



DEPARTMENT of
PRIMARY INDUSTRIES,
WATER *and* ENVIRONMENT

Hydrological Analysis of the Duck River Catchment

A report forming part of the requirements for State of Rivers reporting

Authors:
Shivaraj Gurung & Sunil Dayaratne
Water Assessment & Planning Branch
Water Resources Division
DPIWE

December, 2003.



Copyright Notice:

Material contained in the report provided is subject to Australian copyright law. Other than in accordance with the *Copyright Act 1968* of the Commonwealth Parliament, no part of this report may, in any form or by any means, be reproduced, transmitted or used. This report cannot be redistributed for any commercial purpose whatsoever, or distributed to a third party for such purpose, without prior written permission being sought from the Department of Primary Industries, Water and Environment, on behalf of the Crown in Right of the State of Tasmania.

Disclaimer:

Whilst DPIWE has made every attempt to ensure the accuracy and reliability of the information and data provided, it is the responsibility of the data user to make their own decisions about the accuracy, currency, reliability and correctness of information provided.

The Department of Primary Industries, Water and Environment, its employees and agents, and the Crown in the Right of the State of Tasmania do not accept any liability for any damage caused by, or economic loss arising from, reliance on this information.

Preferred Citation:

DPIWE (2003) *State of the River Report for the Duck River Catchment*. Water Assessment and Planning Branch, Department of Primary Industries, Water and Environment, Hobart.
Technical Report No. WAP 03/08

ISSN: 11449-5996

The Department of Primary Industries, Water and Environment

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

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

TABLE OF CONTENTS

HYDROLOGICAL ANALYSIS OF THE DUCK RIVER CATCHMENT	1
1. <i>Historical Background</i>	1
1.1 Catchment and Drainage Systems	1
1.2 Rainfall	2
1.3 Water Usage and Diversions	2
2. <i>Hydrological Monitoring in the Catchment</i>	3
2.1 Rainfall Monitoring	3
2.2 River Flow Monitoring	3
3. <i>Catchment Yields and Distribution of Flows</i>	4
3.1 Catchment Yields	4
3.2 Monthly Yields	5
4. <i>Comparison between Study Period and Historical Data</i>	5
5. <i>Recessions and Low Flows</i>	6
6. <i>Floods</i>	8
7. <i>References</i>	9

Hydrological Analysis of the Duck River Catchment

1. Historical Background

1.1 Catchment and Drainage Systems

The Duck River catchment is located in the northwest of the state and occupies an area of approximately 542 km². It is bordered by the Black-Detention River catchment in the east, the Montagu River in the west, and the Arthur River in the south. The location of the catchment and stream network is shown in Figure 1.1.

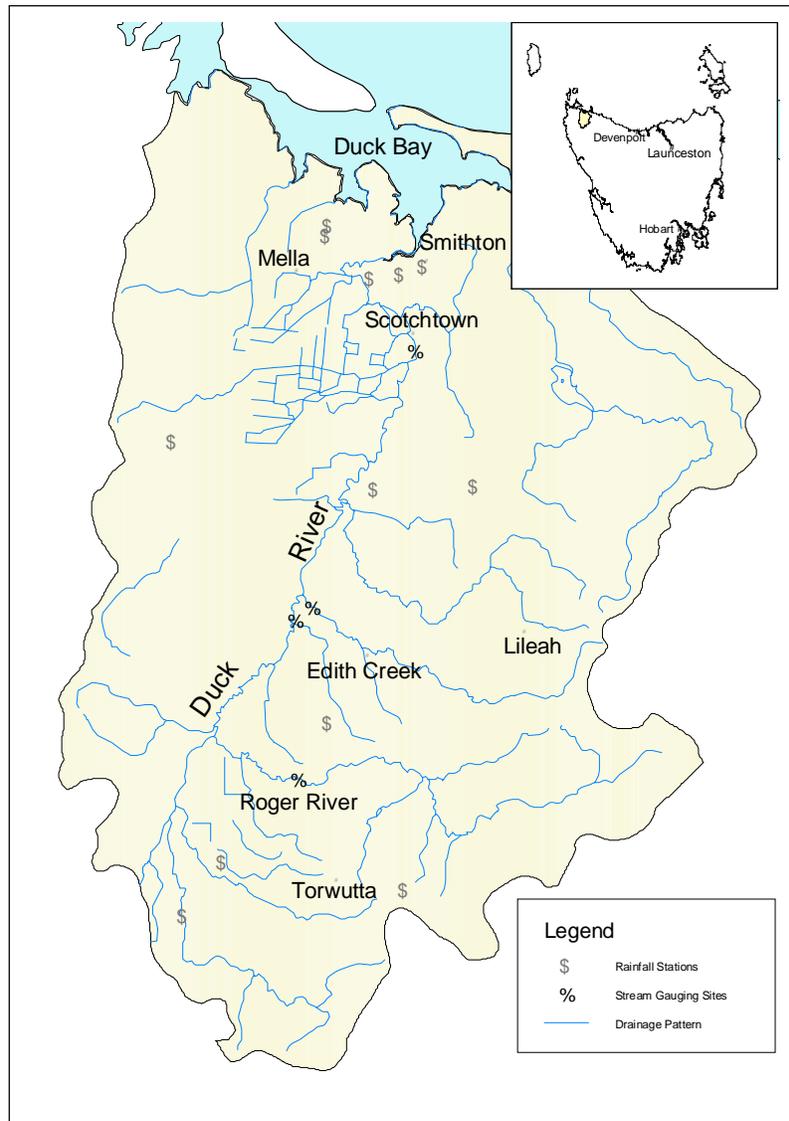


Figure 1.1 Hydrological set up of Duck River catchment.

The Duck River originates in Gibson Plains, southeast of Nabageena. It flows roughly west to Junction Plains crossing the Bass Highway at Roger River township. From there the river flows north through low-lying plains, accepting flows from its main tributaries (Roger River, Edith Creek, Allen Creek and Geales Creek) before flowing through to Smithton and into Duck Bay approximately 45 km downstream from the source. Several minor ephemeral creeks and farm drains discharge into Duck River during the winter months.

1.2 Rainfall

Annual average rainfall in the Duck River catchment varies spatially from approximately 1100 mm to 1500 mm. Rainfall is mainly dictated by topography, with highest rainfall occurring in the upper catchment (Trowutta). As expected in such a small catchment, the pattern of average monthly rainfall is relatively similar across the catchment (as shown for Smithton, Irishtown and Trowutta in Figure 1.2), with highest rainfall occurring during the winter months and lowest during summer.

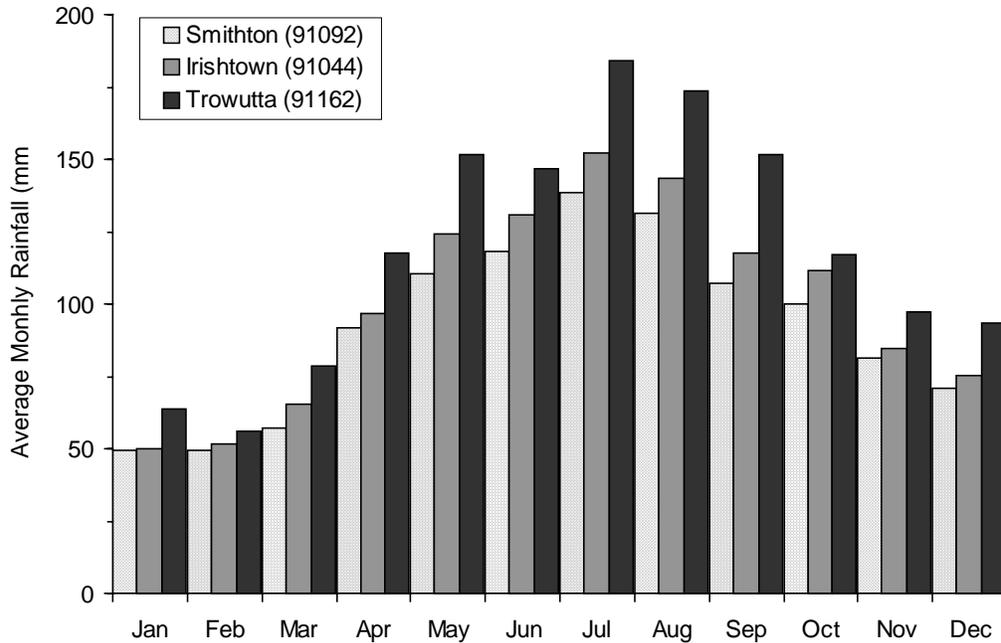


Figure 1. 2 Average monthly rainfall at selected sites in the Duck River catchment.

1.3 Water Usage and Diversions

Land use practices in the catchment include pasture, irrigated cropland, forestry and rural residential development. Direct offtakes, in-stream and off-stream farm dams have traditionally provided the major irrigation and stocking water supply over dry summers in the Duck River catchment. The majority of water allocations for agricultural purposes in the catchment are located on the main tributaries (Coventry Creek, Allen Creek, Edith Creek, Roger River and Geales Creek), as many of the allocations are linked to on-farm storages which make up 62% of the total water allocation. Water usage is also high from subsidiary drainages like Fentons Creek and Scopus Creek, which do not directly flow into Duck River but receive considerable discharge from shallow groundwater in the Mella area. A summary of the direct summer takes from the Duck River catchment (including Deep Creek) is presented in Table 1.1.

Table 1.1 A Summary of water allocations in the Duck River catchment.

Source	Intended Use	License Volume (ML)
Duck River & tributaries	Irrigation	7,790
	Stock & Domestic	456
	Commercial & Industrial	2,983
	Water Supply	2,028
	Total	13,257

Data source: WIMS: Water Information Management System website @ <http://wims.dpiwe.tas.gov.au> .

2. Hydrological Monitoring in the Catchment

2.1 Rainfall Monitoring

There are 12 rainfall stations with varying periods of recorded rainfall data. Of these, 5 are currently operated by the Bureau of Meteorology (Table 2.1). Some of the stations also maintain daily measurements of evaporation and temperature. Historical records are also available for a number of stations that are no longer operational. The Bureau of Meteorology data can be accessed from the Internet site <http://www.bom.gov.au> or from the regional Bureau of Meteorology office at Hobart.

Table 2.1 Bureau of Meteorology rainfall stations in the Duck River catchment.

Station	Station Name	AHD (m)	Start Record	End Record
91044	Irishtown (Johns Hill Road)	51	31/12/1907	Current
91074	Edith Creek	50	31/05/1924	Current
91092	Smithton (Grant Street)	7	31/07/1911	31/10/1997
91139	Smithton (Leesville)	10	31/12/1934	31/07/1940
91162	Trowutta (Ringwood)	190	29/02/1964	Current
91163	Roger River (West)	6	29/02/1964	28/02/1969
91178	Christmas Hills	80	30/11/1965	30/11/1970
91201	Smithton (Upper Havelock St)	8	31/10/1999	Current
91204	Roger River Estate	33	28/02/1969	31/05/1977
91224	Smithton Aerodrome_1	8	31/08/1961	31/08/1998
91231	Pelerine (Newington Park)		31/12/1909	30/11/1917
91292	Smithton Aerodrome_2	8	03/12/1996	Current

AHD: Australian Height Datum in metres.

2.2 River Flow Monitoring

Table 2.2 lists 7 stream flow monitoring sites in the Duck River catchment of which only one stream gauge is currently operational. Flow data from other gauging sites are either discontinuous or are daily measurements for short periods.

Table 2.2 Stream flow monitoring sites in the Duck River catchment.

Site	Site Name	Area (km ²)	Start Record	End Record
14214	Duck at Scotchtown Road	339	22/04/1966	Current
14232	Duck River at Roger River		22/05/1985	08/02/1990
14233	Duck River at Edith Creek		01/05/1985	30/04/1989
14239	Edith Creek at Edith Creek		20/11/1990	12/01/1999
14240	Edith Creek u/s Duck River		20/11/1990	08/04/1991
14244	Roger River at Buffs Road		30/10/1991	14/12/1998
14256	Coventry Creek at Scotchtown Road		24/04/1992	14/12/1998

3. Catchment Yields and Distribution of Flows

3.1 Catchment Yields

The historical total annual discharge volumes at Duck River at Scotchtown Road (14214) are shown in Figure 3.1. Blank sections in the figures indicate periods for which there was no flow data recorded. The annual discharge volume at this site ranges from 98,000 to 342,000 ML, with an annual average discharge of 183,000 ML (based on 35 years of record). The estimated average annual catchment yield is approximately 288,000 ML.

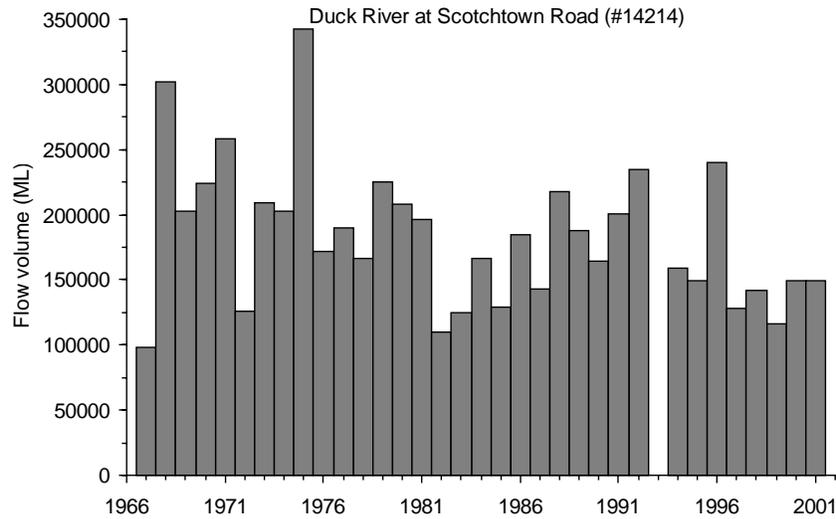


Figure 3.1 Annual flow volumes at Duck River at Scotchtown Road.

As expected, there is a distinctly seasonal pattern of flow in the Duck River (Figure 3.2), with winter discharge volumes about 3 to 5 times greater than that which occurs during the summer. Winter discharge ranges from 35,000 to 275,000 ML and summer discharge ranges from 17,000 to 70,000 ML with a mean of 31,000 ML. The average estimated catchment yields were 50,000 ML and 238,000 ML for summer and winter period respectively. The low summer flow conditions indicate that rainfall and runoff are generally low during irrigation seasons.

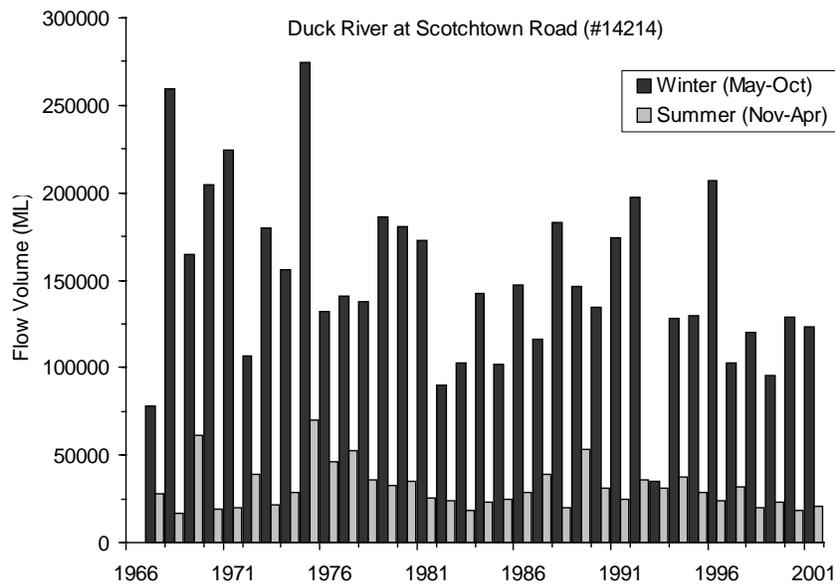


Figure 3.2 Seasonal flow volumes at Duck River at Scotchtown Road.

3.2 Monthly Yields

The variability of monthly flows in the Duck River catchment is shown in Figure 3.3, which provides box and whisker plots of monthly average instantaneous flow data. Extreme outliers have been excluded from the plot. The horizontal line across the box represents the median flow whereas the bottom and top edges of the box mark the first and third quartiles respectively. The ends of the whiskers show the spread of 95% of the data. The crosses beyond the whiskers indicate high and low outliers.

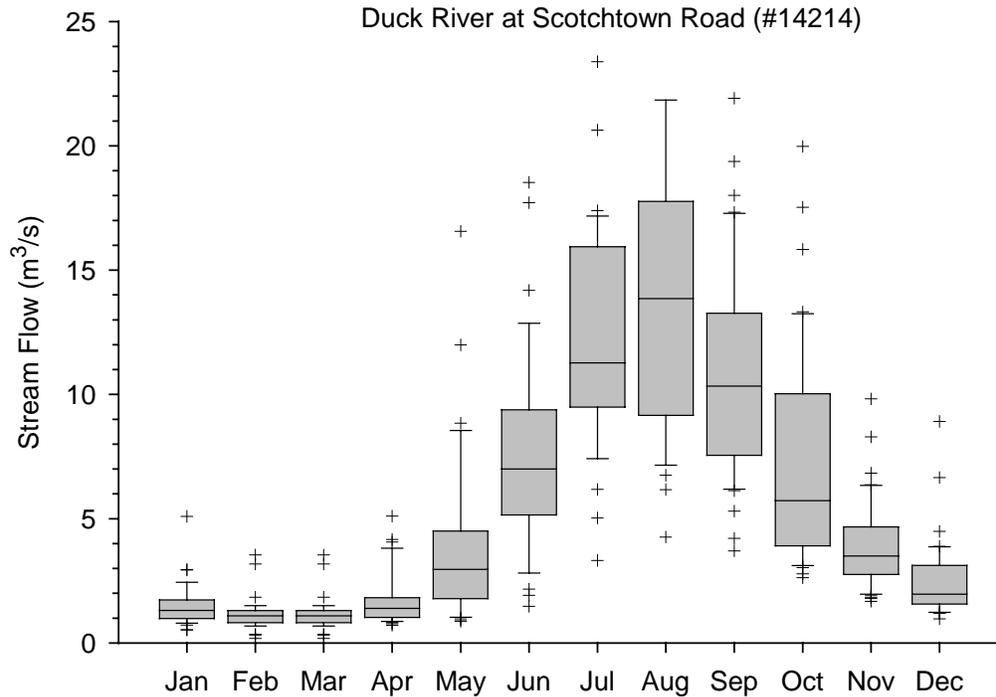


Figure 3.3 Monthly Flow Analysis from Duck River at Scotchtown Road.

Monthly flows from Duck River at Scotchtown Road (14214) show patterns of seasonal variations with higher flows during winter period followed by low flows during the summer period. Monthly median flows from the Duck River site ranged from 1 m³/s flows in summer to around 14 m³/s during winter. Average monthly flows ranged from low 2.0 m³/s in summer to high 10.0 m³/s during winter.

4. Comparison between Study Period and Historical Data

Figure 4.1 shows a comparison between the monthly average flow volumes experienced at the Duck River at Scotchtown Road (14214) during the study period (1999-2001) with the historical records. The bar chart shows that the flows in all months were generally lower than the historical flow record, particularly during the autumn and winter seasons. The monthly flows during the study period ranged from approximately 1.0 m³/s to 12 m³/s with an average of 4.4 m³/s. The historical monthly flows ranged from 1 m³/s to 14 m³/s with an average of 5.7 m³/s. The overall monthly average flows during the study periods were approximately 24% lower than the historical average flows.

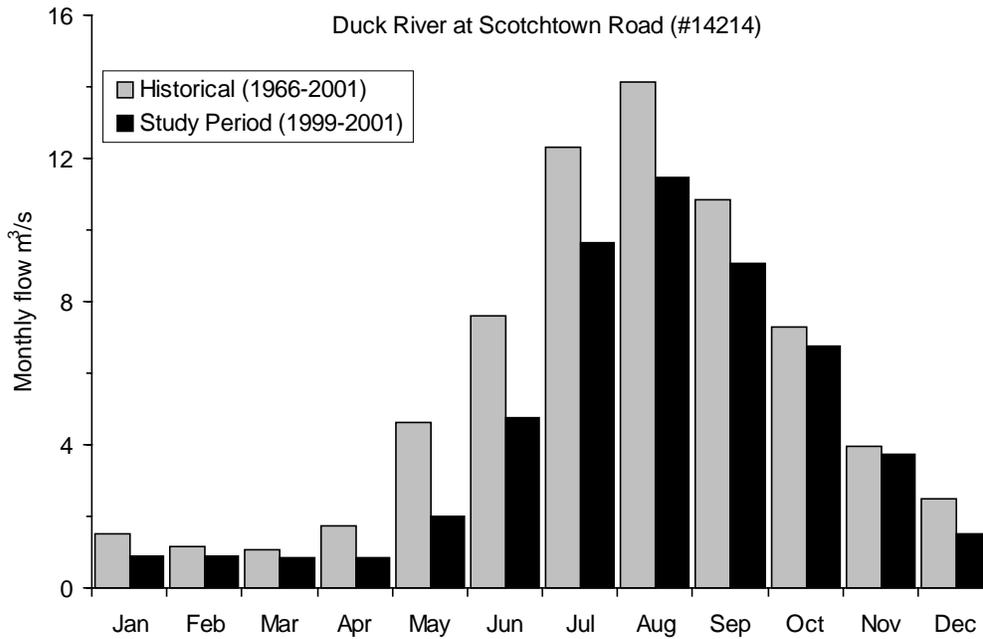


Figure 4.1 Comparison of monthly flows from Duck River at Scotchtown Road.

5. Recessions and Low Flows

Segments of peak flow hydrographs covering the study period were analysed to describe the recession flows for the Duck River at Scotchtown Road (14214). The recession curves are segments of hydrographs, which show how the water storage in the river decreases over time following peak river flows. Using several recession segments for the analysis, a 'recession curve' can be generated which represents the basic pattern of decrease of flow in the river. The recession curve also reflects the groundwater discharge to the river and how groundwater storage influences and sustains flows in rivers.

The winter and summer recession curves for the Duck River at Scotchtown are presented in Figure 5.1. The upper part of the recession curves is comprised mostly of surface water flow. With time, the surface flow contribution gradually decreases until the flow is comprised almost entirely of groundwater flow (or base flow) which is depicted on the lower section of the curves.

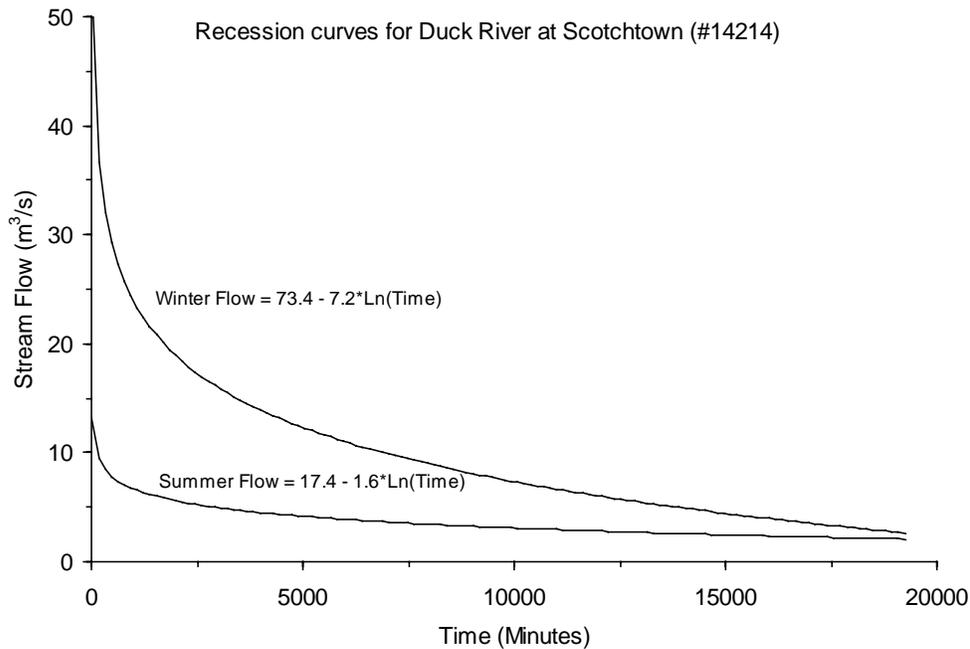


Figure 5.1 Recession curves for Duck River at Scotchtown Road.

The flow recession at Duck River at Scotchtown Road roughly follows a lognormal fitted curves described by the following equations:

$$\text{Winter Flow} = 73.4 - 7.2 * \text{Ln}(\text{Time in minutes}), R^2 = 0.95$$

$$\text{Summer Flow} = 17.4 - 1.6 * \text{Ln}(\text{Time in minutes}), R^2 = 0.81$$

The curves demonstrate that it takes approximately 19000 minutes (13 days) for the flow to recede from 45 m³/s to 5 m³/s during winter. During the summer the recession period was considerably shorter (7 days) for flows to recede from approximately 12 m³/s to base flow of around 5 m³/s.

Low flow frequency curves were derived for 10, 30, 60 and 90-day durations (Figures 5.2). The curves are intended to indicate probability of minimum flow occurrence over various durations. For example, the probability that a minimum average daily flow of 1 m³/s will occur in any given year over 10 days is approximately 80%, while over a longer period such as 90 days this probability decreases to around 60%.

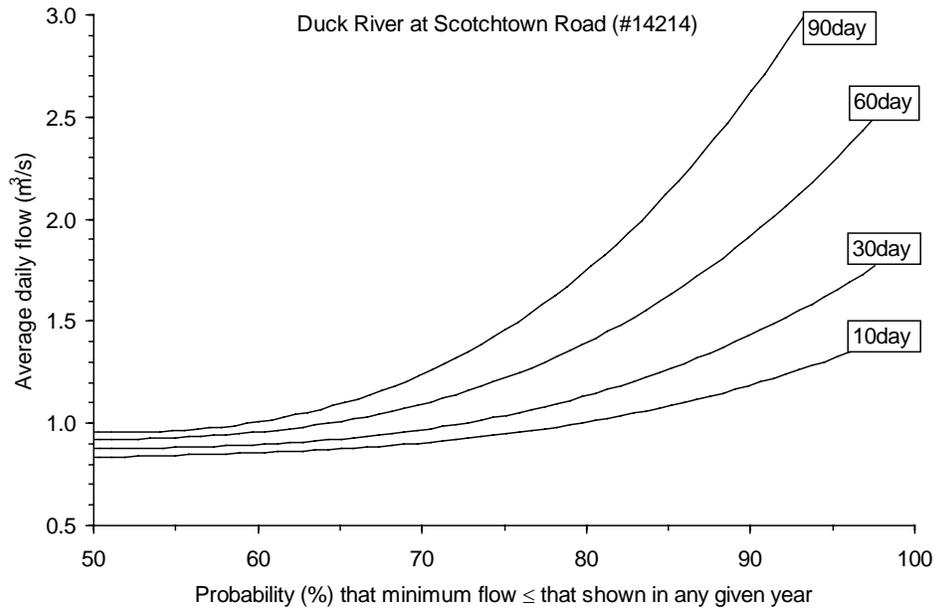


Figure 5.2 Low flow frequency curves for Duck River at Scotchtown Road.

The probability of low flow information has implications for the establishment of environmental flow allocations for the Duck River catchment and for the assessment of risk in supply of water from the rivers for purposes such as irrigation and domestic use.

6. Floods

Flood frequency analysis for the Duck River at Scotchtown Road (14214) was carried out to estimate the probability of floods in the river at this location. The result of this analysis is presented in Figure 6.1. An example of how to read this graph is that the magnitude of 1 in 10 year flood event in the catchment is approximately 75 m³/s. The historical annual peak floods ranged from 25 m³/s to 100 m³/s over 35 years of record period (1967-2001). During the study period, the highest discharge of 100 m³/s (3.45 m river level) occurred on 21/07/2000 which is equivalent to a 1 in 50 years flood event at the Scotchtown Road location.

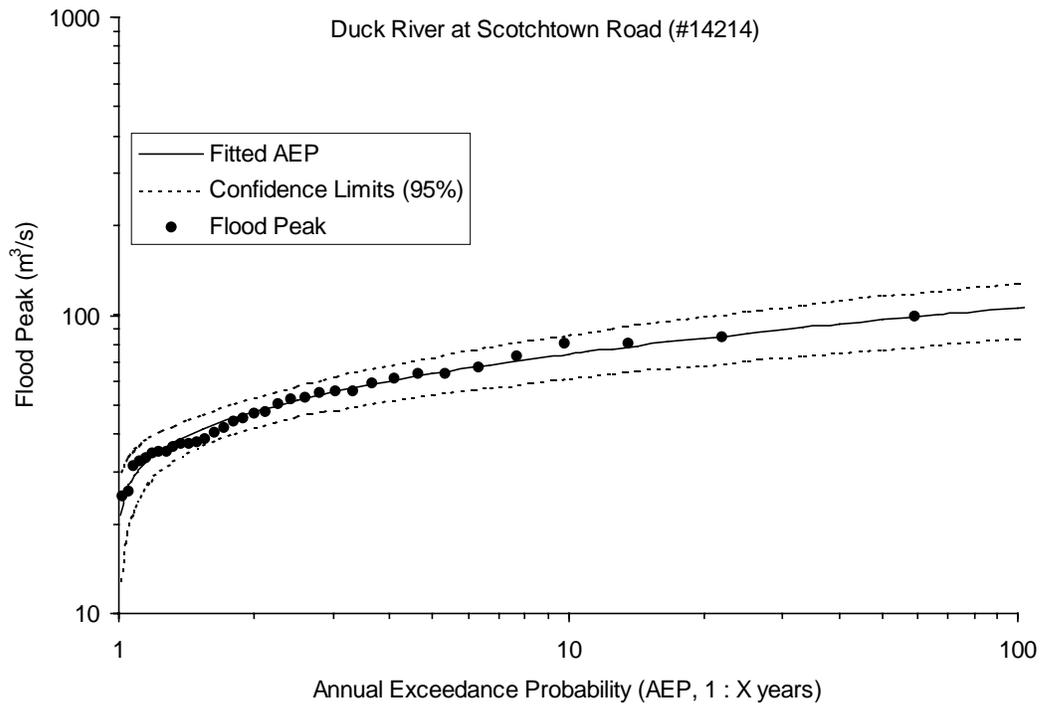


Figure 6.1 Flood frequency curves for Duck River at Scotchtown Road.

7. References

WIMS: Water Information Management System, <http://wims.dpiwe.tas.gov.au>

BOM, 2001. Bureau of Meteorology rainfall data, <http://www.bom.gov.au>

HYDROL: DPIWE Water Quantity and Quality Database.