DEPARTMENT *of*
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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 3

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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.

2.3 Nutrient Results

Monthly sampling was carried out at 5 key sites for the entire duration of the project (Table 2.1). Additional sampling at 4 sites occurred between late May and early August 1999 as requested by the Brighton Council for their AEAM modelling of the Jordan catchment. These sites are located in Bagdad Rivulet Catchment (J5a, N=8 and J5b, N=8), Jordan River at Bellvale Road (J18 N, =9) and Exe Rivulet (J19, N= 9). Number of samples taken for all other sites varied between 25 and 39 depending on the availability of water. Due to dry conditions in the catchment interim sites were sampled in some areas. An alternative site for Strathallan Rivulet upstream of the Ford at Pontville (J4, N=25) during summer was Jordan River upstream of the confluence with Strathallan Rivulet (J4b, N =14) (Figure 1). The variation in sampling frequency between all sites monitored should be considered when interpreting these data.

The main focus for sampling nutrients was for total concentrations of nitrogen and phosphorus. Laboratory analysis also included testing for nitrite, nitrate and dissolved reactive phosphorus. For the purposes of this report discussion will be limited to total nitrogen (TN), total phosphorus (TP), nitrate –nitrogen (NO_3-N) and ammonia-nitrogen (NH_3-N). Where a significant concentration of nitrite-nitrogen (NO_2-N) is recorded specific mention may be made regarding the water quality at that site.

Concentrations of nutrients in surface waters draining agricultural lands vary in response to the intensity and type of agricultural practice. Agricultural activities which influence nutrient concentrations include fertiliser application, pasture drainage, removal of riparian vegetation, tillage and stock access. The intensity of agricultural activities can have a dramatic influence on nutrient concentrations. Where agricultural activities are dispersed, such as that experienced in the North Esk River catchment, nutrient concentrations tend to be markedly lower (Wilson *et al.*, 2003*)*. In comparison catchments such as the Duck River and Montagu River where there is intensive agriculture, high concentrations of nutrients have been monitored (Bobbi *et al.*, 2003a and 2003b). These high concentrations are reflected in the highest nutrient load estimates calculated for rivers monitored under the current State of Rivers Program.

Total nitrogen in environmental waters is the sum of organic nitrogen, nitrate-nitrogen (NO_3/N) and nitrite-nitrogen (NO_2-N) with the latter two being dissolved forms. Nitrite-nitrogen is usually detected at very low levels unless there is some form of local pollution entering the waterway. Organic nitrogen is generally the dominant form and is usually present in the water column as fine particulate material. Nitrate-nitrogen generally fluctuates on a seasonal basis. The leaching of NO_3/N through the soil profile during and following rainfall usually results in higher concentrations in the winter months. This has been recorded in other Tasmanian catchments such as the North Esk River, and Inglis/Flowerdale River (Wilson *et al.*, 2003; and Bobbi *et al.*, 2003c)

For the purpose of illustration, all nutrients in the following discussion and figures is reported in mg/L due to high concentrations of nutrients at some sites.

2.3.1 Total Nitrogen

Monitoring in the Jordan River catchment during this study shows that TN concentrations at sites in the tributary streams are lower than those in the main river (Figure 2.3.1). These data suggest a trend for increasing TN concentrations toward the bottom of the catchment. The lower median values experienced at sites J5a, J5b, J18 and J19 may be attributed to the lower sampling frequency (N=8-9). The period of time when these samples were collected (May 1999 to August 1999) coincided with a period when there was some flow in the system that may have provided dilution, and hence the lower TN concentrations. In comparison, the sampling regime for sites J1, J6, J11 and J15 (N= 38-39) includes substantial periods where there was no flow. This may have some bearing on the higher median TN values for these sites.

All main stream sites sampled during the study (J1, J6, J11 and J15) recorded median TN concentrations in excess of the recommended ANZECC (2000) trigger value of 0.48mg/L (480µg/L) for Tasmanian upland rivers. Factors influencing TN concentrations at these sites include lack of riparian vegetation, unrestricted stock access, soil disturbance and storm water runoff. Jordan River at Elderslie Road bridge at Green Glory (J6) recorded the highest median value of 1.2mg/L. At this site a combination of pasture improvement practices, unrestricted stock access, river channel modification, and effluent from a local dairy are likely to significantly influence TN concentrations, and result in the high level of primary production (algal and plant growth) that was seen at this site.

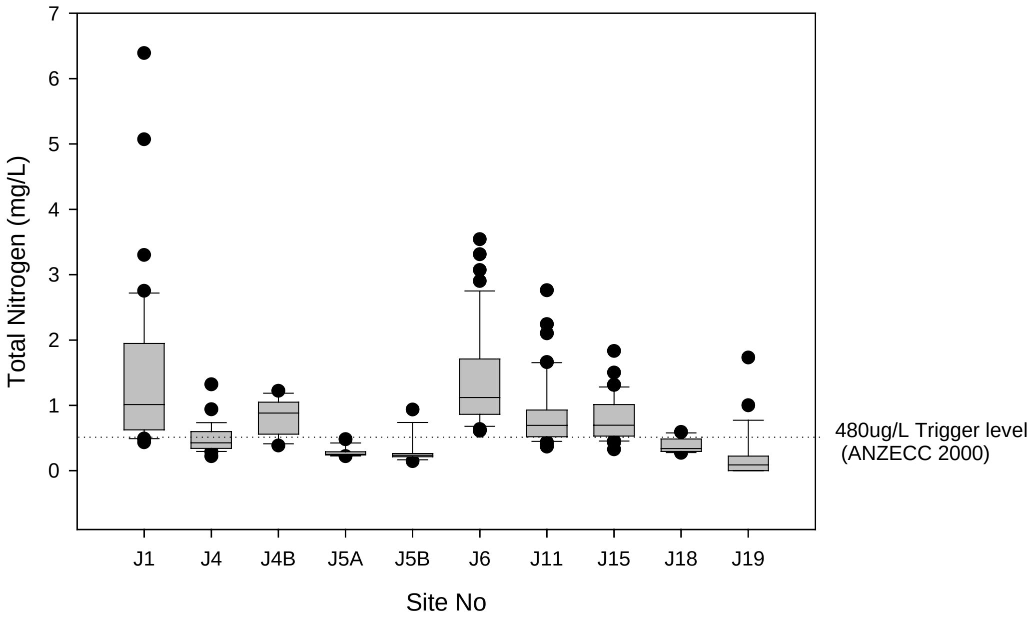

Figure 2.3.1: Statistical plot for total nitrogen (TN) concentration at 10 sites in the Jordan River catchment, recorded monthly from February 1999 to December 2001.

The monthly plot of TN in Figure 2.3.2 illustrates the seasonal and annual variation in TN concentration at sites monitored continuously throughout the study. Spikes in TN concentration at all sites generally occurred when there was little to no flow in the system. Summer concentrations are generally higher than those in winter, when the diluting effect of increased surface runoff is likely to reduce the TN concentration at sites. This pattern is not as distinct during 2000 when, for the majority of the year there was little to no flow at most sites. An exception to this was J1, which in May 1999 recorded a spike in TN concentration that coincides with very local rainfall during the previous 24 hours.

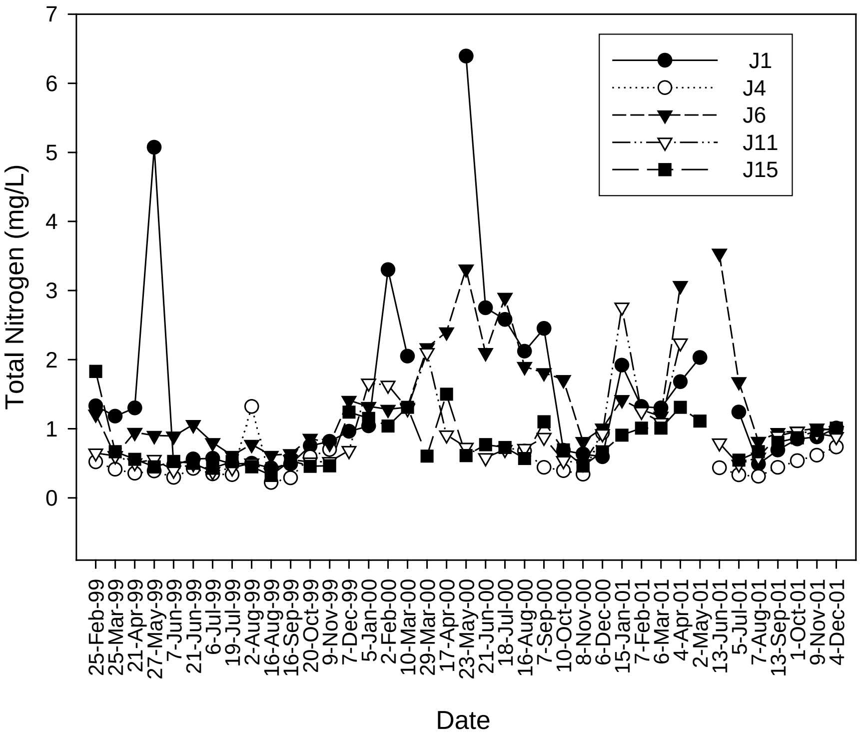

Figure 2.3.2: Monthly total nitrogen (TN) concentrations recorded for 5 sites in the Jordan River from January 1999 to December 2001.

2.3.2 Nitrate-N

Nitrate nitrogen (NO_3/N) is the soluble form of TN and easily passes into groundwater, from where it can influence riverine concentrations during baseflow conditions. Natural sources of NO_3/N are generated by geological processes, the breakdown of plant and animal material and in rural environments from the use of organic fertilisers and animal and plant wastes (UNESCO, 1992). Land clearing for pasture and cropping also increases soil aeration, which enhances the action of nitrifying bacteria, and can result in an increase in NO_3/N concentrations in the soil that can then be leached by rainfall.

Nitrate concentrations across the Jordan Catchment were varied, but generally low. Highest median concentrations were recorded at J5A, J5B and J6. The highest median concentration (0.51mg/L) was recorded at J5B, which is above the recommended trigger value of 0.19 mg/L (190µg/L) for upland rivers (ANZECC, 2000). As mentioned above, the sampling frequency for the Bagdad Rivulet sites is low and this must be taken into consideration when viewing these data. It is likely that a combination of runoff and rural landuses contribute to these high levels. The catchment above J5B contains a high number of small rural landholdings and is extensively vegetated with Crack Willow (*Salix fragilis*) and this may be another factor contributing to these elevated levels. However due to the low frequency of sampling, further monitoring of these sites is recommended to determine the seasonal variation and source of these concentrations (ie leaf input, local rural runoff).

Highest concentrations of NO_3/N were recorded at J6 (0.72 mg/L), which had a much lower median concentration of 0.028mg/L. Higher concentrations of NO_3/N generally occurred at this site when there was some flow and was usually accompanied by an extensive mat of *Azolla*. This site is surrounded by a dairy farm, and immediately upstream receives effluent from dairy sheds. It is likely that this is the main factor contributing to nutrient enrichment at this site. The only significant concentrations of nitrite-N that were recorded during this study were at this location (see below).

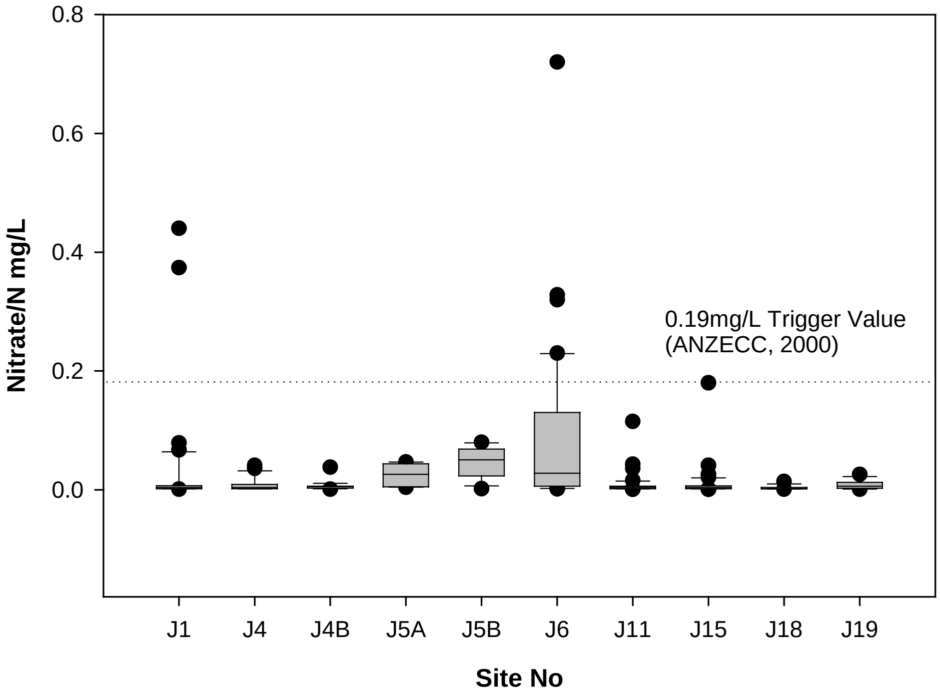

Figure 2.3.3: Statistical analysis of monthly data for NO_3/N in the Jordan Catchment from January 1999 to December 2001.

Figure 2.3.4 presents the monthly concentration of NO_3/N recorded at J6 and J1 during the study period. From these data it is clear that there is no distinct seasonal variation. This is not unexpected, as the Jordan River in recent times has not had a ‘normal’ seasonal pattern of discharge, and studies elsewhere have shown that NO_3/N concentrations in rivers can be driven by the seasonal changes in hydrology (Bobbi, *et al.*, 1996). In the Jordan catchment rainfall is much more variable, and has less of a seasonal signal, however the pattern of increase in NO_3/N concentration does appear to be driven by the same basic mechanism (infiltration and groundwater discharge to the river). As Figure 2.3.4 shows, NO_3/N concentration increases prior to the actual recommencement of flow, and once flow through the ponds is detected, NO_3/N concentration is in decline as the NO_3/N that has been ‘flushed’ through the soil profile and the groundwater reservoir. This is most clearly seen at J6, where dairy farming is likely to be more substantially increasing soil NO_3/N during the dry periods.

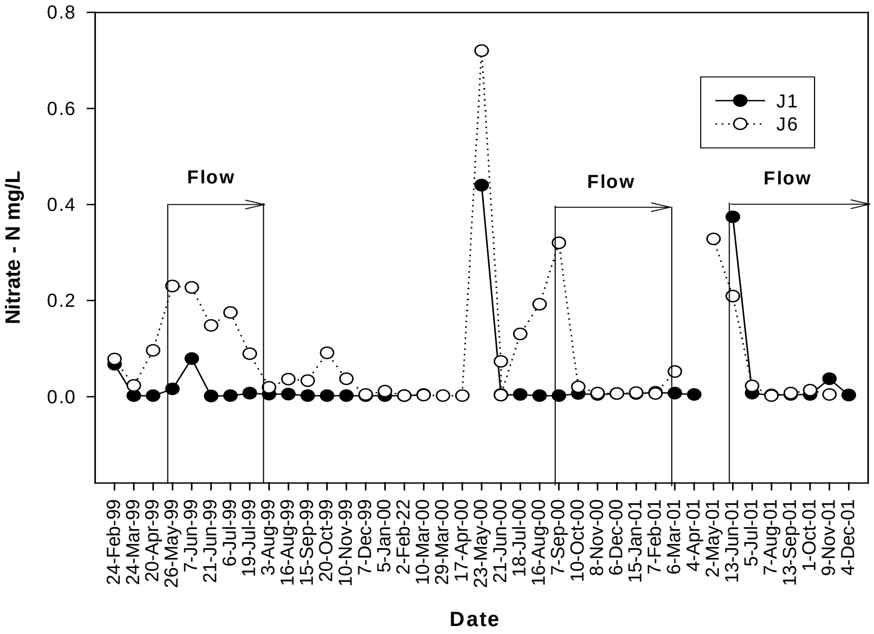

Figure 2.3.4: Monthly nitrate-N concentrations at J1 and J6 from February 1999 to December 2001. Direction of arrow indicates decreasing flow.

2.3.3 Nitrite-N

Nitrite nitrogen (NO_2/N) in environmental waters is usually only detected at low concentrations unless there is some form of local pollution. Nitrite usually does not present a problem to aquatic ecosystems unless it is in high concentrations. Anthropogenic factors that contribute to high NO_2/N concentrations include fertiliser application, human and animal waste and stock access to waterways. Physico-chemical conditions that may assist with elevating NO_2/N include high temperatures and poor oxygenation, high NO_3/N and pH > 7.5 or a combination of both these factors (Hatch, *et al*, 2002).

Throughout the Jordan River catchment NO_2/N concentrations were found to be low or below detection limits (Figure 2.3.5), with the significant exception of J6. This site had a median NO_2/N concentration well above the other sites sampled, and a maximum concentration of about 0.08 mg/L. The extreme outlier recorded at J1 coincided with very low dissolved oxygen (Figure 2.3.6), suggesting that anaerobic bacteria at this site may have been producing NO_2/N. This provides further evidence of the level of impact that surrounding landuse has on eutrophication of this reach of the Jordan River.

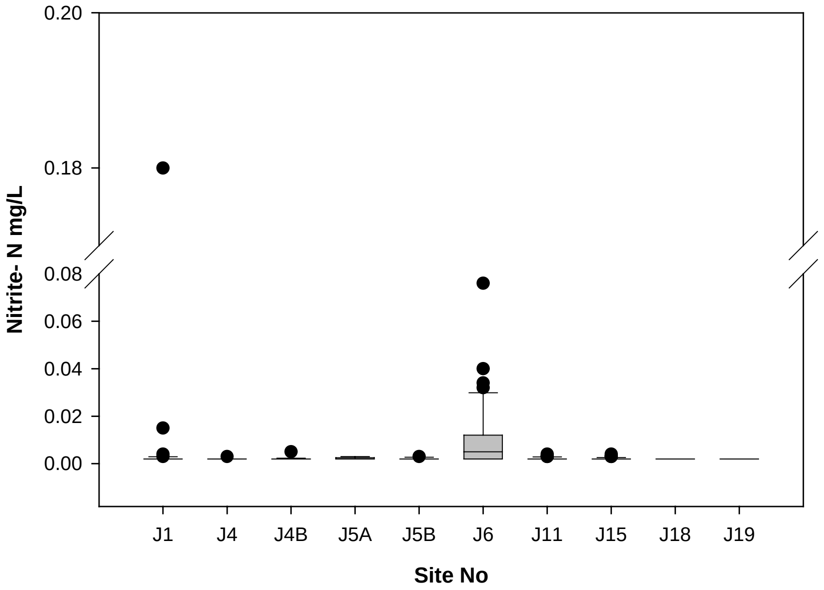

Figure 2.3.5: Statistical plot of NO_2/N in the Jordan Catchment from January 1999 to December 2001.

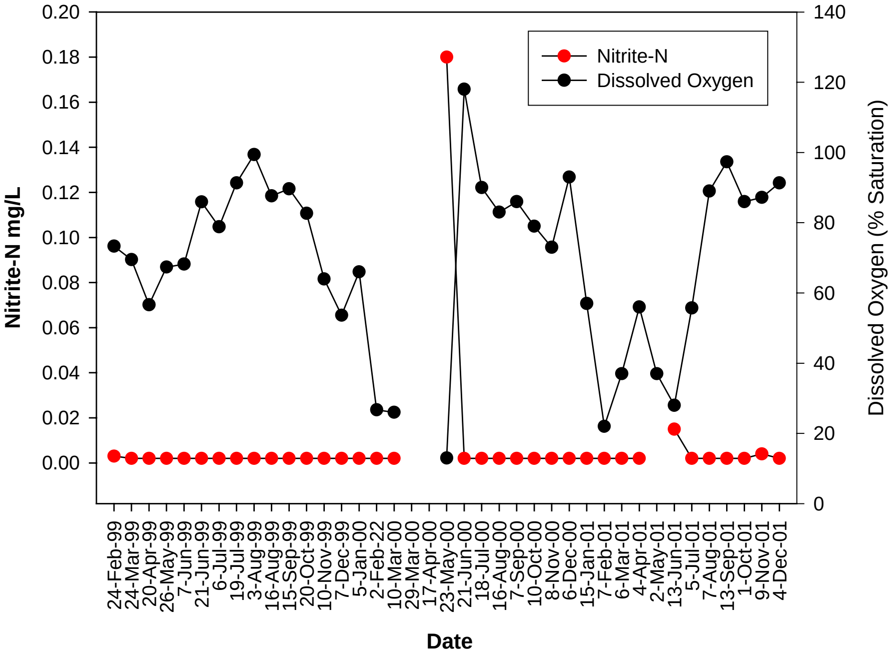

Figure 2.3.6: Monthly variations in NO_2/N and dissolved oxygen (% saturation) at J1 from January 1999 to December 2001.

2.3.4 Ammonia

Ammonia (NH_3/N) naturally occurs in surface waters as a result of the breakdown of organic and inorganic materials and the excretion from biota. High concentrations of NH_3/N can be an indicator of organic pollution (UNSECO, 1992) In other Tasmanian catchments such as the Montagu River high concentrations NH_3/N have been recorded in regions where there is intensive dairy industry (Bobbi *et al*, 2003). This also appears to be the case in the Jordan catchment. The highest median and maximum concentration of NH_3/N were recorded at J6 (Figure 2.3.6), where the only major dairy operation in the catchment is located.

While these values are very high relative to the rest of the catchment, the environmental impact of these concentrations is low given the near-neutral pH of the water at this site (Section 2.2.2). The National Water Quality Guidelines (ANZECC, 2000) suggest a trigger value of 0.9mg/L (900 µg/L) at pH 8 for the protection of 'moderately disturbed' ecosystems. The median value for pH at this site is 7.3, which increases this trigger value to approximately 1880µg/L (1.88 mg/L), which is more than double the maximum concentrations recorded at J6.

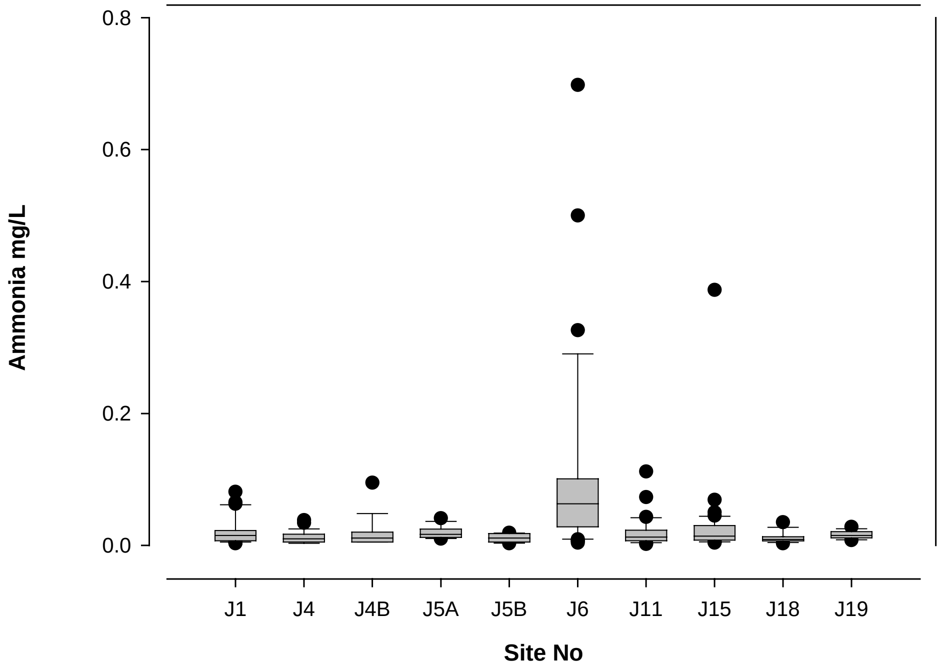

Figure 2.3.6: Statistical plot of NH_3/N in the Jordan Catchment from January 1999 to December 2001.

2.3.5 Total Phosphorous

Phosphorous in one of the nutrients essential for the growth of aquatic plants and animals and is the underlying factor driving ecosystem productivity. Usually present at low levels in surface waters total phosphorous (TP) is the nutrient that limits the growth of algae. When present in high concentrations TP can often trigger algal blooms. Algae and aquatic plants require TP in its dissolved form, and once present in surface waters TP can fluctuate between its dissolved and particulate form depending upon environmental conditions (UNESCO, 1992). Therefore it is best to measure both total and dissolved forms of phosphorous, as at some stage all of this may become available for plant uptake.

Natural sources of phosphorous mainly originate from parent rocks or the decomposition of organic matter. In anthropogenic landscapes contributions to TP often originate from fertiliser application, animal manures, domestic wastewaters, detergents and industrial effluents. In agricultural regions the application of fertilisers and animal manures to increase soil productivity are often major contributors to elevated TP levels in surface waters. In regions of intensive agriculture (ie Duck River and Montagu River) very elevated TP concentrations have been recorded (Bobbi *et al*, 2003 and 2003b).

Total phosphorus within the Jordan catchment (Figure 2.3.7) largely mirrored that for TN. Five sites recorded median values above the suggested National Guideline trigger value of 13µg/L (0.013mg/L) for Tasmanian upland rivers. Both J1 and J6 recorded the highest median values of 0.036mg/L and 0.06 mg/L respectively. Extremely high concentrations of TP were recorded at J6 (0.828 mg/L) and J11 (0.71 mg/L), and these indicate the level of eutrophication that can occur within 'ponds' along the Jordan River during very dry conditions when these ponds become the only source of surface water. Contributions to high concentrations monitored at J1 are likely to have resulted from unrestricted stock access, runoff from an urbanised area (Brighton) and decomposition of plant and animal matter.

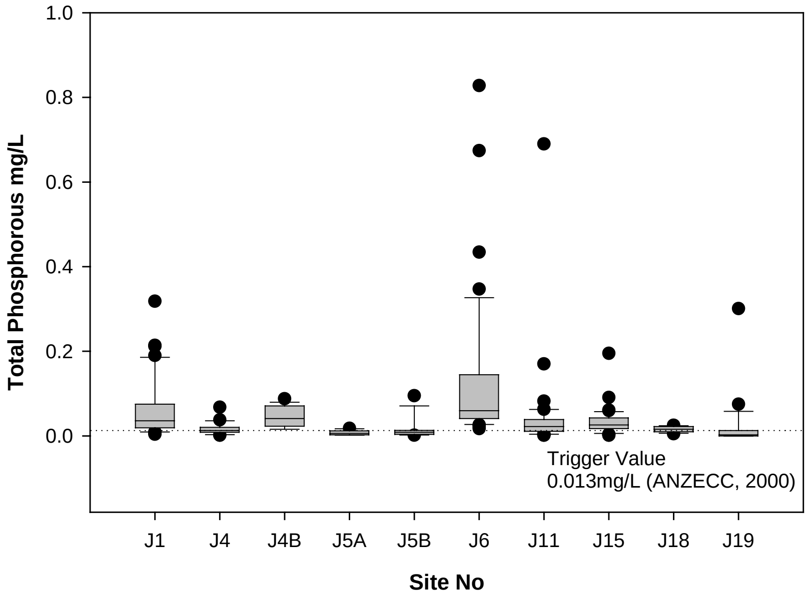

Figure 2.3.7: Statistical plot of TP for the Jordan River between January 1999 and December 2000.

Figure 2.3.8 illustrates the seasonal and annual variations in TP, which is a similar pattern to that for TN. Winter TP concentrations in 1999 and 2001 were generally lower than those compared to the summer months. A less distinct seasonal pattern is evident for 2000 (the driest year of the study), when the river was reduced to a series of 'ponds' for much of the year.

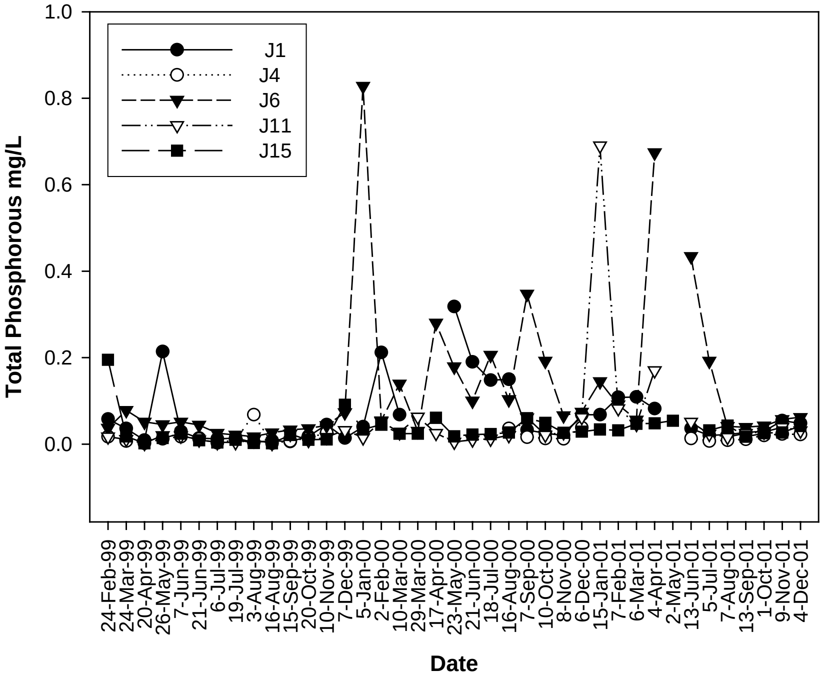

Figure 2.3.8: Monthly TP concentrations in the Jordan River from January 1999 to December 2001.

2.3.6 Dissolved Reactive Phosphorous

Figure 2.3.9 illustrates the variation in dissolved phosphorus through the catchment. The higher concentrations of DRP at J1, and in particular J6, indicate that in comparison to other sites monitored a greater portion of the TP at these sites is in its dissolved form and therefore available for plant uptake. At J1 the extensive cover of aquatic weed in this pool is indicative of nutrient availability. Throughout the study an extensive covering of *Azolla* was often noted at J6, and the availability of DRP at this site would aid the spread of this plant. In April 2001 a maxima of 0.205mg/L of DRP was recorded at J6. This was approximately 30% of TP (0.674 mg/L) that was available for biological uptake.

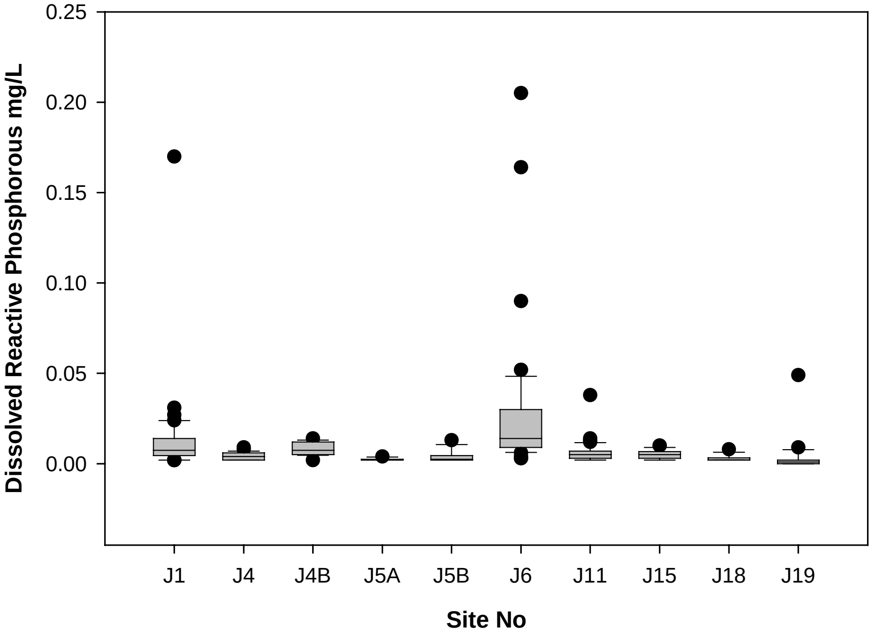

Figure 2.3.9: Statistical plot of DRP in the Jordan River from January 1999 to December 2001.

2.3.7 Nutrient Summary

The Jordan River catchment exhibits nutrient concentrations indicative of an agricultural catchment. The presence of extensive mats of *Azolla* at some sites is visible evidence as to the influence of high nutrient concentrations in surface waters. Jordan River at Elderslie Road Bridge at Green Glory (J6) can be considered substantially impacted by local land use activities and is subject to significant eutrophication. The high concentrations of nutrients recorded at some sites will also impact on other water quality parameters such as dissolved oxygen and pH. This is exemplified at both J1 and J6, where fluctuations in low dissolved oxygen concentrations and hence pH are likely to be influenced by biological activity at these sites (Section 2.2).

The ephemeral nature of the Jordan River contributes to the nutrient concentrations in summer months as these pollutants are retained in the system. This is further exacerbated by drought periods where 'flushing' of the system does not occur and the river is reduced to a series of ponds that become the last sources of surface water in the catchment. During the study period it was noted that extensive in-stream works, (primarily deepening and widening of the river) were conducted at a number of sites. These activities not only disturb nutrient rich soils and destabilise the riverbanks (increasing nutrient inputs) but also act as dams. The retention of water in these areas not only reduce the availability of water for users downstream during periods of low flow, but is also likely to reduced the length of time and the number of 'flushing' flows.