Water Management Planning
Report Series

Consultative Group

Water Resources Information Package

for the

South Esk Catchment
(above Macquarie)

Water Management Plan

Meeting Two

August 2008

Preferred Citation

DPIW (2008). Water Resources Information Package for the South Esk catchment *(above Macquarie)* Water Management Plan Technical Report No. WMP 08/03. Water Resources Division, Department of Primary Industries and Water, Hobart.

The Department of Primary Industries and Water (DPIW)

The Department of Primary Industries and Water provides leadership in the sustainable management and development of Tasmania's natural resources. The Mission of the Department is to support Tasmania's development by ensuring effective management of our natural resources.

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

Contents

1. Introduction

1.1 Content of this document

This document presents background information on the current status of the South Esk catchment. The document summarises information on

- freshwater environmental values in the catchment and their associated needs;
- results of water quality and river health monitoring;
- the hydrology of the catchment (including changes in rainfall, evaporation and flow);
- current water use and management arrangements in the catchment, and future water demand;
- water development projects and progress towards groundwater management;

The last section introduces Water Management Plan objectives and describes the types of objectives that should be included in a water management plan.

1.2 Reports

Most of the information presented in this document has been summarised from reports produced to assist with the development of the South Esk catchment Water Management Plan, which are listed in the References section. The reports are available on the DPIW web site (http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-5663BY?open) and include: a report on the freshwater values of the catchment, (DPIW, 2007a), a report on the hydrology of the catchment (DPIW, 2007b), a report on the assessment of environmental flow requirements for the catchments (DPIW, 2007c) and a report on water quality in the catchment (DPIW, 2008a).

Reports on water use and management in the catchment include; an assessment of current water use and management arrangements in the catchment (DPIW, 2008b); and an assessment of future water demand in the catchment (DPIW, 2008c).

2. The South Esk catchment

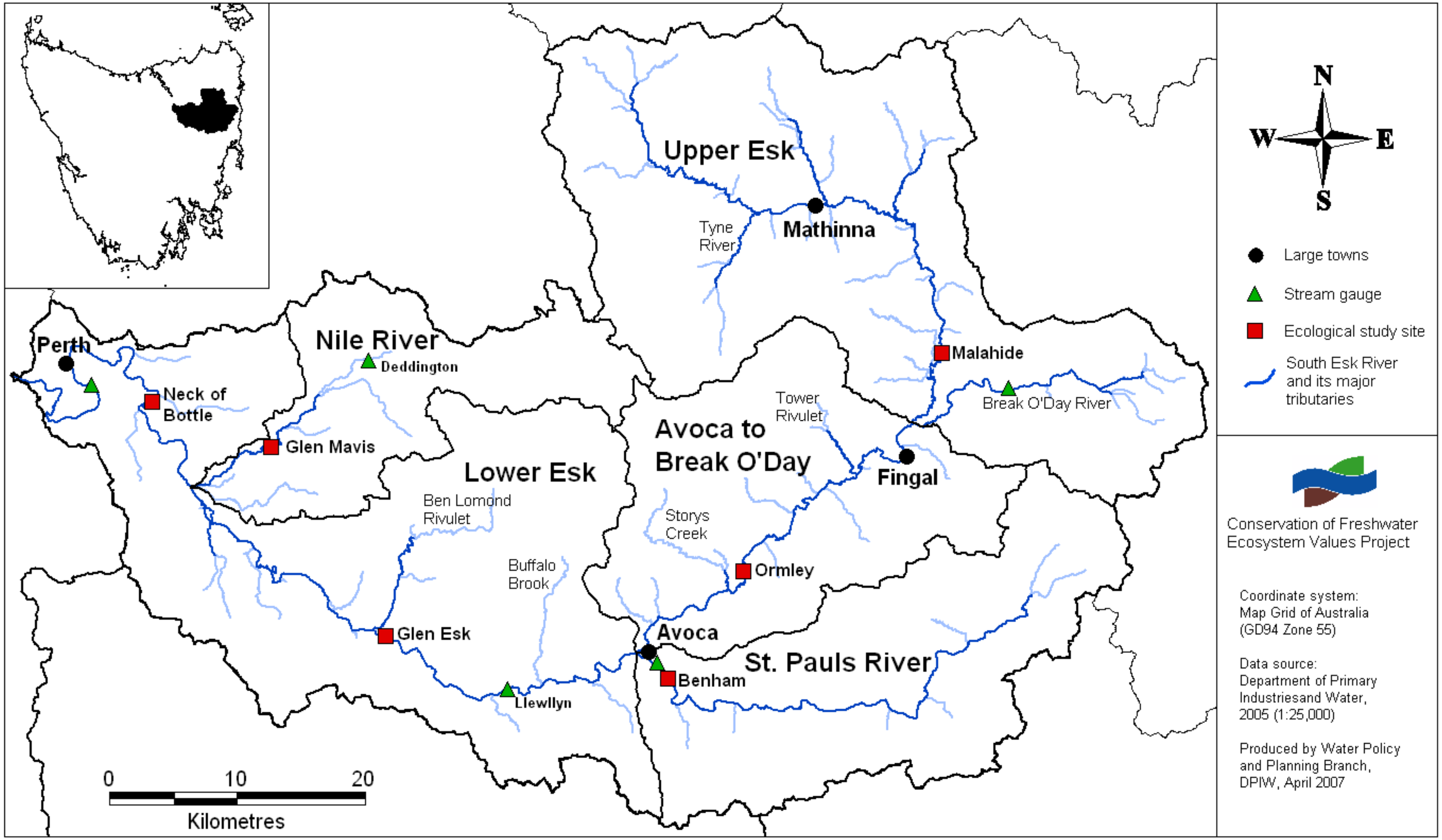
2.1 Introduction

The area the South Esk catchment Water Management Plan covers includes all of the South Esk River and its tributaries above the confluence of the Macquarie River at Longford (Figure 1). The catchment covers an area of 3350 km^2.

Most of the water in the catchment originates from the high altitude dolerite plateau and hill country of Ben Lomond and the Eastern Highlands, and drains through Mathinna ridges and associated escarpments into midland Tertiary basins. Major tributaries of the South Esk River include the Break O'Day River (which enters the South Esk north of Fingal), the St Pauls River (which enters the South Esk at Avoca), and the Nile River (which enters the South Esk River near Nile) (Figure 1). Other significant tributaries in the catchment include the River Tyne (upper reaches), Storys Creek (mid-reaches), Buffalo Brook and Ben Lomond Rivulet (lower reaches).

The South Esk River catchment has been divided into five water management subregions (hereafter referred to as 'subregions'): (1) Lower South Esk River from Longford to Avoca, (2) the Nile River, (3) St Pauls River, (4) South Esk River from Avoca to Break O'Day River, and (5) Upper South Esk River above Fingal and the Break O'Day River catchment (Figure 1). Whilst the catchments of the Upper South Esk River and the Break O'Day River are quite large areas, they have a relatively small number of water users and few areas of high Conservation Value; therefore, the two catchments have been combined to form the Upper South Esk subregion.

Figure 2. Surface water drainage in the South Esk River catchment including stream gauging stations, ecological study sites and subregions. CFEV, © State of Tasmania.



2.2 Freshwater values in the South Esk catchment

The Conservation of Freshwater Ecosystem Values (CFEV) analytical framework and database has been developed by the Department of Primary Industries and Water. The database contains comprehensive information on freshwater ecosystems throughout the state. The information in the database was collated by a number of experts in aquatic ecology. CFEV is now the first port-of-call for the identification of conservation values in the assessment of freshwater ecosystems, and for establishing the drivers of that value.

CFEV draws together the biological and physical parameters in each freshwater ecosystem or river section, and assigns each parameter (or biophysical class) a rating based on how unique, representative or rare it is. The biophysical class with the highest rating is combined with information on the current condition (or Naturalness) of the ecosystem (Figure 2) to obtain a Representative Conservation Value. The Integrated Conservation Value of freshwater ecosystems, shown in Figure 11 for the South Esk catchment, is determined by including information on the presence of any threatened species or communities, called Special Values. For more details on the CFEV database and how it was constructed, see the report on 'Assessment of freshwater ecosystem values in the South Esk River catchment: Guidance for water management' (DPIW, 2007a).

Interrogation of the CFEV database for the South Esk catchment revealed that fish assemblage, riparian tree assemblages, geomorphology, macrophyte assemblages and special values are the main drivers of the high conservation value ratings.

Fish assemblage

The natural fish assemblage in the South Esk catchment includes the Short-finned eel (*Anguilla australis*), Tasmanian mudfish (*Neochanna cleaveri*), Blackfish (*Gadopsis marmoratus*), Pygmy Perch (*Nannoperca australis*) and Swan galaxias (*Galaxias fontanus*). However, today the downstream limit of Swan galaxias is limited by the upstream limit of trout (Fulton *et al.,* 1990).

Riparian Tree assemblages

Three types of native riparian tree assemblage have been identified as being of important biophysical class in the South Esk catchment. Each assemblage is named according to the type of forest and where it is found. For more detail of what species make up the different tree assemblages, see the report 'Assessment of Freshwater values in the South Esk catchment'. The three tree assemblages include

- northern midlands dry sclerophyll vegetation in the lower part of the catchment and in the lower parts of the Nile River
- south-eastern wet and dry schlerophyll forest and woodland near the South Esk River from Avoca to Break O'Day River and in the lower part of the St. Pauls River
- damp and dry schlerophyll forest with *Allocasaurina verticilla* and *Acacia mearsii* present found in the upper South Esk River and lower parts of the Break O'Day River.

Figure 2. The South Esk catchment showing water management subregions of the South Esk Catchment and the Naturalness (or condition) ratings for freshwater ecosystems in the catchment according to the CFEV database. CFEV, © State of Tasmania and the LIST.

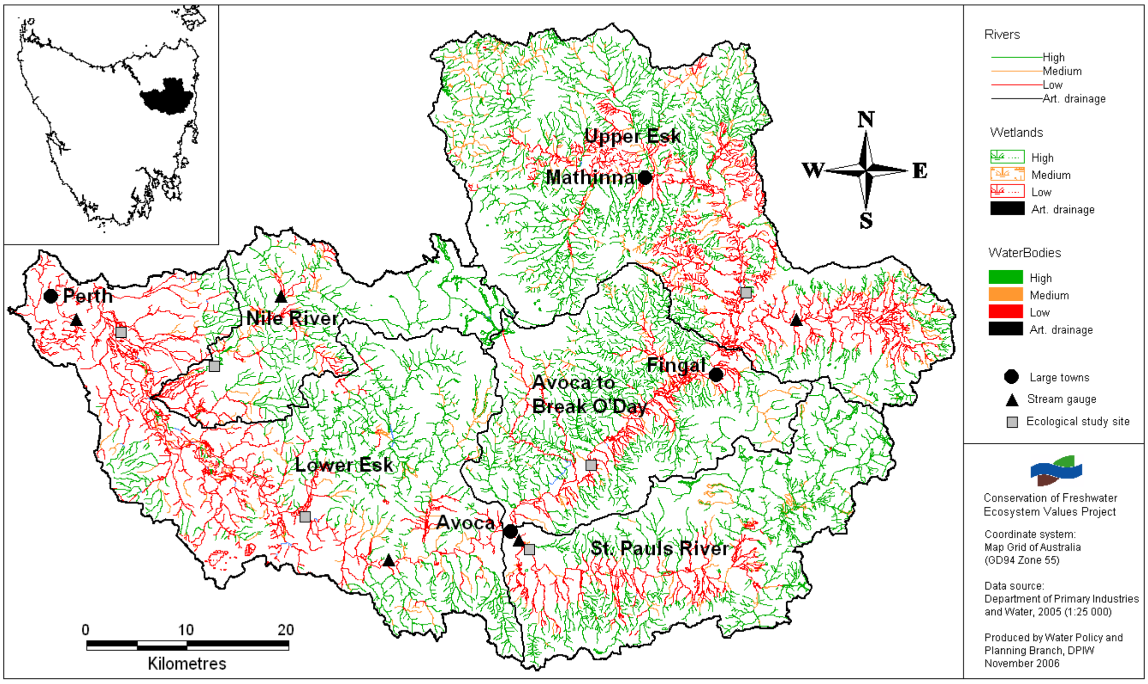


Figure 3. The South Esk catchment showing water management subregions of the South Esk Catchment and the Integrated Conservation Value ratings for freshwater ecosystems in the catchment according to the CFEV database. CFEV, © State of Tasmania and the LIST.

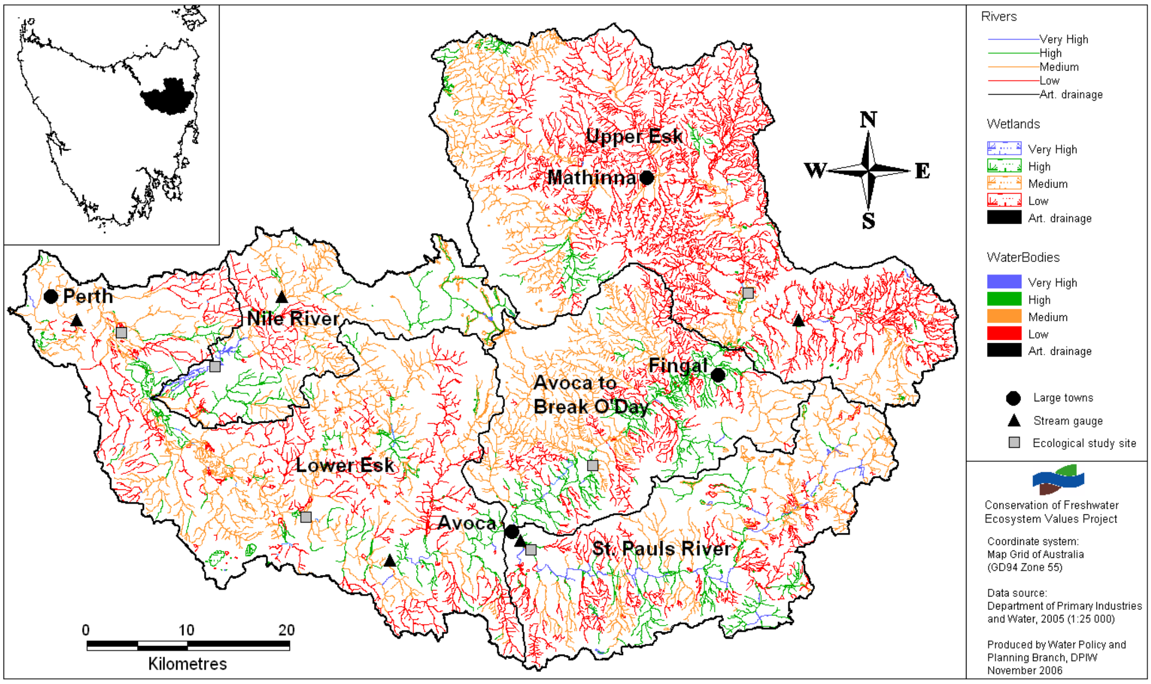


Table 1. Naturalness, primary biophysical classes and special values of freshwater-dependent ecosystems of very high ICV in subregions of the South Esk catchment according to the CFEV database (CFEV, 2005). The percent of river sections of the main stem of the South Esk River in each subregion that are of Low, Medium and High Naturalness is shown.

Subregion	Naturalness	Primary biophysical classes	Special values
South Esk River from Longford to Avoca	Low (52%) Medium (16%) High (32%)	Fish assemblage Tree assemblage Macrophytes	Caddisfly (*Oecetis gilva*) Caddisfly (*Hydroptila scamandra*) South Esk freshwater mussel (*Velesunio moretonicus*) Purple loosestrife (*Lythrum salicaria*) Tasmanian *bertya* (*Bertya tasmanica subsp. tasmanica*) South Esk Pine (*Callitris oblonga subsp. oblonga*) Lowland *Poa* grassland Riparian vegetation community Platypus (*Ornithorynchus anatinus*)
Lower Nile River from Deddington. & Ravine Creek, Patterdale Creek	Low (29%) Medium (11%) High (60%)	Fish assemblage Macrophytes Tree assemblage	Bitter *Cryptandra* (*Cryptandra amara*) Drooping sedge (*Carex longebrachiata*) *Shrubby* Eucalyptus ovata *forest* Lowland *Poa* grassland Riparian vegetation community Platypus (*Ornithorynchus anatinus*)
St Pauls River from Avoca to 'No where'	Low (44%) Medium (11%) High (45%)	Tree assemblage Fish assemblage Geomorphology	Hydrobiid snail (*Beddomeia krybetes*) White-bellied sea-eagle (*Haliaeetus leucogaster*) South Esk freshwater mussel (*Velesunio moretonicus*) Narrow leaf *Pomaderris* (*Pomaderris phylicifolia subsp. phylicifolia*) Small leaf *Spyridium* (*Spyridium lawrencei*) Tall quillwort (*Isoetes elatior*) Slender knotweed (*Persicaria decipiens*) Tasmanian *bertya* (*Bertya tasmanica subsp. tasmanica*) South Esk Pine (*Callitris oblonga subsp. oblonga*) Midlands wattle (*Acacia axillaris*) Shrubby *Eucalyptus ovata* forest Lowland *Poa* grassland Riparian vegetation community Platypus (*Ornithorynchus anatinus*)
South Esk River from Avoca to Break O'Day River	Low (56%) Medium (6%) High (38%)	Tree assemblage Fish assemblage Geomorphology	*Caddisfly (*Oxyethira mienica*)* South Esk freshwater mussel (*Velesunio moretonicus*) South Esk Pine (*Callitris oblonga subsp. oblonga*) Tall quillwort (*Isoetes elatior*) Lowland *Poa* grassland Riparian vegetation community Platypus (*Ornithorynchus anatinus*)
Upper South Esk River and lower Break O'Day River	Low (18%) Medium (5%) High (77%)	Fish assemblage Geomorphology Tree assemblage	Tall quillwort (*Isoetes elatior*) Shrubby *Eucalyptus ovata* forest Lowland *Poa* grassland Riparian vegetation community Platypus (*Ornithorynchus anatinus*)

Macrophyte assemblage

'Emergent and submergent aquatic plant communities' is an important biophysical class in some river sections of the Nile River, but are also common in the rest of the South Esk catchment.

Geomorphology

The geomorphology including 'midlands hills and basins' in the lower part of the catchment and 'dolerite plateau and scree slopes, hill country and alluvial basins' in the middle and upper parts of the catchment are common important biophysical classes.

Special Values

Special values are threatened, vulnerable, rare or endangered species or communities. According to the CFEV database, special values in the catchment are mostly riparian flora species and communities, aquatic macroinvertebrates and the South Esk Freshwater Mussel. Platypus is also a special value in all of the major rivers in the catchment. Special values identified in the Great Forester Catchment are listed below.

In stream fauna of special value include:

- South Esk freshwater mussel (*Velesunio moretonicus*)
- Hydrobiid snail (*Beddomeia krybetes*)
- Caddisflys (*Oecetis gilva, Hydroptila scamandra, Oxyethira mienica*)
- Platypus

Riparian flora and communities of special value include:

- Lowland Poa grassland
- Shrubby Eucalyptus ovata forest
- South Esk Pine
- Midlands wattle
- Tall quillwort
- Tasmanian *Bertya*
- Purple loosestrife
- Slender knotweed
- Small leaf *Spyridium*
- Narrow leaf *Pomaderris*
- Bitter *Cryptandra*
- Native riparian vegetation communities.

2.3 Conceptual Models for the South Esk catchment

Conceptual models provide a useful way to help explain the spatial and temporal variations in water, sediment and nutrient flows in a river system, and the resultant structure and function of the riverine ecosystem.

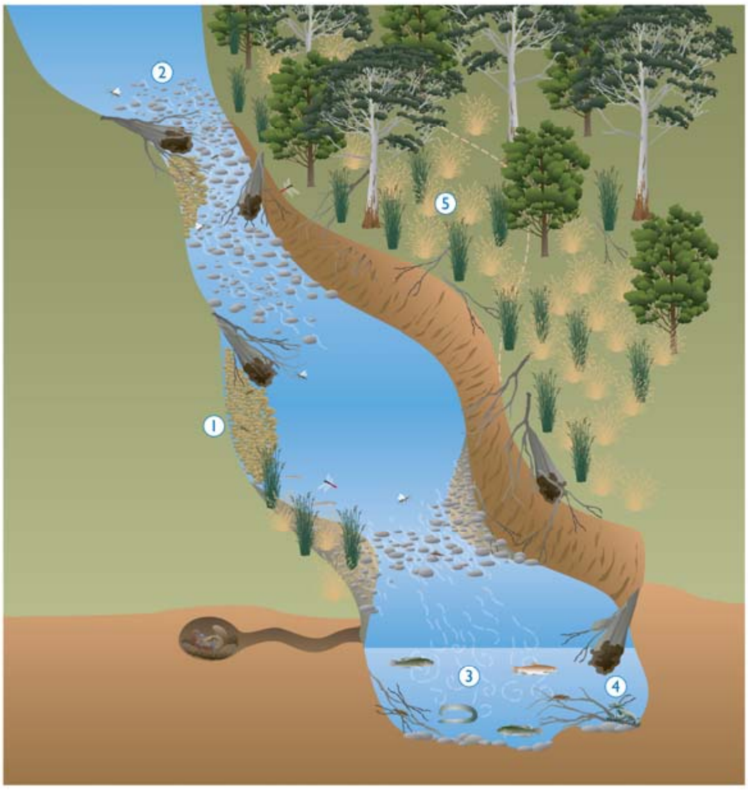
Two conceptual models for the South Esk River system have been developed, based on, amongst other things, an understanding of the ecological values in the system and studies undertaken to assess the environmental flow requirements of the river (for more detail on how they were developed see Chapter 2 of the Environmental Flows report for the South Esk Water Management Plan). One of the models is for the river in the upper part of the river catchment and the other if for the river catchment (Figures 4 and 5).

The upper reaches of the river have a steeper gradient, the channel is more defined, has shallower water depths and is characterised by short riffle-pool sequences (Figure 4). The river in the lower part of the catchment lies within a broader floodplain landscape, has a lower gradient and the channel contains broadwaters (Figure 5). The two models highlight aspects of the ecosystem or flow regime that are considered to be important to the environmental values of these systems.

2.3.1 The river in the upper catchment.

The upper reaches of the South Esk River system are located largely in a heavily forested landscape and hence native riparian vegetation is often very dense. Because of this, the river channel is well shaded, and in-stream production is mostly driven by the transfer of energy from terrestrial areas to the river in the form of organic material. In this area, the river functions more as a longitudinal conduit, with less reliance on lateral hydrological connectivity, although groundwater is likely to play some role in sustaining summer and autumn base flows.

Figure 4. Conceptual model of the riverine ecosystem in the upper reaches of the South Esk River catchment. Five important features that need to be considered in environmental flow are indicated. (1 = leaf-packs, 2= riffle zones, 3 = general habitat diversity, 4 = woody debris, 5= riparian vegetation).



Based on the conceptual understanding of the river ecosystem in its upper reaches (Figure 4), certain components of the flow regime play an important role in the way the river ecosystem is structured and functions:

1. Freshes and high flows inundate and distribute leaf-packs, which are important habitats for invertebrates and platypus.
2. Base flows to maintain water levels in pools so that there is sufficient hydraulic head to maintain flow through riffles, which are important areas for microbial organisms and invertebrates.
3. Variable flows maintain a diverse range of hydraulic conditions within the river channel, which are important for biodiversity.
4. High flows, freshes and occasional inundation flows maintain processes associated with the supply and dispersal of woody debris, which form important habitats for invertebrates and fish.

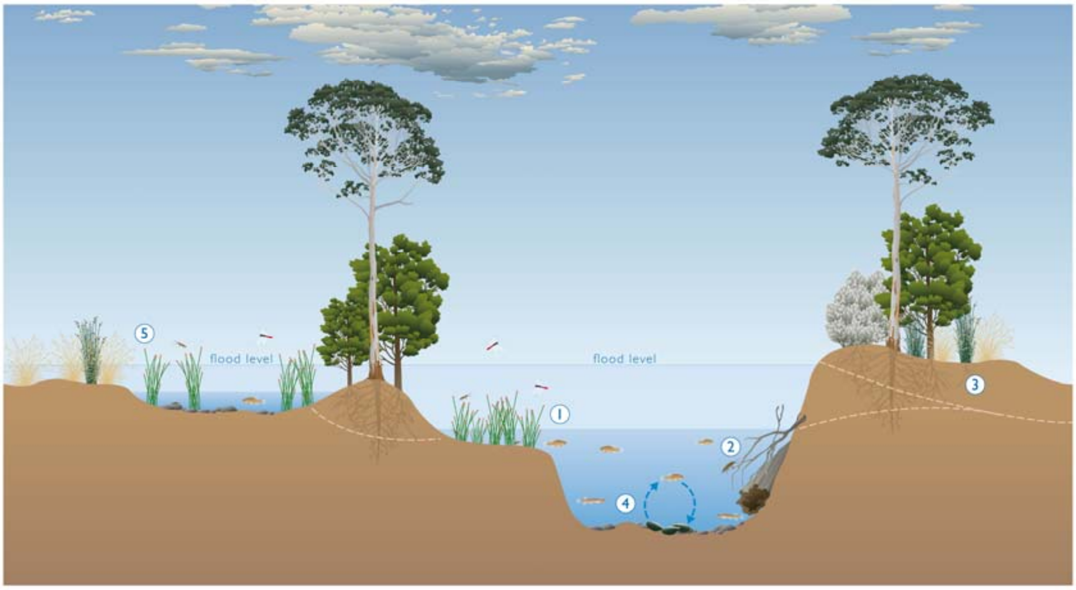
5. Flood flows provide water and nutrients to riparian vegetation and also transport terrestrial organic material to the river channel. Riparian vegetation and the movement of material from this area to in-stream habitats are integral components of the riverine ecosystem in upland rivers.

Many of the habitats highlighted in the upper catchment river model (Figure 4) are subject to negative impacts from low flow events. Such events can de-water areas that are important for primary production and disconnect biota from food sources and refuge habitats. Whilst some of the biota within rivers of this type are resilient to impacts from extreme low flow events, factors that lead to an increase in low flow frequency and duration are a threat to the character and function of the ecosystem.

2.3.2 The river in the lower catchment

The lower reaches of the South Esk River system lie within a depositional environment (i.e. deposition of sediment that originates from higher in the catchment is a prominent feature of in-stream and floodplain habitats), with strong lateral hydrological connectivity between the river channel and adjacent floodplains. The river typically has low energy (i.e. slower flows) and is reliant on nutrients and organic material that are delivered from both upstream and floodplain areas (Figure 5.).

Figure 5. Conceptual model of the riverine ecosystem in the lower reaches of the South Esk and St Pauls River systems. Five important features that need to be considered in environmental flow considerations are indicated (1 = fringing macrophyte beds, 2 = woody debris, 3 = riparian vegetation and local groundwater systems, 4 = freshwater mussels, 5 = floodplain vegetation communities and wetlands).



During extended periods when there is minimal exchange of water and nutrients between the river channel and the floodplain, the material that accumulates within the littoral fringes of the river can contribute substantially to in-stream productivity. In the lower reaches of the South Esk River, fringing macrophyte beds provide structurally complex habitats that are important for in-stream biota (particularly macroinvertebrates and fish); these habitats are also important for primary production.

Based on the conceptual understanding of the river ecosystem in its lower reaches, certain flow components of the flow regime play an important role in the way the river ecosystem is structured and functions:

1. Natural patterns of water level variation within the channel are important for the condition and productivity of fringing macrophyte beds that provide critical habitat for native fishes.
2. High flows that maintain processes associated with the supply and dispersal of woody debris, which provide important habitat for invertebrates and fish.
3. Over-bank flows are important in providing water to the root zone of riparian vegetation and replenishing local groundwater systems. During periods of low flow, local groundwater also helps maintain baseflow in the river.
4. Baseflows that maintain the preferred habitats of freshwater mussels (riffles) and accommodate the hydrological requirements of the life cycles of native fishes (mussels have a parasitic stage in their life cycles for which native fish are hosts).
5. Large floods, which deliver water and nutrients to floodplain vegetation communities and wetlands, and also transport terrestrial organic material from floodplain areas to the river channel.

Declines in baseflows during summer (through direct abstraction of water from the river or local groundwater), may also increase the likelihood of fringing macrophyte beds being de-watered. Whilst aquatic plants are likely to have some resilience to these events, prolonged periods of lower water levels can alter the abundance and distribution of aquatic plants. Periodic de-watering of these habitats would impact on small-sized native fishes, as many species use these habitats for feeding and refuge during their life cycle (i.e. as adults or juveniles). If these habitats are not available, native fishes are likely to be at greater risk of predation by introduced trout and redfin perch.

An increase in the frequency and duration of low flow events is also likely to allow introduced willows, which already proliferate in lower and middle reaches of the South Esk catchment, to expand their distribution. Incursion by willows into and along the river channel, including colonisation of lateral benches, will further degrade the areas that are used by native aquatic fauna.

Declines in frequency and duration of floods threaten ecological and physical character of river reaches that are represented by the lowland river model (Figure 5), as this may disconnect the river channel from the floodplain and local groundwater systems.

2.4 Monitoring of Water Quality and River Health

Monitoring in the South Esk catchment suggests that river health and water quality in the catchment is generally good. However, at some sites there are river health and water quality issues. Below is a summary of the Water Quality Report (DPIW, 2008a) and river health monitoring in the catchment.

2.4.1 Water Quality Monitoring

A summary of the information from the water quality monitoring program in the South Esk catchment is given below. For more detail see the Water Quality Monitoring Report in the South Esk Catchment (DPIW, 2008a).

The Water Quality in the catchment (above the confluence with the Macquarie River) has been measured at various sites, at a number of different monitoring frequencies.

Continuous water quality and water level monitoring is measured at five stations as a part of the DPIW base line monitoring program: South Esk River at Perth; St Pauls River upstream of South Esk River, Nile River at Deddington, Break O' Day River at Killymoon and Back Creek at Wilmores Lane (upstream of the Longford water treatment plant outlet). In-situ probes measure continuous electrical conductivity; turbidity; water temperature, dissolved oxygen (Nile at Deddington only) and water level.

In addition spot samples are also taken monthly from four of the five above sites (with the exception of Back Creek) for the following parameters: dissolved oxygen, electrical conductivity, turbidity, pH, water temperature, total nitrogen, ammonia-N, nitrite-N, nitrate–N, total phosphorus and dissolved reactive phosphorus. Back Creek is not part of the network, however monthly readings of turbidity, water temperature, conductivity, dissolved oxygen and pH are taken, as the site is visited for QA/QC purposes.

A large number of other spot samples have also been collected from the catchment as part of the DPIWE State of River (SoR) reports, DPIW (AUSRIVAS) river health surveys (discussed below) and as a part of NRM North's Northern Water Monitoring Program.

Water quality data from the sites outlined above suggest that in most parts of the catchment conductivity is low, there are low levels of suspended solids and turbidity, and that most sites have healthy levels of dissolved oxygen. The median results for all of the sites except one are within ANZECC 2000 guidelines. However, some readings fall either side of, or outside the guidelines:

- Some very low and very high oxygen results at Perth, which if maintained could have an adverse effect on aquatic ecosystems.
- While conductivity and turbidity results at the Nile site are good, the median nitrate levels exceed those of more impacted catchments.
- Some very low oxygen readings and high nutrient results from the Break O'Day River, with all basic water quality and nutrient maximums (except nitrate) exceeding the ANZECC guidelines.
- At Buffalo Brook pH levels are highly variable with the median and maximum pH levels, and some conductivity levels, exceeding the ANZECC guidelines.
- The site on Back Creek at Wilmores Lane, which is upstream of the sewage treatment plant outlet near Longford is still impacted with elevated turbidity, low dissolved oxygen and some samples containing elevated electrical conductivity and nutrient values.
- The effects of heavy metal pollution from Story's Creek and Aberfoyle mines on water quality and macroinvertebrate communities in the South Esk River is still evident and will also be discussed in the river health section below.

Catchment specific trigger levels have been established at all four DPIW Baseline Monitoring Stations in accordance with ANZECC 2000 guidelines. Where catchment specific trigger values do not exist then the default ANZECC 2000 values for upland streams can be used.

2.4.2 River Health Monitoring

Introduction

Assessment of river health in the South Esk catchment has been undertaken biannually using the Australian River Assessment System (AUSRIVAS). The Department of Primary Industries and Water uses this bioassessment approach, to assess river health in Tasmania.

This report combines information from regular biannual monitoring from the waterways monitoring report, which is a part of the Tas Together program and other short-term assessments in the South Esk River catchment above the confluence with Lake River.

The AUSRIVAS method

The AUSRIVAS models predict the aquatic macroinvertebrate fauna that would be expected to occur at a site in the absence of environmental stress such as pollution, habitat degradation or flow regulation. The AUSRIVAS method compares the results from a test site with a group of reference sites that are as free as possible of environmental impacts, but have similar physical and chemical characteristics.

One of the outputs of AUSRIVAS is a list of probabilities of occurrence of macroinvertebrates that would be expected to occur at a test site if there were no impacts. The summed probabilities of the fauna expected to occur (Expected) are compared to those that are actually collected (Observed). The Observed/Expected ratio (O/E score) provides a measure of the biological health of the site. The O/E scores can then be placed into categories or bands of biological health (Table 2) which provide an overall assessment of the ecological health of the site.

Table 2. River health categories and associated O/E scores for the springtime riffle model.

Band Label	O/E Scores	Band Name	Comments
X	>1.15	Above Reference	• More families than expected • Potentially biodiverse site • Possible mild organic enrichment
A	0.86–1.15	Equivalent to Reference	• Index value within range of the central 80% of reference sites
B	0.57–0.85	Significantly Impaired	• Fewer families than expected • Potential mild to moderate impact on water quality, habitat or both, resulting in the loss of families
C	0.28–0.56	Severely Impaired	• Considerably fewer families than expected • Loss of families due to moderate to severe impact on water and/or habitat quality
D	<0.27	Impoverished	• Very few families collected • Highly degraded • Very poor water and/or habitat quality

Most AUSRIVAS macroinvertebrate community models are based on survey data that are transformed to presence/absence information. The disadvantage of such models is that their sensitivity is dependent on losses of taxa resulting from human impacts.

As AUSRIVAS macroinvertebrate assessments are based on identification to the family level (in most cases), an impact must result in the loss of whole families in order for the O/E value to change. Diffuse impacts, such as the input of sediments or nutrients or changes to the flow regime, can cause the loss of macroinvertebrate taxa, but more frequently result in changes in the relative abundances of taxa. The presence/absence models cannot detect changes in relative abundance, hence, significant information on the status of macroinvertebrate community composition is not available when using these models.

Results

AUSRIVAS assessments of river health in the South Esk Catchment have been carried out for a number of different projects over the past 15 years. The observed/expected results for riffle and edge water habitats for all sites in spring and autumn for the different projects are presented in Figure 6.

AUSRIVAS assessments for Tas Together

Regular long term AUSRIVAS assessments are undertaken by DPIW at four locations in the South Esk River catchment and a part of the Tas Together Project. Locations include:

- Nile at Deddington
- South Esk River at Perth
- South Esk River at Cokers Road
- Tower Rivulet at Rossarden Road.

The three upper catchment sites generally have scores that are equivalent to reference and water quality at the sites is generally good. The site at the South Esk River near Perth is significantly to severely impaired. For more information on the four long term monitoring sites see the South Esk Waterways Reports.

Initial Sampling for AUSRIVAS

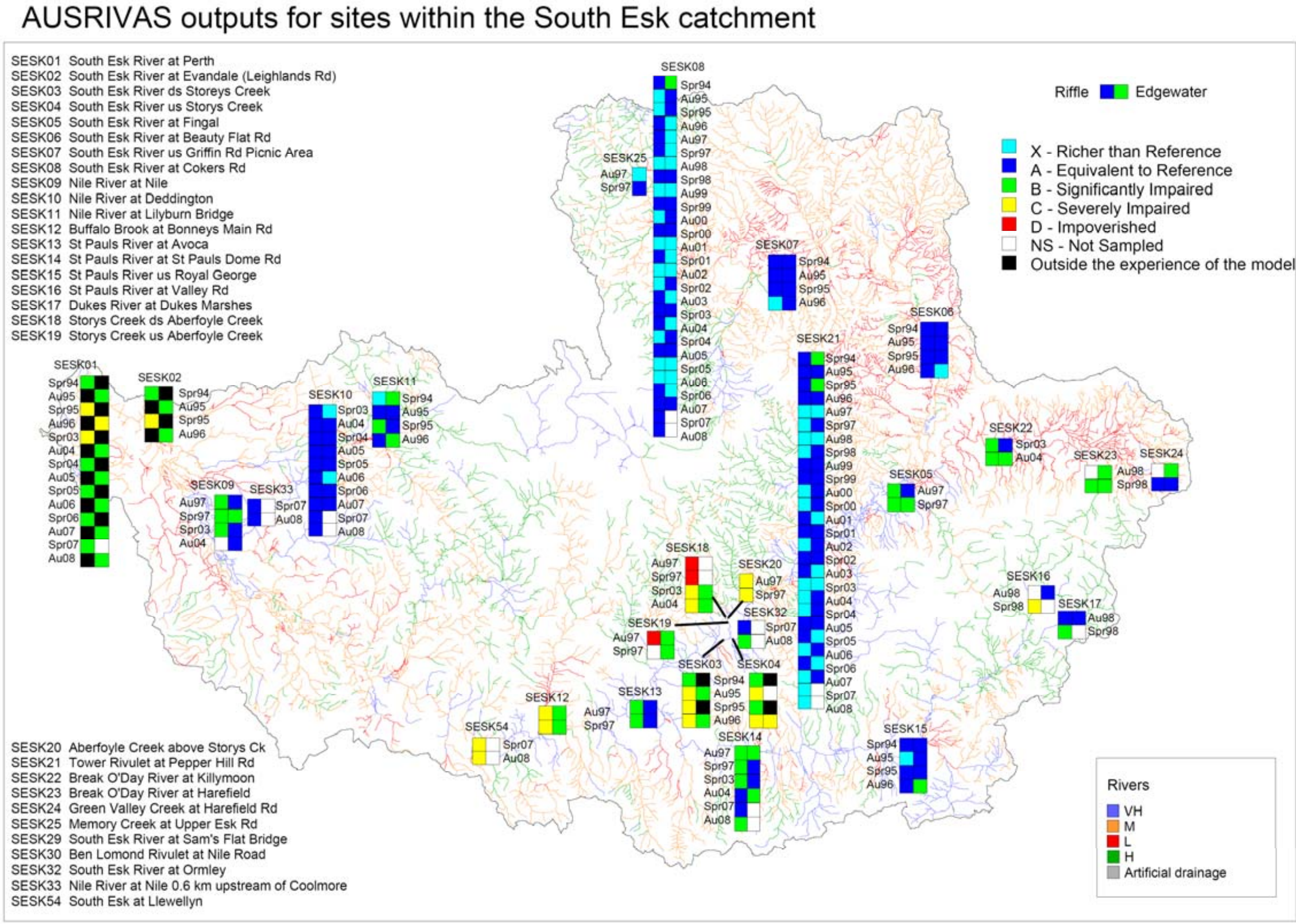
The first sampling of the original AUSRIVAS reference sites took place throughout the catchment in spring 1994, autumn 1995, spring 1995 and autumn 1996 (Figure 6).

To determine the degree of the biotic response using the AUSRIVAS model an assessment of stream sections with different degrees of impact by intensive agricultural land use and mining was undertaken in 1997 (Figure 6). Some of these impacted sites were also assessed in spring 2003 and autumn 2004. Additional reference sites, that were not included in the original AUSRIVAS assessment, were added in 1998. The additional sites were added to develop a truly state wide model, largely as part of an assessment of agricultural impacts (Krasnicki *et al*.,2001).

Assessment at environmental flows sites

AUSRIVAS analysis using macroinvertebrate assemblages were assessed at most of the environmental flow sites to establish base line conditions. Sites include Nile River upstream of Coolmore, St. Pauls River at Avoca, and South Esk River at Llewellyn and at Ormley (Figure 6).

Figure 6. AUSRIVAS outputs for sites within the South Esk catchment.



Overall patterns from AUSRIVAS macroinvertebrate monitoring

The headwaters of the South Esk River catchment are generally in good condition. The lower reaches of the Nile, mid to lower St. Pauls River and the main stream of the South Esk River show some impact from agricultural activity.

The assemblages in the Break O'Day River are likely to be impaired due to combination of agricultural activities and insufficient habitat for invertebrate groups arising from the intermittent nature of the streams in this subcatchment. The influence of the Break O'Day River and agricultural activities are also apparent in South Esk River at Fingal.

Storys and Aberfoyle Creeks are severely impacted to impoverished due to heavy metal pollutants from mine tailing dams in the upper reaches of the two streams. The impact of the pollutants from Storys Creek can be seen in riffle habitats at least as far downstream in the South Esk River as the Llewellyn gauging station.

Fish Assemblages

Blackfish, pygmy peach and shortfinned eels are found in most locations throughout the catchment. Swan galaxias have been found in Tullochgorum Creek, in the upstream parts of the St. Pauls River and in the Duke River. No Swan galaxias are found where introduced fish species are present. Introduced species found at many locations throughout the South Esk River catchment include brown trout, redfin perch, goldfish and tench.

2.5 Hydrology

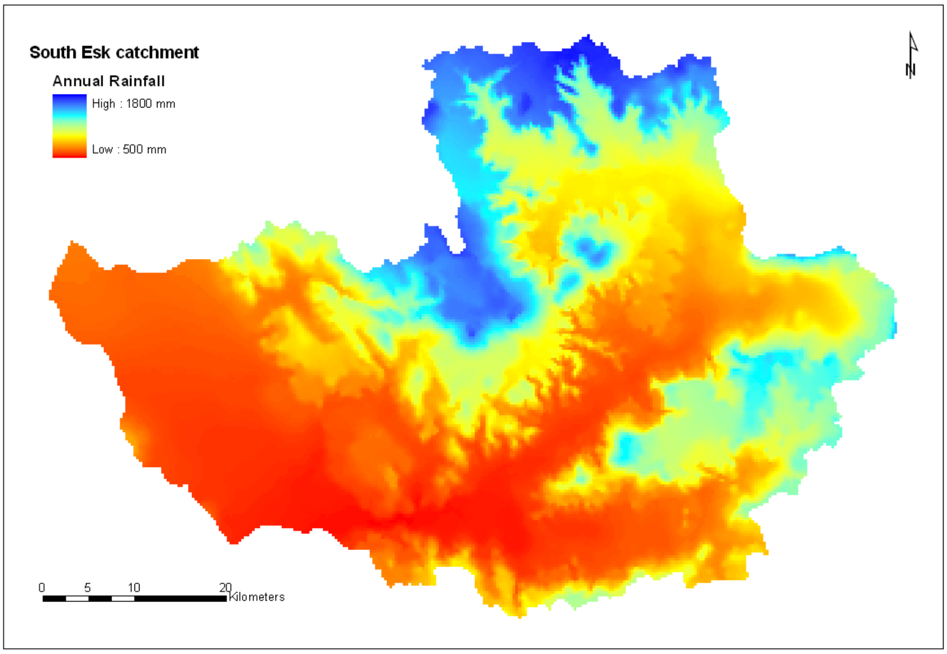
The following section summarises of information presented in a Report on the Surface Water Hydrology of the South Esk River Catchment (DPIW 2007b).

2.5.1 Rainfall and evaporation

The South Esk River catchment is situated in one of the drier parts of eastern Tasmania and experiences widely varying climatic conditions with rainfall ranging from 500 mm in the low lying areas to up to 1,800 mm in the highlands (Figure 7). Substantial parts of the catchment are prone to drought.

Considerable climate variability within the catchment results in high variability of runoff yield. The Upper Esk subregion and Nile River subregion are identified as the most productive areas in the region in converting rainfall into runoff and hence high relative river yield.

Figure 7 Distribution of mean annual rainfall in the South Esk River catchment



With an annual average rainfall of 835 mm, the total water input into the South Esk River catchment is approximately 3,000 GL/year. The total catchment annual yield at Longford is around 900 GL/year and therefore comprises about 43% of the total annual water input. This simple water budget indicates that the vast majority (57%) of total water input into the catchment is either evaporated, transpired or moves into the local and regional groundwater systems.

Figure 8 Mean monthly rainfall / evaporation in South Esk River catchment.

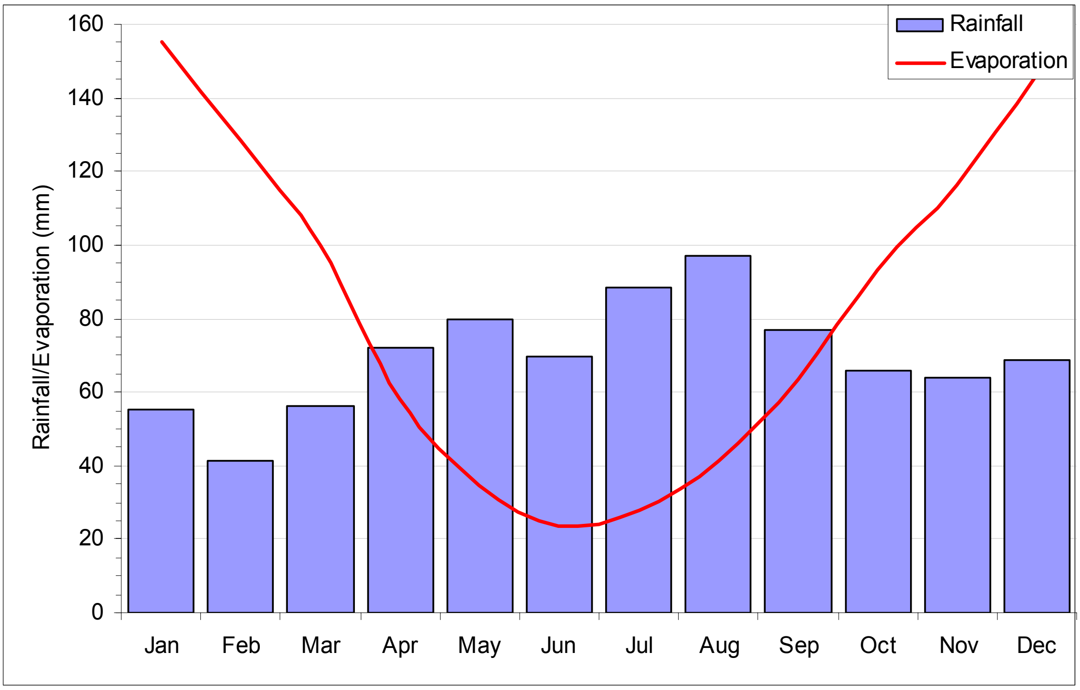
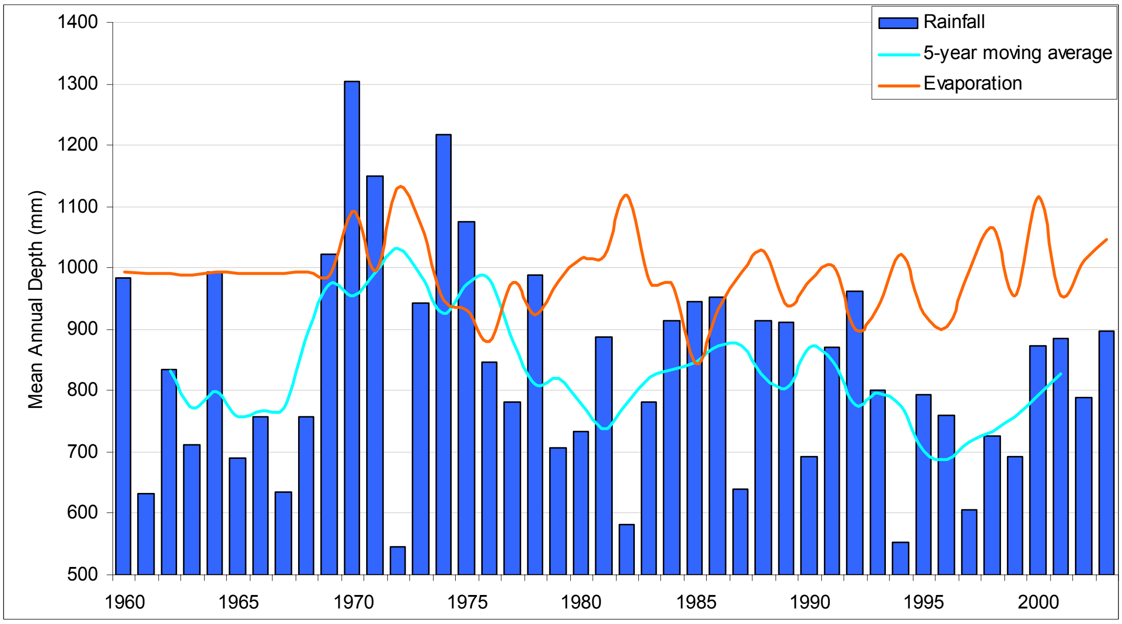


Figure 9. Variation in annual rainfall and evaporation data (1960-2003) superimposed with 5-year moving average.



A 5-year moving average analysis of annual rainfall data (1960-2003) indicates a roughly decadal cycle of wet and dry years over the 43 years of the record period (Figure 9). The years 1972, 1982 and 1994 were identified as the driest years with annual average rainfall of <600 mm across the catchment. The 1970s were the wettest years with peak annual rainfall in the range 1,000-1,300 mm. Since 1975, the annual average rainfall in the South Esk catchment has not exceeded 1000 mm.

2.5.2 Stream flow

There are currently six stream flow monitoring stations in the South Esk River catchment including the South Esk River at Perth, the South Esk River at Llewellyn, Nile River at Deddington, St. Pauls River at Avoca, Break O'Day River at Killymoon and a new site located on the South Esk River at Upper Esk (data from this site is not yet available). Historical records also exist from 5 other stream flow monitoring sites that are no longer active.

Summary statistics of data from the stream flow monitoring sites are shown in Table 3. Figure 10 shows the mean and standard deviation of flow in the South Esk River at Llewellyn. Average daily flows for each month range from 2951 ML/day in August to 562 ML/day in March. Extremes in flow at Llewellyn gauging station range from as much as 200 000 ML/day to as little as 29.6 ML day, although flows as low as 4.9 ML/day have been read at Perth.

Figure 10. Stream flow (ML/day) at the Llewellyn gauge, showing the mean and standard deviation for each month.

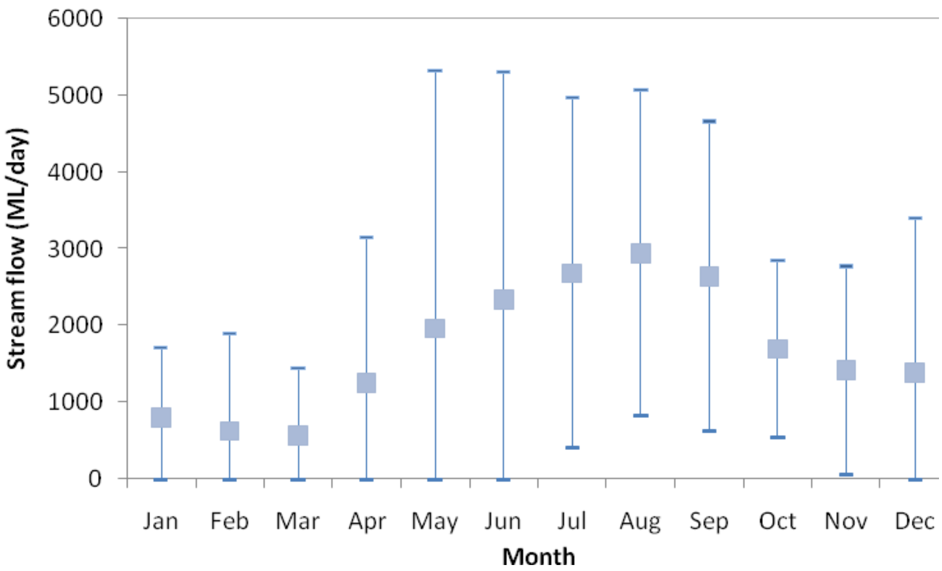


Table 3. Summary statistics of stream flow (ML/day) at the selected stream flow monitoring sites.

South Esk @ Perth (181)	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	2064.0	955.1	735.1	650.2	1284.3	1879.5	2753.7	3305.4	4145.7	3549.9	2382.5	1539.6	1492.3
Std.Dev.	1062.2	1180.2	1217.8	1442.0	1686.1	2140.2	3136.9	2644.8	3025.7	2479.3	2088.7	1521.7	2081.6
Minimum	4.9	14.5	4.9	10.9	11.2	48.4	68.7	218.9	363.3	192.2	143.1	48.9	15.1
Maximum	199715.0	81857.0	38596.0	114480.0	71818.0	199715.0	133193.0	48895.0	82230.0	58512.0	81989.0	38116.0	65169.0

South Esk @ Llewellyn (150)	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	1678.3	801.5	627.9	561.8	1257.1	1963.5	2344.0	2689.0	2951.1	2647.9	1699.7	1418.9	1385.7
Std.Dev.	974.0	922.5	1273.6	890.0	1895.0	3352.5	2954.4	2281.2	2123.1	2010.8	1153.8	1357.0	2011.0
Minimum	29.6	39.6	33.7	29.6	29.8	56.3	125.4	301.5	247.9	211.7	133.5	74.4	52.7
Maximum	203816.0	49938.0	42106.0	20678.0	61008.0	203816.0	104842.0	82131.0	41455.0	58271.0	22100.0	35496.0	54701.0

Nile at Deddington (25)	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	305.4	175.7	79.9	61.8	212.2	276.5	379.7	558.8	581.5	544.1	322.7	163.5	242.2
Std.Dev.	82.8	158.1	88.7	62.3	200.4	218.1	210.3	217.9	333.8	347.8	222.1	86.7	296.5
Minimum	3.3	7.1	5.5	4.1	3.3	11.7	18.0	36.9	36.8	34.8	20.9	13.8	7.5
Maximum	9743.8	6794.1	1926.0	2573.4	6874.6	7893.2	7798.5	6543.9	9743.8	5713.2	7863.2	2678.0	6250.1

St Paauls at Avoca (18311)	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	270.6	237.1	127.6	67.1	331.5	239.1	223.4	398.3	349.2	288.2	269.0	237.7	253.3
Std.Dev.	175.5	324.9	185.7	83.2	529.4	499.3	269.8	401.2	468.6	282.1	363.6	289.4	527.1
Minimum	0.1	0.1	0.1	0.3	0.8	0.8	1.5	9.5	13.2	7.5	1.0	0.9	0.0
Maximum	36095.0	36095.0	4197.8	2812.2	14081.0	12710.0	9063.4	9694.2	22333.0	5876.8	16132.0	6707.1	28274.0

Break O'Day at Killymoon (191)	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	138.4	155.5	58.6	30.2	128.4	179.8	79.7	207.3	186.6	183.2	131.7	129.6	162.7
Std.Dev.	82.3	255.0	87.2	37.9	239.6	393.7	89.0	233.5	289.7	290.7	232.6	176.7	304.4
Minimum	0.3	0.4	0.3	0.4	1.0	3.4	3.2	6.7	4.3	5.7	2.6	1.6	0.6
Maximum	31008.0	21921.0	2132.2	2125.1	7772.4	31008.0	2623.2	12523.0	13299.0	6880.3	14773.0	6903.9	10158.0

Flood flows and low flows

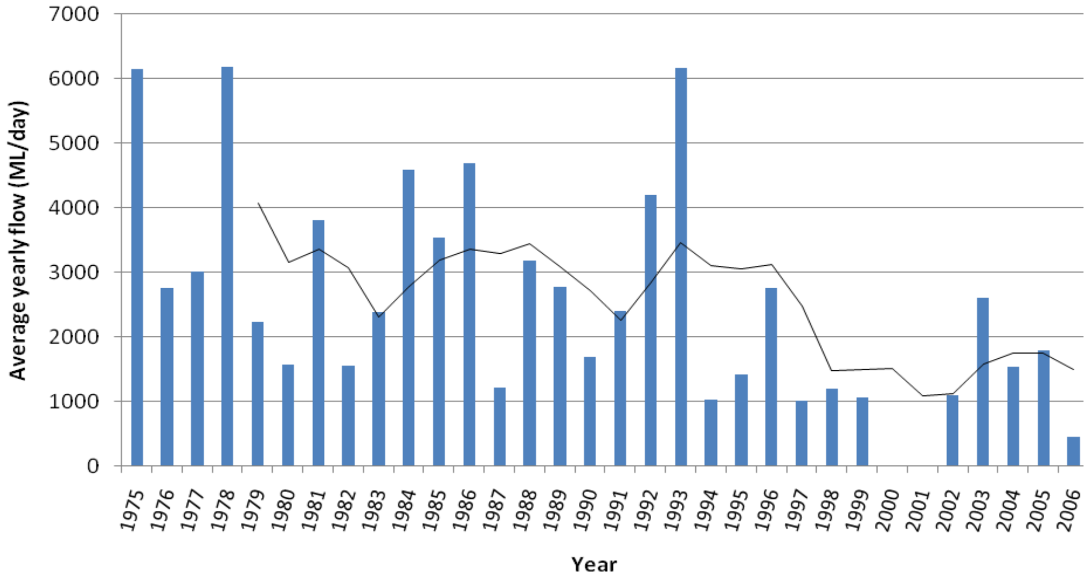
Average floods (1 in 2 year floods) in the lower reaches of the South Esk River catchment peak at around 400 m^3s^{-1}, while floods range from 100 to 150 m^3s^{-1} in the major tributaries. At Perth the observed stream flow recession after an average flood event is around 72 m^3s^{-1} per day and it takes roughly five days for the peak flow to recede to an average river flow of 24 m^3s^{-1}.

Low flow probability analysis indicated that within any given year the likelihood of occurrence of average flows ≤ 1.0 m^3s^{-1} over a period of five consecutive days is around 60%.

Average daily flow per year

Average daily flow for the years 1975 to 2006 at the Perth gauging station is presented in Figure 11. Mean daily flow for each of these years ranged between 459 ML/day (2006) and 6180 ML/day (1978). The five year moving average shows that since 1993 there has been a steady decline in mean daily average flow.

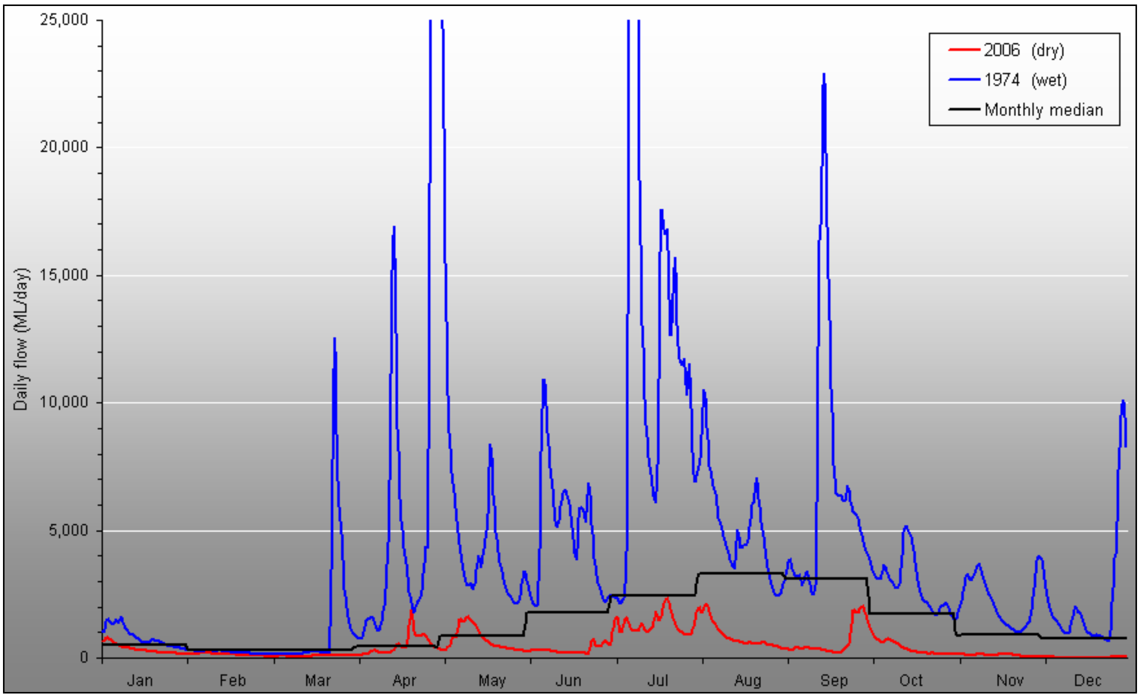
Figure 11. Average daily flow (ML/day) for each year at the Perth gauging station. The trend line shows the 5 year moving average. Records from the years 2000 and 2001 were not available.



2.5.3 Wet and dry season comparison

Observed flow data (1960-2007) from the South Esk River at Perth was examined to identify relatively wet and dry years. The data indicated that the years 1974 and 2006 represent years of wetter-than-average conditions and drier-than-average respectively. Figure 2 provides a comparison of the hydrographs for these years plotted along with the monthly median flow for the record period 1960-2006. This has been included to demonstrate the degree of interannual variation that occurs in runoff from this catchment.

Figure 12. Median monthly flow compared to wet and dry year hydrographs of flows from South Esk at Perth.

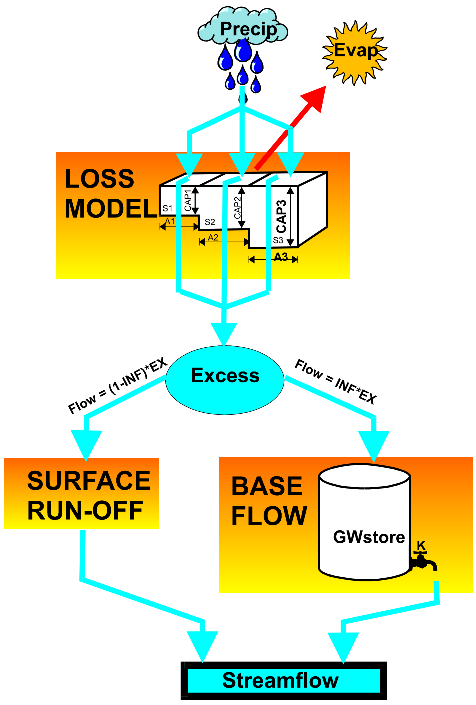


2.5.4 Hydrological modelling of the South Esk catchment

Australian Water Balance Models are used model the hydrology of Tasmania's, developed catchments, including the South Esk catchment, under both current and natural (no water abstraction) conditions.

The approach the model takes is shown in Figure 13. A detailed description of the model's development and its outputs is presented in the Department of Primary Industries and Water report on the NAP Region Hydrological Model South Esk Catchment (DPIWE, 2005).

Figure 13. Australian Water Balance Model Schematic (from the Report on the NAP Region Hydrological Model South Esk Catchment).



Whilst gauged data provide a good picture of the hydrology of a catchment, they are generally limited in the length of time they have been collected. They are not able to provide a clear picture of catchment hydrology under natural conditions, nor can they generally provide a picture of long term trends related to climate variability.

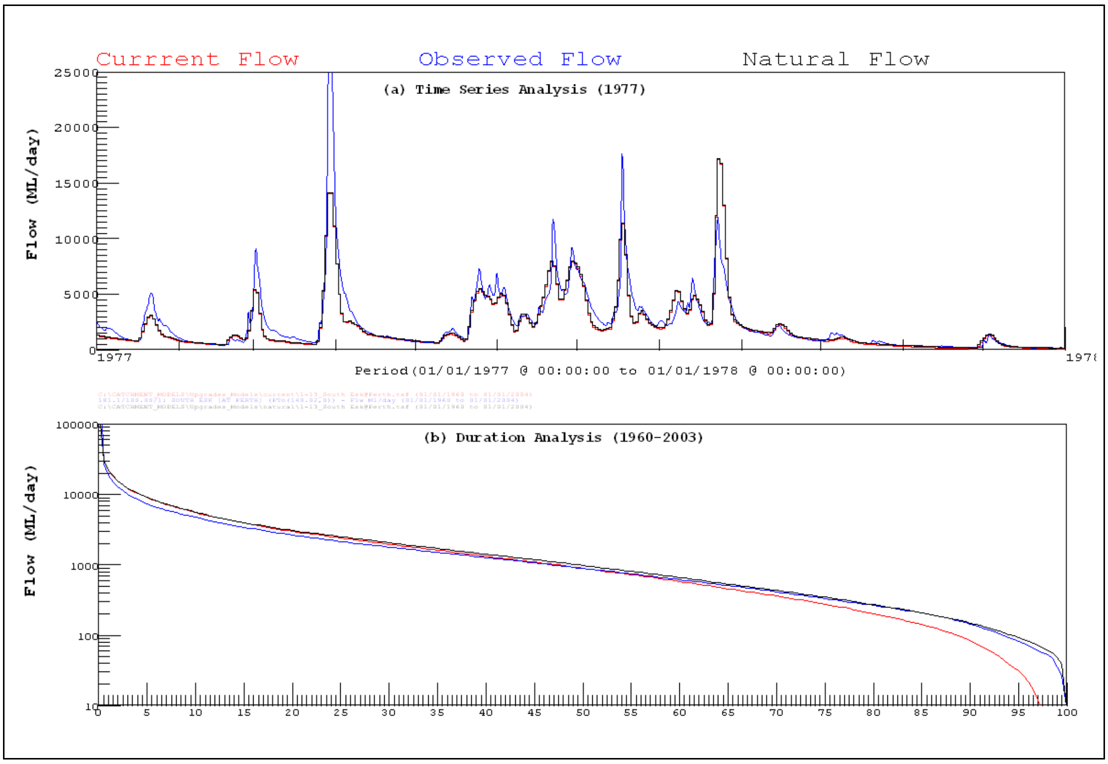
A hydrological model is used to generate natural flow and current flow time series data over a much longer time period, using rainfall and evaporation data. These models allow an assessment of changes in hydrology due to current water abstraction, and allow catchment yield to be determined so that various water allocation scenarios can be tested.

The models can generate a daily time-series of natural flow based on daily rainfall and evaporation records, which generally extend back over a hundred years or more. The models can also be used to derive a daily time-series of current streamflow, which takes into account water abstractions from the system and gives an indication of impact on the natural streamflow and hence on the gross catchment yield. A daily time-series of current flow can also be generated over the length of record for rainfall; that is, what the flow would have been had current water abstractions occurred in those years.

As a part of the development of the model the Department now has a user interface that allows its hydrologists to run the models under varying catchment demand scenarios. It allows the addition of further extractions to catchments to see what affect these additional extractions have on water availability in the catchment of concern. The interface provides subcatchment summaries of flow statistics, flow duration curves, hydrological indices, and water allocation data.

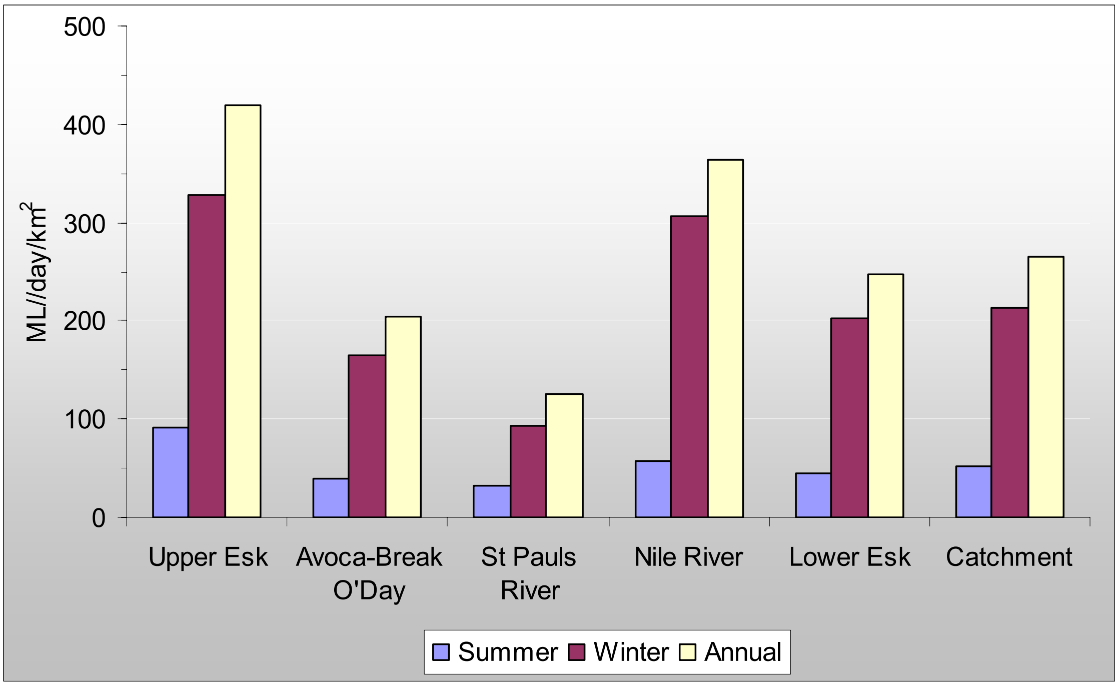
Flow duration curves showing modelled natural flow and modelled current flow for the South Esk River (assuming all of the water allocations are used) at Perth are presented in Figure 14.

Figure 14. a) An example of time series data over one year, and b) flow duration curves (modelled data), for the gauging station at Perth, showing modelled natural flow (black), modelled current flow assuming all allocations are used without restriction (red), and observed flow (blue).



The modelled natural median yield for summer and winter in each of the subregions in the South Esk catchment is shown in Figure 15. The distribution of water yield across the catchment is clearly evident, as is the marked difference between summer and winter yield.

Figure 15. Distribution of yields in the water management subregions.



2.6 Water Use and Management Arrangements

The Water Use and Management Arrangements report provides details of water management activities in the South Esk catchment and provides background information for the development of the South Esk catchment Water Management Plan.

2.6.1 Water Usage

Water usage within the catchment is primarily surface water with little groundwater used. Use of fresh water resources is comprised of town water supply, stock and domestic, irrigation, fish farm and power generation.

Water used for town water, stock and domestic and fish farm operations rely on taking water from permanent stream flows where irrigation and power generation usage is broken up into river run and/or dam storage.

Water usage figures were taken from a survey undertaken during the 2002-03 irrigation season. Water usage data was collected for the 1999/2000, 2000/2001 and 2001/2002 irrigation seasons. Table 4 shows the annual surveyed water usage for each subregion over the survey period. The usage figures identified an average level of water usage of 17,986 ML.

Table 4 Annual survey water usage for the 1999-2002 survey period.

Upper Esk	Avoca to Break O'Day	St Pauls River	Nile River	Lower Esk	TOTAL
3060	4025	422	3394	7085	**17986**

2.6.2 Current Allocations

There are at present 86 water licence holders within the catchment ranging from Surety 1 (town water and stock and domestic) to Surety 8 (flood harvesting).

Table 5 provides a breakdown of the surety levels and their respective allocation volumes and Table 6 provides a list of current allocations for each subregion by purpose. Table 7 shows storage allocation for each subregion.

There is a fish farm operation in the headwaters of the catchment with an annual allocation of 9490 ML. This water is returned to the stream as it is operated as a flow in/flow out system and as such is non-consumptive. The remaining allocations are consumptive.

Table 5. Surety level allocations for each subregion (ML).

	Upper Esk	**Avoca to Break O'Day**	**St Pauls River**	**Nile River**	**Lower Esk**	**TOTAL**
Surety 1 (direct)	201.5	90.9	0	0	30.4	**322.8**
Surety 3 (direct)	0	0	197.1	7320	0	**7517.1**
Surety 5 (direct)	10054.6	1247.2	239.25	45	3635.3	**15221.35**
Surety 5 (storage)	4083.5	232	371	2913.5	4768.65	**12368.65**
Surety 6 (direct)	2045	845	300	10	4640	**7840**
Surety 6 (storage)	0	0	0	0	3948	**3948**
Surety 8 (storage)	0	375	0	0	1983	**2358**
TOTAL	**16384.6**	**2790.1**	**1107.35**	**10288.5**	**19005.35**	**49575.9**

Table 6. Current allocations by purpose for each subregion (ML).

	Upper Esk	**Avoca to Break O'Day**	**St Pauls River**	**Nile River**	**Lower Esk**	**TOTAL**
Irrigation	6592.5	2339	1107.4	10288.5	18959.6	**39287**
Fish Farm	9490	0	0	0	0	**9490**
Mining	0	314	0	0	0	**314**
Water Supply	302.1	136.7	0	0	45.80	**484.6**
TOTAL	**16384.6**	**2789.7**	**1107.4**	**10288.5**	**19005.4**	**49575.6**

Table 7 Storage allocation in each of the subregions.

	Upper Esk	Avoca to Break O'Day	St Pauls River	Nile River	Lower Esk	TOTAL
Storage Allocations (ML)	**4083.5**	**607**	**371**	**2913.5**	**10699.7**	**18674.4**
No of allocations	**12**	**6**	**10**	**8**	**35**	**71**

2.6.3 Flow Meters

All water users with direct take allocations are required to have flow meters installed on all off take points and report their water usage information to the Department. A weekly record is to be maintained throughout the season and provided to the Department by June each year. During restriction periods however, daily records are to be kept and forwarded to the Department at the end of each restriction week.

There are currently 49 meters installed with another 17 required to be installed, identified as a result of a field survey undertaken by the regional Water Ranger during the 2007-08 irrigation season.

2.6.4 Management Arrangements

South Esk Hydro District

Hydro Tasmania has the right (special licence-Surety Level 4) to all the water resource within the South Esk Hydro District for power generation. The South Esk Hydro District includes the South Esk River Catchment, Meander River catchment and Macquarie River catchment.

Prior to January 2000 Hydro Tasmania allowed water to be allocated for irrigation and other commercial uses and town water was allowed to be taken under various Municipal Acts.

On the 13 January 2004 a Memorandum of Understanding MOU was signed between Hydro Tasmania, The Tasmanian Farmers and Graziers Association and the Department of Primary Industries, Water and Environment. This set out a framework for future water allocations within the catchment. The following sections provide details on the framework.

Historical use

The MOU recognises that some users were taking water in excess of their current allocation limits. It was agreed that this over usage would be recognised formally and placed on water licences as a permanent right. A survey was undertaken during 2003 to collect water usage data from the irrigation seasons 1999 to 2002 and adopted the highest annual usage figure. This included water taken under previous Temporary Water Allocation arrangements.

New Surety 6 allocation have been issued as a result of the 2003 water usage survey and as such, water that had been used over and above existing allocations has been recognised.

Flood takes

It was agreed that taking water during high flow periods would not impact on the capacity for Hydro Tasmania to generate power. A catchment wide trigger was set at 70 cumecs based on the sum of the flows at the three gauging stations within the District. Also triggers were set for each of the three catchments, which reflect that these flows would equate to a Trevallyn Dam spill event. The catchment based trigger for the South Esk catchment are shown in Table 8.

As part of the flood flow management arrangements, DPIW determined that a minimum flow must be maintained before a flood take within a particular is approved. The minimum flows for South Esk catchment are presented in Table 9. The flood take will be approved subject to the flow exceeding the minimum flow level for the month.

Table 8 Trigger flow levels (ML/day) for the South Esk catchment.

Site name	Summer Trigger (ML / day)	Winter Trigger (ML / day)
South Esk @ Llewellyn	2020	1750

Source: Memorandum of Understanding between Hydro Tasmania, The Tasmanian Farmers and Graziers Association and the Department of Primary Industry, Water and Environment, 2004

Table 9 Minimum flow requirements (ML/day) for the South Esk catchment.

Site name	Dec-April	May	June	July	Aug	Sep	Oct	Nov
South Esk @ Llewellyn	172	250	400	700	850	850	475	172

Dams on ephemeral streams

Where dams are on ephemeral streams dam owners are required to release water when the stream is flowing, but do not have to release water when it is not.

Large dams

Where large dams in excess of 3,000ML are proposed the MOU requires the proponent to develop alternative arrangements with Hydro Tasmania and other stakeholders.

Water trading

The MOU stipulates that any water allocation issued under these arrangements may not be traded on a permanent basis until the allocation issued under this agreement has been held for at least twelve months. If the property has changed hands prior to the twelve months the allocation is transferred to the new owner on a permanent basis. Temporary trading is allowed to take place during the twelve-month period.

Monitoring and metering

Water users who received an allocation under the MOU agreement are required to install flow meters and report water usage information to the Department.

Non-flood water

An initial transfer of 10,000ML per annum was agreed to be made available to dam permit holders who have obtained a permit to construct a dam since 1 July 1999. This water can be taken as either a fixed term or an absolute transfer at a maximum volume of ⅓ of storage capacity.

Review of MOU

It was agreed that this MOU was to continue for a ten-year period from signing and may be renewed for a further ten-year period with written approval from all parties.

Restriction Management

The river system is managed at two points within the catchment;

1) St Pauls River at a site just up-stream with the confluence of South Esk River (station number 18311); and
2) South Esk River at Llewellyn (Hydro Tasmania site).

Current restriction trigger levels for both of these locations are outlined in Table 10.

Table 10. Restriction trigger levels for the South Esk catchment.

Sub-catchment name	Cease to Take ML/day	Stages
St Pauls River u/s South Esk River	1.5	• Stage 1 – 5ML/day (roster) • Stage 2 – 2ML/day (roster)
South Esk River at Llewellyn	40	• Stage 1- 125ML/day (50% S6) • Stage 2 - 105ML/day (100% S6) • Stage 3 – 86 ML/day (50% S5) • Stage 4 – 50ML/day (maximum 0.65ML/day S5, Tue, Thur and Sat) • Stage 5 – 40ML/day (100% S5)

Historical Restriction Management

The history of restriction is varied and relates to the stream flow conditions at the time, but over the last five or so seasons some level of restriction has been imposed, including several bans during the last two seasons.

2.6.5 Dams in the catchment

There are 160 permitted dams in the South Esk catchment with a storage capacity of just over 40,000 ML. The dams range from <1 ML up to 2140 ML and are predominantly used for irrigation.

Information on Dam permits issued prior to 2000 to the present day is presented in Table 11. While there is a capacity to store 40,000 ML in the catchment, due to administrative issues, the Department has only issued allocations for 18,675 ML to date and is in the process of determining appropriate daily allocations for the remainder. This is recognised as a priority and is being addressed by The Department and Hydro Tasmania.

Table 11. Dams permits within the South Esk catchment issued since 2000.

	Dam Permits	Irrigation dams ML (permits)	Stock dams ML (permits)	TOTAL ML (permits)
Pre 2000	113	23001 (94)	405 (19)	**23406 (113)**
2000	6	520 (5)	1.5 (1)	**521.5 (6)**
2001	11	4345 (11)	0	**4345 (11)**
2002	5	662 (5)	0	**662 (5)**
2003	6	1435 (6)	0	**1435 (6)**
2004	5	2664 (4)	8 (1)	**2672 (5)**
2005	5	1757 (4)	10 (1)	**1767 (5)**
2006	1	408.5 (1)	0	**408.5 (1)**
2007	6	5175 (6)	0	**5175 (6)**
2008	2	582 (2)	0	**582 (2)**
TOTAL	**160**	**39967.5 (138)**	**424.5 (22)**	**40392 (160)**

2.6.6 Future water demand in the South Esk catchment

A summary of potential future water use in the South Esk catchment is given below. For more detailed information refer to the report on future water demand for the South Esk River catchment (DPIW, 2008c).

The quality of land in the South Esk catchment suggests that there are opportunities for more land to be converted from dry land agriculture to irrigated agriculture. Land of lesser quality still has the potential for non-cropping, or pasture-based irrigated agriculture. This land has been identified as having potential for the growth of a dairy industry in the Northern Midlands.

2.6.7 Water development

A number of water development proposals are currently being investigated in the South Esk Catchment.

Proposed water developments include:

- Meadstone Dam (St. Pauls River) – proposed to store 30,000 ML from the St. Pauls River and is in the final stages of evaluation.
- China Cup Dam (St. Pauls River) – engineering and environmental issues are currently being re-evaluated
- Hop Pole Creek – has been identified as best suited for a small to medium private development.
- Ben Lomond Rivulet – a private initiative; requirements based on the hydrology of the catchment is currently being evaluated.
- Midlands Water Scheme – proposed to take 50,000 ML from the Poatina Power Station and the South Esk River. The hydrological implications of the movement of water from the South Esk catchment to the Macquarie catchment and a far South as Oatlands and Mt. Seymour are currently being assessed.
- Evercreech Dam – is doubtful for engineering and geotechnical reasons.

For more information on water developments in the South Esk see the DPIW website at the link below.

http://www.dpiw.tas.gov.au/inter.nsf/Attachments/SSKA-7H29R6/$FILE/Status%20of%20Key%20Water%20Development%20Projects%20300708.pdf

2.7 Groundwater

2.7.1 Groundwater resources in the South Esk River catchment

The South Esk catchment potentially contains extensive groundwater resources. Groundwater occurs in the water bearing layers (aquifers) within unconsolidated sediments (silt, sand and gravel) and fractured rocks. Parts of the catchment have been subjected to various studies including the Tasmanian Regional Drought Initiative, Project 1 – Groundwater Field Investigation 2001, Geology and Groundwater Resources of the Longford Tertiary Basin, Geological Survey Bulletin 59, 1983 and geological mapping carried out by the Department of Mines/Mineral Resources of Tasmania. The studies aid in the characterisation of groundwater resources in the catchment but were not specifically produced for this purpose and do not provide entire coverage of the catchment.

Geology is one of the major controls on groundwater quantity and quality in any given catchment. The South Esk catchment comprises a complex series of sedimentary and igneous rocks. The following rock types have been mapped and characterised in the catchment:

Age	Rock Type	Description
Quaternary	Unconsolidated sediment	Sand, gravel and mud of alluvial, lacustrine and littoral origin; Talus
Tertiary	Unconsolidated sediment	Interbedded clay, silt sand and gravel layers of variable thickness.
Tertiary	Igneous	Basalt
Jurassic	Igneous	Dolerite
Triassic	Sedimentary	Fluviolacustrine sequences of sandstone, siltstone and mudstone
Permian	Sedimentary	Upper glaciomarine sequences of pebbly mudstone, pebbly sandstone and sandstone; Freshwater and paralic sandstone and mudstone with some coal measures.
Devonian	Igneous	Granite
Devonian-Silurian-Ordovician	Sedimentary	Mathinna Beds – Micaceous quartzwacke turbiditic sequences

The catchment can be divided into two main areas of hydrogeological importance; the western Tertiary sedimentary basin (Longford Tertiary Basin) and the eastern predominantly fractured rock basin.

Longford tertiary basin

The sediments of the Longford Tertiary Basin are relatively unconsolidated and consist of interbedded clay, sand and gravels. Yields in this type of material can be variable, however high yields (up to 15 L/sec) have been obtained in the basin. The yield obtained will largely depend upon which layer a given borehole penetrates. Typically areas which contain thick coarse-grained sand and gravel layers will yield higher quantities of water than those which contain clay layers.

Eastern predominantly fractured rock basin

The fractured rock aquifers of the eastern part of the catchment have the potential to yield significant quantities of groundwater. Fractured rock aquifers store and transmit water in joints, bedding planes and fractures. The degree of fracturing and deformation can be a determining factor in the yield of a bore. The sedimentary units comprising the Mathinna Beds and Permian sedimentary sequences have the highest groundwater prospectively of the fracture rock aquifers in the catchment and generally acceptable groundwater salinity values.

Igneous rocks within the catchment, such as the Tertiary basalts and dolerite aquifers can locally yield stock and domestic quantities of groundwater. However, they are generally less prospective than the sedimentary aquifers. Groundwater salinity in the basalt and dolerite aquifers is on average higher than the sedimentary units and in some cases significantly exceeds Australian Drinking Water guidelines.

Only one groundwater bore is recorded as being installed in the granite and limited data was recorded for that bore. In general, granite aquifers act as fractured rock aquifers and based on similar aquifers found elsewhere in the state are generally regarded as low yielding with variable water quality.

Recharge of the aquifers in both the Longford Basin and the eastern fractured rock basin is difficult to ascertain as there is limited data available. There is some evidence to suggest that the South Esk and Nile Rivers are contributing to groundwater recharge. This is based on a general trend of improving groundwater quality in the downstream areas of the catchment indicating good quality surface water is recharging the aquifer and hence diluting poorer quality groundwater.

A summary of the main groundwater aquifers, including likely yield and groundwater salinity is provided in Table 12. The yields and salinity values are based on records of bores drilled into each aquifer. The vast majority of successful bores have been drilled into the basalt aquifer in the upland basin.

Table 12. Summary of groundwater aquifers in the South Esk catchment.

Groundwater Aquifers in the South Esk Catchment#					
Aquifer Type		**Bore Yields (litres/sec)**		**Groundwater Salinity (mg/L)**	
		Range	**Average**	**Range**	**Average**
Unconsolidated sediments 1	Quaternary (10)	0.25-7.58	2.5 (4)	NA	1220.4 (1)
	Tertiary (55)	0.07-15.12	2.4(36)	180-7340	2426.8 (27)
Fractured rock 2	Basalt (8)	0.25-4.93	1.92 (7)	381.7-3640	1632.4 (4)
	Dolerite (11)	0.32-5.68	2.7 (8)	284.8-7880	3844.7 (4)
	Triassic	0.06–7.58	1.67 (9)	326-4185	1613 (4)
	Permian (15)	0.1-12.6	5.0 (9)	190-1291.6	830.6 (6)
	*Granite (1)	NA	NA	NA	NA
	Mathinna Beds (8)	0.19-12.6	4.9 (5)	54.1-406.8	230.5 (2)

Notes:

1. *Unconsolidated sediments consist of interlayered clay, silt, sand and gravel. The two main sedimentary sequences are the deep Tertiary sediments (up to 65 million years old) and the relatively deposits of alluvium, windblown sands and gravels and sands that were deposited in more recent times. Groundwater is stored between the grains or particles making up the sedimentary material. The best bore yields are obtained where the clay and silt content is low. In some cases the most productive aquifer may occur at depth with another aquifer overlying it.*
2. *Fractured rocks – Mathinna Beds (siltstone, sandstone, mudstone and slate), granites and basalt. Groundwater is stored in joints, bedding planes and fractures in the rock.*
3. *Groundwater salinity – groundwater in all aquifers listed is generally suitable for stock purposes. Groundwater with a salinity greater than 500 mg/L is generally not suitable for irrigation.*

() Parenthesis indicate the total number of boreholes installed in each geological unit and the number of boreholes used to calculate statistics.

All data is derived from the MRT groundwater database (January 2007) and uses data supplied by drillers at the time of drilling.

^ Groundwater salinity in the Mathinna Beds may be much higher in the contact zones near the granite

** No data available for boreholes installed in granite*

2.7.2. Groundwater issues in the South Esk catchment

Three potential groundwater issues have been identified in the South Esk catchment.

1. Groundwater retained in Tertiary basalts and sedimentary rock aquifers in the southern sections of the catchment near Conara contains high total dissolved solids. It is possible that during periods of low flow in the South Esk River this water may discharge into the river increasing the salt load.
2. Dryland salinity processes should be considered with any change in landuse or agricultural activity to avoid salt mobilization from shallow aquifers.
3. The potential effect of landuse change, such as forestry operations, on groundwater recharge of local springs, streams and groundwater quality.

2.7.3 Groundwater activities in the South Esk catchment

The Department of Primary Industries and Water is currently working towards licensing and monitoring of groundwater use in the State.

Groundwater licensing

The Department aims to introduce groundwater licensing in the next 4 to 8 years. The Department is currently developing a regulation framework for groundwater. It is expected that basins in catchments along the north coast will be the first catchments to have licensing arrangements implemented.

Groundwater monitoring

The State Government is increasing the number of bores in the statewide groundwater-monitoring network. Some additional bores may be drilled for this purpose in the South Esk catchment.

Other Statewide groundwater activities that will affect the South Esk catchment

- The Department is aiming to introduce a drillers licensing system by 2009. This will regulate bore construction standards.
- The Department is anticipating the introduction of a permit-to-drill system, which coincide with the introduction of drillers licensing. This will help ensure that bores are located and constructed to optimise the advantage of available groundwater resources, and protect the interests of other groundwater users.

3. Developing Objectives for the South Esk Water Management Plan

Water Management Plans present a clear statement of the community's environmental, social and economic objectives for the relevant water resources and describe the water management regime that best gives effect to these objectives.

Under the *Water Management Act 1999* a water management plan "is to include a statement of the objectives of the plan including environmental objectives." These objectives need to take into account outcomes of consultation with local stakeholders to determine important environmental, economic and social values and other relevant interests and local concerns.

The objectives can be divided under three main headings:

- Environmental
- Water usage and development
- Social

Environmental objectives – set out what the Plan aims to achieve in terms of environmental outcomes, based on the natural and environmental values in the catchment that have been identified as important.

Water usage and development objectives – set out what the Plan aims to achieve in terms of economic outcomes, based on the existing consumptive use of water and potential future demand.

Social objectives –reflect the more general values of the community with regard to water and its management which can include recreational and aesthetic values.

Water management provisions provide the mechanisms through which specific Plan objectives can be met, including water allocation limits that will define the volume and timing of water available for sustainable allocation at various sureties.

There have been a number of meetings and surveys of individuals throughout the South Esk catchment, seeking community input on water resource values. The outcome of these has been included in Appendix A, and along with generic objectives, provide a guide for the establishment of objectives for inclusion in the Plan.

Appendix A Information for establishing objectives of a plan

A1 Generic Plan Objectives

Environmental objectives

- Provide a flow regime to conserve important fresh water ecosystem values (normally as identified through the Conservation of Freshwater Ecosystem Values database).
- Provide flows to protect locally important geomorphic and ecological processes.
- Provide healthy refuges for in-stream communities during periods of low flow reflective of natural flow regimes.

CFEV will provide the baseline information for determining a Plan's environmental objectives.

Water usage and development objectives

- Provide water for stock and domestic use as a high priority.
- Formalise existing water usage as appropriate to ensure compliance with the *Water Management Act 1999*.
- Recognise historical water taking where such taking is necessary to underpin commercial enterprises, while giving higher priority to existing legal entitlements.
- Ensure as far as practicable that future allocations are not detrimental to the quality of water resources in the Plan area.

Objectives for improving knowledge of the water resources

- Continue to improve knowledge of the condition and state of the Plan's water resources and aquatic environment.
- Continue to improve knowledge of surface water and groundwater use.

A2 South Esk above Macquarie Catchment - Community and State Water Values

The following community water values were identified at a number of workshops in the Macquarie River and South Esk River catchment areas during the development of environmental management goals for Tasmanian surface waters under the Protected Environmental Values (PEVs) setting process. These values relate to both water quality and water quantity and while many of them may relate to values outside of the South Esk catchment they can be used as a guide when considering catchment specific values for objective setting.

Table A1: Nominated Water Values - Campbell Town stakeholder workshop (14 March 2000) and advertised public meeting (3 April 2000).

Water Value Categories	Nominated Water Values
Ecosystem values	• Water for maintaining riparian vegetation • Waterways with less willows and more tea-trees • Less cumbungii in waterways (possibly related to flows or spread by birds) • Successful translocation of Swan galaxiids (native fish) to upper South Esk tributaries • Pygmy perch in the Macquarie and South Esk rivers • Brown trout in some of the region’s waterways • Rainbow trout at Lake Leake • Platypus widely distributed • Eels • Fresh water mussel in parts of the South Esk & Macquarie • Provides bird habitat • Astercopsis franklinii (freshwater crayfish) • Provision of seasonal flow cycles • Maintaining fish life • Maintain instream habitat for animals and plants • Maintain environmental flow in Elizabeth/Macquarie system (3 ML/day suggested)
Consumptive or non-consumptive values	• Water storage values of broadwaters • Irrigation use • Hydro electricity generation (Hydro has primary control over waters in South Esk Basin) • Stock and domestic use • Coal washery at Fingal • Town water supply • Feedlot supply on South Esk at Powranna • Swimming pools at Campbelltown and Ross • Use for forestry activities (new growth reduces catchment yield as opposed to old growth, this change in yield is particularly significant over low flow summer periods)
Recreational values	• Fishing for trout and eels (particularly Tooms Lake, Lake Leake and lower reaches of Macquarie and South Esk rivers)

Water Value Categories	Nominated Water Values
Recreational values cont.....	• Canoeing on the Macquarie (starting at Ross) • Camping (Griffen Park on South Esk; Bridge at Mathinna) • Swimming at all towns without pools. At Mathinna. Possibly weir at Campbell Town but broken glass. • Power-boating on broadwaters • Duck shooting all waterways • Bird watching
Aesthetic landscape values	• Rivers at Ross, Campbell Town and Perth as part of townscape
Physical landscape values	• Water over Perth weir • Riffle (rapids) zones along rivers • Broadwaters on the Macquarie and South Esk
Other issues	• Hydro operations and interactions with u/s users in terms of peak flows periods • Relative economic values of different water usages • Need for well-controlled weirs • Storage of excess winter flows and releases which mimic seasonal flow variations • Call for construction of dam at Longmarsh on upper Macquarie

Table A2: Nominated Water Values - Cressy stakeholder workshop (15 March 2000) and advertised public meeting (4 April 2000).

Water Value Categories	Nominated Water Values
Ecosystem values	• Native vegetation instead of willows on waterways (while willows generally undesirable because they block river and reduce habitat, they may be preferable to no vegetation cover) • Macquarie free of 'ricegrass' (probably reed *Phragmites australis*), some patches upstream of Woolmers Bridge • Waterways free of blue-green algal blooms • River flows which maintain native vegetation of waterways • Maintaining variable flows in waterways • Breeding habitat (flow over gravel bed ideal for breeding trout) • Clear water in tributary streams • Maintaining threatened galaxiids in Woods Lake
Consumptive or non-consumptive values	• Rivers have value as transport mechanism for tradeable water • Town drinking water • Stock and domestic use for riparian landowners • Homestead use (drawing water from waterways for individual domestic use [this may include drinking but the Director of Public Health requires all drinking water to be treated]) • Watering gardens (domestic) • Irrigation (increasing demand)

Water Value Categories	Nominated Water Values
Consumptive or non-consumptive values cont.	• Water supply for power generation at Trevallyn (ability to undertake works allowed for under the water licence) • Stable regulated flow regimes arising from Hydro operations (opportunity for community input into these operations) • Industrial use at Sevrup fish farm and Longford abattoirs (however PEVs have already been set for these areas) • Use by small scale commercial enterprises in the area – vehicle wash downs etc
Recreational values	• Swimming at varied locations. Particularly over summer where public roads cross over rivers. Not on the Lake River. • Angling • Kayaking (scouts use the Macquarie between Campbell Town and Longford) • Duck shooting along the Macquarie and South Esk • Camping & bushwalking on riverbanks
Aesthetic landscape values	• General appeal of native riparian (riverside) vegetation
Physical landscape values	• Unblocked streams (no blockages due to sediment build-up around willows)
Other issues	• Woods Lake used for flood control • Minimise sewage input into waterways • Private storages – could be used as flood buffer for downstream areas by keeping empty over high rainfall period, alternative view that should fill up at these periods • Higher water levels in Woods Lake provide higher water values – in terms of the ecology, water quality and downstream use • Lake Sorell related to upper Macquarie river and catchment health.

Table A3: Nominated Water Values – Fingal stakeholder workshop (16 March 2000) and advertised public meeting (5 April 2000).

Water Value Categories	Nominated Water Values
Ecosystem values	• Protection and retention of riparian vegetation • Water filtering role provided by wetlands (including Epping Marshes) • Galaxiids (native fish) translocated to sites in upper South Esk • Blackfish • Waterways free of weeds (willows, cumbungii etc.) • Visits by white breasted sea eagle • Role of floods in maintaining floodplain and wetland health
Consumptive or non-consumptive values	• Stock watering • Household/Domestic (this may include drinking but the Director of Public Health requires all drinking water to be treated) • Town drinking water supply (both river and groundwater) • Irrigation • Other water used in food production • Coal washery at Fingal • Electricity generation
Recreational values	• Tourism related • School camping and water related activities at Rostrevor • Photography • Fishing • Duck shooting • Water skiing (Ormley between Avoca and Fingal) • Bird watching • Swimming (Fingal upstream of sewage treatment plant past railway; Mathinna; Avoca; Briar Corner on Break O'Day; Royal George) • Camping (Griffen Park at Mathinna; State Forest areas; where permitted on private land)
Aesthetic landscape values	• Tourism related (waterfalls etc.) • Provides more interesting surroundings • Aesthetic value of river as whole
Physical landscape values	• Meadstone Falls in St Pauls catchment • Falls at Mathinna
Other issues	• Educational value as resource for schools • Waterways have historical and cultural value in determining the pattern of settlement • Scientific value for water quality & ecological studies • Water has range of economic values • Social value for recreation, tourism and aesthetic appreciation • Use of waterways as drain (runoff from private dwellings, irrigation etc)

Water Management Goals

The values above were reviewed and finalised down to the following Water Management Goals at a meeting of the South Esk above Macquarie Water Management Planning Focus Group, held at Avoca on April 19, 2000.

Water Allocation

1. Allocate water for stock, domestic and town supplies (Avoca, Fingal, St Marys, Mathinna, Rossarden, Cornwall, Mangana and Royal George).
2. Allocate sufficient water for the environment to protect stream habitats and ecosystems, including any endangered species.
3. Allocate water for irrigation and industry, including hydroelectric power generation at Trevallyn, the Fingal coal washery, Powranna Feedlot and other commercial enterprises.

Water Management

4. Maintain seasonal variability in all streams.
5. Maintain groundwater levels critical to surface flows and ecosystems.
6. Encourage storage of water and optimise the timing of water takes.
7. Establish guidelines for an equitable water trading system.
8. Establish and enforce a clear set of water management rules to:
   - support water allocations;
   - maintain irrigation, stock and domestic supplies from groundwater systems;
   - protect riparian (particularly native) vegetation and minimise any effects on the riparian zone;
   - protect the water storage value of broadwaters; and
   - maintain recreational, aesthetic, educational and tourism values, consistent with other uses of the river.

Water Quality Protection

9. Manage flows to minimise algal outbreaks and maintain water quality in tributary streams.

Appendix B. Environmental Priorities in the South Esk Catchment and their associated risk based on flow requirements.

Table B1. Environmental priorities identified through assessment of environmental flow requirements of the South Esk River and the associated flow components that support those priorities, and the indicative risk posed by current water use. Risk is categorised as low or medium level of risk, based on the part of the flow regime that appears to be most affected by current water abstraction.

Environmental priorities	Flow components that support the priorities	Flow component	Season	Risk
Maintain populations of native fish	Seasonal occurrence and magnitude of freshes and minor flood events that act as triggers for migration, spawning and dispersal.	Freshes, Bank full, Over bank	Spring Autumn-Winter	Low Low
	Base flows that provide connectivity between pools.	Low flows	Summer-Autumn	Medium
	Flood events that flush out fine sediments and rejuvenate spawning sites	Freshes, Bank full	Autumn-Winter	Low
	Seasonal base flows to maintain water in fringing aquatic weed beds as habitat for juvenile and adult native fish.	Low flow	Winter - Spring Summer-Autumn	Low Medium
Maintain existing macro invertebrate community diversity and abundance	Seasonal pattern of change in base flow and flow variability to support in stream dispersal mechanisms.	Low flow, Freshes, Bank full	Anytime	Low
	Base flows that provide adequate in-stream habitat during dry months.	Low flow	Summer-Autumn	Medium
	Flow events that flush out unpalatable filamentous algae (late summer and autumn).	Freshes, Bank full	Summer-Autumn	Low
	Freshes and flood events that redistribute bed material and large woody debris and provide a diversity of benthic and hydraulic habitats.	Freshes, Bank full	Anytime	Low
	Flow events that inundate littoral leaf packs and detritus.	Low flows, Freshes	Summer-Autumn	Medium
	Flow events that maintain riparian vegetation as sites for breeding and oviposition, as well as source of instream wood and leaf-packs for food and habitat.	⇒	⇒	See flow components for riparian vegetation

Table B1. Continued…

Maintain population of freshwater mussels	Minimise duration of extreme low flow events (duration)	Low flows	Summer-Autumn	Medium
	Flows that sustain fish populations upon which the life-cycle and dispersal of this species relies.	⇒	⇒	See flow components for fish
Maintain population of platypus	Summer low flows and winter high flows that maintain foraging habitat and food supply.	Low flows Bank full, Over bank	Summer-Autumn Winter	Medium Low
	Flow events that maintain riparian vegetation habitat that is suitable for burrows.	⇒	⇒	See flow components for riparian vegetation
Provide habitat of good quality for in-stream biota	Flow events that flush out fine sediment.	Freshes Bank full, Over bank	Autumn-Winter	Low
	Flood events that import and move large woody debris and redistribute detritus.	Bank full, Over bank	Anytime	Low
	Freshes and moderate flow events that maintain habitat within riffle substrate.	Bank full, Over bank	Anytime	Low
	Large flood events that maintain broadwater habitats.	Large Over bank flood	Anytime	Low
Maintain productivity and benthic metabolism of riverine ecosystem	Base flow conditions that maintain sufficient hydraulic gradient through interstitial pores of riffle zones	Low flows	Summer-Autumn	Medium
	Flow events that reduce abundance of filamentous algae, flush out interstitial pores and reset biofilms.	Freshes, Bank full, Over bank	Summer-Autumn	Low
Maintenance of healthy in-stream macrophyte communities and current spatial coverage/distribution	Seasonal pattern of wetting and drying (frequency, duration, rate of rise and fall) of fringing lateral benches.	Freshes, Bank full	Spring-Summer-Autumn	Low
	Freshes and floods during summer and autumn to reduce epiphytic algal growth.	Freshes Bank full	Summer-Autumn	Low

Table B1. Continued…

	Freshes and floods during summer and autumn to prevent reduced water clarity by planktonic algae and reduce potential bloom development.	Freshes, Bank full	Summer-Autumn	Low
Sustain existing riparian and floodplain vegetation	Bankfull flows (frequency and duration) to replenish riparian groundwater levels.	Bank full, Over bank	Winter-Spring	Low
	Large flood events (frequency and duration) to recharge local and regional groundwater systems.	Over bank	Winter-Spring	Low
	Regeneration of established trees and shrubs through disturbance flow events.	Over bank	Anytime	Low
	Freshes and floods that provide function of seed dispersal and trigger for germination.	Freshes, Bank full	Winter-Spring	Low
	Periods of stable low flows and short duration wetting events to stimulate seedling establishment and survival.	Low flows, Freshes, Bank full	Spring-Summer Autumn	Medium Low
Sustain floodplain wetlands and associated *Poa* grasslands	Frequency and duration of overbank events that inundate riparian areas and floodplains.	Over bank	Winter-Spring	Low
	Events that transfer nutrients and sediment from the river to the floodplain.	Over bank	Anytime	Low
Maintain current geomorphic character and processes	Frequency and duration of events that provide scouring of finer sediment.	Freshes, Bank full	Anytime	Low
	Flow events that redistribute larger bed material and create new 'patches' of instream physical features.	Bank full, Over bank	Anytime	Low
	Large events that maintain floodplain development processes and character.	Over bank	Anytime	Low

References

CFEV (2005) Conservation of Freshwater Ecosystem Values Project Database. Water Resources Division, Department of Primary Industries and Water, Hobart, Tasmania.

DPIWE (2005) NAP Region Hydrological Models. South Esk Catchment. 0Department of Primary Industries, Water and Environment, Hobart. Technical report.

DPIW (2007a) Assessment of Freshwater Ecosystem Values in the South Esk River catchment: Guidance for Water Management, Primary Industries and Water, Report Series WMP 07/11.

DPIW (2007b). Surface Water Hydrology of the South Esk River catchment. Technical Report No. WA 07/02. Water Assessment Branch, Department of Primary Industries and Water, Hobart.

DPIW (2007c) Environmental Flows for the South Esk Water Management Plan. Technical Report No. 07/01. Water Assessment Branch, Department of Primary Industries and Water, Hobart.

DPIW (2008a). Water Assessment Water Monitoring Report Series, Water Quality Monitoring in the South Esk River Catchment (above Macquarie). (Internal Reference No. WA 07/12) Water Assessment Branch, Department of Primary Industries and Water, Hobart.

DPIW (2008b) Water Use and Management Arrangements for the South Esk River (above Macquarie junction). Water Policy and Planning Branch, Technical Report WMP 08/01, Department of Primary Industries and Water, Hobart.

DPIW (2008c) Future Water Demand in the South Esk River Catchment (above Macquarie junction). Water Policy and Planning Branch, Technical Report WMP 08/02, Department of Primary Industries and Water, Hobart.

Fulton, W. (1990) Tasmanian Freshwater Fishes. Fauna of Tasmania Handbook no 7. Fauna of Tasmania committee, University of Tasmania in association with the Inland Fisheries Commission of Tasmania.

Krasnicki, T., Pinto, R., and Read (2001). Australia Wide assessment of River Health; Tasmanian Program Final Report. Department of Primary Industries, Water and the Environment. Report Series WRA 01/2001.