SOUTH ESK BASIN

STATE OF RIVERS REPORT

A Technical document presenting data collected during a study of rivers of the South Esk, Meander and Macquarie catchments during the period 1992 - 1995.

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NOTE: Apologies are made regarding the reduced quality of many of the plots and figures contained in this electronic version of the report. Most of these have been scanned from the original hard-copy version.

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Aims of this document

The South Esk Basin is an area extensively used for agriculture, forestry and mining. The basin covers approximately 8,900 km^2 and is drained by three major rivers; the South Esk River, the Macquarie River and the Meander River. As greater pressures are placed on both land and water resources in the basin, a more detailed understanding of the condition of the resources within the basin is being called for. With the development of integrated catchment management, this information has clearly been identified as a necessary requisite if informed decisions concerning resource management are to be made.

As part of the knowledge required for this process, information on the state of rivers has been noted as being of primary interest, and as a consequence the Dept. of Primary Industry and Fisheries, which is presently responsible for ambient monitoring of rivers around the State, has initiated a plan to provide 'state of the rivers' reporting in Tasmania. The aim of producing these reports is to collect and interpret information on the quality, quantity and ecosystem health of rivers in the State so as to provide catchment management groups with the information they require for the formation of catchment management plans. While this document and the information collected through this study will be available to the general public, it is intended that the primary users will be resource managers, catchment management committees and planning authorities. A condensed version of this report, outlining the major findings will be presented in a shorter document which will be extensively distributed to community groups and educational facilities to help raise the awareness of the public to the major issues in water quality and the riverine environment.

Together, these documents represent the first of what is proposed to be a series which it is hoped will eventually cover all of the major rivers in the State.

Executive summary

Total P export from the South Esk Basin was conservatively estimated at 272.2 tonnes for the period 5/5/92 - 12/10/95. This amounts to an annual average export load of 80.1 tonnes per year entering the Tamar estuary. The total nitrogen load was estimated at 3, 490.6 tonnes, or an average of 1,026.7 tonnes per year.

South Esk Catchment (~ 3,650 km^2)

- The conductivity of rivers within the South Esk catchment is generally low, with EC in the South Esk increasing from 45 μS/cm at Mathinna to 97 μS/cm at Perth. The tributaries of the St Pauls and Break O'Day rivers are slightly higher (128 μS/cm and 183 μS/cm respectively).

- Most sites in the South Esk catchment were very clear, with very low suspended solids concentrations and turbidity. Sites downstream of Perth show higher turbidity levels as a result of inflow from the Macquarie and the Meander rivers.

- Most sites in the catchment had healthy levels of dissolved oxygen. Lowest daytime DO was recorded in the Break O'Day River, where a minimum of less than 5 mg/L was measured.

- Nitrate-N concentrations were highest in the headwaters the South Esk river. The median concentration at Mathinna was 0.13 mg/L.

- Total phosphorus load from this catchment for the 3.4 years of the study was 100.7 tonnes. This is equivalent to an annual average export load of 29.6 tonnes. Wet years tend to have higher export loads than dry years.

- Total nitrogen load estimated to leave this catchment over the 3.4 years of the study was 1,480.41 tonnes, amounting to an annual average of 435.4 tonnes per year.

- Peak nutrient loads were recorded in the Break O'Day River after drought breaking rains caused significant erosion in the catchment.

- Back Creek at Longford is degraded, with elevated turbidity, conductivity and nutrient concentrations. Operation of the Cressy - Longford irrigation scheme dilutes these parameters significantly.

- The effects of heavy metal pollution from the Storys Ck and Aberfoyle mines on water quality and macroinvertebrate communities in the South Esk River is still evident, with the number of invertebrate taxa significantly decreased downstream of the Storys Ck junction.

- Taxa numbers in the South Esk upstream of Storys Ck were also found to be depressed, possibly due to habitat degradation in this section of river. Further work may be needed to clearly establish the cause of this.

- Community health from Storys Creek downstream as far as Perth is significantly affected although the influence of habitat degradation may further compound the affects of heavy metal pollution.

Sites in the upper parts of the St Pauls and Nile rivers and at Tower Rivulet all had healthy macroinvertebrate communities.

- Four species of invertebrates (two snail species and two species of caddisfly) are known to be endangered or threatened. Main threats to these species are water quality degradation and stream habitat alteration.

Meander Catchment (~1,400 km^2)

- Conductivity at most sites in the Meander ranges between 29 μS/cm and 86 μS/cm. The exception is lower Quamby Brook which has a median conductivity of 173 μS/cm.

- Suspended solids concentrations and turbidity were highest in the lower reaches of Western Creek and Quamby Brook, with levels at all other sites in the Meander catchment generally below 9 NTU. Baseflow concentrations of suspended solids at most sites was below 4 mg/L. Suspended solids concentrations during flooding was found to increase by up to 100 times baseflow conditions.

- Dissolved oxygen in the lower reaches of Quamby Brook showed strong evidence of oxygen depletion, with daytime DO levels in the river during the summer of 1995 - '96 rarely rising above 2 mg/L.

- Nutrient concentrations in the Meander catchment were found to be the highest in the South Esk Basin.

- Total N concentrations ranged from 0.14 mg/L to 0.47 mg/L with the exception of Quamby Brook at Westbury, which was highly eutrophic (median concentration 0.75 mg/L).

- Total P concentrations ranged from 0.005 mg/L at Meander to 0.025 mg/L at Western Ck. Quamby Brook at Westbury was highly eutrophic (median of 0.15 mg/L).

- Total P load from the Meander for the 3.4 years of the study was 147.1 tonnes, at an annual average export load of 43.3 tonnes.

- Total N load estimated to leave this catchment over the 3.4 years of the study was 1,593.1 tonnes, amounting to an annual average of 468.6 tonnes per year.

- Indicators of faecal pollution were found to be high throughout the lower reaches of rivers in the Meander catchment. In the Meander River, faecal indicator measurements were highest in the Deloraine area.

- Examination of macroinvertebrates in lower Quamby Brook indicated a severe level of impact, with Caddisfly, Stonefly and Mayfly missing from the river at that site in Autumn of 1995. These three groups are sensitive to most types of pollution.

- In the Meander River, there was a decrease in the condition of the macroinvertebrate community downstream of Cubits Sugarloaf, with a number of key families missing from sites lower in the river. In addition to water quality changes, severe low flows and habitat degradation are also possible causes.

Macquarie Catchment(~3,860 km^2)

- Conductivity throughout the Macquarie River is the highest in the South Esk Basin (142 - 230 μS/cm). Conductivity at the catchment outlet is dominated by Poatina Power Station operation, which releases very dilute water into the lower Macquarie.

- Turbidity is generally below 5 NTU within the Macquarie River, However turbidity in the tributaries of the Lake and Elizabeth rivers is significantly higher.

- Concentrations of total dissolved salts were generally higher in the Macquarie than in the South Esk or Meander catchments.

- Concentrations of nitrate-N at sites in the Macquarie catchment were the lowest in the South Esk Basin, however Total N concentrations were higher than at sites in the South Esk and comparable to those of sites in the Meander catchment.

- The concentration of Total P at most sites in the Macquarie is below 0.02 mg/L with the exception of the Elizabeth River below Campbelltown which receives sewage pond effluent.

- 40% of the phosphorus measured in the Elizabeth River is in the dissolved form which promotes growth of algae.

- Concentrations of nutrients (nitrate-N and Total P) in the Lake River appear to reflect conditions in Woods Lake, the storage from which flows in the river are controlled.

- Phosphorus export from the upper 2,041 km^2 of the catchment, including the Elizabeth River and tributaries upstream, was estimated at 24.5 tonnes for the 3.4 years of the study. Two major floods in the first 20 months of the study were responsible for 80% of this load.

- During the autumn and winter of 1995, 70% of the estimated export load of P from the upper catchment originated from the Elizabeth River.

- Total N export from the upper catchment was estimated at 417.1 tonnes for the 3.4 years of the study, which is equivalent to 122.7 tonnes per year.

- Microbial indicators are highest in the upper reaches of the Macquarie River but are generally much lower than was found in the Meander River. Long-term contamination, as indicated by samples containing sediment, was greatest downstream of the Ross sewage treatment plant outfall.

GLOSSARY OF TERMS

Algae
A group of microscopic plants, usually aquatic. Either attached or free floating.

Apparent Colour
The colour and turbidity of water influence the depth to which light can penetrate. Dissolved minerals and organic substances give water its true colour, while turbidity is more a result of fine suspended matter. True colour should therefore be measured in samples after filtration. Apparent colour is that colour caused by both dissolved substances and fine particulate matter and is measured by the comparison of the unfiltered sample against standard solutions of potassium choroplatinate and crystalline cobaltous chloride.

Backwater
Backwaters occur in rivers where there is a constriction in the river channel which causes river levels upstream to be higher than those which would occur if there were no constriction. This is also commonly refered to an 'afflux'.

Baseflow
Flow in a stream is essentially a function of overland flow, subsurface flow and groundwater input. During periods when there is no contribution of water from precipitation, flow in a stream 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.

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, photsynthetic 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 centimetre (mS/cm) at a standard reference temperature of 25^{o} Celsius.

Ephemeral stream
Refers to a stream which dries up during prolonged periods when no rain occurs.

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 produce a synthetic time series of concentration. With this, the load of a particular nutrient leaving the catchment can be estimated (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) = Z **Export Coefficient** ($kg\ mm^{-1}\ km^{-2}$)

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

Faecal Coliforms
Faecal coliform bacteria are a sub-group of the total coliform population that are easy to to measure and are present in virtually all warm blooded animals. Although measurement of this group is favoured by the NHMRC (1994) 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 are very 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.

Intermittent stream
Refers to a stream which regularly dries up after periods of no rain.

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 50th 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 in mind, though there are many other elements that living organisms require for survival.

Precipitable water
The amount of water which runs off a given catchment area in a stated time period. (eg Annual water yield).

Rain Shadow
Area which receives relatively little rainfall due to its location. Typically a rain shadow is formed in the lee of a mountain range. The higher and wider the mountain range(s) the more extreme the rain shadow effect.

Reaction (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, although dilute waters naturally high in organic content may have a pH of around 5.0. 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 $CaCO_3$) have a low buffering capacity and are susceptible to changes in pH from outside sources.

Riparian Vegetation
Vegetation in that part of the terrestrial riverine environment directly influenced by the presence of water (peak flow - low flow) which is part of a river, stream or creek line.

Substrate
Composition of the river bed.

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.

Taxa
A group of taxonomic units. A taxonomic unit being any definite unit in the classification of plants and animals.

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 be determine separately, 'organic nitrogen' can be obtained 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 However, dissolved phosphorus is easily bound to particulate material and in natural waters particulate phosphorus generally contributes more to total phosphorus levels.

Transect
In this report, river transects were carried out to gain some idea of the change in water quality conditions along the entire length of a river. This technique hinges on sampling at as many points along the a river as possible in a short time. Another important pre-requisite is that hydrologic conditions in the river are stable and that no recent rain has fallen and introduces disproportional inputs from any particular area. The main aim in employing this technique is to highlight the areas where water quality is better or worse relative to the rest of the river. It must be stressed that this technique provides only a snapshot of conditions at that time and should not be extrapolated beyond that period.

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.

SUMMARY OF NATIONAL GUIDELINES FOR WATER QUALITY

Australian Water Quality Guidelines as per ANZECC (1992)
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. These guidelines are meant to act as a reference tool for catchment management plans and policies, and while based on current scientific knowledge, are only a guide to help government and communities set targets against which management decisions can assessed.

The following table is adapted from one of the publications in the series produced by this group; 'Australian Water Quality Guidelines For Fresh and Marine Waters (1992) '. For a more detailed treatment of these guidelines, please refer to the original publication.

Parameter	Ecosystem Health	Recreation	Raw Drinking	Livestock	Agricultural
Dissolved Oxygen (mg/L)	> 6		> 6.5		
pH	6.5 - 9.0	5 - 9			4.5 - 9.0
Salinity (µS/cm)	< 1,500				2,300*
Copper (µg/L)	2.0 - 5.0		1,000	500	200
Iron (µg/L)	1,000		300		1,000
Zinc(µg/L)	5 - 50		5,000	20,000	2,000
Total Phosphorus (µg/L)	10 - 1,000				
Total Nitrogen (µg/L)	100 - 750				
Nitrate-N (µg/L)			< 10,000	30,000	
Chloride (mg/L)			400		30 - 700
Faecal Coliforms (per 100 mL)		< 150#	0	1000^	1000**
Enterococci (per 100 mL)		35##			

* Maximum recommended for fruit crops.
# Median of at least five samples with four of the five having < 600.
Median of at least five samples with none > 100.
^ Median with no more than one in five samples > 4000
** Median with no more than one in five samples > 5000

Units and Conversions:
mg/L = milligrams per litre (1000 milligrams per gram)
µg/L = micrograms per litre (1000 micrograms per milligram)
e.g. 100 µg/L = 0.1 mg/L
µS/cm = Microsiemens per centimeter

PART I THE SOUTH ESK BASIN

1.1 Catchments and River Systems

The South Esk Basin is the largest water catchment in Tasmania with a catchment area of about 8,900 Km^2. Considerable water quantity data exists for the Basin, largely as the result of early survey work commenced by the Hydro-Electric Department in the 1920's. At Launceston a set of gauge boards were read on a daily basis as early as 1901, and gauge board readings have been recorded at Fingal and Avoca since about 1921.

The South Esk Basin is made up of three major sub-catchments, all of which have individual hydrological, agricultural and sociological characteristics. The South Esk catchment, after which the basin is named, is the eastern-most catchment covering approximately 3,650 km^2. As well as the South Esk River, the catchment is drained by three other main tributaries; the Break O'Day River, the Saint Pauls River and the Nile River.

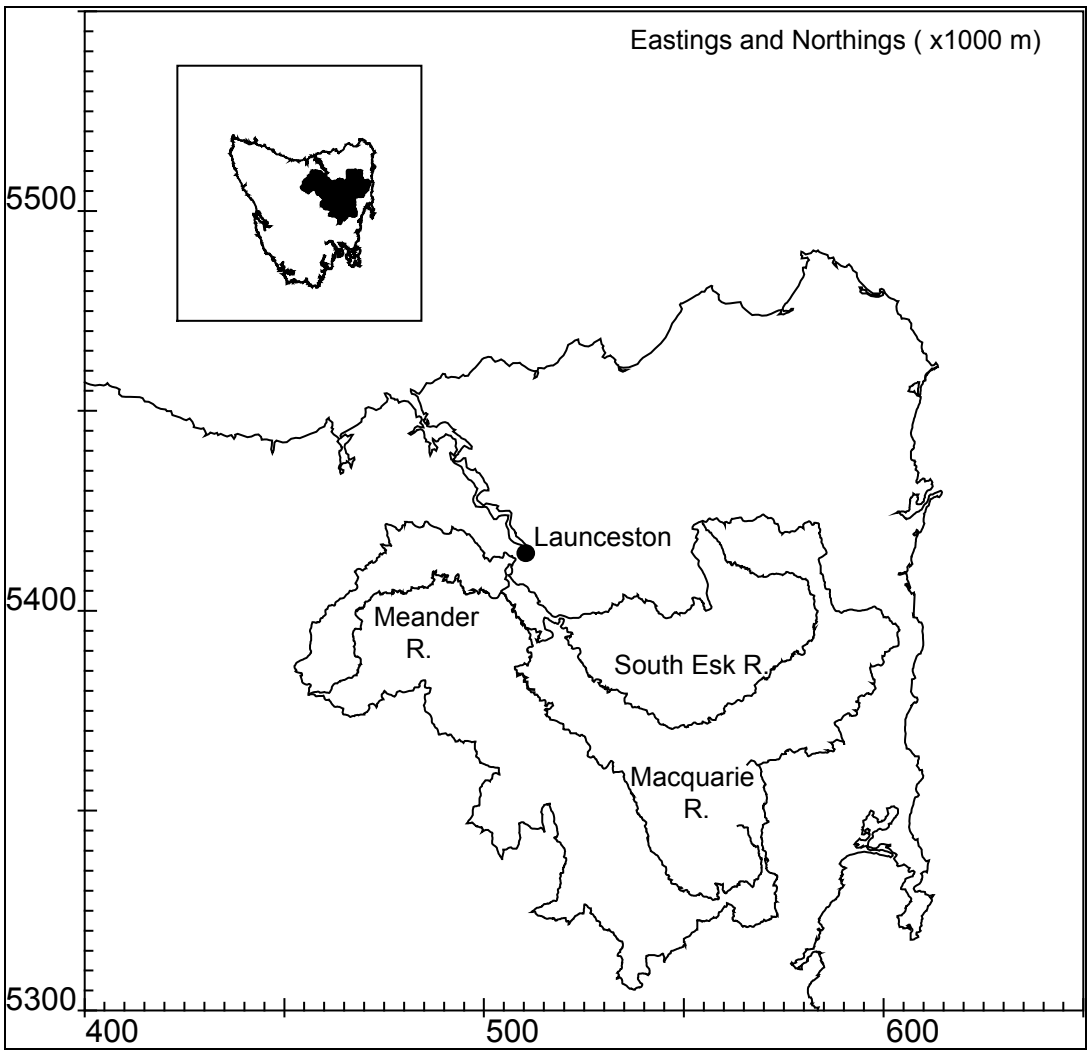

Figure 1.1 Map of north-eastern Tasmania showing the South Esk Basin and the major rivers which drain it.

On the western side of the basin, draining in an easterly direction is the Meander catchment covering an area of about 1,400 km^2 . In addition to the Meander River, this catchment is

drained by three other main tributaries; Western Creek, Quamby Brook and the Liffey River, which range in catchment size from 151 km^2 to 230 km^2.

To the south is the Macquarie catchment, covering about 3,800 km^2 and draining north. This catchment is drained by the Macquarie River and the major tributaries of the Blackman, Isis, Elizabeth and Lake rivers, which range in catchment size from 233 km^2 to 430 km^2. There are several features of this catchment which separate it from the other two. One is the presence of storage's at Tooms Lake, Lake Leake and Woods Lake which during the summer are used to supplement flows in the Macquarie river for irrigation purposes. Another is the discharge of large volumes of Great Lake water from the Poatina Power Station which was established in 1964 and discharges water into the lower Macquarie River via Brumbys Creek. The combined result of these two activities is a highly regulated system where riverine flows are adapted to sustain human activities within the catchment.

The quality of the early flow records varies considerably, in some cases only gauge height records rather than stream flow data are available; in many instances undocumented datum shifts, intermittent readings and poor gauging information means that data can only be used as a guide to prevailing stream flow conditions. This report is generally restricted to data which is available for more than 10 years, is reasonably reliable, and/or is representative of a range of hydrological regimes in the Basin.

1.2 Geomorphology and Geology

For the purposes of clarity, the geology of the basin will be discussed on the basis of each of the major catchments. Much of this information is available from publications of the Tasmanian Development and Resources Department and Land Capability and Land System Surveys carried out by the Department of Primary Industry and Fisheries.

i) South Esk

The lower section of the South Esk River flows through the Launceston Tertiary Basin which is made up of alluvial gravel, sands and till, with outcrops of older volcanic and igneous rocks. These have produced flat and broadly undulating valleys.

Prior to entering this region, the South Esk flows through a narrow belt of Jurassic dolerite and Carboniferous granite which has produced steeper hill slopes leading up to the Ben Lomond Range and the North Eastern highlands which form the northern catchment boundary.

Further up the catchment, to the north east, the land opens up into long rolling hills and gentle slopes formed by the quartzwacke and mudstone of the Mathinna Bed sequence. To the East and South East the catchment is bounded by dolerite mountains of the Fingal Tiers and Nicholas Ranges

ii) Meander

The Meander valley is characterised by flat plains which lie on recent alluvial sediments and higher terraces which lie on older clays and gravels (elevation 160 metres - 280 metres). The long rolling hills around Deloraine and Exton are underlain by Tertiary basalt and are a feature of the more elevated areas (at around 300 metres) . The steeper hill slopes separate the low country and flat plains (e.g. Needles Ridge, Long Ridge, Black Jack Hill and Cluan Tiers), and also occur along the foothills of the Great Western Tiers (e.g. Western Creek, Meander, Jackeys Creek, Golden Valley and Liffey). The elevation of these areas is between 300 metres and 800 metres. These hills are formed of less erosive dolerite, slate and quartzite, with some minor outcropping of sandstone and mudstones.

The Western Tiers which form the south and south western boundary of the catchment are dolerite cliffs and talus. Altitude increases rapidly from around 260 metres to about 1100 metres.

iii) Macquarie

The topography of the Macquarie is influenced by Jurassic dolerite which dominates the western and southern area, and the weaker rocks of the Launceston Tertiary Basin to the north. The dolerite forms the cap of the Central Plateau and Great Western Tiers and the rugged hills from the Lake River south to the Blackman River and east to the Upper Macquarie and Elizabeth Rivers.

The lowland area, below about 250 metres, is typically low relief hills with relict terraces and floodplains. The modern flood plain, called Canola (Nicholls, 1960), is characterised by narrow and wide river flats interrupted by abandoned river channels. The area is prone to stream bank erosion and flooding.

1.3 Climate and Rainfall

Rainfall is variable across the South Esk Basin with annual averages ranging from as low as 510 mm at Ross in the Macquarie catchment to over 1200 mm at Gray on the very eastern boundary of the South Esk catchment.

In the South Esk catchment rainfall is strongly influenced by topography, with lowest annual average rainfall occurring at sites lower in the catchment, to the west, and highest totals occurring high in the catchment, to the east. Rainfall throughout most of the catchment is highest in winter. However at St Marys and Gray, where highest annual rainfall is recorded, peak monthly totals occur in autumn when low pressure systems off the east coast of Tasmania generate significant storms.

TABLE Long Term Average Rainfall at sites in the South Esk catchment.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gray	78	74	123	125	138	106	69	111	86	96	112	120	1238
St Marys	56	83	96	86	99	106	99	92	69	88	75	83	1032
Fingal	41	40	46	54	53	69	80	59	49	56	44	50	641
Avoca	38	33	38	46	48	52	48	53	50	55	46	50	557
Trevallyn	39	38	52	60	77	67	92	86	71	62	53	58	755

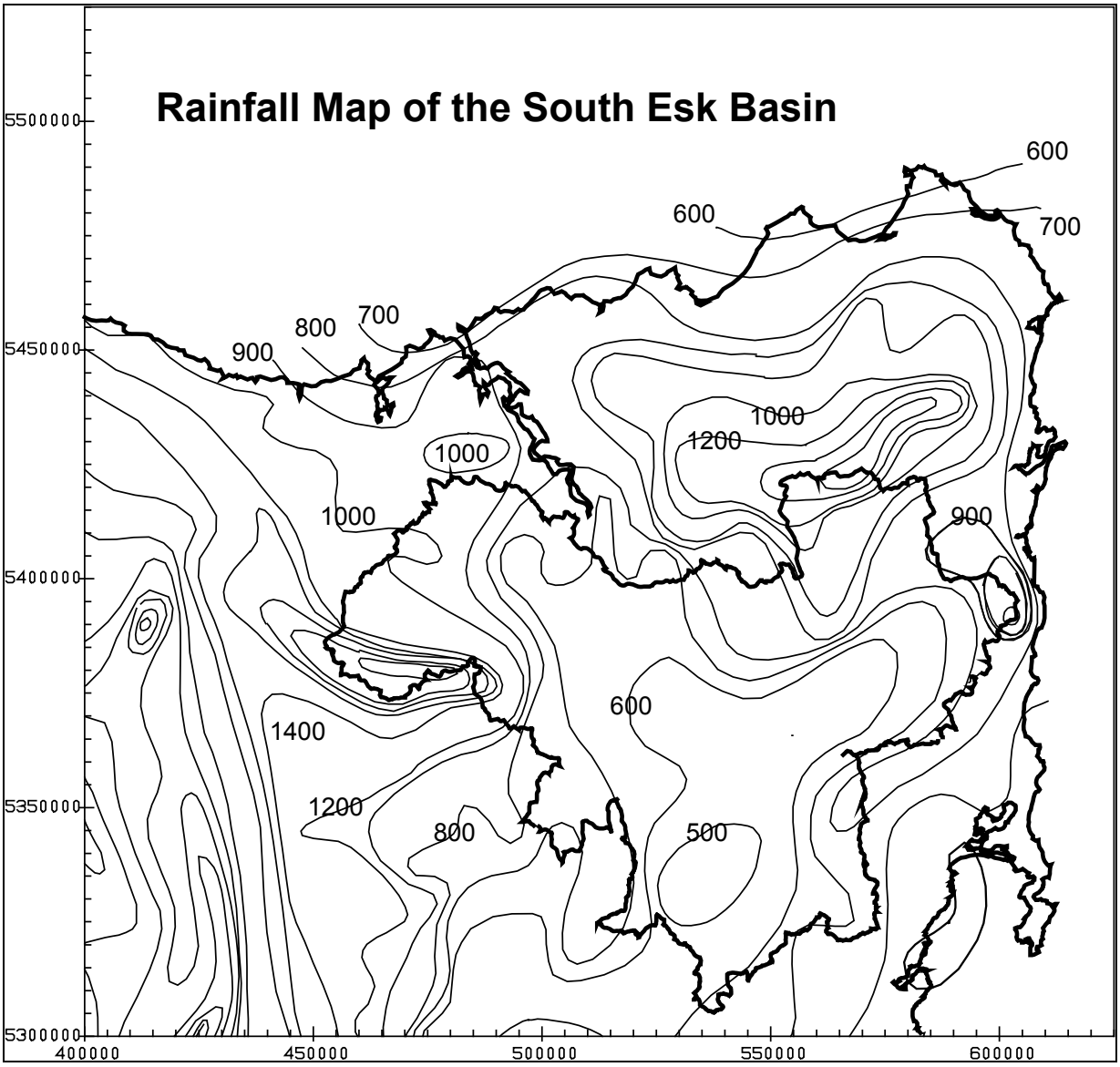

FIGURE 1.2 Diagram of rainfall pattern across the South Esk Basin.

In the Meander catchment, rainfall is also dominated by topography, with most rain falling in the region of the Great Western Tiers which form the southern boundary of the catchment. There is a significant decrease in rainfall from west to east across the catchment, from around 1200 mm on the slopes of the Great Western Tiers to about 750 mm at Lake Trevallyn. Rainfall is generally winter dominant with rainfall generated by the passage of cold fronts from the west. During summer the area is also subject to strong thundercell activity created by northerly winds and resulting in very localized heavy falls.

The Macquarie catchment covers an area of Tasmania which is most prone to drought, with large areas of the catchment experiencing less than 600 mm of rainfall per year. As a consequence, much of the agricultural activity in this catchment is heavily reliant on irrigation releases from impoundments at Tooms Lake, Lake Leake and Woods Lake. Lowest monthly totals tend to occur in the period January - March when high pressure systems tend to dominate. Low pressure systems just south of Tasmania result in westerly winds during late winter - early spring, bringing cold fronts and resulting in highest monthly rainfall totals.

TABLE Long Term Average Rainfall at sites in the Macquarie catchment.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lk Leake	54	46	66	72	80	93	106	76	71	79	65	76	884
Tooms Lk	43	35	46	56	61	46	64	63	58	52	52	62	638
Lewis Hill	40	41	52	57	58	65	93	60	53	56	52	59	686
Ross	38	33	38	39	41	39	44	46	45	51	43	53	510
Campbell -town	38	36	36	44	47	43	48	47	48	56	47	54	544

Snow can occur in the upper catchment at any time throughout the year, with heavier falls generally occurring between late June and October. Snow occasionally settles in the lower catchment (below 150 metres) but rarely persists for any length of time. Highland snow patches may remain visible well into December (Tas. Dept Agriculture; 1980 and 1988).

Evaporation data is available for selected sites in the basin and indicates that evaporation exceeds rainfall for eight months of the year, between September and April. Highest evaporation is recorded at Launceston Airport, where annual evaporation is 1386 mm per year (Bureau of Meteorology, 1995). Evaporation depends mainly on wind strength, moisture content of the air and on the amount of sunshine. During the warm summer months, high evaporation levels are brought about by the drying effects of winds descending from the Great Western Tiers. During winter, cold southerly winds from the Southern Ocean reduces evaporation to below 50 mm per month.

TABLE Long Term Average Evaporation at sites in the Macquarie catchment.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cressy	186	164	118	69	37	21	25	43	69	102	132	164	1130
Campbell-town	189	155	106	66	34	21	31	47	69	105	126	177	1129
Launceston Airport	220	190	190	81	47	30	31	50	78	118	156	195	1386

1.4 Land Use and Degradation

Land use in the Basin is primarily agriculture and forestry with limited mining for coal and metals in the upper catchment of the South Esk river. The major agricultural activities in both the South Esk and Macquarie catchments are sheep and beef cattle farming. The area is known for the high quality super-fine wool it produces. While in the past little area has been used for the cultivation of crops other than grains, a growing number of farms are becoming involved in irrigation, especially of high yield crops such as potatoes.

Near the bottom of the catchment, the Cressy - Longford area is served by an irrigation scheme using water from the Poatina Power Station. This has permitted more intensive cultivation of vegetable crops. Parts of the Cressy - Longford area are now showing effects of salinity, mostly due to localized areas of poor drainage.

Forestry activities are presently centered in the upper catchment, around the upper South Esk, the Lake Leake area and along the southern parts of the Great Western Tiers. Land clearing lower in the catchment is extensive and problems are now being encountered with many of the remaining trees displaying dieback, the cause of which is not clearly known. Tree decline in the Midlands area is presently a major concern of the community.

In the Meander catchment, agricultural activities are more intensive, with a significantly larger percentage of the land under irrigation. Population density in this catchment, which lies in closer proximity to Launceston, is also greater than either the South Esk or Macquarie catchments.

Land degradation within the Meander is mainly limited to problems created by pervasive weeds and erosion along river corridors. Streambank erosion is a significant problem as is the flooding hazard created by extensive willow infestation along most waterways in the catchment.

Willows and gorse are also a significant problem in the South Esk and Macquarie catchments. Management of gorse is a considerable management problem for farmers, especially in the lower South Esk and in the area around Campbelltown in the Macquarie. The loss of native riparian vegetation in these catchments is also considered a significant cause of streambank and gully erosion (Askey-Doran, 1993) and where native vegetation is sparse there is often low level invasion by exotic plant species. Greater concern is also being expressed over the level of wind erosion in the South Esk and Macquarie, which many suspect is possibly the greatest cause of soil loss in these catchments.

1.5 Biological monitoring of rivers and streams

Monitoring changes in the plant and animal life of rivers and streams provides an indication of broad aquatic ecosystem changes and provides an opportunity to record the condition of native biota, which are of intrinsic conservation value as components of the aquatic environment. In assessing and monitoring the condition of aquatic ecosystems biological monitoring offers a number of advantages over the more traditional techniques of measuring physical and chemical parameters.

- Biological indicators reflect the cumulative effects of various impacts or changes, such as habitat degradation, heavy metal contamination and the introduction of exotic species.
- They provide a direct evaluation of an impact.
- They are less susceptible to the production of erroneous results and meaningless measurements than sampling for most physico-chemical parameters.

Macroinvertebrates as indicators

Benthic macroinvertebrates are animals without backbones - such as insects, crustaceans, snails and worms - that inhabit most inland waters. They are termed benthic because they inhabit the bottoms of streams, rivers and lakes, burrowing into sediments or clinging to the upper and lower sides of rocks. For a detailed description of Australia's aquatic macroinvertebrates see 'The Invertebrate Fauna of Australia's Lakes and Streams' by Williams (1980).

As a group they have become widely used as biological indicators of stream and river health.

- They are one of the most easily studied biological components of streams. They can be easily collected in large quantities with inexpensive equipment and readily preserved and identified.

- They occupy a central role in the food chain and include herbivores which eat algae and other material, detritivores which eat dead animal and plant material and carnivores that eat other invertebrates. They themselves provide a valuable food source for freshwater vertebrates such as fish, platypus and birds.

- A large number of species, or groups of species, are highly sensitive to even a mild stress. Impacts from agricultural and industrial activities, forestry operations and mining, and physical modification of streams such as damming and channelisation have all been known to effect the abundance and or composition of the macroinvertebrate community.

1.6 Community Activities and Perceptions

In line with the other parts of Australia, community awareness of water related issues in Tasmania has increased phenomenally in the last few years with the establishment of Waterwatch Tasmania. In the South Esk Basin, the growth of Waterwatch has involved Primary and Secondary schools, Landcare groups, Local Government and private landowners. At present there are established Waterwatch groups in the South Esk and Macquarie catchments with increasing interest being shown in the Liffey and Deloraine areas by Landcare groups and the Deloraine Field Naturalists.

High on the list of concerns expressed by most groups is drinking water quality and the level of bacterial contamination of water in the rivers, which determines to a large degree the bacterial quality of rural township drinking water. Other commonly expressed concerns are about turbidity, streambank erosion, willow infestation and pesticides. The active Landcare groups in the basin have generally had some interest in issues related to erosion, riparian vegetation management and streambank rehabilitation.

Local councils, which often have representation on these community groups and give them support, are also interested in gaining assistance from the community in collecting information which may assist them in planning and management. Greater environmental responsibilities are being placed on councils, which often lack the resources to perform monitoring activities. Yet this information is necessary if informed decisions are to be made regarding management.

Other groups with a concern about water quality are anglers who are interested in issues relating to the environment and ecosystem of the rivers. The major aim of this group is maintenance of the trout fishery and suitable habitat for trout and insects.

Another major issue in the Basin, particularly in the Meander catchment, is that of water use and the allocation of water from rivers. With the increasing reliance of agriculture on irrigation water for the cultivation of intesive crops such as vegetables there is considerable debate over the allocation of water and its equitable distribution. This debate is considerably heightened during dry summers when restrictions are enforced to ensure rivers continue to flow.

PART II WATER ALLOCATION AND USE

2.0 Water Allocation

2.1 Hydro Electric Commission

Since the Water Act of 1957, a Hydro Electric Commission (HEC) Water District which covers all of the South Esk Basin has been in place. This followed the construction of the Trevallyn Power Station. As a result, the HEC is entitled to all of the water in the basin for power generation purposes. However, provision is made for the needs of town water supplies and riparian stock and domestic use. Water is also taken, (under the Loan (HEC) Act 1957), by riparian users along the Lake River and the Macquarie River downstream. Prescriptive Rights also ensure supply of some properties, and the water of Tooms Lake and Lake Leake also supplies landholders along the Elizabeth River and Macquarie River above Lake River. These Rights are not controlled by the Rivers and Water Supply Commission (RWSC) as they are governed by a historical right to water for irrigation purposes. There are five Prescriptive Rights registered in the South Esk Basin.

By way of Agreements with the RWSC, the HEC have made the following quantities available for the RWSC to allocate out for Commissional Water Rights (CWR's):

i. 18000 Megalitres per year for the entire South Esk Basin;
ii. 2500 Megalitres per year up until 30 June 1999 for landholders located on Brumbys Creek, Macquarie River below Brumbys Creek and South Esk River below the Macquarie River.

CWR's are licences issued to a property on a two yearly basis for the extraction of water from rivers. These licences are renewable and are for allocation of water over and above the riparian right of a property (explanation below). A moratorium on the allocation of new CWR's in the South Esk Basin has been in place since 1991. A more detailed discussion on the issue of water allocations in the South Esk Basin is presented in the proceedings of a workshop 'South Esk Basin Water Management Review ' (Fuller and Phillips, 1992).

2.2 Irrigation allocations from rivers, streams and farm dams

Irrigation water allocated under the Water Act by the RWSC for licensed river pumping is summarised in the following table. It shows that water allocation in each of the catchments is around 30% of the total 42816 ML allocated by the RWSC. A more detailed breakdown of water allocated within each sub-catchment is set out in the tables at Appendix B.

TABLE Irrigation allocations licensed under Commissional Water Rights

Sub-catchment	Annual licensed allocation (ML) 1 Dec to 30 Apr	Annual licensed allocation (ML) 1 May to 30 Nov	Total Annual licensed allocation (ML)
Meander River & tribs.	2365.9	10089.4	12455.3
South Esk River & tribs.	6737.2	7814.4	14551.6
Macquarie River & tribs.*	3464.11	12352.85	15816.96
Total	12567.21	30256.6	42823.86

* Macquarie River amounts do not include Lake River or Macquarie River below Lake River

Of the annual licenced allocation for 1 December to 30 April (the summer season) the volume of water that can be taken on any one day is shown below. Highest daily limits are set in the South Esk catchment and lowest limits set in the Meander.

Sub-catchment	Daily licensed allocation 1 Dec to 30 Apr (ML/d)
Meander River & tribs.	20.65
South Esk River & tribs.	69.9
Macquarie River & tribs.*	54.73
Total	145.28

* Macquarie River amounts do not include Lake River or Macquarie River below Lake River

Water for the Lake River and Macquarie River below Lake River is allocated under the Loan (HEC) Act 1957. Under this Act the HEC is required to make available to riparian landholders 'all the water they may reasonably require'. The estimated amounts of water allocated for this river is a daily amount of 184 ML/d and an annual amount of 12427 ML.

In addition to allocations under the Water Act and Loan (HEC) Act, water is allocated under Prescriptive Rights. These are listed in Appendix B. On viewing these, Prescriptive Rights to water quite often are not specified volumetrically.

Northern Midlands Council presently control irrigation allocations for landholders diverting water directly from the Macquarie River upstream of the Elizabeth River junction. Allocations in this section of the river were previously undertaken under the Macquarie Water Act 1892. This Act has recently been repealed.

2.3 Town Water Supply Allocations

Town water supplies take their water supply under the terms of Part XV of the Local Government Act 1906, Division 24 of Part XVI of the Local Government Act 1962, or from special acts within the meaning of the Water Works Clauses Act 1952. Commissional Water Rights from the RWSC are not required for these extractions.

Water allocations for towns in many instances are not specifically defined in terms of quantity. As a guide to the amount of water presently taken under town water supply rights, estimated water usage has been tabulated at Appendix B.

2.4 Riparian Stock and Domestic Rights.

All persons having a frontage to any stream in the South Esk Basin have a riparian right to extract water for stock and domestic purposes. The amounts that can be extracted are set out under Regulation 12A of the Water Act. The total amount taken under riparian rights approximates that tabulated in the water usage section of this report.

2.5 Cressy Longford Irrigation Scheme

The Cressy Longford Irrigation Scheme serves one of the oldest and most intensively farmed districts of Tasmania. Irrigation scheme developments for the district were considered in the early 1900's however soil fertility problems in the 1930's caused a shift away from cropping towards pasture production of sheep and beef products.

Approval of the Great Lake Power Development Scheme in 1957 revived interest in an irrigation scheme for the district. In 1962 the RWSC began investigating options for an irrigation scheme and in 1964 submitted a report to the Tasmanian Government. The scheme proposed by the RWSC involved use of water from the Poatina Power Station discharge for distribution by open channels to properties in the Cressy/Longford districts. In 1967 the Cressy Longford Irrigation Scheme Proposal was submitted to the Federal Government for consideration under the National Water Resourses Program. A grant of $750,000 was made in 1969 and construction work commenced in 1971. The scheme was completed and operational in 1974 at a final cost of over $1,100,000.

2.6 Future Directions

The scheme has been managed by State Government agencies since inception, however the thrust of national water industry reforms is for separation of water user and water manager through corporatisation or privatisation of publically owned irrigation schemes. The Cressy Longford Irrigation Scheme has recently undergone significant review of operational and management practices and is progressing quickly towards local management committee control.

3.0 Water Use

3.1 Irrigation

River Extractions

Very little information is available on actual irrigation water extractions from rivers and streams. Information that is available has been derived from water use surveys conducted during 1994/95 for the Meander and South Esk Rivers and 1989 for the Macquarie River. Information for the Macquarie River upstream of the Lake River and Lake River/Macquarie below Lake River were surveyed during 1990 and 1989 respectively. The Macquarie information did not include usage between Tooms Lake and the Elizabeth River junction. The following table sets out diversion information derived from the water use surveys. The maximum and minimum average daily diversions indicate the range of daily diversions made by properties in the catchment.

TABLE Estimated volumes diverted from rivers in the South Esk Basin.

Sub-catchment	Total daily diversion ML/d	Maximum average daily diversion ML/d	Minimum average daily diversion ML/d	Average daily diversion ML/d
Meander River	43	3.6	0.2	1.3
South Esk River	58	3.5	0.5	1.4
Macquarie River upstream of Lake River	50	7	0.1	2
Lake & Macquarie Rivers below Lake River	117	24	0.3	5

Note: Meander and South Esk estimates derived from 1994/95 survey; Macquarie and Lake River estimates derived from 1989/90 survey.

Cressy Longford Irrigation Scheme

The source of water supply is the tailrace of the Poatina Power Station. The scheme district covers a total area of about 10,000 ha of which 5,000 ha can be flood irrigated directly from the scheme channels. Irrigation Rights are allocated to about 80 properties within the district

on the basis of property area. The total Irrigation Rights allocated to properties is 7,200 ML however the scheme has potential to deliver a further 4,800 ML. The annual consumption of water varies between 3,000 and 10,000 ML and is applied at an average rate of about 1.6 ML/Ha. The major use for irrigation water is pasture production (40%) and vegetable crops such as potatoes, peas, beans and onions (40%). The trend for irrigation water use is increasing due to increased cropping activity and strong interest shown by the dairying industry to establish in the district.

3.2 Domestic Water Usage

Estimates for town water supply schemes in the South Esk Basin were last assessed in 1991. These amounts are set out in the table below. A more recent review has not been undertaken. However it is expected that overall usage will not increase significantly in the future due to limited population growth. It is expected that town water usage estimates could vary by +/- 15 percent depending on whether the season is dry or wet.

TABLE Estimated average annual town water supply usage

Town Scheme	**Annual Consumption ML**
Avoca	45
Bracknell	65
Campbell Town	305
Conara	30
Cornwall	30
Cressy	120
Deloraine (surface water)	70
Evandale	135
Fingal	85
Hadspen	925
Longford/Perth	720
Mathina	25
Oatlands	255
Ross	55
Rossarden	35
St Marys	125
Tunbridge	25
Westbury/Hagley	280
Total	**3330**

Based on census information it is estimated that domestic water usage outside of town water supply schemes amounts to about 4100 ML.

3.3 Stock Water Usage

Based on Australian Bureau of Statistics information for stock numbers, the estimated annual amount of water consumed by stock in the South Esk basin amounts to about 4000 ML. A sub-catchment breakdown of this amount is tabulated below.

TABLE Estimated stock water requirements in South Esk Basin.

Sub-catchment	Usage ML
Meander R.	595
Lake and Macquarie R. below Lake R.	700
Elizabeth&Macquarie R. above Lake R.	715
Macquarie R above Elizabeth R	930
South Esk R.	1040
Total	3980

3.4 Power Generation

Hydro electric power is generated from the HEC power station situated near Trevallyn Dam at the bottom of the South Esk River. Since 1955, when the power station was completed, this station has used an average of 4553 ML per day. It is also estimated that on average, 947000 ML is lost each year through spills over Trevallyn Dam.

3.5 Farm Dams in the Basin

Total farm dam approvals in the South Esk Basin over the last ten years are shown in Figure 3.1. The distribution of these across the basin is presented in more detail (as Storage Volume) in Appendix B. It is clear that in the last five years, applications for farm dams have increased substantially as the need for water during the summer period has increased.

Following the severe drought during 1994/95, there was a fairly dramatic increase in farm dam approvals in the basin. This was stimulated by low interest loans and assistance being offered by the State Government, and the realisation by a number of farmers that improved 'on farm' water reliability could be obtained by using farm dams to store the usually plentiful winter stream flows.

Over the past 25 years there has been a State wide trend of increasing numbers of farm dam approvals (Figure 3.2). With the need to reserve water for environmental purposes, direct pumping from streams is anticipated to plateau and possibly decrease. As a consequence of this, it is expected that the trend towards storage construction will continue as farmers look towards harvesting water during winter periods to meet their summer water requirements.

3.6 Environmental Flows

In 1991, the RWSC commenced a water management study of the South Esk Basin. An important component of this study was an environmental flow investigation to estimate how much water was required for environmental purposes. Instream Flow Incremental Methodology (IFIM) was used to help estimate these flows. Sub-catchments examined in the study were the South Esk, Macquarie River upstream of Lake River and the Meander River.

The biological component of the environmental flow study developed a series of relationships between river biological habitat, water quality and streamflow. In addition, a set of draft environmental quality objectives were developed to allow comparison of risks to be made between streamflow and failure to meet these objectives.

During 1996 it is intended to undertake further hydrologic analysis to estimate the extent that water extraction reliability could be affected by the various instream flow scenarios. It is expected that the Meander will be the first catchment assessed. Once this assessment is completed, an instream flow management strategy will be developed utilising a public consultation process to determine the most appropriate strategy.

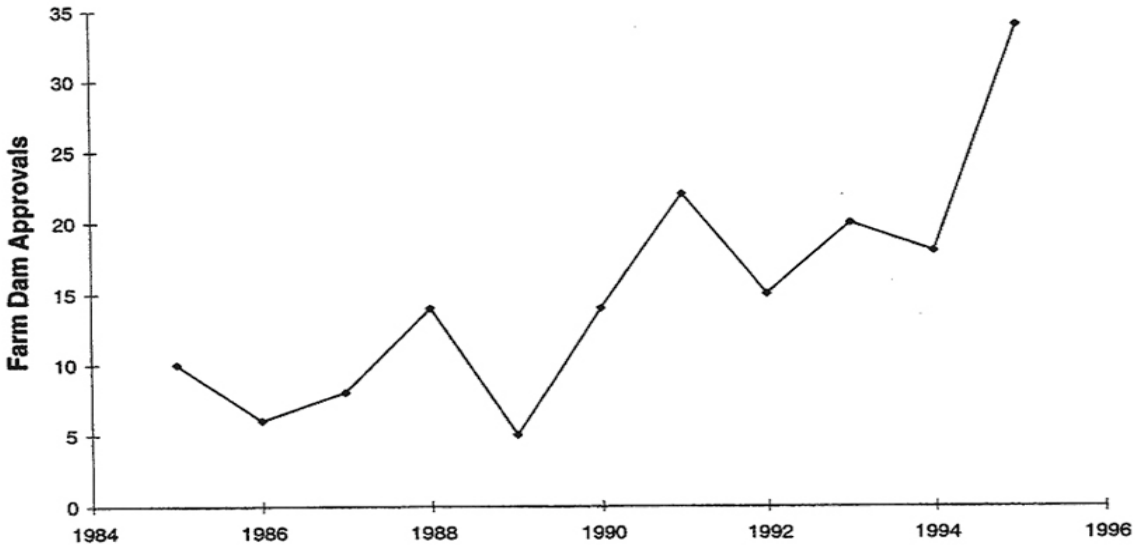

Figure 3.1 Farm dam approvals in the South Esk Basin between 1985 and 1995.

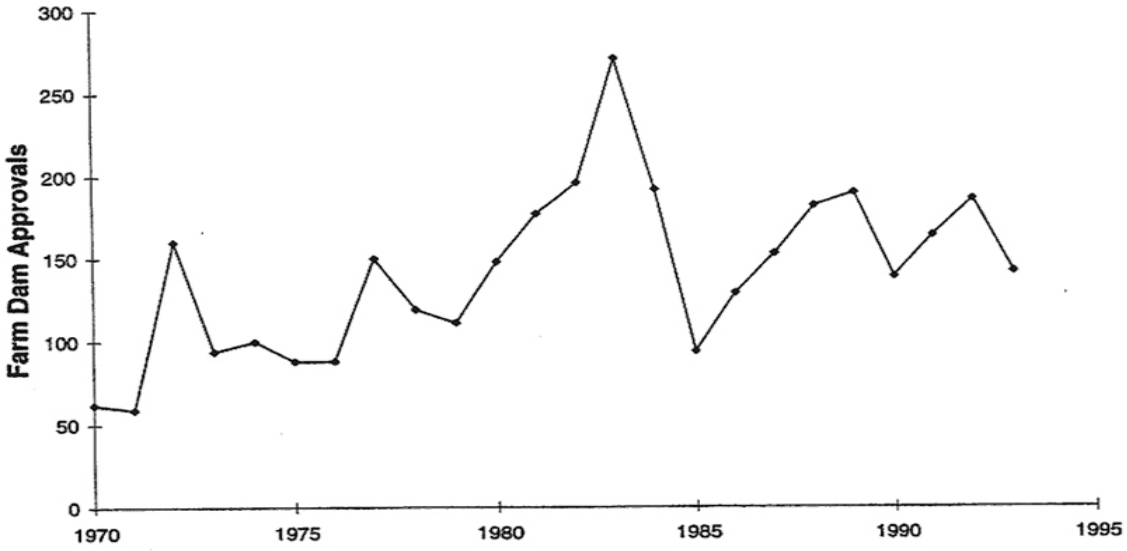

Figure 3.2 State-wide farm dam approvals between 1970 and 1994.