LESCHENAULT INLET MANAGEMENT AUTHORITY

Urban Nutrient Inputs into Leschenault Inlet and Estuary

Waterways Comission
Report No 40
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URBAN NUTRIENT INPUTS INTO LESCHENAULT INLET AND ESTUARY

A working paper for the Leschenault Inlet Management Authority

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CHAIRMANS FOREWORD

The Leschenault Inlet Management Authority and the Waterways Commission have been concerned for some time about the increased nutrient loadings to the Leschenault Inlet and Estuary. In an attempt to identify catchment pollution sources the Leschenault Inlet Catchment Management Plan Steering Committee was established in 1989.

The Committee has taken the approach of integrated catchment management in order to co-ordinate and undertake studies and investigations with the overall aim of developing a regional wastes disposal and catchment management strategy.

As part of the Commission's contribution to Integrated Catchment Management a number of water quality monitoring programs were designed to identify all present sources of pollutants including industrial, domestic and agricultural wastes. The urban water quality monitoring program investigated the nutrients entering the Leschenault Estuary and Inlet from selected urban catchments.

The findings of this study indicate that current levels entering the system do not contribute significantly to overall nutrient loads. However, this should not lead to complacency by the various landowners and government agencies. Should landuse changes occur in the catchment and there is pressure for development, nutrient loads entering the waterways may rise Landuse practices and developments should be designed to minimise nutrients entering the waterways.

I urge all development approving agencies and land owners, to consider these issues and seek the advice of LIMA.

SIR DONALD ECKERSLEY OBE
CHAIRMAN
LESCHENAULT INLET MANAGEMENT AUTHORITY

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1. INTRODUCTION

The Waterways Commission and the Leschenault Inlet Management Authority have been concerned for some time with increased nutrient loadings into the Leschenault Inlet and Estuary through the river systems and drainage within the catchment. The Leschenault estuarine system is composed of the Leschenault Estuary and the Leschenault Inlet. The Leschenault Estuary is the long shallow estuarine lagoon, approximately 11km long and 2km wide. The Leschenault Inlet to the south was cut off from the estuary by reclamation for the inner harbour in 1968-69 and is about 2km long and 200m wide.

The estuary is currently experiencing the first signs of becoming nutrient enriched. There are accumulations of macroalgae in parts of the estuary and summer blooms of phytoplankton in the lower tidal reaches of the Collie River.

Phosphorus and nitrogen are nutrients which are essential for aquatic life. They are the two main nutrients required for plant growth and are normally low in most waterways, thus limiting plant growth. Eutrophication is enrichment of waters with phosphorus and nitrogen, usually as a result of human activities in the catchment such as clearing of vegetation, input of industrial and human waste and use of fertilisers. Eutrophication can result in algal blooms which then decompose causing a decline in oxygen levels, offensive odours and even fish deaths.

The Leschenault Inlet Catchment Management Plan Steering Committee was formed by the South West Development Authority in December 1989 to co-ordinate and undertake studies and investigations with the overall aim of developing a regional wastes disposal and catchment management strategy (Leschenault Inlet Catchment Management Plan Steering Committee, 1990).

One of the terms of reference of the committee was to identify all present sources of pollutants including industrial, domestic and agricultural wastes. The Industrial and Domestic Waste Subcommittee was formed to address issues relating to industrial and domestic waste. This committee is involved in obtaining details of urban point sources (Leschenault Inlet Catchment Management Plan Steering Committee, 1990).

Catchment urbanisation results in an increase in volume of stormwater run-off. Impervious surfaces such as roads, pavements and roofs means rainfall cannot infiltrate into the soil. Drainage networks are designed to intercept and transport stormwater run-off.

Urbanisation also increases the number of pollutants such as nutrients, metals and pesticides which can enter waterways. Sources of nutrients include septic tank seepage, sewage overflows and fertiliser applications to parks and gardens.

Because of this potential for high urban nutrient loads the Waterways Commission monitored urban nutrient inputs into Leschenault Inlet during 1990 and 1991. This was done as part of an annual process of auditing nutrient loads entering waterways. The major rivers in the catchment have been sampled weekly as part of a monitoring program which began in 1984. Thus the relative importance of the urban areas in terms of nutrient inputs can be calculated.

1.1 Aim of the Study

The aim of the urban catchment investigation was to define the nutrient load coming from urban areas into Leschenault Inlet/Estuary and investigate the relationship between sewered areas and unsewered areas, soil types and nutrient loads.

1.2 Catchment Description

The urban catchment area in Bunbury which discharges into Leschenault Inlet/Estuary is 1090 ha. This compares with the catchment area of Leschenault Estuary (below Wellington Reservoir) of 198,102 hectares. Other urban areas in the catchment include the towns of Australind, Boyanup, Brunswick Junction, Dardanup, Donnybrook and Eaton. These other towns collectively have an approximate area of 602 ha.

The four drains which were sampled were at Robertson Rd, Stirling St, Creek St, and Austral Pde in the Bunbury urban area (Figure 1). The respective area and percentage of the catchment which is sewered is given in Table 1.

The drains at Stirling St, Creek St, and Austral Pde all have catchments of the Vasse soil type (Figure 2). These are poorly drained plains with variable undifferentiated estuarine and marine deposits. Soil types in the Robertson Rd catchment include the Vasse, Southern River and Yoongarillup types. The Southern River type is characterised by sandplains with low dunes and many intervening swamps; iron and humus podzols, peats and clays. The Yoongarillup type is a marine deposit of plains with low ridges and swales; shallow yellow and brown sands over marine limestone (Churchwood HM and McArthur WM, 1980).

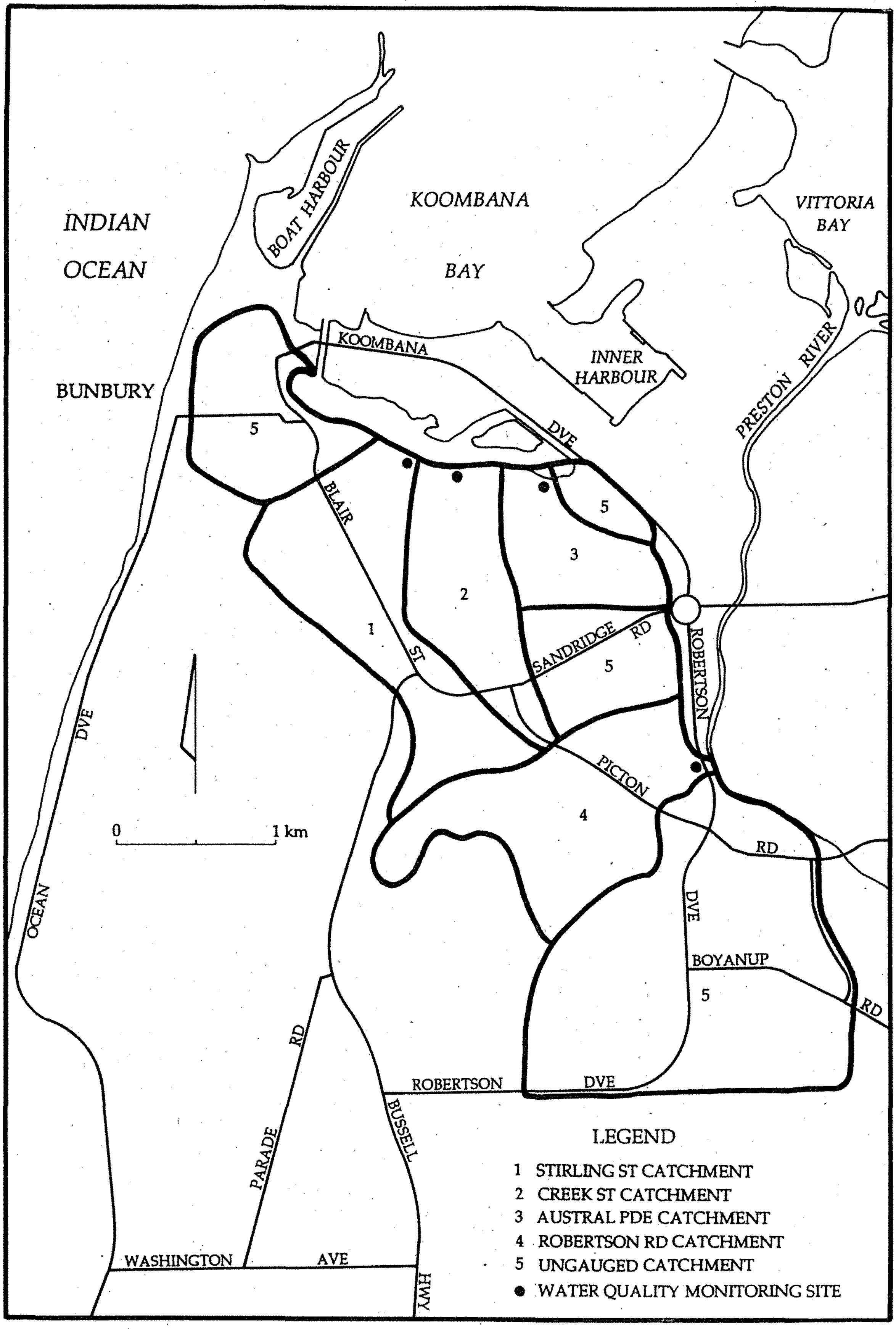

Figure 1. Catchment boundaries and water quality monitoring sites in the Bunbury urban catchment.

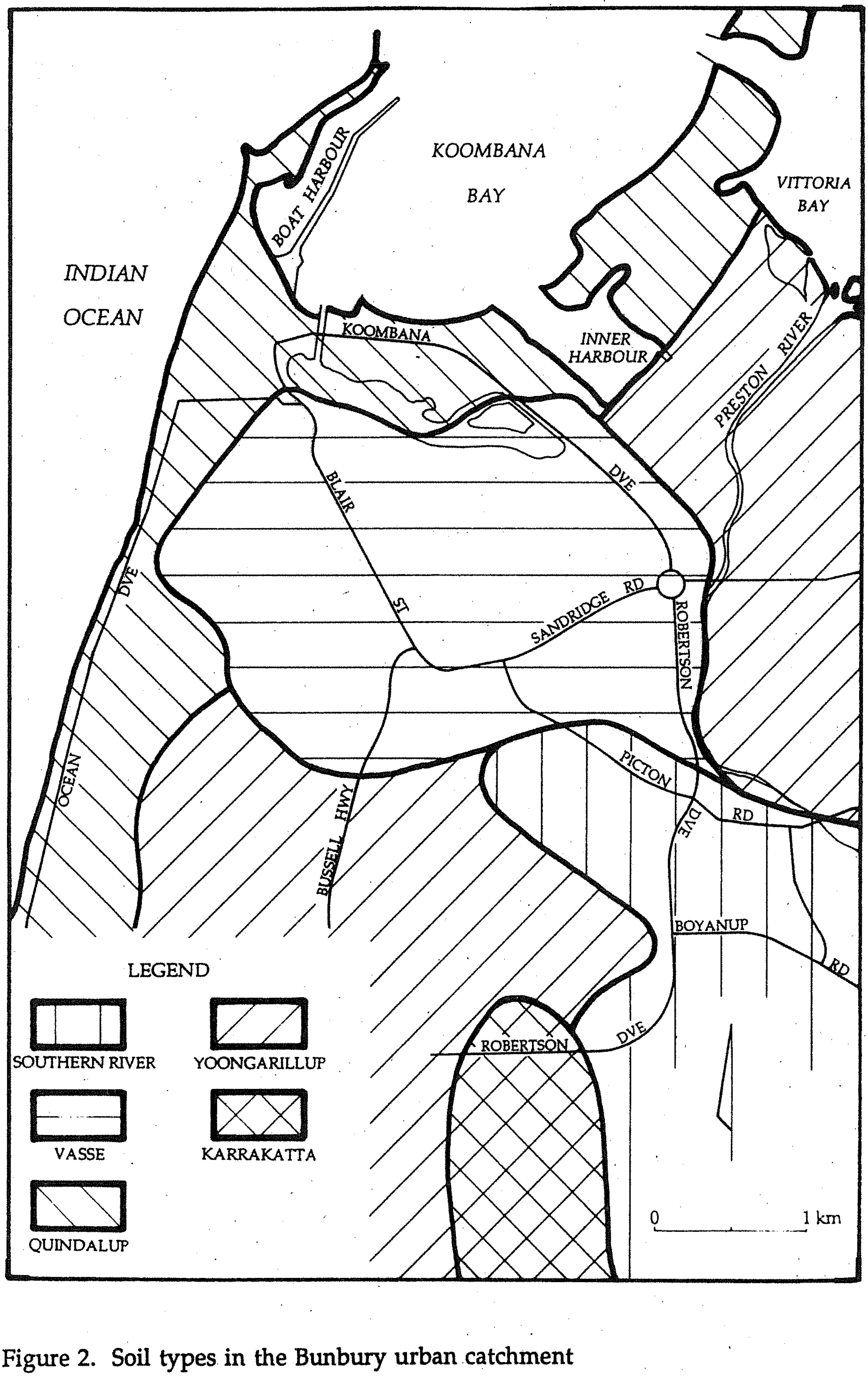

Figure 2. Soil types in the Bunbury urban catchment

2. SITES AND METHODS

Water samples were collected from four drains and analysed for total nitrogen and total phosphorus. The Robertson Rd drain was sampled weekly and the remaining three drains (Stirling St, Creek St, and Austral Pde) were sampled during periods of flow. The City of Bunbury has installed water-level pumps on these drains which controls discharge of stormwater into the Inlet/Estuary.

An annual average concentration was calculated for each site for both nitrogen and phosphorus. Flow was calculated from catchment areas, rainfall and a run-off coefficient as pump hours were not available. A run-off coefficient of 0.25 was used based on the assumption that a quarter of the catchment would be hard surfaces, roads, roofs etc.

Flow (m^3/year) = [Rainfall (mm)/1000] x [run-off coefficient] x [area (m^2)]

These results were used to extrapolate loads for the rest of the urban area which discharges stormwater into the Inlet/Estuary. This area will be referred to in this report as the 'Ungauged' catchment. Nutrient concentrations from Stirling St and Creek St were used for this extrapolation as they are approximately 50% sewered which is assumed to be representative of other urban areas.

This investigation looked only at nutrient loads from the surface water discharging into the estuary and thus assumed there was no ground water component.

3. RESULTS

Drain	Area (ha)	Sewered area (%)	TP load (kg)	P export (kg/ha/yr)	TN load (kg)	N export (kg/ha/yr)
Stirling St	178.0	50	13.4	0.075	185.0	1.040
Creek St	99.2	50	7.5	0.075	121.8	1.227
Austral Pde	66.4	90	2.5	0.038	111.4	1.678
Robertson Rd	153.2	5	1.9	0.013	243.7	1.591
Ungauged	593	50	44.6	0.075	668.5	1.127
Total	**1089.8**		**69.8**		**1330.4**	

Table 1. Nutrient loads from urban drains in 1990 when rainfall was 501 mm.

Drain	Area (ha)	Sewered area (%)	TP load (kg)	P export (kg/ha/yr)	TN load (kg)	N export (kg/ha/yr)
Stirling St	178.0	50	22.8	0.128	420.9	2.364
Creek St	99.2	50	44.2	0.446	225.5	2.273
Austral Pde	66.4	90	5.8	0.087	211.2	3.180
Robertson Rd	153.2	5	5.3	0.035	475.0	3.101
Ungauged	593.0	50	75.8	0.128	1379.1	2.326
Total	**1089.8**		**154.0**		**2711.7**	

Table 2. Nutrient loads from urban drains in 1991 when rainfall was 775 mm.

4. DISCUSSION

4.1 Comparison with the entire catchment

Some of the urban area forms part of the catchment of the Estuary. Robertson Rd drain discharges into the Preston River which flows into the Estuary. The rest of the urban area drains into the Inlet. The total catchment of the urban area which drains into the Inlet/Estuary was 1,090 hectares compared with the catchment area of Leschenault Estuary (below Wellington Reservoir) of 198,102 hectares. The catchment area of the Inlet has not been defined.

Total loads for both phosphorus and nitrogen are not significant compared with what is being discharged from the rest of the catchment. The annual average total nitrogen load entering the estuary from the entire catchment since 1984 is 420 tonnes (Deeley, Donohue and Ruiz-Avila, 1993). This compares with urban area loads of 1.3 tonnes in 1990 (Table 1) and 2.7 tonnes in 1991 (Table 2). This means that the Bunbury urban area is contributing less than 1% of the total nitrogen load entering the estuary.

The annual average total phosphorus load entering the estuary from the entire catchment since 1984 is 38 tonnes (Deeley et al, 1993). This compares with urban area loads of 0.07 tonnes in 1990 (Table 1) and 0.15 tonnes in 1991 (Table 2). This means that the Bunbury urban area is contributing less than 1% of the total phosphorus load entering the estuary.

The Bunbury area is the most urbanised in the catchment it can be assumed that other urban areas would have lower nutrient loss rates. It can also be concluded from these results that other urban areas eg. Australind, Boyanup and Brunswick would not be contributing a significant nutrient load as their total combined area is 602 ha.

4.2 Comparing catchments by area

The Ungauged catchment covers half of the total Bunbury urban area which discharges into the Inlet/Estuary. This makes it the largest area of the five catchments. In both years it was estimated that this ungauged catchment had the greatest load of both phosphorus and nitrogen.

To make a comparison of nutrient loss from catchments of different areas, export rates are calculated. Nutrient export rates from each catchment were calculated by dividing nutrient loads by the catchment area. These are expressed as kilograms per hectare, per year.

In 1990 the Stirling St catchment, the Creek St catchment and the ungauged catchment had the equal highest export rates for phosphorus. The Robertson Rd catchment had the lowest phosphorus loss rate in 1990. In 1991 the Creek St catchment had the highest phosphorus loss rate (0.446 kg/ha/yr) and the Robertson Rd catchment had the lowest loss rate.

In 1991 the phosphorus load of the Creek St catchment increased significantly from 1990, even when the increase in rainfall was taken into account. It increased from 7.5 kg of P in 1990 to 44.2 kg of P in 1991. An increase in rainfall usually causes an increase in nutrient concentrations in adjacent waterways as nutrients are flushed through the soils. There may be point sources contributing to the nutrient load in this catchment but the method of "bottom-end" monitoring used doesn't identify these. Even though the load increased the levels are not considered to be significant in terms of the total load coming in from the catchment.

In 1990 the highest nitrogen export rates were recorded for the Austral Pde catchment and the Robertson Rd catchment but they were only slightly higher than those of other catchments. In 1991 the same two drains recorded the highest export rates but again they were not significantly higher.

There was more variation in phosphorus export rates between the catchments (up to 12 times greater in 1991) than for nitrogen export rates (no catchments had rates which were greater than twice those of other catchments in the same year).

These results show a high level of variability in catchment export rates for nitrogen and phosphorus as well as variation between years. Compared with rural catchments urban catchments tend to have low variability in catchment export rates. No catchment was identified as be a contributor of significant nutrient loads to the system.

It is interesting to note that the Robertson Rd discharge point has a large lake directly upstream of the monitoring site. This may be acting as a nutrient trap/filter which would account for the relatively low phosphorus loads coming from a catchment area which is the second largest of those studied. Thus nutrients measured in the drain downstream of the lake may not reflect the levels coming off the catchment.

4.3 Comparing catchments by sewered areas

Because of the efficiency of reticulated sewerage compared with septic tanks sewered catchments are expected to have low leaching of faecal material which is high in phosphorus and thus the lowest phosphorus export rates.

Austral Pde has the largest percentage of it's catchment sewered (90%) of the catchments and Robertson Rd is the least with 5%. The other catchments have half their area sewered.

The Austral Pde catchment has the second lowest phosphorus load and phosphorus export in both years. The Robertson Rd catchment is only 5% sewered but has the lowest phosphorus load and phosphorus export rate. From this data it appears that the percentage of sewered area does not affect phosphorus loss rates. However, if the lake on the Robertson Rd drain is acting as a compensating basin then the two sets of results cannot be reliably compared, thus a relationship cannot be determined.

4.4 Comparing catchments by soil type

A comparison of the catchments nutrient losses and soil type is difficult because three of the catchments have the same soil type. The Stirling St, Creek St and Austral Pde catchments are comprised entirely of the Vasse soil type. They also have the highest phosphorus export rates. Robertson Rd has the lowest phosphorus export rate and the second highest nitrogen export rate. The Robertson Rd drain catchment is composed of the Vasse, Southern River and Yoongarillup soil types but as previously discussed the nutrient loads coming from this drain cannot be compared because of the lake.

From the two years of monitoring data collected there doesn't appear to be a relationship between soil type and nutrient run-off. Other factors such as soil types and land-use mixes maybe influencing or damping the results.

4.5 Comparison with other urban catchments

The results can be compared with those in another urban catchment (Appendix 1) with comparable proportions of sewered areas in subcatchments of the Bayswater Main Drain catchment (Klemm, Ruiz-Avila and Switzer, 1993). A proportion of the water in the Bayswater drains would come from groundwater flow and so a proportion of the nutrients may not be attributed to surface water flow. There is a limited extent to which the catchments can be compared as soil types are different in the two catchments. Also there is a lack of comprehensive flow and nutrient data for the two studies but particularly for Bunbury.

Nitrogen and phosphorus losses in the Bunbury catchments are lower or the same as the Bayswater subcatchments where there is a large sewered area. The catchments which are half sewered in Bunbury have higher phosphorus and nitrogen losses than in Bayswater. With low proportions of sewerage a clear comparison between the Bunbury and Bayswater catchment cannot be made. This may again be due to the lake in the Robertson Rd drain catchment.

5. CONCLUSION

The nutrient load coming from the urban area was small in comparison with the total catchment nutrient load. The Bunbury urban area is contributing less than 1% of the total nitrogen and phosphorus load entering the estuary.

As the Bunbury area is the most urbanised in the catchment it can be assumed that other urban areas in the catchment would have lower nutrient loss rates. It can also be concluded from these results that these other urban areas would not be contributing a significant nutrient load as the area involved is small.

Nutrient export rates were calculated and expressed as kilograms per hectare, per year. The results showed a high level of variability in catchment export rates for nitrogen and phosphorus and as well as a variation between years. No catchment was identified as be a contributor of significant nutrient loads to the system.

From the two years of monitoring data collected there doesn't appear to be a relationship between soil type and nutrient run-off. Other factors such as soil types and land-use mixes maybe influencing or damping the results.

Results from the Bunbury study were compared with subcatchments of the Bayswater Main Drain with similar sewered proportions. Nutrient losses in the Bunbury catchments are lower or the same as the Bayswater subcatchments where there is a large sewered area. The catchments which are half sewered in Bunbury have higher phosphorus and nitrogen losses than in Bayswater. Again the comparison is limited because of the difference in soil types in the two catchments. Also there is a lack of comprehensive flow and nutrient data for the two studies but particularly for Bunbury.

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APPENDIX 1 MEAN PHOSPHORUS AND NITROGEN CONCENTRATIONS FOR BUNBURY (A) AND THE BAYSWATER MAIN DRAIN (B)

(A)

Drain	Sewered area (%)	Phosphorus (mg/L)		Nitrogen (mg/L)	
		1990	1991	1990	1991
Stirling St	50	0.07	0.07	0.83	1.22
Creek St	50	0.06	0.26	0.98	1.09
Austral Pde	90	0.03	0.04	1.34	1.64
Robertson Rd	5	0.01	0.02	1.29	1.60

(B)

Drain	Sewered area (%)	Phosphorus (mg/L)		Nitrogen (mg/L)	
		1990	1991	1990	1991
King William St	90	0.08	0.10	2.24	2.16
Gummery St	50	0.03	0.04	0.91	0.89
Walter Rd	80	0.02	0.04	1.14	1.15
Redlands St	10	0.05	0.07	1.54	1.57

APPENDIX 2

AVERAGE NUTRIENT LOSS RATES IN 1990 AND 1991 IN THE BAYSWATER MAIN DRAIN

Drain	Sewered area (%)	TP export (kg/ha/yr)	TN export (kg/ha/yr)
King William St	90	0.10	2.20
Gummery St	50	0.04	0.75
Walter Rd	80	0.17	6.39
Redlands St	10	0.06	1.97