Building Capacity of Effective River Management Through Planning and Policies: Tod Catchment - A Case Study

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Abstract

The Tod river system is one of the fragile perennial river systems in semi arid climatic condition of South Australia. The catchment entails a wide range of native flora, fauna, including significant wetland systems of national significance. Over the years, human interaction with the ecosystem developed incremental change to the catchment ecosystem resulting in over extraction of overland runoff for stock and potable water supply, altered stream flow, poor water quality and invasion of exotic weeds. The Eyre Peninsula Catchment Water Management Board undertook a strategic catchment planning process outlining the goals, activities, targets and indicators including regulatory mechanism to improve the condition of the catchment and its resources. In this paper the analysis of maximum harvestable rights as background to formulating the principle for farm dam management is extensively discussed. As an example the planning strategy formalised that all future construction of farm dams in the catchment must be constructed off stream and are required to be approved by the relevant authority through a permit process.

Introduction

The Tod river catchment (Map-1) is the only perennial river system in the region of Eyre Peninsula; one of the driest inhabited regions of South Australia. The Tod catchment is located 20km northwest of the town of Port Lincoln. It is one of the fragile surface water ecosystems managed by the regional catchment authority the Eyre Peninsula Catchment Water Management Board (the Board).

The catchment covers an area of around 400km² and is surrounded by low to medium hilly ranges. The highest of the ranges is the Koppio hills which strands at 330 m above sea level. The River system flows in a southerly direction through the coastal plains creating unique ecosystems before discharging into the Spencer Gulf. The catchment experiences a mediterranean climate with a warm to hot dry summer and wet winter. Rainfall in the region varies between 475mm to 535mm.

The Catchment

Since European settlement (circa 1840) clearing of land, developing of pastoral country and establishing crops have been the primary activity in the region. Agricultural development including harvesting surface water for stock use and use of potable water has changed the landscape to a large extent. Introduction of intensive farming techniques and grazing processes has contributed dramatic changes to water quantity & quality, dryland salinity, water logging associated with acid sulphate soil and invasion of weeds.

The geomorphology of the river system has changed slope, width, depth, and channel shape, altering flow duration and velocity of the river system. Changes in the hydro dynamics of the river systems threaten the diversity of the riparian ecosystem including native flora and fauna. Some of its distinctive plant species such as Blue gums or Water gums (*Eucalyptus petiolaris*), Sugar gum woodlands (*Eucalyptus cladocalyx*) suffer because of water logging and dryland salinity (Rixon, 2002). The permanent flowing river system is an important habitat and refuge to some endangered species such as the Southern Emu Wren (*Spirituous malachurus*), frogs and several species of butterfly. These are now nationally listed as endangered and significantly affected by the reduced flow in the system.

Human induced activities:

Numerous small to large farm dams for stock and domestic use have been developed over the years due to advancing farming systems (reducing tillage) and extensive grazing pressure. The major surface water storage for portable water supply captures on an average captures on average of 3.8ML (Cresswell, 2003) in the Tod Reservoir. Harvesting surface water runoff significantly reduced the average flow in the watercourses which is considered critical during the summer months. During the early winter period a major portion of the surface runoff generated by early rains are trapped in farm dams. The reduction in summer runoff has a significant impact on stream ecosystems dependent on water, including flora and fauna.

Eyre Peninsula Catchment Water Management Board (The Board)

The Eyre Peninsula Catchment Water Management Board (the Board) is responsible for protecting and managing the water resources of the region and ecosystem dependent on water. The Board addressed the issues of integrated catchment management under a catchment water management planning process. The Board approached holistic objective to catchment management including defining regulatory mechanism to maximise harvestable rights for farm dams management. The policy section of Water Affecting Activities in the Plan details regulation to surface water capture, allowable harvest volume and recommendation of farm dam size. The Plan sets out issues for a long term focus on integrated management of catchment water resources to limit further degradation and reverse any degradation that has already occurred.

The blue print was prepared consistent to the legislative directive of the *Water Resources Act 1997* (currently repealed by the *Natural Resources Management Act 2004* as of 1st July 2005). The Board identified a range of principles and policies to minimise and prevent activities that could have potential impact on water courses, and environmental integrity of the catchment. Under these principles the relevant authority has the power to allow or refuse permits.

Determining Maximum Harvestable Rights

Realising the critical nature of surface water harvesting in farm dams, maximum harvestable right was examined in regard to catchment hydrology, stock carrying capacity, and average stock water requirements. Maximum harvestable right is the total capacity estimated as water harvesting rights to support and satisfy basic farming needs. The farm dam policy under harvestable rights can be used for any purpose and is not restricted to stock and domestic purposes.

Analysis of catchment hydrology

Rainfall

Catchment hydrology was modelled at sub catchment level for further evaluating of stream discharge, catchment yield under the existing condition of rainfall, land-use, and concentration of farm dams. Since the catchment characteristics are not uniform throughout the catchment a representative sub-catchment was selected based on continuous and historical data availability. Toolillie gully sub-catchment was considered for modelling. Historic daily rainfall information from the Bureau of Meteorology (BoM 18181) from 1970to 2003 provided the over all trend (Figure-1). The annual average was found to be 477 mm. The trend line for annual rainfall shows a decreasing trend, which is an indication of reducing rainfall over the period form 1970 to 2003. It was further analysed using a residual mass curve method.

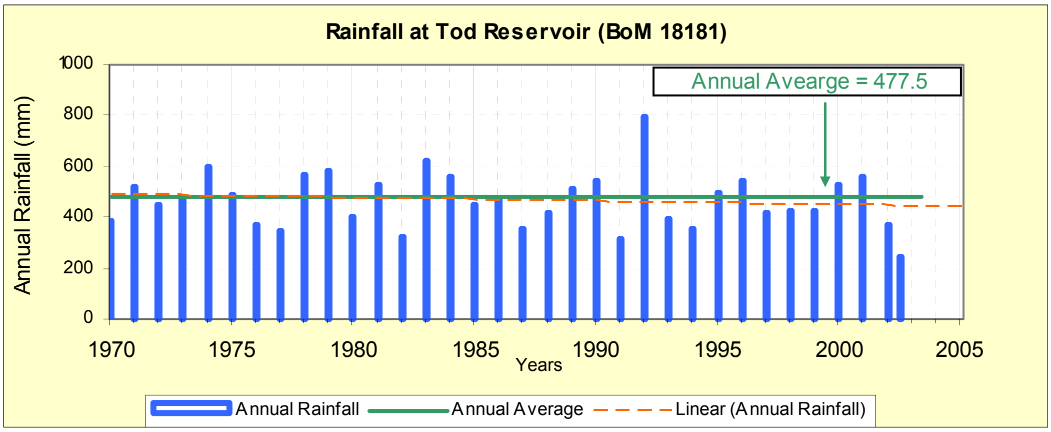


Figure-1: Rainfall at Tod Reservoir

A residual curve is used as a tool to identify wetter and drier periods from historical rainfall records. A distinctive upward slope indicates a wetter than average period and vice versa. The residual mass curve (Figure–2) for the rainfall records shows Toolillie Gully had a wetter than average period between 1900 and 1929. After that there is no significant indication of wetter years rather there is a clear indication of drier years.

Stream Flow

Stream flow information from the gauzing station (AW 512503) shows a high degree of variability in stream flow (Figure-3) from 0.38mm in 1991 to 85.9mm in 1996. Stream flow is measured only for a short period of time from 1992 till 2002. The year 1991, 2001 and 2002 shows a high degree of data discontinuity. The mean stream flow is estimated as 678 ML or 19mm. Hence it could be estimated that in an average year under given conditions, an annual average discharge would be 678ML.

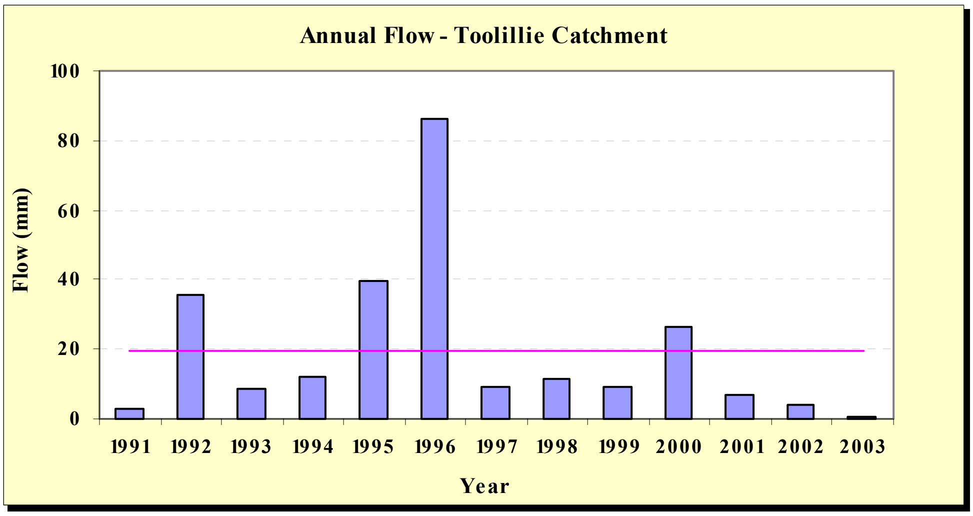


Figure- 3: Annual Flow at Toolillie catchment

The daily stream flow was analysed to estimate the frequency and continuity in the stream flow. The flow frequency curve (Figure–4) from the modelled stream indicates average flow generated in the given stream:

- On an average the flow of 0.12 ML/day or higher would occur would only occur during 150 days,
- On an average the flow of 0.6 ML/day or higher would occur would only occur during 90 days, and
- On an average the flow of 2.2 ML/day or higher would occur would only occur during 36 days.

The flow frequency curve indicates that a minimum volume, 10 % of the stream flow volume (Threshold Volume) is critical to maintain the environmental water requirement for the stream ecosystem and the water dependent ecosystem. The threshold volume suggested for release to the natural environment and greater than the threshold volume could be harvested for any purpose.

Further flow into the stream indicates flow occurs mostly during winter months with little flow (base flow) in the summer. The flow frequency analysis indicates the frequency of annual flow in a year.

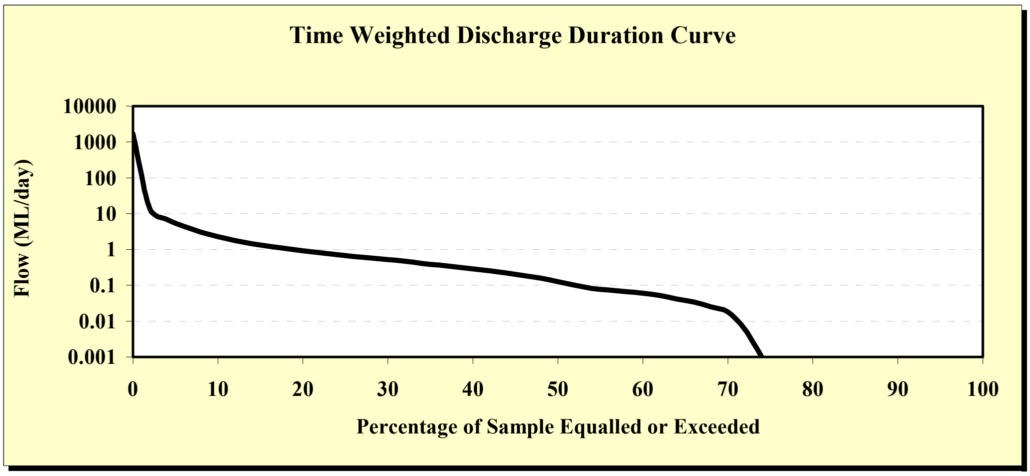


Figure-4: Flow frequency curve at Toolillie

Rainfall – Runoff Relationship

Stream flow was further analysed by plotting annual rainfall versus the catchment runoff. This relationship is expressed with a mathematical equation expressed as Tanh curve equation. This analysis provides a quick assessment of hydrological characteristics of the catchment. The analysis (Figure–5) indicates that on average 524 mm or more rainfall is required to generate the mean runoff of 19mm. Even though annual continuity of stream flow information from 1992 till 2000 is too modest to predict a reliable assessment for at least 30 years, data is warranted. Factors such as storm event, infiltration capacity, and distribution of rainfall over a period of time are the major influenced factors.

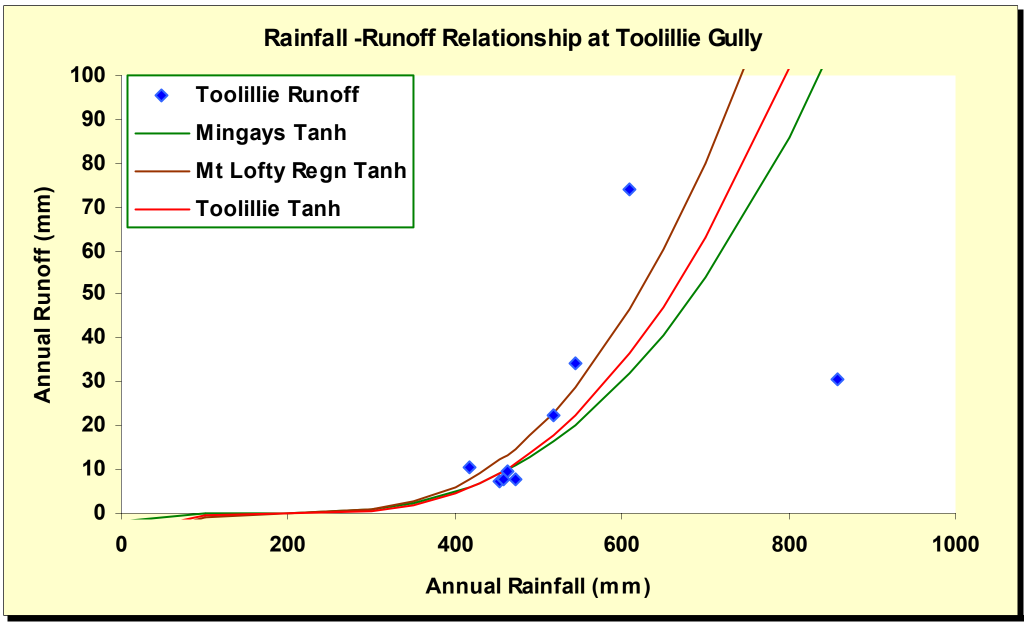


Figure- 5: Rainfall Runoff Relationship

Stock carrying capacity:

Further assessment of catchment hydrology, stock carrying capacity and the demand for stock water use was investigated by consulting with the regional research institution and wider community in general. It is observed that the stock carrying capacity varies widely across the region depending on the feed rate and annual average rainfall. Stock carrying capacity above 450mm rainfall is 7.5 DSE (Dry Stock Equivalent)/ha and rainfall below annual average of 450mm is 3.5 DSE/ha. Dry Sheep Equivalent is the most commonly used livestock unit and most satisfactorily compared with general live stock enterprises.

Stock Water use:

General farm use includes broad acre spraying, stock water supplies and irrigating including the use of water for fire fighting. As a consequence of the wide variety of uses, it is not feasible to lay down specific water quantity requirements. The quantity of water required is also one of the factors which determine the size of the storage. It is important to consider that water quantity requirements especially for stock and general farm use cannot be determined absolutely.

Water needs vary greatly depending on the weather, the distance to feed, the type of feed, the quality of water, condition of the stock, lot fed or pasture. Stock feeding on a higher quantity of dry feed will drink more water compared to animals being fed of pasture.

Research conducted on stock water use for a periods of three years at the Regional Agricultural Research Centre at Minnipa, observed that the average water consumption by sheep was 1.6 litres/day/ DSE. (Ahton, 1997)

Estimating maximum stock water requirement

Considering the average stock carrying capacity is 7.5 DSE/ha and the average daily water use is 1.6 litre/day/DSE. An estimation of 12l/day/ha or 4.5 Kl/yr/ha is the desired volume of water required per annum in an average year. In pastoral country under semi arid climatic conditions, water loss through evaporation and seepage can significantly reduce production. It has been observed that more than 40 percent of water can be evaporated in a 12 month period in certain locations of the State. Pan evaporation measurements at Tod Reservoir indicated an average of three times higher levels of evaporation compared to annual average rainfall. In the Adelaide hills region, 4 times capacity factor is provided to deal with the evaporation and seepage losses (Background to Water Allocation Planning, DWR, 1997). For this region a further conservative approach was undertaken of 6 times capacity factor of stock water requirement (4.5KL/ha/year). Hence the maximum harvestable right is estimated as 27 KL/h/yr or 0.027 ML/ha/yr. it is further considered as an absolute figure of 30KL/ha/yr or 0.030ML/ha/yr.

Estimating the catchment limit

Determining the maximum stock feeding water requirement, the entire catchment region was subdivided into sub-catchments. Based on the application of surface water modelling principles mean annual average surface runoff was determined for all the sub catchments. On-stream equivalent factor is defined from 30% of mean stream flow volume in an average year. Estimated on stream equivalent factor is considered as the rate (ML/ha) for a given catchment to determine the maximum farm dam capacity allowed in a catchment. On-stream equivalent volume is also observed to to satisfy the sock water requirement per hectare (0.03ML/ha/yr)

Realising the critical nature of the catchment hydrology, the policy is prescriptive of off-stream structures with an addition allocation of 1.5 times of the "on-stream equivalent". It is described as the "off-stream equivalent". Off-stream equivalent is the rate (ML/ha), to determine the allowable capacity of off-stream dams that can divert or capture surface runoff in a given catchment. A table detailing catchment area, mean annual average rainfall, estimated mean surface runoff, on-stream equivalent, sub catchment limit, off-stream equivalent and unit threshold flow rate is attached for easy reference to the Plan.

Water Affecting Activities (the Plan)

Under the Water Affecting Activities section of the Catchment Water Management Plan, a range of regulatory mechanisms is listed to prevent further degradation of water resources and water dependent ecosystem. Under these principles for future farm dam development in the region it is stated that a dam for storage of diversion must be constructed off-stream. The policy determines the maximum farm dam capacity in a sub-catchment by considering the on-stream equivalent factor. If any sub catchment has reached their maximum capacity there will not be any additional farm dams. These surface water policies further identifies a range of policies and principles for efficient and effective catchment management through water course management.

These policies include:

(a) Water storage and diversion
(b) Maximum farm dam capacity within a catchment
(c) Allowable farm dam volume
(d) Flow regime
(e) Dam design and construction
(f) Building any structure in water course or lake
(g) Drainage or discharge of water into a watercourse or lake
(h) Depositing or placing any solid material in a watercourse or lake
(i) Excavating or removal of rock, sand or soil
(j) Using effluent in carrying out a business.

These policies are outlined as guiding principles to those activities identified under water affecting activities. Prior to implementation of these activities identified under the water affecting activities, the proponent required to undertake a permit that is assessed by the relevant authority (the Minister for Environment and Conservation). Failure to follow these principles may contravene the *Natural Resource Management Act 2004.*

Consistent to the Act, other regional planning authorities (Local Government) must refer development application (related to water resources) to the relevant authority for assessment. If any of these activitities is regulated under other legislations such as the *Development Act 1993* or the *Environment Protection Act 1993* may not required further approval.

The following processes were developed through rigorous strategic consultation with the community and other relevant stakeholders. Community suggestions and comments are appropriately considered though out this process.

Conclusion:

This snapshot is a coordinated and strategic approach to manage and control farm dam development in order to improve the health of the Tod catchment. These strategic policies and principles are created from is a coordinated approach of research & investigation, planning, policies and implementation through extensive consultation and engagement of the community. This robust surface water policy system provides clear, concise and measurable objectives for longer term management of catchment resources through water resource assessment and enforcing permit policies.

References:

Rixon Sharon, Kotz Steven, and Thomas Deborah. 2002 “A River Management Plan for the Tod Catchment” Environment Protection Agency & Department for Environment and Heritage.

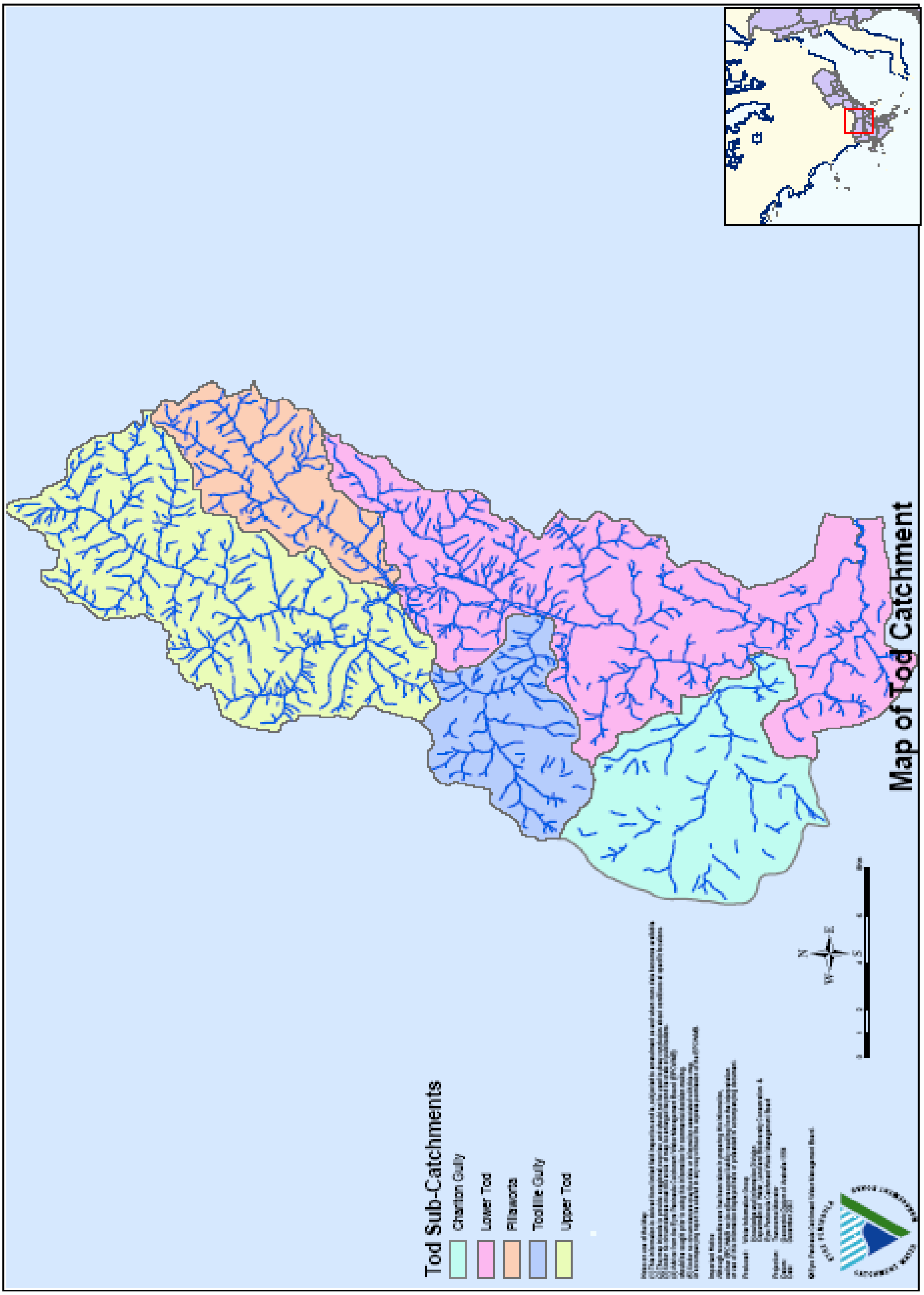
Ashton Brian, Solomon Andrew. 1997 “Livestock Water Supplies”, PIRSA, Fact Sheet 82/77.

Cresswell D C. 2003 “Preliminary Assessment of Tod Reservoir”, DWLBC, Unpublished.

“Water Resource Act 1997” Government of South Australia.

“Natural Resource Act 2004” Government of South Australia.

Map 1.Map of Tod Catchment


Map of Tod Catchment
Tod Sub-Catchments
Charlton Gully
Lower Tod
Pillaworta
Todillie Gully
Upper Tod