments monitored under the current State of River program (N = 15). The estimates that have been made for this catchment have a high degree of uncertainty.

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A GLOSSARY OF TERMS

Baseflow
Flow in a stream is a function of inputs from overland flow, subsurface flow and groundwater. During periods when there is no contribution of water from overland flow, river flow is composed of water from deep subsurface and groundwater sources and is termed 'baseflow'.

Box and Whisker Plots
One common method of examining data collected at varous sites is to plot the data from each site as a 'box and whisker' plot. These plots display the median (or the middle of the data) as a line across the inside of the box. The bottom and top edges of the box mark the first and third quartiles respectively, indicating the middle 50% of the data. The ends of the whiskers show the extremes of the data and together enclose 95% of the data.

Catchment
The land area which drains into a particular watercourse (river, stream or creek) and is a natural topographic division of the landscape. Underlying geological formations may alter the perceived catchment area suggested solely by topography (limestone caves are an example of this).

Discharge
The volume of water passing a specific point during a particular period of time. It usually refers to water flowing in a stream or drainage channel, but can also refer to waste water from industrial activities.

Diurnal Variation
'Diurnal variation' is a term that is used to describe the cyclical pattern of change that occurs within a daily timescale. Water temperature variation is a typical example of a parameter that varies 'diurnally', with lowest temperatures occurring in the hours before dawn and the highest temperatures occurring around the middle of the day. Many water quality parameters that are influenced by biological processes also tend to vary on a diurnal basis.

Dissolved Oxygen
Oxygen is essential for all forms of aquatic life and many organisms obtain this oxygen directly from the water in the dissolved form. The level of dissolved oxygen in natural waters varies with temperature, turbulence, photosynthetic activity and atmospheric pressure. Dissolved oxygen varies over 24 hour periods as well as seasonally and can range from as high as 15 mg/L to levels approaching 0 mg/L. Levels below 5 mg/L will begin to place stress on aquatic biota and below 2 mg/L will cause death of fish.

Ecosystem
An environment, the physical and chemical parameters that define it and the organisms which inhabit it.

Electrical Conductivity (EC)
Conductivity is a measure of the capacity of an aqueous solution to carry an electrical current, and depends on the presence of ions; on their total concentration, mobility and valence. Conductivity is commonly used to determine salinity and is mostly reported in microSiemens per centimetre (µS/cm) or milliSiemens per metre (mS/m) at a standard reference temperature of 25^{o} Celsius.

Eutrophication
The enrichment of surface waters with nutrients such as nitrates and phosphates, which cause nuisance blooms of aquatic plants and algae.

Export Loads / Export Coefficients

The calculation of export loads of nutrients, or any other parameter, involves using nutrient concentration data collected over a wide variety of flow conditions and from various seasons. This information, when plotted against flow at the time of collection, can reveal relationships between flow and concentration which can then be used to estimate the load of a particular nutrient leaving the catchment (estimates of export loads should be regarded as having no greater accuracy than +/- 15%).

The export coefficient (also known as the Runoff Coefficient) corrects for catchment size so that export loads from variously sized catchments can be compared. The most commonly used formula to perform this correction is;

Discharge (ML) / **Catchment Area** (km^2) = **X** ($mm\ km^{-2}$)

Total Load (kg) / **X** = **Y** ($kg\ mm^{-1}$)

Y / **Catchment Area** (km^2) = **Export Coefficient** ($kg\ mm^{-1} km^{-2}$)

Where Z is the Export Coefficient and is equivalent to Total Load (kg) / Discharge (ML).

Faecal Coliforms (also known as 'thermotolerant coliforms' - eg. *E.coli*)

Faecal coliform bacteria are a sub-group of the total coliform population that are easy to measure and are present in virtually all warm blooded animals. Although measurement of this group is favoured by the NHMRC (1996) as suitable indicators of faecal pollution, it is recognised that members of this group may not be exclusively of faecal origin. However their presence in samples implies increased risk of disease. Pathogenic bacteria are those which are considered capable of causing disease in animals.

General Ions

General ions are those mineral salts most commonly present in natural waters. They are primarily sodium, potassium, chloride, calcium, magnesium, sulphate, carbonates and bicarbonates. Their presence affects conductivity of water and concentrations variable in surface and groundwaters due to local geological, climatic and geographical conditions.

Hydrograph

A plot of flow (typically in a stream) versus time. The time base is variable so that a hydrograph can refer to a single flood event, to a combination of flood events, or alternatively to the plot of all flows over a month, year, season or any given period.

Macroinvertebrate

Invertebrate (without a backbone) animals which can be seen with the naked eye. In rivers common macroinvertebrates are insects, crustaecans, worms and snails.

Median

The middle reading, or 50^{th} percentile, of all readings taken.

i.e. Of the readings 10, 13, 9, 16 and 11

{Re-ordering these to read 9, 10, 11, 13 and 16}

The median is 11.

The **Mean** (or Average), is the sum of all values divided by the total number of readings (which in this case equals 11.8).

Nutrients
Nutrients is a broad term which encompasses elements and compounds which are required by plants and animals for growth and survival. In the area of water quality the term is generally used with only phosphorus and nitrogen species in mind, though there are many other 'nutrients' that living organisms require for survival.

pH and Alkalinity
The pH is a measure of the acidity of a solution and ranges in scale from 0 to 14 (from very acid to very alkaline). A pH value of 7 is considered 'neutral'. In natural waters, pH is generally between 6.0 and 8.5. In waters with little or no buffering capacity, pH is related to alkalinity which is controlled by concentrations of carbonates, bicarbonates and hydroxides in the water. Waters of low alkalinity (< 24 ml/L as CaCO3) have a low buffering capacity and are susceptible to changes in pH from outside sources.

Riparian Vegetation
Riparian vegetation are plants (trees, shrubs, ground covers and grasses) which grow on the banks and floodplains of rivers. A 'healthy' riparian zone is characterised by a homogeneous mix of plant species (usually native to the area) of various ages. This zone is important in protecting water quality and sustaining the aquatic life of rivers.

Suspended Solids
Suspended solids are typically comprised of clay, silt, fine particulate organic and inorganic matter and microscopic organisms. Suspended solids are that fraction which will not pass through a 0.45μm filter and as such corresponds to non-filterable residues. It is this fraction which tends to contribute most to the turbidity of water.

Total Kjeldahl Nitrogen (TKN)
The Kjeldahl method determines nitrogen in water and is dominated by the organic and ammoniacal forms. It is commonly used to determine the organic fraction of nitrogen in samples and when the ammonia nitrogen is not removed, the term 'kjeldahl nitrogen' is applied. If the ammonia nitrogen is determined separately, 'organic nitrogen' can be calculated by difference.

Total Nitrogen (TN)
Nitrogen in natural waters occurs as Nitrate, Nitrite, Ammonia and complex organic compounds. Total nitrogen concentration in water can be analysed for directly or through the determination of all of these components. In this report, Total Nitrogen has been calculated as the sum of Nitrate-N + Nitrite-N + TKN.

Total Phosphorus (TP)
Like nitrogen, phosphorus is an essential nutrient for living organisms and exists in water as both dissolved and particulate forms. Total phosphorus can be analysed directly, and includes both forms. Dissolved phosphorus mostly occurs as orthophosphates, polyphosphates and organic phosphates.

Turbidity
Turbidity in water is caused by suspended material such as clay, silt, finely divided organic and inorganic matter, soluble coloured compounds and plankton and microscopic organisms. Turbidity is an expression of the optical properties that cause light to be scattered and absorbed rather than transmitted in a straight line through the water. Standard units for turbidity are 'nephelometric turbidity units' (NTU's) standardised against Formazin solution.

Units and Conversions

mg/L = milligrams per litre (1000 milligrams per gram)
μg/L = micrograms per litre (1000 micrograms per milligram)
e.g. 1000 μg/L = 1 mg/L
μS/cm = Microsiemens per centimeter
m^3/s = cubic metre per second (commonly referred to as a 'cumec')
ML = 1 million litres (referred to as a 'megalitre')

Acronyms

ANZECC - Australian and New Zealand Environment and Conservation Council
ARMCANZ - Agricultural and Resource Management Council of Australia and New Zealand
DPIWE - Department of Primary Industries, Water and Environment
DPIF - Department of Primary Industry and Fisheries (replaced by DPIWE)
DCHS - Department of Community and Health Services
NHMRC - National Health and Medical Research Council
NHT – Natural Heritage Trust (formerly the National Landcare Program)

B SUMMARY OF NATIONAL GUIDELINES FOR WATER QUALITY

Australian Water Quality Guidelines as per ANZECC (2000)

As part of a National strategy to 'pursue the sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development' the Australian and New Zealand Environment and Conservation Council (ANZECC) has been developing guidelines for water quality for a range of Australian waters. Since 1992, a document titled 'Australian Water Quality Guidelines for Fresh and Marine Waters (1992) ' has been available for use as a reference tool for catchment management plans and policies. Since 1995, these guidelines have been under review and have now been superseded by new and more rigorous guidelines (ANZECC, 2000). Where possible, these new guidelines have had a more regional focus. This new approach has changed the emphasis of guideline setting, suggesting a 'risk assessment' approach which utilises the concept of increased risk with increasing departure from 'safe' levels.

The revised guidelines also restate the principle that guidelines are only to be used in the absence of local data, and that where local data can be obtained, they should be used to develop local water quality standards. For some water quality parameters, this approach has been taken, with data from Tasmanian systems (where available) being used to develop guidelines for use within Tasmania. In the National document, Tasmanian rivers have been broadly classified as upland or alpine rivers, as available data at the time was from upland river systems only. For the purposes of this report the Jordan River Catchment has been classified as an upland river catchment.

Table 1. Trigger Levels for Nutrients, pH and Dissolved Oxygen (ANZECC 2000).

Ecosystem Type	TP (µg/L)	FRP (µg/L)	TN (µg/L)	NOx (µg/L)	pH	DO (%sat)
Lowland River	50	20	500	40	6.5 - 8.0	<85 & >110
Upland River	13	5	480	190	6.5 to 7.5	<90 & >110
Lakes and Reservoirs	10	5	350	10	6.5 to 8.0	<90 & >110

Table 2. Trigger Levels for Conductivity and Turbidity (ANZECC 2000).

Ecosystem type	Salinity (μScm^{-1})	Explanatory notes
Lowland Rivers	125-2200	Lowland rivers may have higher conductivity during low flow periods and if the system receives saline groundwater inputs. Low values are found in eastern highlands of Victoria (125μScm^{-1}) and higher values in western lowlands and northern plains of Vic (2200μScm^{-1}), NSW coastal rivers are typically in the range 200-300 μScm^{-1}.
Upland Rivers	30–350	Conductivity in upland streams will vary depending upon catchment geology. Low values found in Victorian alpine regions (30 μScm^{-1}) and eastern highlands (55 μScm^{-1}), high value (350 μScm^{-1}) in NSW rivers. Tasmanian rivers mid-range (90 μScm^{-1}).

Lakes/ Reservoirs	20–30	Conductivity in lakes and reservoirs are generally low, but will vary depending upon catchment geology. Values provided are typical of Tasmanian lakes and reservoirs.

Ecosystem type	Turbidity (NTU)	Explanatory notes
Lowland Rivers	6-50	Turbidity in lowland rivers can be extremely variable. Values at the low end of the range would be found in rivers flowing through well-vegetated catchments and at low flows. Values at the high end of the range would be found in rivers draining slightly disturbed catchments and in many rivers at high flows.
Upland Rivers	2–25	Most good condition upland streams have low turbidity. High values may be observed during high flow events.
Lakes & Reservoirs	1–20	Most deep lakes and reservoirs have low turbidity. However shallow lakes and reservoirs may have higher natural turbidity due to wind-induced resuspension of sediments. Lakes and reservoirs in catchment with highly dispersable soils will have high turbidity.

4. Proposed Microbiological Guidelines

Primary contact

The median bacterial content in samples of fresh or marine waters taken over the bathing season should not exceed:

- *150 faecal coliform organisms/100 mL (minimum of five samples taken at regular intervals not exceeding one month, with four out of five samples containing less than 600 organisms/100 mL);*
- *35 enterococci organisms/100 mL (maximum number in any one sample: 60–100 organisms/100 mL).*

Pathogenic free-living protozoans should be absent from bodies of fresh water. (It is not necessary to analyse water for these pathogens unless the temperature is greater than 24°C.)

Secondary contact

The median bacterial content in fresh and marine waters should not exceed:

- *1000 faecal coliform organisms/100 mL (minimum of five samples taken at regular intervals not exceeding one month, with four out of five samples containing less than 4000 organisms/100 mL);*
- *230 enterococci organisms/100 mL (maximum number in any one sample 450–700 organisms/100 mL).*

National Health and Medical Research Council - Drinking Water

For drinking water, guidelines published by the National Health and Medical Research Council (NHMRC, 1996) suggest that no thermotolerant coliforms (eg *E. coli*) should be present in water used for drinking.

1 Historical Data

1.1 Overview of the Jordan Catchment

The Jordan River catchment is located within the south east of Tasmania and encompasses approximately 1253 square kilometres. The Jordan River catchment has the lowest average rainfall of any river this size in Tasmania. As such, this region is prone to drought conditions. The Jordan River is ephemeral and is often dry for extended periods. During the winter months the flow is dependent on rainfall resulting from easterly winds bringing moist air over the catchment. The average annual rainfall is around 500-600 mm. The River originates in Lake Tiberias, in the Midlands district near the town of Oatlands and flows in a northwesterly direction until Burnt Log Gully where it then flows in a southerly direction for about 80 km into the tidal zone of the Derwent River at Bridgewater.

The primary landuse practices in the Jordan River catchment are pasture, irrigated cropland, forestry, and some industrial, rural and urban developments. The lower catchment has a long history of agricultural use with the river heavily used for irrigation water. The Jordan River catchment has been extensively cleared and the banks of the river and major tributaries are substantially degraded with little of the native riparian vegetation remaining. A major concern in the catchment is the extent of infestation by Crack willow (*Salifax fragilis*).

Geology of the catchment varies and includes dolerite, sandstone, basalt, mudstone and interbedded sequences of sandstone and mudstone (North, 1999).

1.2 DPIWE Water Quality Database

Scant historical water quality data is available from the State water quality database for rivers and streams in the Jordan catchment. The continuous flow data that is stored on the State database has been collected from the Jordan River at Mauriceton (J11) and Jordan River at Bridgewater (J1). A number of water quality parameters were also sampled at these two sites (Table 1.1 and 1.2). In addition to the data collected from J1 and J11, a single sample trip occurred in March 1991 where a number of water quality parameters were analysed at four different sites (Table 1.3).

Jordan River at Mauriceton

There is currently one operational stream gauging station in the Jordan River catchment. It is located at Mauriceton, Jordan River at Mauriceton (4201). From 1984 until 1992 there was an operational stream gauging station located at Bridgewater (J1). The flow data from both these stations clearly shows that the Jordan River has a highly variable flow regime with frequent and often extended periods of low or zero flows in summer-autumn, interspersed aseasonal flood events. The flow regime recorded at Mauriceton from 1965 until 2003 is shown in Figure 1.1. It is evident from historical records that there has been a general decline in baseflows since the 1980's, but the record also indicates that there has been a reduced incidence of flood events. For the majority of the study period (1999 to 2001) drought conditions prevailed (Figure 1.2). In July 2001 flow returned to the system with a peak flow of approximately 25 m^3s^{-1} recorded at Mauriceton (J11) in October 2001.

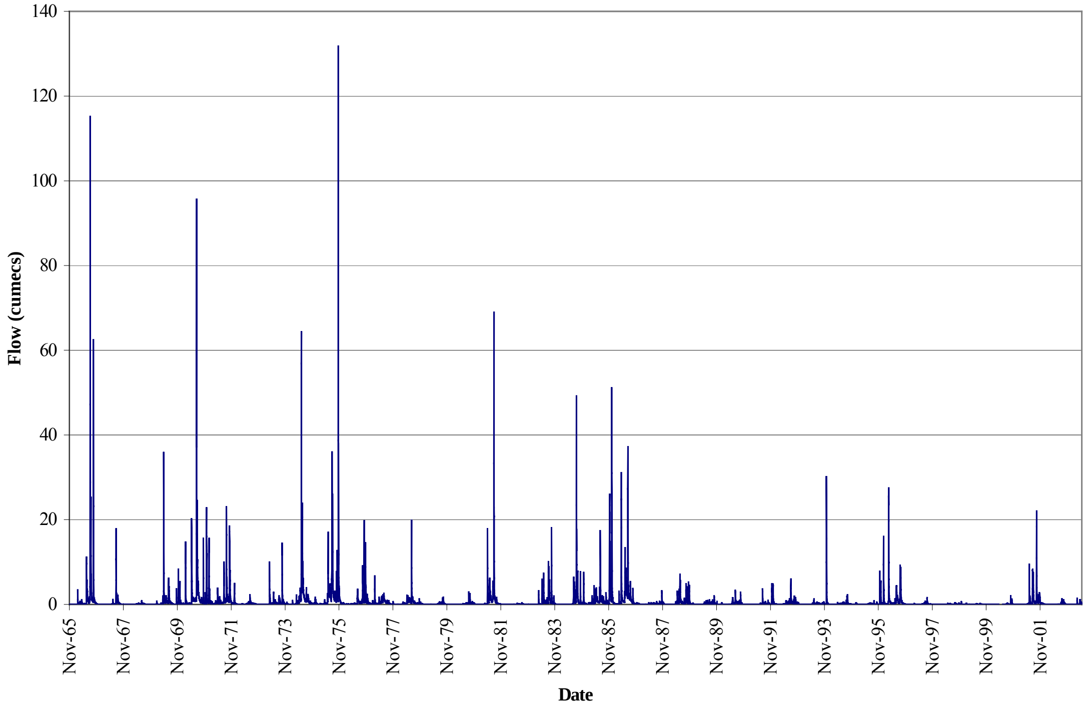

Figure 1.1 Historical records for flow (cumecs) recorded for the Jordan River at Mauriceton.

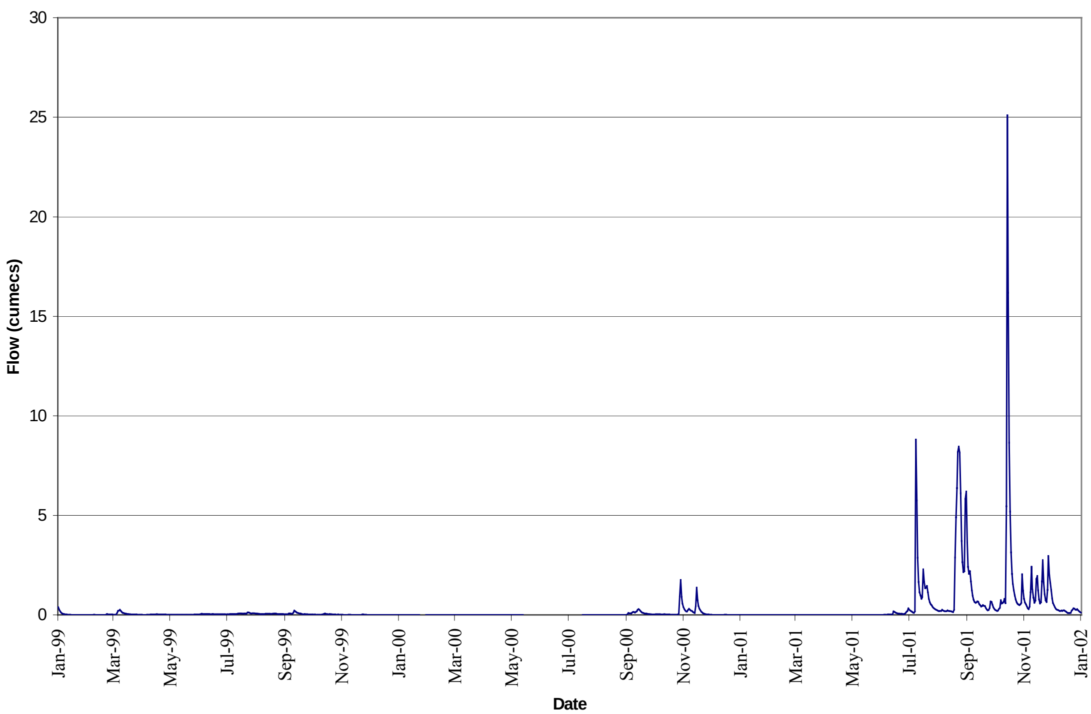

Figure 1.2 Historical records for flow (cumecs) recorded for the Jordan River at Mauriceton for the duration of the project.

Table 1.1 provides the statistics of the water quality data collected for the Jordan River at Mauriceton. The pH values recorded at this site range from slightly acidic (6.3) to alkaline (8.7) with a median value of between 7.0 and 8, depending on wether data was collected in the field or via bottled samples. The historical data for salinity at Mauriceton (J11) illustrates that the system is quite saline with a median range between 740-795 µS/cm. The highest recorded value for salinity was 1980 µS/cm in July 1991. Conductivity levels of this magnitude are likely to have an impact on ecosystem health, and water with this level of salt will be unsuitable to use as irrigation water for certain crops. During most sampling visits to this site, river levels were less than 0.5 metres, which corresponds to flows of less than 0.5 m^3s^{-1}. Water temperatures ranged from 2 °C to 28 °C with a median value of 12 °C.

Table 1.1 Summary statistics for data contained on the HYDROL samples database for the Jordan River at Mauriceton (4201). N= number of readings taken. The collection period was from 1974 – 1996.

Jordan River at Mauriceton 4201						
Parameter	**Units**	**N**	**Min**	**Max**	**Average**	**Median**
Apparent Colour	hazen	8	20	150	66	60
Field Conductivity	uS/cm TRef 20	25	362	1980	902	740
Field Conductivity	uS/cm TRef 25	17	460	1345	882	795
Filtered Residue (103-105)	mg/L	8	330	1160	633	605
Laboratory pH		38	6.3	8.7	7.9	8.0
pH Field CLOSED	CLOSED	45	6.4	8.5	7.3	7.0
River Level	Metres	92	0.01	1.34	0.4	0.28
Suspended Solid	mg/L	8	1.0	30	6.1	3.0
Turbidity	NTU	3	1.5	57	21	3.5
Turbidity	Hellige	5	11	3.4	6.7	6.5
Water Temperature	Degrees C	92	2.0	28	12	12

Jordan River at Bridgewater

Continuous records for flow have been recorded for the Jordan River at Bridgewater between 1984 until 1992 (Figure 1.3). The data shows that there is a marked difference between flow at this location in the mid-1980's and the subsequent period. This is displayed as a decline in the magnitude and frequency of high flow events as well as in the level of baseflow. During site visits to collect water quality samples, river levels of less than 0.2 metres (which corresponds to flows of less than 0.5 m^3s^{-1}) occurred on 39% of visits.

Table 1.2 provides the statistics of the water quality data collected for the Jordan River at Bridgewater. The laboratory pH values ranged from 7.4 to 8.3 units. The median value for conductivity (TRef 20°C) was 750 µS/cm.

Table 1.2 Summary statistics for data contained on the HYDROL samples database for the Jordan River at Bridgewater (4210). N=number of readings taken. The collection period was from 1983 to 1992.

Jordan River at Bridgewater 4210						
Parameter	**Units:**	**N**	**Minimum**	**Maximum**	**Average**	**Median**
Apparent colour	hazen	10	0.06	150	69	50
Field Conductivity	uS/cm TRef 20	13	474	1480	840	750
Filtered Residue (103-105)	mg/L	8	366	1220	639	556
Laboratory pH		7	7.4	8.3	8.0	8.1
Nitrate as N	mg/L	2	0.01	0.16	0.09	0.09
pH Field CLOSED	CLOSED	26	6.2	8.2	7.1	7.0
River Level	Metres	31	0.03	0.38	0.18	0.19
Suspended Solids	mg/L	8	1.0	28	8.1	4.5
Total Phosphate	mg/L	1	0.07	0.07	0.07	0.07
Turbidity	NTU	2	3.1	12	7.5	7.5
Turbidity	Hellige	6	1.9	29	13	10
Water Temperature	Degrees C	29	5.0	22	13	14

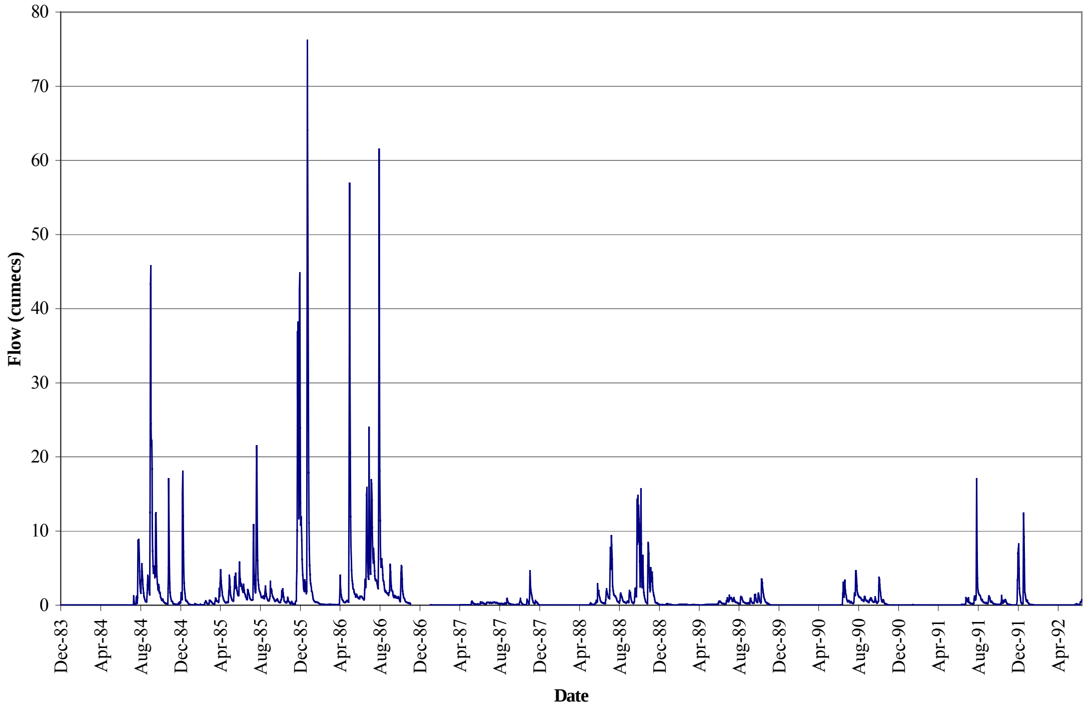

Figure 1.3 Historical data for flow (cumecs) recorded at Jordan River at Bridgewater.

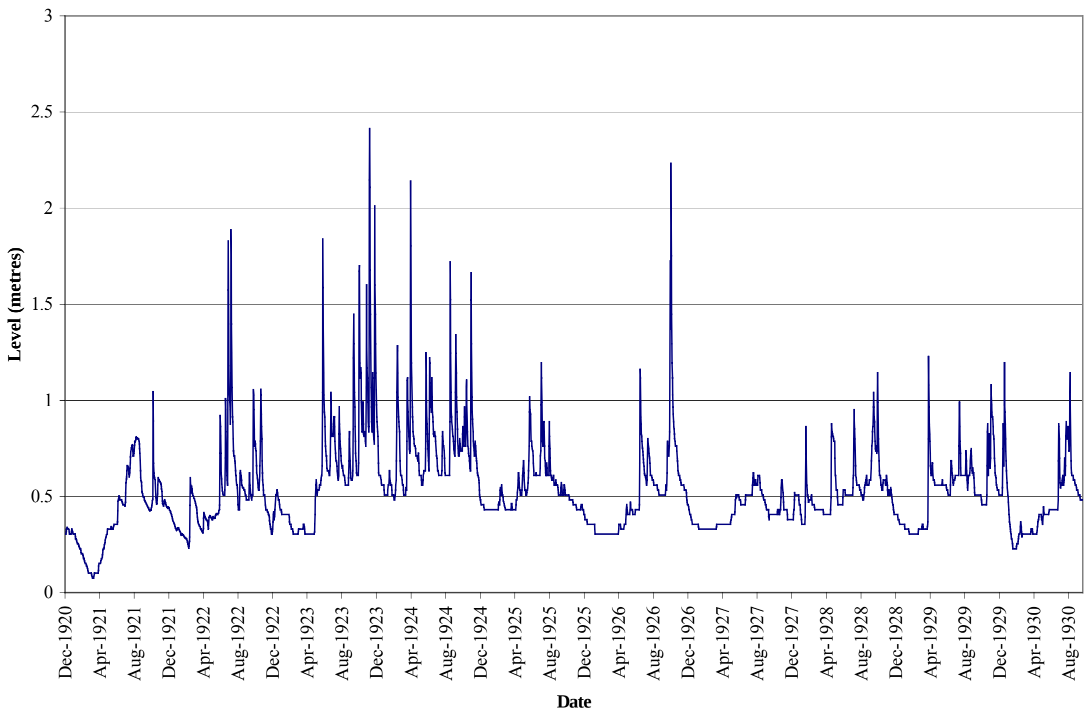

Figure 1.4 Historical river level data recorded for the Jordan River at Apsley (1920-1930).

Four sites were sampled on the 18th March 1991 for a range of water quality variables. From these spot samples it is evident that the conductivity levels (830 µS/cm to 1815 µS/cm) were above the ANZECC Guidelines (2000) recommended trigger values of 90 µS/cm for Tasmania. The pH for these were all slightly alkaline, and dissolved oxygen at three of the four sites was quite low.

Table 1.3 Water quality samples analysed from four different sites on the 18th March 1991: Jordan River at Arndell (1221), Jordan River at Black Brush Rd (1222), Jordan River at Clifton Vale Rd (1223), Jordan River at Winton (1224).

		Hydrol number			
Parameter	**Units:**	**1221**	**1222**	**1223**	**1224**
Water Temperature	Degrees	19.5	16.3	17.8	18.1
Apparent Colour	hazen	40	30	30	40
Turbidity	NTU	4.2	0.97	6.2	1.48
Field Conductivity	uS/cm TRef 20	1815	973	830	1667
Laboratory pH		8.0	7.4	8.1	7.7
pH Field	CLOSED	8.0	7.7	8.5	7.8
Suspended Solids	mg/l	5.0	2.0	48	3.0
Nitrite as N	mg/l	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.1	0.1	0.1	0.1
Ammonia as N	mg/l	0.05	0.05	0.05	0.05
Dissolved Oxygen	mg/l	8.6	4.6	6.3	5.5
Total Phosphate	mg/l	0.03	0.03	0.06	0.02
Filtered Residue (103-105)	mg/l	1410	700	565	1380
Faecal Streptococci		10	60	40	10

1.3 Brighton City Council

The Brighton City Council established a water quality monitoring program in 1990 in order to monitor overflow from the sewerage holding lagoons that entered into the Jordan River. This monitoring program continued until 1999 when the effluent was diverted into the Brighton Effluent Re-use Scheme. The Council established two monitoring sites upstream and one downstream of the discharge point of the holding lagoons. The lower site has a potential intertidal influence. The parameters sampled were biological oxygen demand, suspended solids, pH, nitrate, nitrite, ammonia, total phosphorous, presumptive faecal coliforms, and presumptive faecal streptococci. Table 1.4 provides the statistics for these water quality data. Figure 1.6 and 1.7 illustrate changes in presumptive faecal coliform and presumptive streptococci for the duration of the monitoring project.

Thermotolerant coliforms are used to indicate the presence of faecal contamination. Faecal streptococci are used as a secondary indicator of bacteria (NHMRC, 1996). The data on thermotolerant coliforms and faecal streptococci indicates that levels are higher upstream of the holding lagoon. The concentration of thermotolerant coliforms and faecal streptococci reached their highest levels both upstream and downstream of the holding lagoon in April 1996. According to the ANZECC Guidelines (2000) the median bacterial count in fresh and marine waters should not exceed 1000 faecal coliform organisms/100 mL and 230 enterococci organisms/100 mL.

Table 1.4 Summary statistics for data collected by the Brighton City Council for the Jordan River upstream and downstream of the holding lagoon. N= number of readings taken. The collection period was from 1990 to 1999.

Presumptive Faecal Streptococci Site (cfu/100mL)	N	Minimum	Maximum	Median
Jordan River at Cole Hill Road	1	680	680	680
Jordan River - Downstream of Lagoon Outlet	13	10	970	100
Jordan River - upstream of Lagoon Outlet	13	10	9300	70
Presumptive faecal Coliforms Site (cfu/100mL)	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	2	100	200	150
Jordan River - Downstream of Lagoon Outlet	13	10	2700	100
Jordan River - upstream of Lagoon Outlet	14	10	3300	165
Suspended Solids (mg/L) Site	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	10	10	10
Jordan River - Downstream of Lagoon Outlet	17	1	18	6
Jordan River - upstream of Lagoon Outlet	18	1	42	4.5
pH	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	8	8	8
Jordan River - Downstream of Lagoon Outlet	16	7.6	9.4	7.8
Jordan River - upstream of Lagoon Outlet	17	7.3	8	7.7
Nitrate Nitrogen (mg/L) Site	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	0.2	0.2	0.2
Jordan River - Downstream of Lagoon Outlet	17	<0.1	1	0.1
Jordan River - upstream of Lagoon Outlet	18	0.01	0.8	0.1
Nitrite Nitrogen (mg/L) Site	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	0.05	0.05	0.05
Jordan River - Downstream of Lagoon Outlet	17	0.01	0.1	0.01
Jordan River - upstream of Lagoon Outlet	18	0.01	0.01	0.01
Ammonia (mg/L) Site	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	0.1	0.1	0.1
Jordan River - Downstream of Lagoon Outlet	17	0.05	12	0.3
Jordan River - upstream of Lagoon Outlet	18	0.005	7.9	0.1
Phosphorous Total (mg/L) Site	**N**	**Minimum**	**Maximum**	**Median**
Jordan River at Cole Hill Road	1	4.5	4.5	4.5
Jordan River - Downstream of Lagoon Outlet	17	0.06	4.5	0.25
Jordan River - upstream of Lagoon Outlet	18	0.07	4.5	0.45

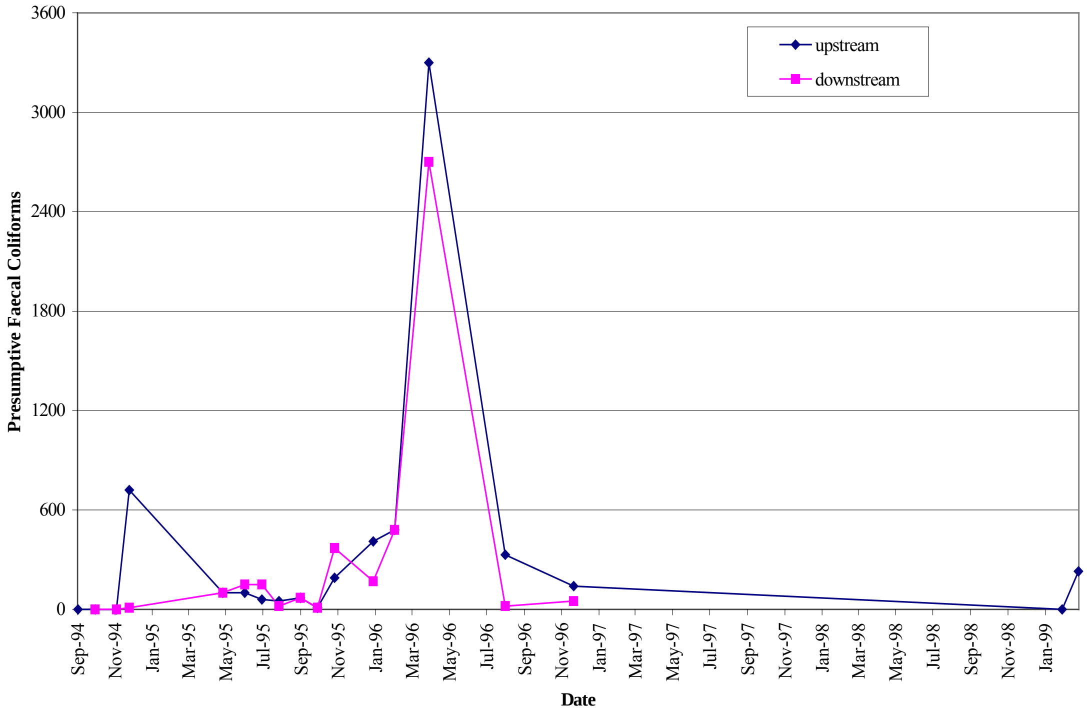

Figure 1.6 Presumptive faecal coliform (cfu/100mL) concentrations recorded upstream and downstream of the holding lagoons.

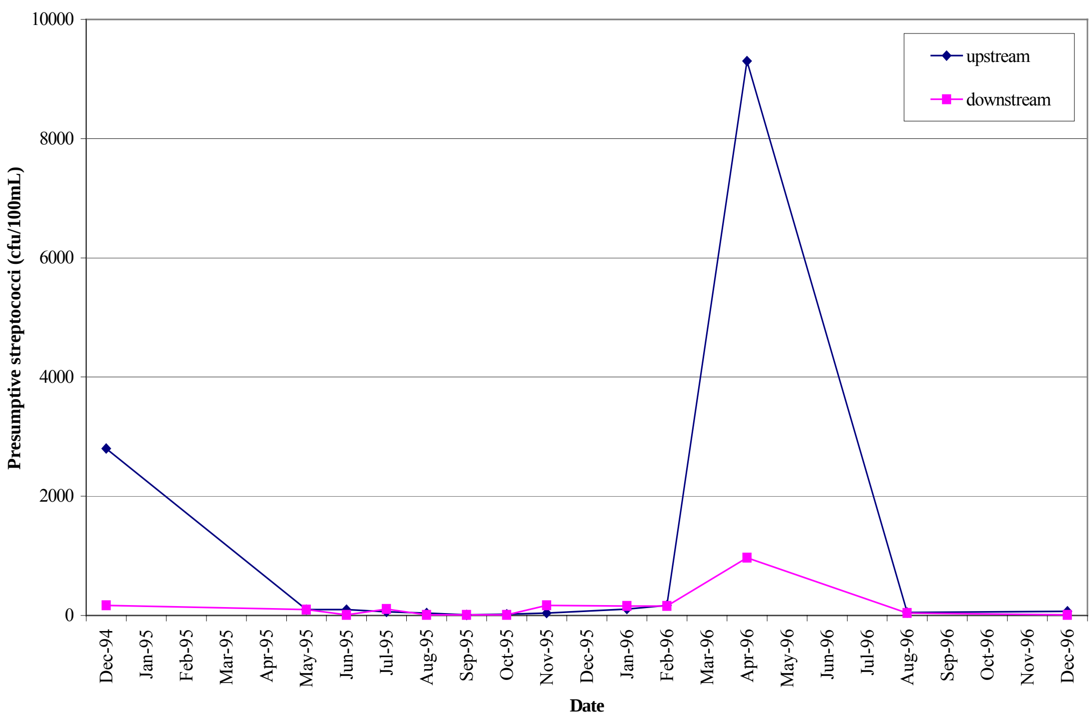

Figure 1.7 Presumptive streptococci (cfu/100mL) concentrations recorded upstream and downstream of the holding lagoons.