



Department of
Primary Industries
Water

Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources

*Background document for amended plan 2016
incorporating Kangaroo River Management Zone*



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Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone.

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More information

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Note on Agency names:

Since the commencement of the water sharing plan for the Greater Metropolitan Region there have been a number of changes in Agency names, and in some cases the transfer of water management functions into new agencies.

To assist the reader the following is a list of the relevant changes:

- NSW Office of Water is now Department of Primary Industries Water (DPI Water)
- Sydney Catchment Authority is now part of WaterNSW
- Catchment Management Authorities are now Local Land Services
- The Office of Hawkesbury-Nepean is now closed and its work transferred to DPI Water

The former agency name has been retained in this document where it relates to decisions or recommendations made at the time of plan preparation.

Where reference is made to current operations or responsibilities the current agency name has been used.

Contents

| | |
|--|-----------|
| 1. Introduction..... | 1 |
| Water sharing in NSW | 1 |
| An amended plan for the Greater Metropolitan Region incorporating the Kangaroo River | 1 |
| About this document | 3 |
| Why are water sharing plans being prepared? | 3 |
| Environmental considerations..... | 4 |
| Unregulated water sources..... | 5 |
| Pre existing rules | 5 |
| Proposed rules..... | 5 |
| 2. Description of the plan areas | 7 |
| Land use history | 9 |
| Climate..... | 12 |
| Stream flows | 13 |
| Climate change and variability | 13 |
| Entitlement and use | 14 |
| Local water utility and major utility requirements | 15 |
| 3. Developing the plan | 17 |
| Scope of the plan | 17 |
| Water management units..... | 17 |
| Extraction management units | 17 |
| Water sources | 17 |
| Management zones | 18 |
| Project groups..... | 18 |
| State Interagency Panel | 18 |
| Interagency Working Group (formerly the Interagency Regional Panel)..... | 19 |
| Lower Nepean - Hawkesbury Minister’s Advisory Group..... | 21 |
| Interagency Regional Panel for replacement of the Kangaroo River plan | 21 |
| Policy context..... | 21 |
| National Water Initiative..... | 21 |
| Natural Resources Commission | 22 |
| Catchment action plans | 22 |
| Other considerations..... | 23 |
| Managing surface water and groundwater connectivity..... | 23 |
| Granting new access licences | 24 |
| Mandatory conditions | 24 |

| | |
|--|-----------|
| Protecting Aboriginal values | 25 |
| Considering environmental values..... | 25 |
| Protecting estuary health..... | 26 |
| Maintaining ecosystem function..... | 28 |
| First flush rules | 28 |
| Protecting basic landholder rights..... | 28 |
| Water interception activities..... | 28 |
| Protecting town water supply access..... | 29 |
| Aboriginal community development access licences..... | 29 |
| ACDLs in the Kangaroo River Management Zone | 30 |
| High flow conversion | 32 |
| High flow conversions in the Kangaroo River Management Zone | 32 |
| Defining water extraction limits | 33 |
| 4. Rules for unregulated water sources..... | 34 |
| Classification method..... | 34 |
| Classification for the Kangaroo River | 35 |
| Developing the water sharing rules..... | 35 |
| Developing the access and dealings rules | 36 |
| Exceptions to the generic rule approach | 36 |
| 5. Consultation..... | 37 |
| Targeted consultation on the draft rules..... | 37 |
| Public exhibition of the water sharing plan..... | 38 |
| Consultation and public exhibition for Kangaroo River water sharing plan replacement | 39 |
| Targeted consultation | 39 |
| Public exhibition..... | 39 |
| 6. Key policy issues for the plan | 40 |
| Protection of environmental releases from Nepean River dams | 40 |
| Signal stage and daily access rules for weirs | 41 |
| Varying daily access rules | 41 |
| Transmission losses | 41 |
| Travel time | 42 |
| Releases from Warragamba Dam | 42 |
| Access to very low flows and environmental flow protection rules in the Hawkesbury – Nepean Rivers | 44 |
| Terminology for ‘cease-to-pump’ | 44 |
| Pre cease-to-pump (EFPR) notification | 44 |
| Boundaries for the tidal pool..... | 44 |
| Access to very low flows during a water shortage and ‘repayment’ | 45 |

| | |
|---|-----------|
| Very low flow access (due to water shortage) in the Upper Hawkesbury River Management Zones..... | 46 |
| Very low flow access (for survival watering) in the Lower Nepean River Management Zone and Upper Hawkesbury River Management Zones..... | 47 |
| Daily access rules for the Lower Nepean River | 49 |
| Daily access rules and annual extraction limits for Sydney Water Corporation on the Hawkesbury River at North Richmond..... | 49 |
| Water sharing rules to protect water savings delivered through the Hawkesbury-Nepean River Recovery Project..... | 49 |
| Varying access to releases of Advanced Wastewater Treatment Plant discharge from the St Mary's Water Recycling Plant..... | 50 |
| Discharge from sewage treatment plants for irrigation..... | 51 |
| Western Sydney Recycled Water Initiative | 51 |
| Other water sources linked to the Hawkesbury-Nepean rivers | 53 |
| Accounting for tributary flows | 53 |
| Trading of licences and water allocations between weirs on the Nepean River..... | 53 |
| Trading between management zones on the Hawkesbury River above Colo River .. | 54 |
| Trading into the Lower Nepean Management Zone..... | 54 |
| Daily access rules for the Mongarlowe River | 54 |
| Environmental flows for the Shoalhaven River below Tallowa Dam | 54 |
| Daily access rules for the Shoalhaven River below Tallowa Dam | 55 |
| Imposing limits on extractions for WaterNSW | 55 |
| Environmental flows for Manly Dam | 57 |
| Application of daily access rules to stormwater channels | 58 |
| Goulburn Mulwaree City Council water supply and environmental flows..... | 58 |
| Suspension of environmental flows from dams and weirs | 58 |
| 7. Changes to water sharing rules in Kangaroo River Management Zone | 60 |
| Estimate of basic landholder rights | 60 |
| Cease-to-pump | 60 |
| Pool management..... | 61 |
| Water trading | 61 |
| Amendment provisions | 61 |
| 8. Adaptive management | 62 |
| Amendment provisions | 62 |
| Monitoring, evaluation and reporting..... | 62 |
| Performance indicators | 63 |
| Audit | 63 |
| Plan review | 63 |
| Metering and compliance..... | 64 |

| | |
|--|-----------|
| 9. Glossary | 65 |
| 10. References | 69 |
| 11. Appendices | 70 |
| Appendix 1: Water sharing plan area | 70 |
| Appendix 2: Identified threatened species | 72 |
| Appendix 3a: Interagency Working Group and support staff for Greater Metropolitan Region plan | 76 |
| Appendix 3b. South Coast Interagency Regional Panel for replacement of the Kangaroo River water sharing plan | 78 |
| Appendix 4: Contribution towards meeting the river flow objectives | 79 |
| Appendix 5: Reference materials | 80 |
| Appendix 6: Final classification summary | 82 |
| Appendix 7: Water sharing rules based on Interagency Working Group knowledge . | 84 |
| Appendix 8: Adaptive management | 93 |
| Appendix 9: Stream gauging stations in the Greater Metropolitan Region used as flow reference points | 97 |
| Appendix 10: New stream gauging stations proposed for the Greater Metropolitan Region | 99 |
| Appendix 12: Changes to water sharing rules as a result of public exhibition and updated data | 102 |
| Appendix 13. Summary of the field verification studies | 110 |
| The 2008 field verification report | 110 |
| Abstract | 110 |
| Hydrological assessment of very low flows | 110 |
| Hydraulic assessment of velocity microhabitats | 111 |
| Water quality | 111 |
| Fish passage | 111 |
| Recommendation | 111 |
| Addendum to the field verification report 2014 | 113 |
| Recommendations | 113 |
| Appendix 14. Summary of the socio-economic studies | 115 |
| The 2012 socio-economic study | 115 |
| Supplementary socio-economic analysis 2014 | 115 |

Tables

| | |
|--|----|
| Table 1: Management zones with a high level of economic dependence | 4 |
| Table 1 Water sources with high level of economic dependence Error! Bookmark not defined. | |
| Table 2: Management zones with a high instream value (based on initial assessment) .. | 6 |
| Table 3: Total entitlement and number of licences for each water source | 14 |
| Table 4: Town water supplies, location and entitlement volume in the Greater Metropolitan Region | 16 |

| | |
|--|-------------------------------------|
| Table 5: Water management units for this Water Sharing Plan | 19 |
| Table 6: Contribution of the plan to the relevant NRC statewide targets..... | 23 |
| Table 7: Connectivity between aquifer types and surface water | 24 |
| Table 8: Inflow sensitivities for Greater Metropolitan Region catchments | 27 |
| Table 9: Total limits on extraction by Aboriginal Community Development Access Licences in management zones..... | Error! Bookmark not defined. |
| Table 10: Review of management zones for the application of Aboriginal Community Development Access Licences in the Greater Metropolitan Region as a result of public exhibition | 31 |
| Table 11: Management Zones where high flow conversion licences are permitted in the plan | 33 |
| Table 12. Classifications and indicative access rules applied to the Kangaroo River in 2013 | 35 |
| Table 13: Key groups consulted in the plan area as part of targeted consultation | 37 |
| Table 14: Public exhibition meetings held in the plan area | 38 |
| Table 15: EFPR conditions for management zones on the Nepean River above Warragamba River | 42 |
| Table 16: Water shortage access conditions on the Nepean River..... | 45 |
| Table 17: Temperature and EFPR conditions used to trigger limited access to very low flows due to a water shortage | 47 |
| Table 18: Exemptions for access to very low flows for survival water on the Lower Nepean and Upper Hawkesbury River management zones | 47 |
| Table 19: Proposed Quakers Hill STP discharges into Eastern Creek..... | 52 |
| Table 20: Proposed St Marys STP discharges into South Creek..... | 52 |
| Table 21: Conditions to signal a 'water shortage' on South and Eastern Creeks | 52 |
| Table 22: Extraction by WaterNSW in the Greater Metropolitan Region..... | 57 |

1. Introduction

Water sharing in NSW

Water sharing plans are being progressively developed for rivers and groundwater systems across New South Wales following the introduction of the *Water Management Act 2000* (WMA 2000). These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

The first round of water sharing plans commenced on 1 July 2004. The development of these plans resulted in around 80% of the water use in NSW being managed under the WMA 2000. By the end of 2012, over 95% of all water extracted in NSW was covered by a water sharing plan. By the end of 2016 it is anticipated that all extraction in NSW will be covered by a water sharing plan.

Water sharing plans for the unregulated rivers¹ and groundwater systems have been completed using a broad scale 'macro' approach based on whole river catchment or aquifer systems. Each macro plan covers a large river basin rather than a single subcatchment, or in the case of groundwater systems, cover a particular type of aquifer (for example fractured rock). These river basin or aquifer macro plans will generally apply to catchments or aquifers where there is less intensive water use.

General information on the macro planning process is available in the water sharing plans section of the DPI Water website www.water.nsw.gov.au. This includes:

- *Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation* – explains the method used to classify and set water sharing rules for unregulated streams across the state,
- *Macro water sharing plans – the approach for unregulated rivers. Access and trading rules for pools* – explains the method used to set access and trading rules for pools in unregulated water sources across the state,
- *Macro water sharing plans – the approach for groundwater. A report to assist community consultation* – explains the method used to classify and set water sharing rules for groundwater across the state, and
- A series of water policy advisory notes to assist in the development of the water sharing plans.

An amended plan for the Greater Metropolitan Region incorporating the Kangaroo River

The *Water Sharing Plan for the Kangaroo River Water Source 2011* commenced on 1 July 2004. This plan was one of the first water sharing plans to commence in NSW and was due to expire in July 2014, yet extended to 2016.. Prepared in consultation with the former Shoalhaven Illawarra Water Management Committee, the plan established a water sharing regime that provided water for the environment and water for extractive purposes such as irrigation. Many of the rules represented a significant change from the existing water sharing arrangements while other rules formalised existing operational practices.

1. The supply of water in unregulated rivers is typically not controlled by releases of water from dams but rather is dependent solely on rainfall and natural river flows.

In May 2014 the Minister for Lands and Water approved the replacement of this plan based on reports from the Natural Resources Commission and the former NSW Office of Water (NRC 2013 and NOW 2013). At that time the term of the plan was extended to 30 June 2016 to allow for the preparation of the replacement plan. The Minister advised that any proposed changes to these early plans must be permitted under the *Water Management Act 2000* and need to consider the significant amount of consultation that was undertaken in their initial development.

Since commencement of the Kangaroo River water sharing plan there has been a shift in the government's water sharing approach to the current 'macro approach', which has allowed for the implementation of water sharing plans across larger catchment areas. *Water Sharing Plan for the Greater Metropolitan Region Unregulated Water Sources 2011* commenced on 1 July 2011 and included all of the Shoalhaven catchment with the exception of the Kangaroo River above Hamden Bridge.

The expiry and replacement of the Kangaroo River water sharing plan provided the opportunity for the plan to be merged with the Greater Metropolitan plan so that all unregulated water in the Greater Metropolitan Region is managed through the one water sharing plan. The term of the amended plan for the Greater Metropolitan Region remains unchanged. It sets the rules for water sharing arrangements until July 2021.

The objectives of the plan are to:

- protect the important water dependent environmental, Aboriginal cultural and heritage values,
- protect basic landholder rights,
- manage water extraction from the rivers and the closely linked aquifers to ensure equitable sharing between users,
- provide opportunities for market based trading of licences and water allocations,
- provide flexibility for licensed water users in how they can use their water, and
- allow for adaptive management, that is, to allow changes to the plan to be made as a result of more information that will become available during the life of the plan.

The *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* (the plan) now covers 88 management zones that are grouped into six water sources (refer Appendix 1). Water sharing rules detailed within the plan include:

- environmental water rules – the share of the water reserved for the environment,
- access rules – which determine when extraction is allowed (for example above a set river flow rate),
- dealing rules – which control the trade of water, both the transfer of share components of an access licence and assignment of water allocation between access licences, as well as changing the location for water extraction,
- long term average annual extraction limits – a growth-in-use assessment and management tool,

- rules for granting access licences – what types of licences may be granted,
- rules for granting works approvals – what types of set back conditions are required, and
- system operation rules.

About this document

This document provides background to the development of the rules in the plan and the amendment of the plan in 2016 to incorporate water sharing rules for the Kangaroo River. It includes information on:

- the purpose of the statutory plan,
- a physical description of the Greater Metropolitan catchment including land and water use,
- the process of plan development including scope, history and basis for decisions,
- the use of adaptive management, and
- the activities associated with implementation, monitoring and review of the plan.

This document is part of a range of material available specifically on the plan including:

- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* (a legal instrument written in its required statutory format),
- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources - Guide* (a plain English version of the plan explaining the key sections and rules), and
- rule summary sheets for each water source detailing the management rules.

Why are water sharing plans being prepared?

Expansion of water extraction across NSW in the 20th century has placed most valleys at or close to the limit of sustainable water extraction. This has seen increasing competition between water users (towns, farmers, industries and irrigators) for access to water. This has also placed pressure on the health and biological diversity of our rivers and aquifers.

Under the *Water Management Act 2000* the sharing of water must protect the water source and its dependent ecosystems and must protect basic landholder rights. Sharing or extraction of water under any other right must not prejudice these shares. Therefore, sharing water to licensed water users is effectively the next priority for water sharing. Amongst licensed water users, priority is given to water utilities and licensed stock and domestic use, ahead of commercial purposes such as irrigation and other industries. Water sharing plans provide a legal basis for sharing water between the environment and consumptive purposes.

Water sharing plans also recognise the economic benefits that commercial users such as irrigation and industry can bring to a region. Upon commencement of the plan, access licences held under the *Water Act 1912* (WA 1912) are converted to access licences under the WMA 2000, and land and water rights are separated. This facilitates the trade of access licences and can encourage more efficient use of water

resources. It also allows new industries to develop as water can move to its highest value use.

With the introduction of the plan, a number of benefits will flow to water users including:

- greater certainty for water users – the plan sets out the water sharing arrangements for a 10 year period,
- clear trading and access rules which will help foster trading, and
- automatic conversion of licences in the plan area to perpetual water access licences providing greater security for water users – meaning the volumetric water access licences do not have to be renewed, however approvals for the works used to extract water under these access licences will need to be renewed.

The plan recognises the economic benefits to the region that are generated by commercial users such as irrigators and industry. It sets rules so that commercial users can continue to operate productively. Fourteen of the management zones covered by the plan are considered to have a high economic dependence on commercial extraction (see Table 1).

Table 1: Management zones with a high level of economic dependence

| Management zone | Description |
|------------------------|---|
| Lower Hawkesbury River | High dependence on extraction for irrigation (mainly pasture, cereals, turf, vegetables and fruit) and town and/or industrial water supplies. |
| Upper Hawkesbury River | |
| Mid Nepean River | High dependence on extraction for irrigation (mainly pasture, lucerne, cereals, turf and vegetables) and town and/or industrial water supplies. |
| Lower Nepean River | |
| Cattai Creek | High dependence on extraction for irrigation (mainly pasture, lucerne, cereals, turf and nurseries) and town and/or industrial water supplies. |
| South Creek | High dependence on extraction for irrigation (mainly turf, pasture and lucerne) and town and/or industrial water supplies. |
| Werriberri Creek | High dependence on extraction for irrigation (mainly pasture, lucerne, fodder, turf and vegetables). |
| Broughton Creek | High dependence on extraction for irrigation (mainly pasture, lucerne, cereals, turf) and town and/or industrial water supplies. |
| Broughton Mill Creek | |
| Upper Nepean River | High dependence on extraction for irrigation (mainly pasture and vegetables) and town and/or industrial water supplies. |
| Lower Kangaroo River | High dependence on extraction for irrigation (mainly pasture, lucerne and cereals) and town and industrial water supplies. |
| Kangaroo River | High dependence on extraction for irrigation (mainly pasture and vegetables) and town and/or industrial water supplies. |

Environmental considerations

Water sharing plans are required to reserve water for the overall health of the river and to protect specific ecosystems that depend on river flows, such as wetlands, lakes, estuaries and floodplains. This share of water reserved for the environment is also intended to sustain a river system's aquatic fauna and flora.

Unregulated water sources

Most of the demand for water from unregulated systems usually occurs at those times when stream flow is low. While there is only limited research on the importance of protecting very low flows, a body of evidence does suggest that low flows are essential for maintaining water quality, allowing passage over riffles for fish and other fauna to pools for drought refuge, maintaining those parts of aquatic ecosystems that are most productive and reducing salt water intrusion in tidal pools. For example, the faster flowing riffle areas between pools usually contain the highest abundance and diversity of aquatic fauna. Although many streams will naturally stop flowing in dry times, it is the increased frequency and duration of drying as a result of extraction that has the potential to impact on stream ecosystems.

Accordingly, in order to protect a proportion of these very low flows for the benefit of the environment, the plan imposes new access restrictions on days when flows are low. This is achieved by establishing 'environmental flow protection rules' (EFPR) that describe when water must not be extracted, depending on the amount of flow in the river on any given day.

When an EFPR event has been activated for a period of time eventually flows will increase again above the EFPR level. After an EFPR has occurred, a commence-to-pump (ComTP) will then be activated to let users know that they are able to extract water again. The ComTP level can vary between management zones and may be immediately introduced once the river levels have exceeded the EFPR or it may be delayed for 24 hours after river levels have exceeded the EFPR level.

Thirty unregulated management zones have been identified as having high instream values (Table 2). For these management zones, trading into the water sources is limited. In some zones the trading rules aim to decrease water entitlements over time. Where instream values are at high risk from extraction, the EFPR tends to be conservative. Appendix 2 details the threatened species considered when assessing the management zone values (note this only includes species that are likely to be sensitive to extraction).

Pre existing rules

A number of licences within the plan area previously had a cease-to-pump condition. These ranged from a volume of 48 megalitres per day (ML/day) to 'no visible flow at the pump site'. In the past, these conditions have only been applied to specific licences and not to a water source or management zone as a whole. In some water sources there has been no previous history of a cease-to-pump condition imposed during low flow periods. These are mainly in water sources with few or no users. Several water sources have also been subject to statutory restrictions and suspensions in the past. These have mainly occurred during summer months and have ranged from only pumping for two hours between six to eight pm, to a total suspension on irrigation pumping.

Proposed rules

Upon commencement of the plan, surface water licences in all unregulated water sources became subject to EFPR rules (excluding licences listed in Schedule 2 of the plan. Rules vary depending on where a licence is located within the plan area. This information can be found on individual rule summary sheets available on the DPI Water website at www.water.nsw.gov.au.

In instances where the existing cease-to-pump rule under the *Water Act 1912* was based on a higher flow rate than the EFPR proposed by the plan, the existing cease-to-pump rule took precedence, but the EFPR exemptions will be applied.

Table 2: Management zones with a high instream value (based on initial assessment)

| Management Zone | Description of instream value |
|---------------------------|--|
| Lane Cove River | 25 threatened species, 4 endangered ecological communities (EECs), high recreation value |
| Middle Harbour | 23 threatened species, 4 EECs, high non extractive values |
| Mid Shoalhaven River | 16 threatened species, 1 EEC, high rarity |
| Mongarlowe River | 13 threatened species, high diversity and rarity |
| Nerrimunga Creek | 13 threatened species |
| Reedy Creek | 18 threatened species, high rarity |
| Shoalhaven River Gorge | 13 threatened species |
| Boro Creek | 17 threatened species, high rarity and diversity |
| Broughton Creek | 25 threatened species, 3 EECs, high diversity |
| Corang and Endrick Rivers | 15 threatened species |
| Kangaroo River | 28 threatened species, 2 EECs, high diversity, high rarity |
| Lower Kangaroo River | 27 threatened species, 1 threatened riparian vegetation, 2 EECs, high diversity and rarity |
| Minnamurra Coastal | 25 threatened species, 2 EECs, 2 endangered populations, high naturalness |
| Minnamurra River | 21 threatened species, 2 endangered populations |
| Lake Illawarra | 25 threatened species, 2 threatened populations, high non-extractive use |
| Macquarie Rivulet | 20 threatened species, 2 endangered populations |
| Berowra and Cowan Creek | 28 threatened species, 5 EECs, high naturalness and diversity |
| Colo River | 13 threatened species, 2 EECs, high naturalness and diversity |
| Grose River | 18 threatened species, high diversity |
| Upper Hawkesbury River | 22 threatened species, high diversity |
| Lower Hawkesbury River | 22 threatened species, high diversity |
| Lower Nepean River | 14 threatened species, 1 EEC, high diversity |
| Mid Nepean River | 15 threatened species, 1 EEC, high diversity |
| Wollondilly River | 18 threatened species, high diversity |
| Wingecarribee River | 16 threatened species |
| Kowmung River | 19 threatened species, high naturalness |
| Mulwaree River | 18 threatened species |

2. Description of the plan areas

The Greater Metropolitan Region water sources are located on the south-east coast of NSW, covering an area of approximately 32,500 square kilometres, from Shoalhaven Heads in the south, Broken Bay in the north, Lithgow to the west, and Goulburn to the south west. The region is bounded by the Hawkesbury River catchment to the north and west and Shoalhaven River catchment to the south and south west. The region also includes the rivers of the Illawarra and metropolitan Sydney.

The Shoalhaven River catchment has an area of 7,300 square kilometres and a length of approximately 300 kilometres. The catchment is bordered by the catchments of Tuross River to the south, Murrumbidgee River to the south west, Deua, Moruya and Clyde Rivers to the east and Wollondilly River to the north. The river rises to around 1,250 metres in the hilly to mountainous country between the Gourrock and Minuma ranges, approximately 40 kilometres west of Moruya and 70 kilometres south of Braidwood. Downstream of these short headwater reaches, the valley floor ranges in width from 300 to 1000 metres. At the foot of the Budawang Range, near Braidwood, the river has an elevation of 670 metres and flows in a predominantly northerly direction through the Shoalhaven Plain, where the valley floor is between 5,000 and 6,000 metres.

Below the Mongarlowe River confluence some 30 kilometres north of Braidwood, the river flows through 300 to 500 metre deep gorges of Morton National Park. Here Corang and Endrick Rivers, two large tributaries, enter the Shoalhaven River. Together with 30 kilometres of the Shoalhaven River upstream of the Mongarlowe River confluence, these gorges have been identified as 'wild' and 'scenic'. At the eastern limit of these gorges, the Shoalhaven River enters Lake Yarrunga, the storage lake of Tallowa Dam. Here it is joined from the north by Kangaroo River, and turns east sharply to its estuarine mouth, 10 kilometres north east of Nowra. Below Tallowa Dam, the river continues through confined valleys for approximately 20 kilometres, where it enters alluvial estuarine floodplain at the tidal prism near Burrier, west of Nowra.

The Hawkesbury and Nepean Rivers have a combined catchment area of 22,000 square kilometres and a length of close to 339 kilometres. The rivers rise to over 800 metres as the Wollondilly River on the Great Dividing Range, 42 kilometres north west of Goulburn and 12 kilometres east of Crookwell. The Wollondilly River is largely confined by valley sides with few or no floodplains. The Mulwaree River chain of ponds, Paddys River, Tarlo River, and Wingecarribee River enter the Wollondilly River before it meets Lake Burragarang at Jooriland. Lake Burragarang is formed by Warragamba Dam on the Warragamba River.

Coxs River, with a catchment area of 1,700 square kilometres and a headwater elevation of over 1,000 metres, is also a significant tributary to Lake Burragarang. The 80th percentile flow is 35 ML/day while the 50th percentile is 87 ML/day. Coxs River comprises significant gorge reaches through Blue Mountains National Park and Kanangra Boyd National Park.

Warragamba River meets Nepean River some 3 kilometres below Warragamba Dam. The Nepean River rises to over 700 metres about one kilometre north-east of Robertson and flows into Lake Nepean created by Nepean Dam. Approximately 10 kilometres below Nepean Dam and immediately above Pheasants Nest Weir, Cordeaux River enters the Nepean River. Bargo River comprises significant intact

gorge and sandstone headwaters and with a catchment area of 131 square kilometres enters the Nepean River below the Cordeaux River confluence. Avon River is a significant tributary to Cordeaux River, entering the river 11.5 kilometres below Avon Dam and 20 kilometres below Cordeaux Dam. Cataract River enters the Nepean River about 21 kilometres below the confluence of the Cordeaux and Nepean Rivers and 17 kilometres below Cataract Dam. The Nepean, Avon, Cordeaux and Cataract rivers above and below the dams comprise significant gorge reaches. The gorges are near intact above the dams.

The Nepean River below the Cataract River flows for approximately 100 kilometres through confined and partially confined channels and gorges to the confluence of the Grose River approximately 5 kilometres south west of Richmond. The channels are degraded while the gorges are in good condition. The confined channels include large wavelength meanders. Erskine Creek and Glenbrook Creek enter Nepean River below its confluence with Warragamba River. Erskine Creek rises to about 850 metres at Katoomba. The creeks have a combined catchment area of 463 kilometres and comprise near intact sandstone gorges and headwaters.

The Grose River rises to 1,000 metres north of Blackheath and has an area of 669 square kilometres. The Grose River comprises large gorges of good condition and confined channel of moderate condition at the Nepean River confluence. The Grose River provides significant flows to the Hawkesbury River. The 80th percentile flow is 39 ML/day while the 50th percentile flow is 82 ML/day.

Below the Grose River confluence, the Nepean River becomes the Hawkesbury River with a catchment area including the estuary of 796 square kilometres. Between the Grose River confluence and the Colo River confluence Hawkesbury River is either a degraded confined channel or a degraded partly confined channel. Below the Colo River confluence the Hawkesbury River is a degraded tidal river. Between the Grose River and Colo River confluences, South Creek and Cattai Creek enter the Hawkesbury River north-east of Richmond and from the south. South Creek has a catchment area of 784 square kilometres and rises to 120 metres north of Narellan. The creek is primarily a degraded meandering deep and narrow channel with chain of ponds headwaters. The 80th percentile flow of South Creek is 34 ML/day and the 50th percentile flow is 58 ML/day, although these flows are primarily treated effluent discharge.

Cattai Creek has a catchment area of 283 kilometres and rises to over 140 metres at Castle Hill. The creek includes confined and partly confined channels of moderate condition, gorges of moderate condition, although Little Cattai Creek includes near intact gorges, and channel wetlands that are degraded. The 50th percentile flow is 15 ML/day and the 80th percentile flow is 7 ML/day, although a portion of the flow is treated effluent discharge.

The Macdonald River enters the Hawkesbury River from the north at Wisemans Ferry. Although the Macdonald River has a large catchment, 1,909 square kilometres, its contribution to Hawkesbury River is quite small. The 80th percentile is 1 ML/day while the 50th percentile is 16 ML/day. Other minor tributaries to the Hawkesbury River within the area of the plan include Webbs, Berowra and Cowan Creeks.

The main rivers of the Illawarra catchment are Minnamurra River and Macquarie Rivulet. The remaining rivers are small urban creeks that drain the Illawarra Range and the narrow coastal floodplain. Minnamurra River rises to over 700 metres at Knights Hill on the Illawarra Range, 10 kilometres south east of Robertson and flows

to the sea some 20 kilometres to the east. The area of the catchment is 120 square kilometres and has an 80th percentile flow of 6.4 ML/day and a 50th percentile of 19 ML/day. Macquarie Rivulet rises to 670 metres, four kilometres north of Robertson on the Illawarra Range and enters Lake Illawarra some 20 kilometres to the east. The 80th percentile flow is 9.3 ML/day while the 50th percentile is 20.8 ML/day.

The main rivers of metropolitan Sydney include the Georges, Woronora and Hacking Rivers in the south and Parramatta River in the north. The Georges River rises to 389 metres, six kilometres south east of Appin and falls to the north and east for 90 kilometres where it enters Botany Bay at Dolls Point. Woronora River rises to 360 metres 6 kilometres north west of Darks Forest and falls north and east for 36 kilometres to where it meets Georges River at Como. Woronora Dam is located on Woronora River 11 kilometres downstream of its headwaters. Hacking River rises to 750 metres, two kilometres west of Stanwell Tops on the Illawarra Range and falls to the east and north for 30 kilometres where it meets Port Hacking at Grays Point. Parramatta River rises to 80 metres, two kilometres north of Baulkham Hills (Toongabbie Creek) and falls to the east for 37 kilometres where it meets Port Jackson at Dawes Point. The 80th percentile flow for Parramatta River is 4.6 ML/day, while the 50th percentile flow is 10.1 ML/day.

Land use history

The region prior to white settlement included country of five indigenous nations. Country of Yuin and Tharawal included the Shoalhaven River, with Tharawal occupying the lower reaches of the river. The country of Tharawal also included lands of the Illawarra and north to Botany Bay. The Eora country spanned the coast north of Tharawal country to about the Parramatta River and west to the eastern boundary of the Hawkesbury River catchment. The Hawkesbury River catchment was largely Dharug country, with the exception of the Wollondilly River, which was Gundungurra country, which may have also included the Shoalhaven River around Kingpin Mountain.

While relations to country may have varied across and between nation, nation shared fire to alter country. Seasonal fire patterns in spring and summer were a mosaic of many small interlocking fires with occasional large fires. An understorey of native grasses across fertile areas and scrubby understorey across drier sandstone country emerged with these regimes.

Aboriginal peoples prior to white settlement were custodians of rivers, lakes and other water sources and today continue a spiritual and cultural relation to water. Rivers of the region were a source of sustenance for Aboriginal peoples, often serving as clan boundaries, and had an important place in the Dreaming. This relationship is articulated in the *United Nations Declaration of the Rights of Indigenous Peoples* (the Declaration), especially articles 3, 25, 28 and 29. Australia is a signatory to the Declaration. Article 3 states that Indigenous peoples have a right to determine their political status, and their economic, social and cultural future. Article 25 states that Indigenous peoples have a right to maintain and strengthen their distinctive spiritual relationship with their lands, territories, and resources confiscated, taken, occupied, used or damaged, while Article 28 states the right to redress for lands, territories, and resources confiscated, taken, occupied, used or damaged. Article 29 states the right to the conservation and protection of the environment, and the productive capacity of lands, territories and resources.

A number of national parks within the plan area are managed in partnership with Aboriginal peoples. Aboriginal peoples, traditional owners and clans are represented across the region by 12 statutory Local Aboriginal Land Councils. The Councils are constituted under the *Aboriginal Land Rights Act 1983* and have a range of functions relating to land acquisition, land use and management, Aboriginal culture and heritage and financial stewardship. The 12 Councils are Metropolitan, Darkinjung, La Perouse, Tharawal, Gandangara, Deerubbin, Pejar, Illawarra, Nowra, Jerrinja, Batemans Bay and Ulladulla.

With European settlement across the region in the late 18th and early 19th centuries, fire regimes changed to simpler, coarser patterns of large fires during the cooler seasons. Fire was used extensively to clear lands for grazing and crop farming in the early years of settlement. Timber, especially red cedar, was harvested extensively and intensively across the region in the last years of the 18th century and the first half of the 19th century. Within 50 years, suitable stands of red cedar were virtually exhausted. Timber getters then sought stringy bark, blackbutt, blue gum and other Eucalypt species.

As clearing and farming intensified on the rich alluvial river flats, native grasses were soon wiped out and replaced with exotics. Wheat, maize, potato, pumpkin, corn and other vegetables were the dominant crop. Stone fruits were even tried as early as 1804. Hogs and goats were the only stock farmed and were soon replaced by cattle. Lands were cleared and cattle were driven deeper into the catchments. During this period the rivers of the region, particularly the Shoalhaven and Hawkesbury Rivers, were an important navigation route for shipping timber and agricultural produce.

During the first half of the 19th century model estate orchards, which followed British scientific agricultural practices, were established. Camden Park on the Nepean River and Berry Estate on the Shoalhaven River are two notable estate orchards. These orchards grew fruits, nuts and vegetables. The Hawkesbury River was first used for irrigation in 1828. Considerable drainage of wetlands for agricultural lands commenced on the lower floodplains of Shoalhaven River around this time. Further extensive drainage was undertaken during the 1870s. During the 1930s, mixed farming in the districts included horse breeding, sheep grazing, beef and pork production and dairying. Crop varieties remained unchanged. With the discovery of coal, iron, gold, silver, shale, copper, lead and tin throughout the region from the 1840s, extensive lands were cleared and mined.

With the onset of wheat rust, wheat production and flour milling declined along the rivers, and was replaced with citrus, and dairying. With the introduction of rail and refrigeration, dairying and ancillary industries such as butter and cheese, became the dominant primary industry, replacing sheep and beef throughout the second half of the 19th century. During this period commercial oyster and fish harvesting commenced on the estuaries of the Hawkesbury and Shoalhaven Rivers.

In 1879 Royal National Park (then 'The National Park') south of Sydney, the first national park in Australia was gazetted to provide for 'rest and recreation'. Some 15 years later, in 1894, Ku-ring-gai Chase National Park was established on the southern banks of the Hawkesbury River in Broken Bay.

From the 1880s, increased affluence and rapid population growth resulted in a gradual expansion in the outer suburbs of Sydney and Wollongong. Towns like Wollongong, Lithgow and Mittagong developed around mining. Silver, lead and gold were mined at Yerranderie and in areas on the Shoalhaven River from the turn of the century. Coal mining resumed in a number of districts and extensive limestone

quarrying commenced on the Shoalhaven River during the 1920s. Dairying continued to grow in importance after the turn of the century and improvements in transport and irrigation encouraged the cultivation of more perishable vegetables.

With urban expansion came significant demands for water harvesting during the 20th century. By the time Warragamba Dam was completed in 1960, Sydney's drinking water catchments, including the catchment of the Nepean River, covered an area of over 9,000 square kilometres. Warragamba Dam alone inundated 140 kilometres of the River. Wingecarribee Dam was completed during the 70's and inundated much of the upper reaches of the Wingecarribee River. Tallowa Dam on the Shoalhaven River was completed in 1976 impounding waters in the Shoalhaven River Gorge, Kangaroo River, and in Bundanoon and Yarrunga Creeks in Morton National Park.

From the 1930s through to the 1950s fresh perishable produce, particularly fruit, vegetables and milk dominated agricultural land use, although it declined in some districts. Dredging, quarrying and mining expanded throughout the region. Large stands of timber were harvested to support Australia's involvement in World War Two (WWII). Commercial forestry was established primarily in the catchment of the Shoalhaven River with state forests declared throughout the catchment during the 20th century. From the 1950s onward, many of these forests, however, were gazetted as national park. Exceptions were a small number of state forests on the northern escarpment of the Shoalhaven River and in the headwaters of Nattai and Wolgan Rivers, which include pine plantations. Tallaganda State Forest of 25,696 hectares in the headwaters of Shoalhaven River is the only significant state forest of the region.

Following prolonged conservation campaigns during the 20th century, many large and internationally significant national parks were declared throughout the region. Blue Mountains National Park, Kanangra Boyd National Park and Wollemi National Park in the catchment of the Nepean and Hawkesbury Rivers were declared in 1959, 1969 and 1979 respectively. In 1993, 35,000 hectares of the Blue Mountains National Park were declared wilderness. Three years later 125,000 hectares of Kanangra Boyd National Park were declared wilderness, and in 1999, 361,000 hectares of Wollemi National Park were declared wilderness. Morton National Park, Bungonia State Recreation Area and Budawang National Park lying in the Shoalhaven River catchment were declared in 1967, 1974 and 1977 respectively. In 1996, 68,000 hectares of Morton and Budawang National Parks were declared wilderness. Between 1956 and 1980 over 10,000 hectares of the escarpment and plateau in the Illawarra were gazetted as National Park, Nature Reserve, or State Conservation Area.

Following WWII, pressures of the major urban centres called for the NSW Government to devote considerable tracts of rural lands for residential purposes. In the 1970s land was acquired to establish the Macarthur Growth Centre close to Campbelltown. From the 1960s councils were already encouraging rural residential subdivisions across the region. Further residential dwellings have expanded throughout the region and are planned. The North Western and South Western Growth Centres in the South Creek catchment proposed in the Metropolitan Strategy continue the expansion of metropolitan Sydney into the catchments of the Hawkesbury and Nepean Rivers. Similar rural residential subdivisions and urban expansion in the Illawarra have also contributed to the decline in availability of fertile agricultural lands. Increased urban expansion and further decline in agricultural land use is anticipated with new land releases proposed for the Illawarra. Over the next 25 years, Sydney will need an additional 770, 000 new homes. Of these new homes, 230,000 dwellings will be developed on land from Greenfield release areas (new

metropolitan fringe areas released by the State Government for residential development) and land not yet released by the State Government in the North West and South West growth centres.² As well as this, 26,300 additional houses are planned for the Shoalhaven City local government area over the next 25 years, the majority of which shall be located on existing vacant urban lands around Nowra and Bomaderry.

In the Shoalhaven River water source, the significant river dependent industries today include dairying (particularly in coastal reaches), vegetables, flowers, olives, vineyards (in the wetter highlands), beef cattle and sheep (in the drier upland reaches), aquatic agriculture, notably prawning, fishing and oysters (in the estuarine reaches), and river and field sport recreation such as fishing, guided tours, river resorts and canoeing the gorge country immediately above and below Tallowa Dam. Field sports such as golf, cricket and football also depend on the river for irrigation. The river also sustains paper, starch and energy production, sand and gravel extraction, and town water supply.

Across the Illawarra catchment, industry dependent upon rivers are located primarily within the Minnamurra River and Macquarie Rivulet catchments. Here, demands are placed on the rivers for irrigation of pasture for dairying and beef, turf farming, vines, vegetables and fruit trees, nurseries and recreation sporting fields. Mining is also dependent on water from the Macquarie Rivulet. The Macquarie Rivulet is a significant tributary to Lake Illawarra, which supports fishing, prawning, tourism, recreational boating, and marine construction.

The Hawkesbury and Nepean Rivers and their tributaries today support significant industries. Considerable irrigation for lucerne, fodder, pasture, nurseries, turf, vegetables, orchards, cereals, cut flowers and stock extends throughout the entire catchment. The estuarine reaches support significant fishing, prawning, and oyster industries together with recreational boating. Recreational facilities such as golf courses, sporting fields and landscaping also depend on the river for watering. The rivers are also a significant water supply for Sydney, the Illawarra and the Blue Mountains. The rivers also provide for mining (sand and gravel extraction for example), and water for electricity generation, cooling and processing of manufacture, water supply for piggeries and poultry, caravan parks, road construction, motels and tourist attractions.

Metropolitan Sydney relies on the rivers of the metropolitan region largely for town water supply, gardens (Botanic Gardens for example), golf courses, bowling greens, playing fields, orchards, turf farming, tourist attractions and facilities.

Climate

Rainfall in the Shoalhaven River catchment increases from the south west to the north east. In the south west of the catchment around Oallen Ford and Windellama the average annual rainfall is 700 mm while in the north east the average annual rainfall is 2400 mm at Barren Ground Nature Reserve, south east of Robertson.

In the Illawarra, rainfall decreases generally from west to east. The highest rainfall occurs on the Illawarra Range south west of Jamberoo with an average annual of

2. New South Wales Department of Planning, (2010), *Metropolitan Plan for Sydney 2036, Strategic Direction D, Housing Sydney's Population*, New South Wales Department of Planning, Sydney

2,300 mm. The lowest rainfall occurs at Albion Park with an average annual of 1,200 mm.

In the Hawkesbury-Nepean catchment, the highest average annual rainfall is 1,600 mm falling in the headwaters of Lakes Cataract and Cordeaux, west of the Illawarra Range. The lowest average annual rainfall of 700 mm occurs around Glen Alice in the Capertee River valley in the north west.

In metropolitan Sydney, the highest average annual rainfall is 1,500 mm and falls in the south east of the catchment around Darks Forest. The lowest average annual rainfall of 900 mm falls in the south west of the catchment around Campbelltown. Average annual rainfall tends to increase from west to north east and south east of metropolitan Sydney.

Stream flows

The average annual discharge from the Shoalhaven River is 1,400,000 ML and in the Hawkesbury-Nepean River 1,600,000 ML. In the Shoalhaven this annual discharge fluctuates significantly from as little as eight per cent to as much as 430 per cent of the annual average discharge. This range illustrates the significant variability in flows between wet and dry years.

Streamflow is currently measured at numerous gauges across the region. The water sharing rules of the plan are based on flows recorded at gauging stations within the Greater Metropolitan Region as listed in Appendix 9. Other records are kept, such as dam water levels and release volumes from dams. Records from both the current and discontinued gauging stations provide a history of stream flows throughout the region and have been used in the development of the plan.

Climate change and variability

DPI Water has forecast rainfall and runoff across NSW using 15 global climate models for the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) A1B climate scenario.³ The A1B climate scenario indicates a global temperature in 2030 that is 0.9°C higher than the global temperature in 1990. For the Greater Metropolitan Region the worst case forecast is a 5 to 10 per cent reduction in mean annual rainfall by 2030, while the best case is a 5 to 10 per cent increase in mean annual rainfall. Seven of 15 models predict that mean annual rainfall would decrease by between 2 and 10 per cent, while eight of 15 models predict that rainfall would increase by between 2 and 10 per cent by 2030. The worst case prediction for mean summer rainfall is a reduction of between 5 and 10 per cent, while the best case prediction is an increase by between 10 and 20 per cent. Thirteen of 15 models predict that summer annual rainfall would increase by between 2-20 per cent, while two of 15 models predict a decrease of between 2 and 10 per cent. Worst case winter rainfall is a reduction of between 10 and 20 per cent, while the best case prediction is an increase of between 2 and 10 per cent. Seven of 15 models predict that annual winter rainfall for the region shall fall by between 2 and 20 per cent, while eight of 15 models predict an increase in annual winter rainfall of between 2 and 10 per cent.

3. Vaze J., Teng J., Post D, Chiew F., Peraud J-M., Kirono D, (2009), *Future climate and runoff projections (~2030) for New South Wales and Australia Capital Territory*, NSW Department of Water and Energy, Sydney

DPI Water has developed a hydrology model for the Hawkesbury-Nepean River to estimate variation in flows and frequency and duration of licensed access to flows due to water sharing rules. This model may be used to investigate the effects of the above rainfall forecasts on flows and water user access across the plan area.

Entitlement and use

There are approximately 2,307 water licences in the area covered by the plan, totalling 1,197,554 ML of entitlement (Table 3). The amended plan includes an additional 4,981 ML of entitlement for the Kangaroo River Management Zone. This represents an increase of 668 ML from the original entitlement included in the 2004 Kangaroo River plan. This is thought to be due to incorrect calculations when the plan was initially developed. The majority of this increase in entitlement is in the escarpment zone.

The majority of unregulated river access licences are for irrigation purposes. However, the largest volumes of water are extracted for town water supply. Water is also extracted from watercourses within the Greater Metropolitan Region through basic landholder rights, which do not require a licence.

Many of the unregulated surface water licences are located along the Nepean River and Hawkesbury River. Twelve of the management zones covered by the plan were classified as being of high economic dependence on commercial water extraction.

Through the Hawkesbury-Nepean Water Balance Accounting Project (concluded in 2011) meters have been installed for 97 per cent of active unregulated river access licences in the Hawkesbury-Nepean catchment. This excludes major water utilities which are managed and metered under separate licensing arrangements.

Table 3: Total entitlement and number of licences for each water source

| Water source | Entitlement (ML) | Number of licences |
|--------------------------------------|------------------|--------------------|
| Shoalhaven River | 367,251 | 284 |
| Illawarra Rivers | 3,045 | 105 |
| Upper Nepean and Upstream Warragamba | 669,520 | 411 |
| Hawkesbury and Lower Nepean | 120,532 | 1,395 |
| Southern Sydney Rivers | 35,341 | 63 |
| Northern Sydney Rivers | 1,865 | 49 |
| Total | 1,197,554 | 2,307 |

Local water utility and major utility requirements

A number of town water supplies, ranging between large storages and small direct river extractions, are located within the Greater Metropolitan Region. These supplies are administered through various local councils and major utilities such as Water NSW.

Local water utilities are managed by local councils. The Goulburn Mulwaree Council supplies the largest amount of water to households. The Goulburn Mulwaree Council extracts water from the Wollondilly River and Sooley Creek to supply water for towns including Goulburn and Marulan. Wingecarribee Shire Council extracts water from Wingecarribee River for towns in the southern highlands.

Shoalhaven City Council draws water from the Shoalhaven River to supply Nowra and surrounding towns. Water is also drawn from the Shoalhaven River by Palerang Council to supply water to Braidwood.

Table 4 lists the local councils which are licensed to extract water from the water sources of the Greater Metropolitan Region.

A major water utility licence allows the take and use of water from authorised water sources in accordance with an extensive set of conditions covering works authorisations, environmental flow releases and other operating requirements, monitoring, reporting and scientific studies. The major water utilities that are licensed to extract surface water in the Greater Metropolitan Region for town water supply are also listed in Table 4. Other major utilities are licensed to extract water for power generation in the region and include Energy Australia and Eraring Energy.

Table 4: Town water supplies, location and entitlement volume in the Greater Metropolitan Region

| Operator | Water Source | Management Zone | Entitlement (ML/yr) |
|------------------------------|--------------------------------------|--|---------------------|
| Local Water Utilities | | | |
| Wingecarribee Shire Council | Shoalhaven | Bundanoon Creek | 1,000 |
| Wingecarribee Shire Council | Upper Nepean and Upstream Warragamba | Medway Rivulet | 900 |
| Goulburn Mulwaree Council | Upper Nepean and Upstream Warragamba | Upper Wollondilly River | 5,100 |
| City of Lithgow Council | Hawkesbury and Lower Nepean River | Colo River | 1,293 |
| Shoalhaven City Council | Shoalhaven River | Lower Shoalhaven River | 22,902 |
| Shoalhaven City | Shoalhaven River | Kangaroo River | 85 |
| Major Water Utilities | | | |
| Water NSW | Shoalhaven River | Lower Kangaroo River/Shoalhaven River Gorge | 329,000 |
| Water NSW | Upper Nepean and Upstream Warragamba | Upper Nepean River Tributaries Headwaters, Lake Burragorang, Pheasants Nest Weir to Nepean Dam, Mid Cataract River | 620,000 |
| Water NSW | Hawkesbury and Lower Nepean River | Grose River | 6,000 |
| Water NSW | Southern Sydney Rivers | Upper Woronora River | 32,000 |
| Sydney Water Corporation | Hawkesbury and Lower Nepean River | Upper Hawkesbury River (Grose River to South Creek)* | 20,075 |
| Energy Australia NSW PTY LTD | Upper Nepean and Upstream Warragamba | | 25,000 |
| Eraring Energy | Shoalhaven River | | 4,021 |

3. Developing the plan

Scope of the plan

The plan covers the hydrological catchments of the unregulated rivers of the Greater Metropolitan Region. The rivers include:

- the Shoalhaven River (now including the former Kangaroo River Water Source),
- the rivers of the Illawarra from Crooked River in the south to Stanwell Creek in the north,
- the Nepean River,
- the Hawkesbury River, excluding Mangrove Creek and Mooney Mooney Creek, and
- the rivers of the Sydney Basin from the Hacking River in the south to the Hawkesbury River in the north.

The plan does not cover the following:

- the area of land below the mangrove limit, as defined in the 'DIPNR Survey of tidal limits and mangrove limits in NSW estuaries 1996 to 2003', and
- Mangrove Creek and Mooney Mooney Creek are dealt with in the *Water Sharing Plan for the Central Coast Unregulated Water Sources 2009*.

Water management units

Water sharing plans have a hierarchy of water planning units. The extraction management unit (EMU) is the highest level in the hierarchy of planning units and may consist of one or several water sources. The daily access rules apply at the water source and management zone level, which are the next level down in the hierarchy of planning units.

Extraction management units

An EMU is specified for the purpose of establishing a geographic area over which the long-term average annual extraction limit (LTAAEL) applies. An available water determination (AWD) is made for each licence category within the EMU and any growth in extraction above the LTAAEL is managed across the EMU, not at an individual water source level.

The plan establishes six EMUs for managing extraction across the region.

The former Kangaroo River EMU has been merged with the Shoalhaven River EMU. This change simplifies water administration associated with long term average annual extraction limits but is unlikely to have significant implications for water users in the valley. The establishment of a single EMU avoids necessary adjustments to the individual LTAAELs associated with licence dealings across EMUs. A single EMU also simplifies compliance of licensed extraction against the limit.

Water sources

Water sources usually coincide with sub-catchment boundaries. Access and trading rules are developed for each of these water sources.

The plan contains six water sources:

- the Shoalhaven River Water Source – all unregulated surface water in the hydrological catchment of the Shoalhaven River,

- the Illawarra Rivers Water Source – all unregulated surface water in the Illawarra,
- the Upper Nepean and Upstream Warragamba Rivers Water Source – all unregulated surface water in the hydrological catchment of the Nepean River above and including Douglas Park Weir and in the hydrological catchment of the Warragamba River at and above Warragamba Dam,
- the Hawkesbury and Lower Nepean Rivers Water Source – all unregulated surface water in the hydrological catchment of the Nepean River below Douglas Park Weir and Warragamba Dam and in the hydrological catchment of the Hawkesbury River, excluding the catchments of Mangrove Creek and Mooney Mooney Creek,
- the Southern Sydney Rivers Water Source – all unregulated surface water in the hydrological catchments of Hacking River, Georges River, Woronora River, Cooks River, and the hydrological catchments east of Hacking River and north of Stanwell Creek and south of Port Hacking, and
- the Northern Sydney Rivers Water Source – all unregulated surface water in the hydrological catchments for Parramatta River, Lane Cove River, Middle Harbour River, and the hydrological catchments north of Middle Harbour River, east of the hydrological catchment of Hawkesbury River and south of Broken Bay.

The spatial extent of the water sources in the plan area is shown in Appendix 1.

Management zones

A management zone is the next level down in the planning unit hierarchy and represents a portion of a water source and is the level at which more refined implementation of access or trading rules are applied. In the plan all water sources have been split into management zones which specific daily access rules and trading rules are established.

The **former Kangaroo River Water Source** has become the Kangaroo River Management Zone within the Shoalhaven River Water Source. This brings the total number of management zones within the Greater Metropolitan plan to 88. This change to the management units is primarily an administrative change which has no impact on the rules or extraction limits for the Kangaroo River.

Table 5 summarises the hierarchy of water management units used in this plan.

Project groups

State Interagency Panel

The State Interagency Panel (SIP) has overall responsibility for the statewide strategic direction of water sharing planning, to make certain that adequate resources are available from each agency and to ensure that the varying policy and statutory requirements of the relevant NSW Government agencies are met. The SIP also has the role of making water sharing decisions in cases where the Interagency Regional Panel (IRP), see below, cannot reach agreement or where the issue has statewide significance.

Table 5: Water management units for this Water Sharing Plan

| Extraction management unit | Water source | Management zone |
|--------------------------------------|--------------------------------------|---|
| Shoalhaven River | Shoalhaven River | Upper Shoalhaven River, Mid Shoalhaven River, Reedy Creek, Boro Creek, Mongarlowe River, Corang and Endrick Rivers, Nerrimunga Creek, Bungonia Creek, Shoalhaven River Gorge, Barbers Creek, Fitzroy Falls, Yarrunga Creek, Kangaroo River, Lower Kangaroo River, Bundanoon Creek, Lower Shoalhaven River, Bomaderry Creek, Lower Shoalhaven River Catchment, Broughton Creek, Broughton Mill Creek, Jaspers Brush Creek and Tributaries |
| Illawarra Rivers | Illawarra Rivers | Minnamurra River, Minnamurra Coastal, Lake Illawarra, Macquarie Rivulet, Wollongong Coastal |
| Upper Nepean and Upstream Warragamba | Upper Nepean and Upstream Warragamba | Mulwaree River, Upper Wollondilly River, Lower Wollondilly River, Upper Wingecarribee River, Lower Wingecarribee River, Medway Rivulet, Nattai River, Little River, Lake Burragarang, Werriberri Creek, Maldon Weir, Pheasants Nest Weir to Nepean Dam, Maguires Crossing, Stonequarry Creek, Lower Cataract River, Mid Cataract River, Avon River, Cordeaux River, Upper Nepean Tributaries Headwaters, Wywandy, Dharabuladh, Jenolan River, Kowmung River, Kedumba River |
| Hawkesbury and Lower Nepean Rivers | Hawkesbury and Lower Nepean Rivers | Menangle Weir, Camden Weir, Sharpes Weir, Cobbity Weir, Mount Hunter Rivulet Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir, Mid Nepean River Catchment, Warragamba River, Lower Nepean River, Erskine Creek and Glenbrook Creek, Grose River, Capertee River, Colo River, Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek), Upper Hawkesbury River (Cattai Creek to Colo River), Lower Hawkesbury River, Macdonald River, Upper South Creek, Lower South Creek, Cattai Creek, Berowra Creek and Cowan Creek |
| Southern Sydney Rivers | Southern Sydney Rivers | Upper Woronora River, Lower Woronora River, Hacking River, Lower Georges River and Bunburry Curran Creek, Cabramatta Creek, Prospect Creek, Georges River Catchment, Cooks River and Botany Bay, Southern Sydney Coastal |
| Northern Sydney Rivers | Northern Sydney Rivers | Upper Parramatta River, Lower Parramatta River, Lane Cove River, Middle Harbour, Northern Sydney Coastal |

The SIP is chaired by DPI Water. The group has representatives from the Department of Primary Industries and the Office of Environment and Heritage. There are also three Local Land Services (LLS) representatives as observers. DPI Water is responsible for the overall project management.

Interagency Working Group (formerly the Interagency Regional Panel)

The plan rules were initially developed by the Greater Metropolitan Interagency Regional Panel. This was an inter-agency group consisting of representatives from the former Office of Water, Department of Primary Industries, and the Office of Environment and Heritage, with the participation of the former Sydney Catchment Authority, Sydney Water Corporation, and the Hawkesbury-Nepean, Southern Rivers and Sydney Metropolitan catchment management authorities (CMA) (as observers).

In the Greater Metropolitan Region, the Interagency Regional Panel role was subsumed by the Interagency Working Group (IWG), which also included the Office of the Hawkesbury-Nepean. The IWG became responsible for the resolution of a number of policy matters associated with water management in the metropolitan area. Appendix 3A lists the names of the Regional Panel/IWG representatives and

their areas of expertise. The IWG had access to staff from the agencies to provide technical and scientific information. The key roles of the IWG were to:

- establish and review the hydrological units or water sources
- assign economic, social and environmental values and undertake risk and value assessments to classify each water source
- review the existing licence conditions as to their suitability
- make recommendations on the water access and trading rules for each water source
- assist the former CMAs with the public consultation on the proposed rules
- review submissions received during targeted consultation and public exhibition, and recommend changes where necessary to the water sharing rules.

An independent facilitator was initially engaged to chair the meetings and guide the decision-making process. The IWG used a consensus decision-making approach and where agencies had particular issues those issues were highlighted during the public consultation period for specific attention.

The IWG used local knowledge and expertise in recommending the water sharing rules. For example:

- The option to formalise existing local water sharing rules was examined to determine whether those rules achieved the same level of environmental protection as those proposed under the relevant classification and provided for basic rights. In some instances, indicative rules were further refined if site specific information was available.
- Local studies or information from regional staff in areas such as irrigation (I&I NSW) or aquatic ecology (DPI Water)
- Extraction patterns by local water utilities and major utilities
- Consideration of whether the requirements of the estuary at the end of the system necessitated additional catchment-wide rules to provide adequate protection.

The IWG also considered the ability to manage and monitor flow in a water source. For example, where there was no flow gauging station they assessed the risks, and either:

- recommended new gauges be installed for high-risk or highly stressed water sources, or
- Looked at alternatives such as 'staff' gauges (which measure river height but not flow) or visible flow references where the risk to instream values was low.

The IWG also considered known specific requirements of threatened species in relation to key reproductive needs, migration or other particular ecological activities.

Also recommended was a staged approach to change, to limit adverse social and economic impacts by giving water users time to adapt to new rules. Where the existing rules were not consistent with the IWG recommended rules, the degree of immediate change (and hence the effect on extractors) was limited in the short term, unless a higher level of protection could be achieved with minimal socio-economic impact. The IWG then determined a timeframe and the further steps required to achieve the recommended rules during the life of the plan.

Once the proposed water sharing rules were determined, the rules were reviewed to ensure that they integrate well and can be readily implemented across the plan area.

Lower Nepean - Hawkesbury Minister's Advisory Group

Due to the level of concern raised about the possible impacts of water sharing rules for the lower Nepean River and Hawkesbury River, the former Minister for Water established a Ministerial Advisory Group in 2010 to advise the Minister on ways of addressing these concerns.

The Ministerial Advisory Group was chaired by the Member for Londonderry and comprised a broad cross section of industry groups, including irrigated agriculture, commercial fishing and prawn farming.

Recommendations suggested by Ministerial Advisory Group were then considered by the Interagency Working Group for inclusion into the water sharing plan.

Interagency Regional Panel for replacement of the Kangaroo River plan

Replacement of the Kangaroo River water sharing plan and its inclusion in the Greater Metropolitan Region plan was guided by the South Coast Interagency Regional Panel (the Panel). The Panel comprised representatives from DPI Water, DPI Fisheries, DPI Agriculture, Office of Environment and Heritage, and South East Local Land Services. The Panel is chaired by DPI Water. Panel members are listed in Appendix 3B. The Panel held three meetings between 2014 and 2016 to discuss issues relating to replacement of the Kangaroo River water sharing plan.

Policy context

There are a number of national and state policies that impact on and direct the development of water sharing plans.

National Water Initiative

The NSW Government is a partner to the National Water Initiative (NWI) that was signed by the Council of Australian Governments (CoAG) in June 2004. The NWI recognises the continuing imperative to increase the productivity and efficiency of Australia's water use and the need to service rural and urban communities. It also recognises that there is a need to ensure the health of river and groundwater systems by establishing clear pathways to return all systems to environmentally sustainable levels of extraction.

The NWI has a number of relevant requirements for water planning in Clauses 23, 25, 35 to 40, 52, 78, 79 and Schedule E (refer to the National Water Commission website www.nwc.gov.au in the Water Reform section for details). This intergovernmental agreement contains provisions on water planning including:

- settling the trade-offs between the competing uses must be based on the best available science and socio-economic analysis, as well as consultation with the community
- ensuring that environmental and other public-benefit outcomes are provided for through planned and adaptive environmental water on a statutory basis and achieved, including actions to sustain high-conservation value rivers, reaches, and groundwater areas
- providing for water trading to enhance water markets
- recognising and addressing surface and groundwater connectivity

- managing local impacts in groundwater areas as well as protecting groundwater dependent ecosystems (GDEs)
- providing for indigenous consultation and aboriginal cultural and commercial entitlements
- assessing and addressing interception
- monitoring and reporting on implementation.

The Intergovernmental Agreement on the NWI sets out outcomes and guidelines and timelines for water plans and planning processes. Until 2014 the NWI was implemented and monitored by the National Water Commission, an independent statutory body responsible for providing advice to COAG on national water issues. The role of the National Water Commission ceased in December 2014 and its water management functions have been transferred to other agencies. The role of monitoring progress in the implementation of the NWI is now the responsibility of the Productivity Commission

Natural Resources Commission

The macro water sharing plans must also comply with the NSW Natural Resources Commission (NRC) statewide standards and contribute to the relevant statewide targets such as Targets 5 and 6 (see www.nrc.nsw.gov.au for details), which is a requirement of the NSW State Plan (see www.nsw.gov.au/stateplan).

The NRC was established in 2003 to provide the NSW Government with independent advice on natural resource management issues. To achieve this, the NRC has developed and recommended a Standard for Quality Natural Resource Management and 13 state-wide targets for natural resource management in NSW, which have been embedded in the NSW State Plan. Table 6 lists the state targets and how these are met within the water sharing plan.

As with the National Water Initiative, the components of the State Standard focus on the use of the best available knowledge, use of appropriate information management systems, delivery of integrated outcomes, engagement of the community and regular monitoring, measuring, evaluation and reporting to specify how delivery of the targets is progressing. The NRC reviews water sharing plans against this Standard and its associated targets.

Catchment action plans

This plan at the time of its development was consistent with the goals and targets of the following catchment action plans:

- Southern Rivers Catchment Management Authority Catchment Action Plan
- Hawkesbury - Nepean Catchment Action Plan
- Sydney Metropolitan Catchment Action Plan

One of the responsibilities of the former CMAs as an observer on the IWG was to provide advice on the alignment of the proposed classification and extraction limits and rules with the priorities of the catchment action plans.

In January 2014 the NSW Government established Local Land Services (LLS) and transferred the functions of CMAs into this new organisation. The Greater Sydney LLS and South East LLS are now responsible for continuing the delivery of natural resource management programs within the Greater Metropolitan Region, including catchment management plans.

Table 6: Contribution of the plan to the relevant NRC statewide targets

| Relevant statewide target | Contribution by Water Sharing Plan |
|---|--|
| By 2015 there is an increase in the recovery of threatened species populations and ecological communities (Target 3) | - some access and trading rules developed to help protect water dependent threatened species where these were identified and the risk to these from extraction is high. |
| By 2015 there is an improvement in the condition of riverine ecosystems (Target 5) | - sets a defined share of water for riverine ecosystems - protection of very low flows and a proportion of medium and high flows - trading rules to maintain or reduce entitlement in high value streams - adaptive management, giving the ability to adjust rules once information becomes available or at the end of the plan period. |
| By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained (Target 8) | - trading rules to maintain or reduce entitlement in high conservation value water sources - protection of very low flows. |
| By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems (Target 9) | - trading and access rules developed for tidal pool areas and water sources adjoining tidal areas with recognition of estuarine sensitivity and based on environmental requirements of the estuaries - commence to pump rules introduced to protect first flush to estuaries. |
| Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being (Target 12) | - plans provide a defined share to water and defined certainty of access - separation of land and water enhances trading and value of licences - establishment of perpetual and compensable water access licences provides security for business investment - water markets encourage movement of water licences to high value uses - rules developed which consider community dependence on water extraction. |

Other considerations

There are a number of policies and water related issues that required consideration during the development of this plan.

Managing surface water and groundwater connectivity

A key objective of the National Water Initiative is 'recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource. Connections between surface and groundwater systems vary significantly between systems. For example, surface waters recharging alluvial aquifers may emerge again at a discharge point in the river within hours. In contrast water recharging aquifers of the Great Artesian Basin may not discharge for some tens of thousands of years. The connection characteristics need to be considered in linking surface water and groundwater planning, as often the same resource is being accessed by both surface and groundwater licence holders.

For the purposes of water sharing, aquifer types have been grouped into four basic categories:

- Porous rock aquifers found in rock formations such as sandstone or limestone. Groundwater occurs within the pore space in the rock matrix.
- Fractured rock aquifers found in rock formations such as granite or basalt. Groundwater in these rocks occurs mainly within the fractures and joints.
- Coastal sand aquifers, where groundwater is contained in the pore spaces in the unconsolidated sand sediments.
- Alluvial aquifers, where groundwater is contained in the pore spaces in the unconsolidated floodplain material.

The level of connectivity, the relative level of impact and the timing of connection have been considered in developing both the unregulated river and the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. One of the key factors in determining the sustainable yield for various aquifers is the downstream values in connected streams.

The aquifer types and groundwater sources that occur within the Greater Metropolitan Region groundwater sharing plan and their connectivity characteristics are given in Table 7. The information in this table is based on principles and recommendations by Sinclair Knight Merz in *Towards a National Framework for Managing the Impacts of Groundwater and Surface Water Interaction in Australia* (SKM, 2006).

Table 7: Connectivity between aquifer types and surface water

| Aquifer type | Water Sources | Level of connection between surface & groundwater | Level of impact on instream values | Estimated travel time between groundwater and unregulated river |
|-----------------------------|---|---|--|---|
| Coastal sands | Metropolitan Coastal Sands Botany Sandbeds Maroota Tertiary Sands | Significant (tidal section only) | Low as connection with saline water | Days to months |
| Up-river Alluvial | Hawkesbury Alluvium | Significant | High due to impact on base flows | Day to months |
| Coastal Floodplain Alluvial | Shoalhaven | Low - moderate (tidal section only) | Low as not major contributor and low level of connection | Season |
| Fractured rock | Coxs River | Low - moderate | Low as not major contributor | Years to decades |
| Porous Rock | Sydney Basin Sandstones | Low - moderate | Low as not major contributor | Years to decades |

While groundwater sources were considered when developing this plan, the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* governs the groundwater sources in the Greater Metropolitan Region and includes rules for the extraction of groundwater.

Granting new access licences

Water sharing plans provide for the limited application for new access licences, in addition to those that may be applied for under the *Water Management (General) Regulation 2004*. Under the plan, applications for specific purpose access licences may be made in accordance with Clause 19 of the *Water Management (General) Regulation 2004*, and an access licence may be granted in accordance with a dealing. If additional licences are granted in a water source and usage is assessed to have exceeded the LTAAEL, then growth management provisions of the plan are implemented.

Mandatory conditions

The plan sets out provisions that will be applied as mandatory conditions to water access licences and water supply work approvals. These mandatory conditions are designed to protect the rights of all users in the water source and the environmental

water rules of the plan. They cannot be removed or altered unless the plan itself is amended.

Protecting Aboriginal values

Aboriginal cultural values may be affected by water extraction from aquifers and surface waters. Most of the information about flow-related Aboriginal values resides with Indigenous communities.

Initial consultation sessions provided some insights into Aboriginal cultural values associated with unregulated rivers. Aboriginal communities have indicated that water sharing rules should protect natural instream values. Whilst Aboriginal groups acknowledge the rights of commercial water users, they believe that this entitlement should not be at the expense of the environment or cultural values. In their view, the priority for water sharing plans should be to provide for natural flowing rivers with healthy aquatic biodiversity.

Furthermore, opportunities for granting licences for Aboriginal cultural purposes throughout the Greater Metropolitan Region are included in the plan. These can be used for purposes such as manufacturing traditional artefacts, hunting, fishing, gathering, recreation and ceremonial purposes. In certain management zones, Aboriginal peoples may also apply for community development licences which can be used for commercial purposes. The plan also allows for the identification of water for significant Aboriginal cultural sites. The process of identifying these sites and their water requirements is currently being developed by DPI Water as part of an extensive consultation program funded by the National Water Commission.

More information is available on the DPI Water website at www.water.nsw.gov.au.

Considering environmental values

The Greater Metropolitan Region contains a significant number of threatened flora and fauna species, some of which are sensitive to extraction (Appendix 2). All of these species were considered when assessing the instream values of water sources. Water dependent species have different sensitivity to extraction and the sensitivity of the range of species in each water source influenced the final classification and thus rules put in place those values.

Species that are known to be present in specific locations and are highly sensitive to extraction include the Stuttering Frog, Southern Bell Frog, Macquarie Perch, Adams Emerald Dragonfly and the Australian Grayling.

The Australian Grayling, also known as the Cucumber Mullet, Cucumber Herring or Yarra Herring, is a slender fish with bright yellow eyes and a small head that inhabits freshwater streams and rivers. The larvae and young juveniles also have a marine stage before returning to freshwater when they are six months old. Due to the species once being a popular angling species and its high sensitivity to the extraction of water, the number and distribution of Australian Graylings has declined throughout NSW where it is a protected species. The species is also listed as vulnerable nationally and the related New Zealand Grayling became extinct in the 1930s (NSW DPI, 2006).

In order to prevent extinction of the Australian Grayling in NSW conservation measures have been identified to assist the recovery of the species. Measures include maintaining flow rates and water quality in rivers and streams through water sharing plans to provide an optimal habitat for the species. The IWG considered the

vulnerability of the species to extraction when developing water sharing rules in areas where the Australian Grayling is known to survive.

Management zones where the species occur within the Greater Metropolitan Region include Yalwal Creek, Lower Shoalhaven River, and the Shoalhaven Estuary. These areas are all located within the Shoalhaven River Water Source.

Several water sources are known to host Endangered Ecological Communities (EECs). The Hawkesbury and Lower Nepean Water Source were identified as having the Maroota Sands Swamp Forest and Sydney Freshwater Wetlands, both of which are listed as EECs. The Illawarra Rivers Water Source is also home to Sydney Freshwater Wetlands. Both the Maroota Sands Swamp Forest and Sydney Freshwater Wetlands in these areas are strongly sensitive to water extraction and depend on water to maintain the ecological character of the community. The IWG developed the water sharing rules to preserve these communities.

Protecting estuary health

Estuarine values can be threatened by water extraction. Some estuaries are highly sensitive to freshwater inflows, whilst others are resilient to changed inflows. The size and shape of estuaries vary and this, combined with the amount of freshwater inputs, determines the estuary's overall sensitivity to freshwater extraction. Where possible, extractions were tightly capped in catchments found to be highly sensitive to freshwater inflows.

An analysis was undertaken by a group of estuary specialists from the former Office of Water to determine how sensitive each of the State's estuaries are to changes in freshwater inflows. The method was validated by staff from NSW DPI Fisheries and Office of Environment and Heritage. The sensitivity of each estuary was ranked according to their physical attributes – size, shape and the ratio of catchment size to the surface area of the estuary. Small estuaries, such as coastal lagoons, tend to be highly sensitive to inflows. Barrier estuaries tend to be long and narrow and less sensitive to changes to inflows.

Table 8 summarises the inflow sensitivities for the Greater Metropolitan Region estuaries.

The tidal pool is a part of the upper estuary that is essentially fresh, despite being affected by daily tidal movements. In the Greater Metropolitan Region area, the Hawkesbury River has a fairly significant tidal pool that sustains commercial extraction. Extraction from the tidal pool has the potential to impact on estuary values so specific Environmental Flow Protection Rules (EFPR) have been designed to protect low flows entering the estuary and reducing the risk of salt water intrusion. Further investigations will be undertaken during the term of the plan to determine alternative protection measures based on salinity levels at key monitoring points.

Table 8: Inflow sensitivities for Greater Metropolitan Region catchments

| Name | Groundwater Sensitivity | Low Flow Inflow sensitivity | High Flow Inflow sensitivity |
|---|-------------------------|-----------------------------|------------------------------|
| Hawkesbury River Estuary, Tidal Pool | Medium | Medium | Medium |
| Pittwater | High | Low | Low |
| Hawkesbury River Estuary, Lower Pittwater | Medium | Low | Low |
| Narrabeen Lagoon | Medium | High | High |
| Dee Why Lagoon | Medium | High | High |
| Harbord Lagoon/Curl Curl | Medium | High | High |
| Manly Lagoon | Medium | Medium | Medium |
| Port Jackson | Medium | Low | Low |
| Lane Cove River | Medium | Low | Low |
| Parramatta River | Medium | Low | Low |
| Botany Bay | Medium | Low | Low |
| Cooks River | Low | Low | Low |
| Georges River Estuary | Medium | Low | Low |
| Port Hacking | Medium | Low | Low |
| Bellambi | Medium | High | High |
| Towradgi Creek | Medium | High | High |
| Fairy Creek | Medium | High | High |
| Port Kembla Harbour | Medium | Medium | Medium |
| Lake Illawarra | Medium | Low | Low |
| Bensons Creek | Medium | High | High |
| Minnamurra River | Low | Medium | Medium |
| Wrights Creek | Medium | High | High |
| Werri Lagoon | Medium | High | High |
| Crooked River | Low | High | Medium |
| Shoalhaven River | Medium | Medium | Medium |
| Crookhaven River | Medium | Medium | Medium |

Maintaining ecosystem function

In 1997, the NSW Government undertook a public process of developing water quality and river flow objectives for NSW unregulated river catchments. The relevant river flow objectives are shown in Appendix 4: Contribution towards meeting the river flow objectives. The rules in the plan were developed having regard to these objectives.

First flush rules

First flush rules protect a portion of river flows that occur immediately after rainfall event for estuarine and immediate downstream purposes. The rules usually involve either a 24 hour delay when pumping may recommence or a commence-to-pump flow volume higher than the EFPR flow volume. The majority of management zones across the plan area include first flush rules. Where the river height difference between the EFPR river flow volume and commence-to-pump flow volume is insignificant then a 24 hour delay rule is in place.

Protecting basic landholder rights

Under the WMA 2000, extraction of water for basic landholder rights (BLR) does not require a licence, although in the case of accessing groundwater under BLR the bore must still be approved by the DPI Water. BLR includes water for domestic and stock purposes extracted from a water source fronting a landholder's property or from any aquifer underlying the land, harvestable rights, and native title rights.

The principles of the WMA 2000 also require that water sharing must protect BLR. The plan does this by including an estimate of the water requirements for BLR at the start of the plan. There are currently no extractions for native title rights. However, these rights may be activated during the plan's 10 year term. Furthermore, the access rules apply to licensed water users but not to extractions for BLR. This in effect affords these BLR users some additional protection.

Basic landholder rights can be restricted by the Minister to protect the environment or public health, or to preserve existing basic landholder rights. These restrictions are outside the framework of the plan. *Water Management Act 2000* provides for restrictions on basic landholder rights, through the development of mandatory guidelines.

Water interception activities

Changed land use activities can intercept significant quantities of water. Examples of this include an increased farm dam capacity in a catchment or significant areas of new forestry plantations. Under the National Water Initiative, significant interception activities will require a water access licence.

Farm dams require an access licence only when:

- they are located on a 3rd-order (or greater) river, irrespective of the dam capacity or purpose,
- they exceed the maximum harvestable right dam capacity for the property, which is a capacity that enables the landholder the ability to capture 10 per cent of the mean annual runoff from their property, or
- They are on a permanent (spring fed) 1st and 2nd order stream.

The volume of existing licensed farm dams was considered in determining the hydrologic stress rating and resultant access rules.

Unlicensed extraction from farm dams is permitted as a harvestable right. The full activation of harvestable rights within the area of the plan is considered highly unlikely. The plan, therefore allows for an estimate of the current activation of basic landholder rights within the long term average annual extraction limit. The current activation of harvestable rights is therefore implicitly, rather than explicitly, included within this estimate. The provisions relating to harvestable rights are unaffected by any of the rules established in the plan. However, the uptake of harvestable rights will be monitored to determine if at any stage total unlicensed dam capacity has increased to a level considered significant in terms of interception and to inform the implementation of the NWI.

Protecting town water supply access

Towns have a higher priority of access to water than commercial licences. Water sharing plans recognise this priority by ensuring that a full share of water is allocated for annual town water supplies except where exceptional drought conditions prevent this. The annual share for every town water supply will be specified on the operator's licence. Towns may be able to trade part of their annual account water to other towns but, unlike commercial users, will not be able to sell the licence outright.

In unregulated surface water and groundwater sources, towns will not need to change their existing water access arrangements unless their current infrastructure is unable to meet their water needs and requires upgrading. In this case, when a major augmentation of the works occurs, town water utilities will need to meet conditions specified in the plan to ensure that there is enough water flowing to protect the environment and consider any potential impacts on other consumptive users.

Aboriginal community development access licences

Many of the rivers in NSW are generally considered to be 'stressed' due to a high number of irrigation licences, particularly during dry times when river flows are low. This effectively prevents the issuing of any new irrigation licences. However in some of the coastal rivers, higher and more reliable flows are common and provide an opportunity for the granting of Aboriginal community development access licences, provided this additional extraction would not negatively impact on ecological values that are dependent on these high flows.

In certain coastal catchments, Aboriginal community development licences may be granted which allow water to be pumped from rivers during the higher flows, and stored in farm dams or tanks, to be used as needed. It is important to note that for the purposes of issuing these licences, higher flows are not just peak or flood flows but also include flows that are greater than those that are exceeded 50 per cent of the time, that is, the top half of the flow regime.

Since granting Aboriginal community development access licences would mean less water in the river during higher flows to meet other users' and environmental needs, the total volume of water that can be extracted for Aboriginal commercial purposes from a water source shall be limited. The limit is a proportion of the river flow. The plan does not propose to limit the volume assigned to each individual Aboriginal community development licence.

For the plan area, applications for Aboriginal community development licences will be considered in the management zones shown in Table 9.

At the time of public exhibition a review was undertaken to determine if more management zones could sustain Aboriginal community development access licences than those originally recommended. The review identified additional

management zones that are suitable for new Aboriginal community development access licences, which are listed in Table 10.

Table 9: Total limits on extraction by Aboriginal Community Development Access Licences in management zones

| Management Zone | Total volume that may be extracted by Aboriginal Community Development Access Licences (ML/yr) |
|------------------------|--|
| Upper Shoalhaven River | 218 |
| Colo River | 500 |
| Capertee River | 66 |
| Macdonald River | 192 |
| Lower South Creek | 402 |
| Upper South Creek | 48 |
| Cattai Creek | 81 |
| Wywandy | 40 |
| Jenolan River | 40 |
| Kowmung River | 40 |
| Kedumba River | 40 |
| TOTAL | 1,507 |

ACDLs in the Kangaroo River Management Zone

The 2004 plan for the Kangaroo River did not provide for water for Aboriginal community development licence as this category of unregulated river access licence had not yet been established when the plan commenced. During review of the Kangaroo River water sharing plan the Panel therefore considered whether it was appropriate to allow the granting of this licence category in the Kangaroo River Management Zone.

The current policy on ACDLs does not recommend granting these licences in streams with high instream values, or where town water supply requirements are taken from the water source. Due to the presence of town water supply and high instream values in the management zone, the Regional Panel therefore recommended that applications for Aboriginal community development licences would not be permitted in the Kangaroo River Management Zone.

Table 10: Review of management zones for the application of Aboriginal Community Development Access Licences in the Greater Metropolitan Region as a result of public exhibition.

| Management Zone | Can ACDLs be permitted? | Justification for decision |
|------------------------------------|--|---|
| Mongarlowe River | No | Due to the presence of Macquarie Perch and additional threatened species, additional extraction of high flows is not recommended. |
| Corang and Endrick Rivers | No | Corang and Endrick rivers flow to Shoalhaven River which is a significant source of town water supply. |
| Dharabuldah | No | Due to the presence of the Giant Barred Frog, additional extraction of high flows is not recommended. |
| Kedumba River | ACDLs may be permitted. | |
| Upper Hawkesbury River (all zones) | No | Due to the presence of the Giant Barred Frog, additional extraction of high flows is not recommended. |
| Lower Hawkesbury River | No | Due to the presence of the Giant Barred Frog, additional extraction of high flows is not recommended. |
| Lane Cove River Middle Harbour | ACDLs may be permitted in the future when suitable infrastructure is installed e.g. a gauge and there is sufficient water to meet the needs of this licence without compromising existing users in the management zones. | |

High flow conversion

Competition for water can be high in many coastal rivers of NSW during periods of low flow. Instream values can become stressed during these low flow periods, as wildlife becomes concentrated in particular locations and as water quality deteriorates. Therefore, there is merit in developing incentives that aim to move extraction out of the low flows and into the higher flows to improve environmental condition and reduce competition.

By moving extraction from periods of low flow to periods of relatively higher flow, over time, competition for flows may be reduced and river condition improved. An incentive is required since low flows occur when the extraction of water is most critical and on-farm water storage is required to utilise higher flows. Although access to higher flows may be an expensive approach to irrigation, it may provide enhanced security for water users.

An incentive set out in the plan is to offer additional entitlements to licences that convert to higher flows. The additional entitlement is that for every 1 unit of a normal unregulated river access licence entitlement surrendered, 2.5 units of higher flow access licence entitlement will be granted. The high flow access commences at the 50th percentile which is the flow that is exceeded 50 per cent of days.

Given that the purpose of the high flow conversions is to reduce extraction of low flows in coastal rivers, a detailed assessment was undertaken to ensure that conversions would achieve a net environmental benefit.

Conversion has been recommended in water sources where the following criteria are met:

- the water source is classified as having important instream values at high risk from extraction or in water sources having high hydrological stress
- there are adequate mechanisms in place to ensure the surrendered low flow is reserved for the environment
- there are no highly sensitive estuary or other identified high flow sensitive feature such as a wetland in the water source
- there is no existing high flow stress (i.e. significant extraction already in the high flow periods)
- the conversion would not significantly impact on tidal pool users or town water supplies.

In addition, while trading of higher flow entitlements is possible, the plan states that it will be constrained as follows:

- trading within the water source will generally be permissible, and
- cease and commence to pump levels at the new location will always be the 50th percentile flow.

For the plan area, limited applications for conversion to high flow licences will be considered in the management zones shown in Table 11. The prevalence of a town water supply licence in the management zone restricted the application of high flow licences.

High flow conversions in the Kangaroo River Management Zone

The issue of high flow licences in the Kangaroo River Management Zone was considered by the Panel during the process of plan replacement. The 2004 plan for

the Kangaroo River did not provide for high flow conversions as this type of unregulated river licence had not been established when the plan commenced. The current policy on granting high flow licences uses similar criteria to ACDLs. The Panel therefore determined that the conversion of licences to high flow licences could not be permitted due to the presence of town water supply and high instream values in the Kangaroo River Management Zone.

Table 11: Management zones where high flow conversion licences are permitted in the plan

| Management Zone | The total volume that may be extracted in a water source by high flow licences (unit shares) |
|------------------------|--|
| Upper Shoalhaven River | 392 |
| Broughton Creek | 158 |
| Broughton Mill Creek | 158 |
| Macdonald River | 392 |
| Lower South Creek | 414 |
| Upper South Creek | 88 |
| Cattai Creek | 107 |
| TOTAL | 1,709 |

Defining water extraction limits

The plan adopts a 'long-term planning approach' to sustainable water use by setting a long term average annual extraction limit (LTAAEL), monitoring the benefits and impacts of the water management rules, and reviewing the LTAAEL and management rules if required.

LTAAELs limit the average amount of water that can be extracted each water year from unregulated streams. The limits are based on either the current level of entitlement or the average total licence usage between 1993 and 1999 (as assessed under the volumetric conversion process) plus an estimate of the current basic landholder rights usage and an allowance for 'acceptable growth'. Acceptable growth includes increases in the LTAAEL through the roll-out of tidal pool licences to reflect history of use. In some years the level of extraction may exceed this figure as carryover provisions allow more water extraction in some years as a result of underutilised account water from previous years or where the LTAAEL has been set at less than the total of entitlements, climatic variations in extractions can result in total extractions being either over or under the LTAAEL in any one water year. The LTAAEL does not include water taken through interception for farm dams within their harvestable right.

The plan establishes a monitoring, evaluation and review process that will enable the LTAAELs to be amended if the limits do not maintain or improve river health. Such assessments will require consideration of water sharing externalities such as climatic variability and dry sequences. This adaptive management process is discussed later in this document.

4. Rules for unregulated water sources

Classification method

The classification of water sources was the first step in developing water sharing rules. The Interagency Working Group classified each unregulated water source as being of high, medium or low risk and value. Two matrices were developed - a 'value matrix,' which rated a water source's instream value against its hydrologic stress, and a 'risk matrix' which rated the risk to instream values against its community dependence. The matrices for the Greater Metropolitan Region are included in Appendix 6. A full discussion of the method is provided in *Macro water sharing plans: The approach for unregulated rivers. Report to assist community consultation*, and is available at www.water.nsw.gov.au.

This classification method took into account:

- the volume of water licensed for extraction,
- the potential impact of extraction on rivers and estuaries,
- the associated uses from this extraction, and
- the social and economic impacts of restricting extraction.

Specifically the classification process involved assessment of factors, including:

- instream values, for example, threatened fish that are likely to be affected by extraction,
- risk to these instream values posed by the existing or increased extraction
- hydrologic stress, which is determined based on a comparison of the demands associated with the amount of water licensed for extraction relative to river flows,
- extraction value, which is a qualitative assessment of the economic value of the agriculture which relies on the water licensed for extraction,
- economic dependence of the local community on activities dependent on licensed water extraction,
- sensitivity of estuaries to the removal of freshwater inflows,
- current best estimate of the amount of water extracted under basic landholder rights and for town water supplies,
- whether the existing water sharing rules are adequate to manage the risk of extraction to instream values and basic landholder rights, and
- NSW Government policy.

Tidal pools were classified using a similar method. In the 'value matrix', estuary values were used instead of instream values and low flow sensitivity x hydrologic stress represented hydrologic stress in the tidal pool. For the 'risk matrix', risk to estuary values and community dependence on extraction were used.

A large range of reference material was considered along with the general knowledge of the members of the Interagency Working Group and technical support staff of agencies. The list of reference material utilised by the working group is listed in Appendix 5.

The classification assisted in determining the optimal balance between extraction and protection of water instream for each water source. These broad-scale relative assessments showed where water sharing rules needed to strongly protect valuable

natural assets by limiting extraction or to provide for extraction by water users where there is significant community dependence on extraction.

Generic indicative rules were developed for both matrix classifications for each water source to expedite the development of the water sharing plans by the IWG. The 'value' matrix was used to develop trading rules and the 'risk' matrix was used to develop the water access rules. Where necessary, the IWG refined these indicative rules to reflect local circumstances.

Classification for the Kangaroo River

The original plan for the Kangaroo River was prepared prior to the macro-classification approach outlined above. The Kangaroo River, however, was assessed and given ratings under the macro process when the Greater Metropolitan Region plan was prepared. This classification process was undertaken again in 2013 when new information became available including updated peak daily demand and flow data. The results from the 2013 assessment for the Kangaroo River are shown in Table 12. These values were taken into account by the South Coast Panel when assessing options for changes to the water sharing rules.

Table 12. Classifications and indicative access rules applied to the Kangaroo River in 2013

| Value and rules | Assessment result |
|--------------------------|--|
| Risk to instream values | HIGH |
| Dependence on extraction | HIGH |
| Instream values | HIGH |
| Hydrologic stress | HIGH |
| Indicative access rules | <ul style="list-style-type: none"> • Cease-to-pump to maintain specified depth of flow at the end of the water source, • Cease-to-pump to allow flows at or below the 95th percentile to pass the end of the water source, • Specific flow rules for instream values, and • Environment to receive no less than 40% of the daily flow share |
| Indicative trading rules | Trades are not allowed into or upstream of |

Developing the water sharing rules

The classification process was used as the basis for developing the following type of water sharing rules:

- access rules – which determine at what flow rates and times extraction is allowed to commence/cease and whether these should change in certain climatic circumstances;
- dealing rules – which control the trade of water (both permanent transfer of access licence entitlements and temporary assignment of water allocation between access licences), the change of water sources and the location for extraction.

Other management rules that were considered in the development of the plan include:

- extraction limits – which set the total volume of water that can be extracted on a long-term average annual basis from the water source or water management zone,
- release rules from major storages,
- rules for granting new entitlement – what types of access licences may be granted,
- rules for granting works approvals – what types of set back conditions are required, and
- rules for the protection of a specific environmental asset e.g. the Eastern Freshwater Cod.

Developing the access and dealings rules

The IWG used local knowledge and expertise in developing the water sharing rules. In some instances, indicative rules were further refined if site specific information was available.

Once the proposed water sharing rules were determined, a check was undertaken to ensure that the rules are consistent in their application and practical to implement across the catchment.

Exceptions to the generic rule approach

In reviewing the indicative rules proposed for each management zone the IWG applied local knowledge to refine access and trading rules where appropriate. Amendments made were based on factors such as:

- available infrastructure (eg river gauges),
- available management systems (e.g. ability to manage the rules),
- existing management rules (e.g. existing licence conditions or Water Users' Association self-imposed management rules),
- whether the highly variable nature of the water source required differing management rules, and reliance of users on weir pools on the Upper Nepean,
- consideration of industry concerns in relation to trading between weir pools and within the tidal pool,
- limited possibilities for harvesting overland and high flows,
- augmentation of environmental flows with treated recycled water, and
- the importance of maintaining a viable local agricultural industry.

In management zones where the existing access rule on a *Water Act 1912* licence was more stringent than the indicative rule, generally the existing access rule was adopted, given that there would be no adverse social or economic impact to that individual as there would be no change to current operations. In these circumstances the IWG acknowledged that many of the rules had been negotiated by water users, had been in place for a long period of time and may be protecting environmental values while providing security for water users.

Appendix 7 outlines the changes made to the initial access and trading rules by the IWG. Classifications for some water sources have changed from their initial classification as a result of availability of key data.

5. Consultation

The classifications and the IWG's recommended access and trading rules underwent targeted consultation with water users and specific interest groups⁴ before the plan was drafted. Formal public exhibition⁵ of the plan ensured wider public consultation.

While developing the plan, the participating agencies (NSW Department of Primary Industries, Office of Environment and Heritage, Sydney Catchment Authority, Sydney Water Corporation and the Catchment Management Authorities) identified areas where better data was needed for making future water planning decisions. Similarly, the community were able to suggest areas where further analysis or data gathering was required. This local input was essential in the finalisation of the plan.

The former CMAs managed the public consultation process, and ensured that all stakeholders and interested parties had an opportunity to examine and comment on the proposed water sharing rules. In particular, the CMAs were looking for stakeholders to provide:

- local knowledge and expertise – for example, there may be other natural or socio-economic values that were not yet been considered by the Interagency Working Group,
- feedback on the practical elements of the proposed water sharing rules - to ensure they are understood and able to be implemented by the licence holders,
- confirmation that there are no unintended perverse outcomes from the plan, and
- specific comments on the Minister's notes included in the draft plan.

Targeted consultation on the draft rules

Targeted consultation on the proposed rules for the plan began with a series of meetings in October 2009 (Table 13).

Table 13: Key groups consulted in the plan area as part of targeted consultation

| Date | Group | Location |
|-----------------|-----------------------------------|---------------------|
| 19 October 2009 | Water Users' Associations | Penrith |
| 20 October 2009 | Major Utilities | Penrith |
| 21 October 2009 | Stakeholder representation groups | Sydney |
| 22 October 2009 | Local Government | Penrith |
| 26 October 2009 | Hawkesbury Nepean stakeholders | Windsor and Camden |
| 27 October 2009 | Sydney and Illawarra stakeholders | Chester Hills |
| 28 October 2009 | Shoalhaven stakeholders | Nowra and Braidwood |

The objectives of this consultation were:

4. Targeted consultation refers to informal consultation held with key stakeholders to test the suitability of the proposed water sharing rules and provide feedback on the potential impacts of the rules.

5. Public exhibition is the formal exhibition of a draft plan where the Minister invites submissions on the draft plan and in particular will seek comment on a range of key issues.

- to provide background as to why the water sharing plans were being developed, how they were developed, what rules were proposed in the various areas and how stakeholders could provide feedback, and
- to provide a 'first opportunity' to informally consult with key stakeholders to test the suitability of the proposed water sources and management zones, flow reference points and access and trading rules.

The CMAs encouraged stakeholders to submit their comments in writing. A total of 34 submissions were received as a result. Discussions with water users' associations also continued through to the public exhibition period.

The IWG reviewed all submissions and matters raised during targeted consultation, and recommended some changes to the initial water sharing rules. During this review process updated flow data and water use data was incorporated into the assessment process. Appendix 12 outlines the changes made to the proposed rules as a result of this consultative process and inclusion of new data.

Public exhibition of the water sharing plan

Public exhibition of the proposed water sharing plan was held throughout the region in late 2010. The objectives of this consultation were:

- to provide background to stakeholders as to why the water sharing plan was being developed, how it had been developed to date, what rules are proposed in the various areas and how stakeholders can make a submission
- to formally consult with a broad range of stakeholders to explain the proposed water sharing rules and how they will be implemented, and
- to seek feedback from stakeholders and the general community about the proposed water sharing rules.

Table 14 shows the locations of meetings that were held during the public exhibition process.

Table 14: Public exhibition meetings held in the plan area

| Date | Group | Location |
|-------------------------------|---|----------------------|
| 27 th May 2010 | Local Government Association groups | Penrith |
| 15 th June 2010 | Illawarra stakeholders | Jamberoo |
| 16 th June 2010 | Shoalhaven stakeholders | Nowra |
| 17 th June 2010 | Shoalhaven stakeholders | Braidwood |
| 21 st June 2010 | Hawkesbury Nepean stakeholders | Windsor |
| 22 nd June 2010 | Sydney and Hawkesbury Nepean stakeholders | Liverpool and Camden |
| 28 th June 2010 | Blue Mountains stakeholders | Katoomba |
| 29 th June 2010 | Southern tablelands stakeholders | Moss Vale |
| 30 th June 2010 | Southern tablelands stakeholders | Goulburn |
| 1 st July 2010 | Aboriginal community stakeholder groups | Goulburn |
| 1 st July 2010 | Hawkesbury Nepean stakeholders | Penrith |
| 6 th July 2010 | Capertee Valley stakeholders | Glen Alice |
| 23 rd July 2010 | Capertee Valley stakeholders | Glen Alice |
| 4 th August 2010 | Local Aboriginal Land Councils | Parramatta |
| 14 th October 2010 | Coxs River Water Users Group | Rydal |

During public exhibition period, the Minister for Water established the Lower Nepean-Hawkesbury Minister's Advisory Group (MAG) to advise the Minister on ways of

addressing these concerns. The MAG is further detailed in the “Project Groups” section.

Stakeholders were encouraged to submit their comments in writing and a total of 250 submissions on unregulated water sources were made as a result of the public exhibition. These were reviewed by the IWG and changes were made to the water sharing rules as appropriate.

Appendix 13 lists all the changes that were made to the plan as a result of public exhibition after being reviewed by the IWG.

Consultation and public exhibition for Kangaroo River water sharing plan replacement

Targeted consultation

Public submissions regarding the replacement of the Kangaroo River water sharing plan were called for in early 2013. These submissions and additional information were collated and reviewed during 2013 and in May 2014 the Minister recommended that the plan be replaced (along with 30 other plans due to expire).

Key stakeholders were informed of the proposed changes to the rules in the plan area through information sessions held with escarpment water users at Burrawang in March 2014 and valley water users at Kangaroo Valley in March 2015. The main concern of both groups of water users was the proposed increase in the cease-to-pump level.

Public exhibition

In February 2016 all water users and other stakeholders such as local environment groups were notified by letter of the exhibition period for the draft plan amendments.

The proposed changes for the Kangaroo River management zone were placed on public exhibition from 15 February to 25 March 2016. The plan and supporting documents were on display at Kangaroo Valley Post Office and Robertson General Store. Public information sessions were held at Burrawang on 7 March 2016 (attended by three water users) and Kangaroo Valley on 8 March 2016 (attended by four water users).

Four written submissions were received following exhibition of the plan. The main issue raised in the submissions and discussed at the public meetings was the proposed change to the cease-to-pump. Licence holders were also concerned at the potential loss of local ownership that may result from merging the plan into the Greater Metropolitan Region unregulated water sharing plan. DPI water has assured Kangaroo River water users that they will still be consulted and given the opportunity to participate in future decisions relating to the Kangaroo River once the plans are merged.

6. Key policy issues for the plan

During the development of the water sharing plan a number of significant water policy issues were raised that were specific to the Greater Metropolitan Region and beyond the scope of the macro planning approach. These matters were negotiated between stakeholders and through the Interagency Working Group, the Lower Nepean-Hawkesbury Minister's Advisory Group, the Metropolitan Water Chief Executive Officer's Committee, and NSW Government.

Protection of environmental releases from Nepean River dams

After the completion of Cataract Dam on the Cataract River in 1907, weirs were constructed at nine selected points on the Nepean River between Menangle and Wallacia. The weirs provide access to water for domestic, stock and irrigation purposes to at least partially offset the interruption of flows in these reaches of the river by the construction of the upper Nepean Dams.

In 2004 the NSW Government developed rules for the release of water for environmental purposes from dams and weirs on the Nepean, Avon, Cataract and Cordeaux Rivers. The water sharing plan adopts and implements these releases by establishing the necessary environmental release rules on the dams and the corresponding Environmental Flow Protection Rules (EFPR) for licences located on the weir pools to protect the releases as they pass through the weirs.

The former Sydney Catchment Authority undertook an extensive Weir Modification Program (completed in 2010) which enables these weirs to be operated in real-time to pass the environmental flows. The construction of fish ladders also reduces the impacts of the weirs in terms of barriers to fish passage but may result in releases from these weirs over and above those required by the EFPRs. This has been recognised in the design of the survival watering rules for the relevant management zones.

Tributary inflows downstream of the dams are protected up to relevant flow percentiles within the respective tributaries, yet there is no additional component added to the EFPRs in the main river. This approach enables protection of the local tributary habitats dependent on low flows, and also allows continued access to the weirs whilst flows through the weirs are at or above the environmental flows released from the Upper Nepean Dams.

Following submissions received during public exhibition the boundaries of the management zones on the Nepean River were amended with each of the operable weirs established as a distinct management zone. These management zones are:

- Menangle Weir
- Camden Weir (including Thurns and Bergins weirs)
- Sharpes Weir
- Cobbity Weir
- Mount Hunter Rivulet Weir
- Brownlow Hill Weir
- Theresa Park Weir
- Wallacia Weir

- Mid Nepean River catchment (including the catchment of the Nepean River between Menangle and Wallacia weirs and excludes the storages of each of the weirs).

The daily access rules for these management zones enforce a daily EFPR when flows recorded at the weirs are less than the environmental flows released from Broughtons Pass Weir and Pheasants Nest Weir less estimated transmission losses. Licence holders may access weir storage whilst the weirs are passing environmental flows.

Signal stage and daily access rules for weirs

The EFPRs for each weir are based on that stage (height or level of the weir storage) at which the required environmental flows to be released from the weir over 24 hours cannot be released. This stage is referred to as the 'signal stage' as it signals the triggering of an EFPR. Licensed water users may access water while the stage is above the signal stage. The volume of water stored below the signal stage is referred to as 'signal storage' and may include water for irrigation and/or environmental water. Although the signal stage may lie above the height of the outlet valve, the volume of water stored within the weir below the signal stage is insufficient to exert the required pressure to release the full volume of environmental flows through the outlet valve over a 24 hour period. 'Dead storage' is that volume of water stored in the weir that either licensed irrigators cannot access since their pipes lie above the stage of dead storage or is below the stage of the outlet valve.

Sydney Catchment Authority advised that the probability of passing all environmental flows through the weirs in a given period varies according to the stage. The precise weir stage that signals a change in daily access rules (signal stage), that is from an EFPR to a commence-to-pump situation, shall be negotiated with Water NSW. The daily access rules have been designed and operated to include a varying signal stage to provide for the passage of environmental flows that are to be released from the weirs over the proceeding 24 hours.

Varying daily access rules

The plan has introduced a variable EFPR for three ranges of inflow to the dams. In order to maintain licensed access to water, the EFPR varies according to the variation in the planned environmental water (PEW) released from the dams for the entire range of dam inflows. Table 15 demonstrates the level at which the EFPR is commenced for each management zone. Transmission losses, travel times, tributary inflows and water shortages were all considered in the development of the access rules.

Transmission losses

Transmission losses refer to losses of flows due to evaporation, seepage, leakage, outflows etc. Losses are accounted for by introducing a rule hierarchy based on the volume of inflows to dams, which is adopted as an indicator of antecedent climatic conditions. An estimated transmission loss (10%) is deducted when the catchment is in drier conditions, which is defined as when inflows to the dams are below the 80th percentile inflow (Table 15, columns B and C).

The approach to account for transmission losses reflects the assumption that the Nepean River and its tributaries shift from a gaining river to a losing river when inflows to the Upper Nepean dams fall below the 80th percentile inflow. The access rules introduce a 'transmission loss factor' of 0.9 (or 10% loss) for flows between the 80th and 95th percentile and 0.8 (or 20% loss) for flows below the 95th percentile

Table 15: EFPR conditions for management zones on the Nepean River above Warragamba River

| Management Zone | Environmental Flow Protection Rules | | |
|---------------------------|---|---|--|
| | When inflows to dams > 80 th percentile | When inflows to dams are between the 80 th and 95 th percentile | When inflows to dams < 95 th percentile |
| | A | B | C |
| Maldon Weir | The weir must pass the volume of water released from Pheasants Nest Weir 24 hours before. | A x 0.9 | A x 0.8 |
| Menangle Weir | The minimum height of the weir must be that necessary to pass environmental water released from Pheasants Nest Weir and Broughtons Pass Weir 24 hours before. | A x 0.9 | A x 0.8 |
| Camden Weir | | A x 0.878 | A x 0.761 |
| Sharpes Weir | | A x 0.871 | A x 0.748 |
| Cobbity Weir | | A x 0.863 | A x 0.734 |
| Mount Hunter Rivulet Weir | | A x 0.858 | A x 0.726 |
| Brownlow Hill Weir | | A x 0.856 | A x 0.721 |
| Theresa Park Weir | | A x 0.837 | A x 0.687 |
| Wallacia Weir | The minimum height of the weir must be that necessary to pass environmental water released from Pheasants Nest Weir and Broughtons Pass Weir 24 hours before. | A x 0.81 | A x 0.64 |

commencing at Menangle Weir. The transmission loss factor for Wallacia Weir shall be zero when dam inflows are above the 80th percentile, 0.81 (0.9 x 0.9) for inflows between the 80th and 95th percentile and 0.64 (0.8 x 0.8) for inflows below the 95th percentile. For weirs between Menangle and Wallacia, the losses shall be distributed between each weir according to the ratio of their distance from Menangle Weir to the total distance between Menangle Weir and Wallacia Weir. The transmission losses will be reviewed during the first term of the plan based on any new hydrologic data gained during the life of the plan, with amendments limited to a range of 50% and 0% transmission loss, ie reviewed factors of between 0.5 and 1.0 respectively.

Travel time

Travel time refers to the time duration of a river flow to travel between two points. Travel time is included only in the rules for the weirs below Menangle Weir Management Zone. Travel time is accounted for by referring the daily access rule for a particular day to the planned environmental water release from the town water supply weirs made on the previous day. Specific travel time within a 24 hour period will not be accounted for as individual release volumes are established and made for 24 hour periods.

Releases from Warragamba Dam

In August 2009 the NSW Government resolved that the former NSW Office of Water and Sydney Catchment Authority investigate possible releases of water from Warragamba Dam for consumptive purposes and that these investigations be

undertaken as part of the economic modelling undertaken for the 2009 review of the plan.

There was a pre-existing agreement to make 5 ML/d dilution releases from Warragamba Dam, as a condition of the approval for the Replacement Flows Project⁶. This has become the new release requirement when the Replacement Flows Project became operational, which was a significant drop from the previous releases of 43.3 ML/d. The Office of the Hawkesbury-Nepean had expressed concerns that such a drop would significantly undermine the health of the Warragamba River (which is immediately downstream of the Dam).

As a result of negotiations, a Warragamba Dam release regime was proposed which entailed the following components:

- a) a seasonally varying release:
 - From 1 November to 31 March: 25 ML/day
 - From 1 April to 31 October: 17 ML/daythat is quarantined from extraction upstream of Sydney Water Corporation's North Richmond off take point via the EFP rules.
- b) a fixed 5 ML/day release that is not quarantined from extraction below Warragamba River.

Sydney Water Corporation had asked that the plan provide for an amendment to these volumes during the term of the plan as an agreement on environmental flow rules for Warragamba Dam may include alternative arrangements for the seasonally varying releases from the dam for Sydney Water Corporation.

The seasonally varying release component in (a) provides in full for Sydney Water Corporation's requirements at North Richmond on the Hawkesbury River and also serves to dilute the Wallacia Sewage Treatment Plant (STP) discharge into the Warragamba River directly below the dam.

Sydney Water Corporation would be charged the raw water price for this release on an annual basis. The chargeable volume would be 7.7GL/yr. There are only two change points in the release rates each year and therefore operational and infrastructure costs are minimised.

The fixed release component in (b) also assists with dilution of the Wallacia STP discharge into the Warragamba River directly below the dam. This release was included as a condition of approval for the Replacement Flows Project. This component of the releases effectively serves a 'dual purpose', including additional dilution (on top of the seasonally varying releases) and subsequently becomes available for domestic and stock and other licensed purposes on the Nepean and Hawkesbury Rivers below Warragamba River. This release is available for consumptive purposes upstream of Yarramundi in addition to the varying non-environmental release component from the St Marys Recycled Water Plant.

DPI Water considers that this regime will improve the reliability of flows in the Hawkesbury River and the security of access for licences below Yarramundi (specifically North Richmond), dilution of the STP discharges into the reach immediately below Warragamba Dam and indirectly supplement demands for other consumptive purposes (including irrigation) below Yarramundi through reduced competition for water. The shares of water provided for through the releases are

6. Western Sydney Recycled Water Initiative Replacement Flows Project.

established through daily access rules for licence holders on the Nepean and Hawkesbury Rivers below Warragamba Dam.

Access to very low flows and environmental flow protection rules in the Hawkesbury – Nepean Rivers

Following concerns raised during the public exhibition period regarding the proposed water sharing rules for the Hawkesbury and Lower Nepean Rivers, the Minister for Water established a Lower Nepean-Hawkesbury Minister's Advisory Group in September 2010.

The group was established in part to recommend water sharing rules relating to licensed access to very low flows in the management zones of the Hawkesbury River for the 'survival watering' of crops. Membership of the group was based on a broad range of industry groups and included the Minister for Water's Office, Lower Nepean - Hawkesbury water user associations, Turf Growers Association, Free Growers Association, prawning industry, fishing industry, the former NSW Office of Water and the Office of the Hawkesbury-Nepean. The group was chaired by Allan Shearan MP Member for Londonderry.

Following submissions from members the group resolved recommendations which were then discussed with the Metropolitan Chief Executive Officer's Committee. The final outcomes of recommendations were then discussed by the Interagency Working Group. The following issues were resolved and dealt with via this process.

Terminology for 'cease-to-pump'

Through the above process, it was decided that in the management zones of the Hawkesbury and Lower Nepean Rivers Water Source the term 'cease-to-pump' would be known as an 'Environmental Flow Protection Rule' (EFPR).

The change in terminology did not change the rule in any way but the Minister's Advisory Group considered this alternative term may assist in gaining acceptance among licence holders of the water sharing rules. The plan adopts EFPR for all management zones in the plan due to the administrative difficulties of adopting multiple terms.

Pre cease-to-pump (EFPR) notification

As part of the implementation of the plan DPI Water intends to implement a communication system that provides 24 to 48 hour notification to licence holders on the Lower Nepean and Hawkesbury Rivers of a likely impending EFPR. Notification enables licence holders to commence voluntary sharing (aka rostering) to provide extended access to river flows prior to an EFPR situation. A similar system is proposed for licence holders on the Nepean River above Warragamba confluence.

The notification assists in improving the timing of the commencement of voluntary rostering and other on-farm irrigation practices. An annual seasonal forecast is also proposed to give an indication to water users of the likely frequency and duration of EFPR conditions for the coming irrigation season given current flow conditions and short-term climate forecasts. This type of forecast is more suited to those users on the compensation weirs as it can incorporate the current weir levels. A forecast may, however, still assist all irrigators to plan for the coming irrigation season.

Boundaries for the tidal pool

Following submissions received during public exhibition, amendments were made to the boundaries of the management zones on the Hawkesbury River to reflect that the

tidal pool reaches some distance into the connected tributaries. Licences located in these tidal zones of the lower reaches of the connected tributaries are now subject to the same access rules as the other users in the tidal pool.

Access to very low flows during a water shortage and 'repayment'

The Upper Nepean Water Users' Association raised concerns that the daily access rules proposed at consultation stages prohibited access to entitled irrigation water stored within weirs during EFPR periods. These periods may include times when watering is critical to crops. In view of these concerns, rules were designed to provide users access to water during very low flows in specific conditions, otherwise known as a 'water shortage'.

A water shortage is signalled when a 24 hour forecast temperature above a predefined temperature occurs following consecutive previous days EFPR. Table 16 shows the temperature and EFPR associated with a water shortage. Temperature is the 4:00 pm or later Bureau of Meteorology Campbelltown forecast for the following day.

Table 16: Water shortage access conditions on the Nepean River

| Forecast temperature (°C) | Number of consecutive days EFPR before trigger | Months |
|---------------------------|--|------------------|
| < 4 | 1 | All months |
| 4 – 23 | 15 | May to August |
| | 10 | All other months |
| 23 – 28 | 5 | All months |
| 28 – 31 | 2 | All months |
| 31 + | 1 | All months |

To explain the water shortage by way of two examples, water shortage would occur when:

1. the forecast temperature is below 25 degrees and a EFPR condition has applied for 15 consecutive days during May to August; and
2. the forecast temperature is 35 degrees and an EFPR condition has applied one day (assessed at approximately 9:00 am every day).

Access to very low flows during water shortages is not capped specifically, although access is limited to the following three consecutive days. However, where total extraction is shown to exceed 41 ML/day on any one day during a water shortage, DPI Water shall investigate whether total daily extraction limits and/or individual daily extraction limits should be introduced in these management zones.

DPI Water considers that these arrangements are an exception to the general policy that licensed access to very low flows should not be provided for in a water sharing plan. The basis for this exception in the mid Nepean River management zones is:

- the design and operation of weirs and the daily access rules may prevent entitled licensed access to water,
- periods when entitled access to signal storage and dead storage would not be permitted are highly likely to include critical crop watering periods, and
- the majority of flows above the weirs are being harvested for town water supply.

The new fish ladders on the weirs will result in some over-release of water from the weirs, over and above that required to pass the environmental flows. At the time of gazettal of the plan, preliminary modelling indicated that the cumulative over-release volume would likely be greater than any cumulative volume extracted under water shortages. Therefore, the plan does not require repayment of the water accessed from the weirs during water shortages. The plan also provides for this arrangement to be reviewed subject to any updated hydrologic modelling.

Very low flow access (due to water shortage) in the Upper Hawkesbury River Management Zones

Access rules have been established so that when a 'water shortage' is triggered limited access to the very low flows is permitted during this period for licence holders on the Hawkesbury River above its confluence with the Colo River. A water shortage is signalled when a 24 hour forecast temperature above or below a predefined temperature occurs along with consecutive previous days EFPR. The conditions which will trigger a 'water shortage' situation are shown in Table 17. Note that the temperature conditions are the 4:00 pm or later Bureau of Metrology forecast for Richmond for the following day.

A water shortage exemption circumstance would occur when:

- Example 1: it's May to August and the forecast maximum temperature for the coming 24 hour period is below 21°C and a EFPR has been applied for 15 consecutive days;
- Example 2: the forecast maximum temperature for the coming 24 hour period is 35°C and a EFPR has applied since 9:00 am today (assessed based on flows at the flow reference point at approximately 9:00 am every day); and
- Example 3: the forecast minimum temperature for the coming 24 hour period is below 4°C and an EFPR has applied since 9:00 am today.

The Minister's Advisory Group recommended that once a water shortage exemption is signalled, that it remain in force for 3 days irrespective of the pumping conditions and temperature to provide sufficient time to complete an irrigation cycle for each farm.

Access to very low flows during water shortages is not capped specifically, although access is limited to the following three consecutive days. However, where total extraction is shown to exceed 105 ML/day on any one day during a water shortage, DPI Water shall investigate whether total daily extraction limits and/or individual daily extraction limits should be introduced in these management zones. Access to very low flows does not require repayment. However, this may be reconsidered when the Minister considers the introduction of TDELS/IDELs.

Table 17: Temperature and EFPR conditions used to trigger limited access to very low flows due to a water shortage

| Number of consecutive days of flows of EFPR | Month | Temperature (°C) |
|---|--------------------|-----------------------------|
| 0 | January – December | Less than 4 |
| 14 | May – August | 4 or more and less than 23 |
| 9 | September – April | 4 or more and less than 23 |
| 4 | January – December | 23 or more and less than 28 |
| 1 | January – December | 28 or more and less than 31 |
| 0 | January – December | 31 or more |

Notes:

The lower temperature end of the water shortage table (i.e. < 4 °C) allows access to water to prevent frosts burning a crop. The 4 °C level is chosen since the air temperature at the height of the standard temperature gauge is usually several degrees warmer than the temperature at the ground surface, which is where the actual frost temperature is critical.

The upper end of the water shortage table (i.e. >31 °C) adopts a risk-based approach and recognises that whilst the temperature at Richmond may be 32 °C, there will invariably be some localised areas that are hotter.

Very low flow access (for survival watering) in the Lower Nepean River Management Zone and Upper Hawkesbury River Management Zones

For those licences located in the upper Hawkesbury River management zones as well as the Lower Nepean River Management Zone, there are concessions to the extraction of very low flows to ensure the survival of crops at critical stages in the crop cycle, but where the actual watering requirements are minimal. The uses to which exemptions apply and the reasons for their exemptions are listed in Table 18.

Table 18: Exemptions for access to very low flows for survival water on the Lower Nepean and upper Hawkesbury River management zones

| Exemptions for access to very low flows for survival watering | Justification |
|---|--|
| New plantings of all crops, for a period of 30 days after planting provided that the volume of water taken does not exceed 15 kL/ha per day of these plantings. | At this stage of the growth cycle, crop water requirements are minimal, however, crop is vulnerable to heat and moisture stress. A volume limit of 15/kL/ha of new plantings. Based on an approximate median volume application per hectare during peak months for all licences listed in schedule 2 of the plan. |
| Herbicide application to turf provided that the herbicide application to turf is required under contract and provided that the volume of water taken does not exceed the minimum volume specified in the herbicide product guideline. | Many turf contracts have fixed dates where herbicide must be applied. Without watering in herbicide, the chemicals may burn or poison crops. Furthermore, without watering in, the herbicide will sit on the crop leaves or soil surface and either be ineffective or be at risk of washing off into the environment during significant rainfall events. The fixed dates set by clients for herbicide application mean the turf grower has very little flexibility to manage these risks. |
| Vegetable and turf washing and misting provided that the volume of water taken does not exceed 20 kL/day per access licence. | Many local market contracts require delivery of fresh fruit, vegetables or turf that are free of soil and chemicals. Once washed, the produce would wilt and die very quickly without a small amount of moisture applied directly to the roots and leaves. This water is also used for misting to prevent the decomposition of the produce, which will occur very rapidly upon harvest without moist and cool conditions. The latter is generally achieved through refrigeration. The volume limit is 20 kL per licence, equivalent to current limits on fruit |

| Exemptions for access to very low flows for survival watering | Justification |
|---|--|
| To water turf during the five day period prior to harvest provided that the harvest date is required under contract and for wetting the cutting face of turf provided that the volume of water taken does not exceed 15 kL/ha per day of that turf. | washing. The 5 day period ensures that turf can be separated from the underlying soil without damage and turf is at maximum moisture content prior to harvest and delivery. Where specific dates for delivery are set by clients, the turf grower has very little flexibility to manage this risk. In relation to wetting the cutting face, during harvesting the cutting face of the turf requires a small amount of water to lubricate the cutting blade, and to soften and loosen the turf from the underlying soil. This enables clean separation of the turf from the underlying soils and ensures that the turf has maximum moisture content at the time of harvest. This process requires only a small amount of water. The total volume limit is 15 kL/hectare as per a users contract/day based on approximate per hectare usage for turf licences listed in the plan. |

For those users in the Upper Hawkesbury River management zones, access to very low flows due to a 'water shortage' will be in addition to those for 'survival watering' except where they occur simultaneously. In the situation that a 'water shortage' is signalled during 'survival watering' access, survival watering rules are overridden by the water shortage access rules.

At year five of the plan the Minister will conduct a review to assess that access to survival water is necessary for the ongoing viability of the irrigation industries in the Lower Nepean and Upper Hawkesbury River management zones.

The modelling aforementioned will be undertaken as part of the mandatory year five review of the plan and would align with the review of water shortage access rules. It is anticipated that further information on irrigators' actual water usage will be available at that time as a result of the current metering roll-out under the Hawkesbury-Nepean River Recovery Programme, and will assist with these reviews.

It is important to note that all of the rules allowing limited access to very low flows are only relevant for the specific management zones in the Greater Metropolitan Region because of their unique and specific management issues.

Flows in the upper Hawkesbury River management zones have been augmented by artificial releases of highly treated water from St Mary's Water Recycling Plant and by transfers from Warragamba Dam to the Hawkesbury River for town water supply requirements at North Richmond for many years. Augmentation to this extent is unique to the Hawkesbury-Nepean and has led to the development of a large irrigated agriculture industry historically reliant on this supply of water. The socio-economic value of maintaining a viable local irrigated agricultural industry specifically able to deliver fresh produce to daily markets in a timely and efficient manner (and with minimal carbon footprint) is a significant issue for a population of over four million people.

This agricultural industry also supplies much of Sydney's turf requirements. Some of this is provided under strict contractual arrangements relating to growth, quality and timeliness where alternate arrangements are not possible (including significant venues and events such as Olympic Park, the Sydney Cricket Ground, horse racing venues or other events of significant social/cultural value).

The irrigated agriculture industry is also typified by having constrained small lot sizes on flat land. This further limits the possibilities for adapting to reduced access conditions by employing alternate management techniques such as harvesting overland flows or capturing and storing high flows in hillside dams.

Daily access rules for the Lower Nepean River

The access rule proposed for the Lower Nepean River Management Zone during targeted consultation was an EFPR rule that protected environmental flows from the dams on the upper Nepean Rivers and the Warragamba River and protected the 95th percentile flows (fixed 22 ML/day) from tributaries below Warragamba Dam, from licensed extraction.

During targeted consultation, water users supported the protection of environmental flows from the dams, yet did not support the fixed protection of what are daily varying tributary inflows. Water users stated that the fixed protection of tributary flows would significantly lower water security, particularly when the actual tributary inflows are lower than the fixed amount. Furthermore, they contended that their water security would be lowered due to the loss of access to natural flows associated with the construction of Warragamba Dam.

The plan now states that the Very Low Flow Class for the Lower Nepean River Management Zone does not include the fixed 95th percentile tributary flow (estimated at 22 ML/day) for the first five years of the plan. From year 6 of the plan, the EFPR rule shall include actual gauged tributary inflows up to and including the 95th percentile where investigations show that access to tributary flows is not necessary to the ongoing viability of the irrigation industry.

Daily access rules and annual extraction limits for Sydney Water Corporation on the Hawkesbury River at North Richmond

Sydney Water Corporation currently extracts water from the Hawkesbury River at North Richmond for town water supply purposes. The extraction authority was granted through a licence under the *Water Act 1912*, which permits the corporation to extract water when flows are at or above 44 ML/day and limits the total volume extracted to 55 ML/day and 20 gigalitres (GL) per year. The licence also provides for new daily access rules to be prepared in accordance with the water sharing plan.

The plan states that Sydney Water Corporation may extract water from the Hawkesbury River whilst flows are equal to or in excess of the EFPR at Yarramundi, which is based on the environmental flow target at Wallacia and Warragamba Dam (in combination with the environmental share of inflows from the St Marys Recycled Water Plant).

The extractions for Sydney Water Corporation at North Richmond are approximately 7.5 GL/yr, based on a climatically representative period of 1993 – 1999. There is not likely to be significant growth in these extractions during the life of the plan (10 years), however a small allowance for growth (5 per cent) has been allowed to the long-term average extraction limit.

Water sharing rules to protect water savings delivered through the Hawkesbury-Nepean River Recovery Project

The Hawkesbury - Nepean River Recovery Project was funded by the Australian Government's *Water for the Future* program for up to \$77.4 million. The project, which concluded in 2012, was administered by the former Office of the Hawkesbury-Nepean. The project sought to improve the health of the Hawkesbury - Nepean River

below the major water supply dams by increasing the water available for environmental flows in the rivers. Increases in water available for the environment have been delivered through water savings.

The project was divided into seven components delivering water and or nutrient savings. The project components that deliver water savings include:

- irrigation and landscape efficiency (PC1)
- licence purchase (PC2)
- Water Smart Farms (PC3)
- Hawkesbury City Council South Windsor Effluent Reuse Scheme (PC4).

In total the projects aimed to deliver 11.59 GL of water savings across the catchment of the Hawkesbury - Nepean Rivers. Of this, 7.24 GL of savings were to be legally secured via the *Water Management Act 2000* for additional environmental flows below the major dams and for increasing Sydney's water supply security. An additional 2.85 GL of water savings, delivered through the Improving Hawkesbury-Nepean Water Balance Accounting (metering) project, were to be secured through reduced licensed extraction. The balance of the water savings, 1.5 GL, have been retained by water licensees through the Water Smart Farms water use efficiency project.

The plan provides for amendments to secure water savings made under the recovery programme:

- For savings above Warragamba Dam, these will be released via increased transparent and translucent environmental releases from Warragamba Dam when these environmental releases commence. In the mean time, a fixed release may be required to pass any water savings through the Dam.
- For savings below Warragamba Dam, these will be protected through automatic adjustments to the EFPR, which are based on environmental releases from the Dam.
- For savings within the potable water supply network, these will be reflected in adjustments to the sharing of releases from the St Mary's Water Recycling Plant via automatic adjustments to the EFPR.

The NSW Government originally proposed that the Sydney Water Corporation could meet its obligation under the Hawkesbury-Nepean River Recovery Project to deliver 2.9 ML/day of water savings via increased releases from St Marys Water Recycling Plant. However, due to infrastructure limitations the demonstrated water savings are secured through the plan by increasing the environment's share of the releases by up to 2.9 ML/day and reducing the licensed irrigation share, depending on the demonstrable volume of the savings.

As well as securing savings the plan also establishes dealing rules to assist in the process.

Varying access to releases of Advanced Wastewater Treatment Plant discharge from the St Mary's Water Recycling Plant

Sydney Water Corporation releases an average of 43.3 ML/day from the St Marys Water Recycling Plant to the Nepean River. The plant has the capacity to release up to 50 ML/day to ensure that an average of 43.3 ML/day is released where on any one

day less than 43.3 ML is released. The releases are shared between the environment, licensed irrigation and other water users.

Prior to the commencement of the plan, releases from the St Marys Water Recycling Plant to the Nepean River were generally a constant volume and not reflect seasonally varying inflows to the Upper Nepean dams. The plan introduces variability to the releases by providing licensed access to the releases that varies inversely to the variation in transparent and translucent releases from the Upper Nepean dams. When, for example, the transparent releases from the dams are low due to low dam inflows, the proportion of irrigation access to the fixed releases is high. When transparent releases are high, due to high inflows, consumptive access to the fixed releases is low.

Discharge from sewage treatment plants for irrigation

Western Sydney Recycled Water Initiative

The NSW Government's Western Sydney Recycled Water Initiative Replacement Flows Project, led by Sydney Water Corporation, has redirected sewerage treatment plant (STP) discharges that were previously made to South Creek and Eastern Creek to recycled water projects. Irrigators in South and Eastern Creeks had historically become reliant on the discharge since it comprised the majority of flow in these creeks during dry periods. In view of this situation, the NSW Government asked the former NSW Office of Water and Sydney Water Corporation to explore the possibility of providing South and Eastern Creeks with seasonally varying discharge from St Marys and Quakers Hill STPs to meet irrigation demands. The government also asked that the possibility of providing additional discharges during times of low flow also be considered.

NSW Office of Water and Sydney Water Corporation negotiated the retention of a portion of the historical discharge to South Creek and Eastern Creek for irrigation purposes and this has now been reflected in an Operating Protocol within a Memorandum of Understanding between the two agencies.

The Operating Protocol defines two types of releases: a release to meet average irrigation demands under normal climate conditions, and a release to meet irrigation demands under 'extreme' or water shortage climate conditions. The releases are based on estimated irrigation demands in South and Eastern Creeks, using river basin modelling calibrated based on historical irrigation areas and crop mix. Table 19 and Table 20 show the two types of ongoing releases from the STPs in South and Eastern Creeks for irrigation purposes.

Triggers for switching the STP release regime into 'water shortage conditions' were developed, which includes consideration of both the air temperature and the number of previous days of EFPR conditions being in place (Table 21). The 'Forecast Temperature' is the Bureau of Meteorology 4 pm 48 hour Sydney (West) maximum temperature forecast for the following day.

Table 19: Proposed Quakers Hill STP discharges into Eastern Creek

| Month | Release during normal conditions (ML/d) | Release during water shortage conditions (ML/d) |
|------------|---|---|
| All months | 1 | 1 |

Table 20: Proposed St Marys STP discharges into South Creek

| Month | Release during normal conditions(ML/d) | Release during water shortage conditions (ML/d) |
|--------|--|---|
| Jan | 5 | 17 |
| Feb | 4 | 16 |
| March | 4 | 17 |
| April | 4 | 14 |
| May | 1 | 7 |
| June | 1 | 6 |
| July | 1 | 6 |
| August | 1 | 8 |
| Sept | 5 | 14 |
| Oct | 8 | 18 |
| Nov | 6 | 17 |
| Dec | 7 | 19 |

Table 21: Conditions to signal a 'water shortage' on South and Eastern Creeks

| Forecast Temperature (oC) | No. of consecutive days of EFPR | Months |
|---------------------------|---------------------------------|------------------|
| < 24.9 | 20 | May to August |
| | 10 | All other months |
| 25 – 29.9 | 5 | All months |
| 30 – 32.9 | 2 | All months |
| 33 + | 1 | All months |

Releases shall commence as soon as possible after 5 pm and no later than 11 pm of the day following the 4 pm forecast. Water shall be available for irrigation in the evening immediately prior to and to some extent during the day of the 48 hour forecast.

It is also important to note that due to 'returned flows' (e.g. water that has been extracted from the river and then returned to the water course as a discharge) not being within State's water rights this agreement has been negotiated to reflect the government policy in the 2010 Metropolitan Water Plan, and is not specifically within the regulatory powers of the *Water Management Act 2000* and therefore not written within the plan. This agreement is mentioned here to assist in providing a full account of water sharing arrangements in the Region.

Other water sources linked to the Hawkesbury-Nepean rivers

The majority of flows in Berowra Creek and Cattai Creek comprise discharges from STPs. Flow in tributaries of the mid and lower Nepean River in very dry months also consists mainly of discharges from STP. Licensed irrigators in these creeks have also become reliant on the STP discharge to meet their water requirements for irrigation purposes. In recognition of the importance of maintaining agriculture in the Sydney region, the 2010 Metropolitan Water Plan states that future recycled water schemes developed by Sydney Water Corporation will consider irrigators' water needs and use patterns. The options considered for meeting these needs will include continuing supply by pipelines and managed sewage treatment plant discharges (NOW, 2010).

Accounting for tributary flows

The EFPRs for the main river do not include inflows from tributaries below the water supply diversion weirs (Broughton Pass and Pheasants Nest weirs). The government has resolved that these inflows are available for irrigation purposes. The environmental flows released from the dams and from Broughtons Pass and Pheasants Nest water supply diversion weirs are protected and include an estimated 80th percentile transparent and 20 percent translucent release of tributary inflows between the dams and the diversion weirs. The remaining 80% translucent volume of tributary inflows are available for diversion at the discretion of WaterNSW.

Trading of licences and water allocations between weirs on the Nepean River

The risk assessment undertaken for the Nepean River rated the river as having medium in stream value, high hydrologic stress, low risk to in stream value and medium economic dependence. At the time of targeted consultation the rules allowed for trading within a management zone on the Nepean River but not into a management zone. The plan also prohibited the transfer of an entitlement between a management zone that is located below/above a major or local water utility (dam or weir) to another management zone that is located below/above a major or local water utility.

Concerns were raised from water user associations at both targeted consultation and public exhibition in regard to the limited trading options in this area.

Taking into account feedback and consultation the IWG resolved that trading between the weir pools on the Nepean River would be permitted if it was in a downstream direction and would be permitted in an upstream direction only if there was no net gain in the management zone.

Trading between management zones on the Hawkesbury River above Colo River

During consultation water users raised concerns over the limited trading options in the upper Hawkesbury River management zones proposed at the time of consultation. As a result the plan allows for trading between the three zones of the Upper Hawkesbury River as well as trades from the Lower Nepean Management Zone into the upper Hawkesbury management zones providing that the trade does not increase the total level of entitlement in the upper Hawkesbury River management zones. This was permitted as it would not increase entitlement within the Upper Hawkesbury River as trading from outside into any one of the upper Hawkesbury River management zones is not permitted.

Trading into the Lower Nepean Management Zone

During consultation water users raised concerns over the limited trading options between the Lower Nepean River Management Zone and the management zones of the upper Hawkesbury River. The plan allows trading from the management zones of the upper Hawkesbury River into the Lower Nepean River Management Zone so long as trades would not cause total licence volumes in the latter zone to exceed 3.65 GL. Trades from the Lower Nepean River Management Zone to the zones of the upper Hawkesbury River are permitted so long as trades would not cause total licence volumes in the latter zones to increase above the total licence volumes at the date of the commencement of the plan. Trades from management zones above the Lower Nepean Management Zone into the Lower Nepean Management Zone are not permitted.

Daily access rules for the Mongarlowe River

The risk assessment undertaken on the Mongarlowe River rated the river as 'low dependence on extraction posing low risk to high in stream values'. The access rule proposed by the government during targeted consultation was an EFPR of 7.6 ML/day (95th percentile) and a commence-to-pump of 12.8 ML/day (90th percentile).

During consultation stages, concerns were raised that the access rule would not protect environmental needs given climate change and anticipated increases in local water demand with new residential development.

In recognition of this, a 'special case' rule was proposed and the EFPR and commence to pump rules were increased by 5 percentile points given the high in-stream values of the river and anticipated future growth in water usage in the sub-catchment. The IWG and the Chief Executive Officer's (CEOs) Committee endorsed this proposal.

Environmental flows for the Shoalhaven River below Tallowa Dam

The 2010 Metropolitan Water Plan states that in 2009 the NSW Government adopted an environmental flow regime for the Shoalhaven River below Tallowa Dam. The regime includes a monthly 80th percentile transparent release, and a 20 per cent translucent release. The water sharing plan prescribes that for the majority of the Shoalhaven River and tributaries above Tallowa Dam, a 'first flush' rule applies to protect 100 per cent of first flows associated with rainfall events for downstream purposes. The 'first flush' rule is established as either a 24 hour delay in the commencement of pumping or a commence-to-pump volume that is higher than the EFPR volume.

Concern was raised during targeted consultation that since a 'first flush' rule was not adopted for the Shoalhaven River below Tallowa Dam, the plan did not apply this rule consistently across the catchment and did not provide sufficient water for the lower estuary to support the oyster and other estuarine industries and estuary ecology.

The IWG and CEOs Committee were of the view that the environmental flow rules for Tallowa Dam not be reconsidered since the NSW Government had established a comprehensive procedure, including establishing a Scientific Advisory Group and a Community Consultative Group, for investigating and recommending environmental flows for the Shoalhaven River below Tallowa Dam. The procedure had given careful consideration to the relationship between pumping from the dam and variations to salinity levels in the lower estuary. Estuary studies undertaken on behalf of the Scientific Advisory Group indicated that salinity levels in the lower estuary under a range of pumping conditions do not vary significantly from those levels which would occur in the absence of the dam. Significant flood events would have to occur to lower salinity levels in the lower estuary which would invariably spill from the dam irrespective of the pumping regime and the combination of transparent/translucent release rules because these would typically occur when the dam is spilling and outside the range of control of any management rules. In effect, at the higher end of inflows that are critical to the estuary, the dam would release 100% of inflows rather than the prescribed 20% of inflows as per the management rules. When this is considered in conjunction with the 100% transparency rule up to the 80th percentile, then there is a significant proportion of both the dry and wet regimes when 100% of inflows would be passing through the dam, thus negating its impacts on the downstream environment.

The plan does provide for amendments to the rules where the NSW Government varies the environmental release rules for Tallowa Dam.

Daily access rules for the Shoalhaven River below Tallowa Dam

The risk assessment undertaken for the Lower Shoalhaven River (below Tallowa Dam) rated the river as 'medium extraction posing high risk to in stream values'. The access rule proposed by the NSW Government during consultation reflected the environmental flow regime adopted by the NSW Government in 2009 for the Shoalhaven River below Tallowa Dam.

During consultation, concerns were raised that the EFPR rule was inappropriate due to it being based on environmental flows from Tallowa Dam and that it presumed tributary inflows would meet the demands of licences below the Dam. At public exhibition the former NSW Office of Water demonstrated that tributary inflows would not meet licensed demands below the dam and as such the access rules for licences below Tallowa Dam were amended to reflect this. Licensed users now have an EFPR when the flow at the Grassy Gully gauge (215216) is at or below 69 ML/day (95th percentile) rather than below the 80/20 environmental flow.

Imposing limits on extractions for WaterNSW

WaterNSW currently has a water licence under the *Water Management Act 2000*, one for each water source from which it extracts water. In the Greater Metropolitan Region, WaterNSW extracts from the Shoalhaven River Water Source, Southern Sydney Rivers Water Source (Woronora River), Upper Nepean and Upstream Warragamba Water Source, and the Hawkesbury and Lower Nepean Rivers Water Source (Grose River). Each water access licence includes a share component, also referred to as a water entitlement. The share component is the maximum volume that

may be extracted from the water source in any one year. The share components are based on the maximum volumes that WaterNSW has extracted in any one previous year together with some additional allowance to provide flexibility to cope with any additional variability in demands that may occur in the future.

The share components offer WaterNSW the flexibility to operate its water extraction and transfer system optimally whilst establishing upper limits on extractions from each water source in any one year. DPI Water considers these appropriate maximum volumes to be extracted from each water source in any one year.

Although WaterNSW may extract up to their licence share component in any one year, to protect river health, under the plan, WaterNSW is subject to limits on the average annual volume of water that may be extracted from each of the water sources or EMUs listed above. These limits are referred to as long term average annual extraction limits (LTAAEL). Except for the Shoalhaven River EMU, the extraction limits are based on a combination of the historical average of supplies of water from the former Sydney Catchment Authority to Sydney Water Corporation and system yield modelling, with the following assumptions:

- inflows for 1909-2004
- SCA to supply total unrestricted demand up to 2017 (forecast provided by Sydney Water Corporation in March 2007) + Bowral = 570 GL/y
- population growth of 10 per cent over the next 10 years and permanent demand savings of 10 per cent by 2017
- extractions including transfers into the units (Lower Hawkesbury Unit extractions include transfers from the Fish River Water Scheme; Upper Hawkesbury – Nepean Unit extractions include Shoalhaven transfers).

For the Shoalhaven River EMU, the limit is based on the long-term average annual modelled transfers from the Shoalhaven River EMU to the Upper Nepean River and Upstream Warragamba EMU, as used in the Shoalhaven Environmental Flows Project. The limit allows for possible additional transfers from that system in the future. The licence entitlements (share components) and extraction limits for each water source are shown in Table 22.

Extraction by WaterNSW in an EMU may exceed the limit for the EMU for one or more years. However, the average of extractions over a ten year period should not exceed the limit. Extraction shall not exceed the licence share component (entitlement) in any one year. DPI Water will assess compliance against the limits over the first ten year period and then on a rolling ten year period. The *Water Management Act 2000* does not specify arrangements in the urban context (especially a major utility) for such a compliance assessment methodology nor a response strategy should these limits be deemed to have been breached. However, the compliance assessment would consider climatic representativeness and variability. Exceeding the limit shall trigger a 'growth-in-use' strategy.

Table 22: Extraction by WaterNSW in the Greater Metropolitan Region

| Extraction Management Unit | Share Component (ML/year) | Extraction Limit (ML/year) | Notes |
|--------------------------------------|---------------------------|----------------------------|--|
| Shoalhaven River | 329,000 | 36,000 | Share component based on maximum historical extraction over last 10 years. Annual extraction limit is based on long term average annual modelled transfers to the Upper Nepean River and Upstream Warragamba Water Source. |
| Illawarra Rivers | 0 | 0 | |
| Upper Nepean and Upstream Warragamba | 620,000 | 581,000 | Share component based on maximum historical extraction over last 10 years. Annual extraction limit is based on average historical transfers to Sydney Water and system yield modelling. |
| Hawkesbury and Lower Nepean Rivers | 6,000 | 6,000 | 6000 ML – dams on headwater creeks of Grose River. Annual extraction limit is based on average historical transfers to Sydney Water and system yield modelling. |
| Southern Sydney Rivers | 32,000 | 13,000 | 32,000 ML entitlement - Woronora River. Annual extraction limit based on average historical transfers to Sydney Water and system yield modelling. |
| Northern Sydney Rivers | 0 | 0 | |

While the entitlements establish an upper limit on extraction volumes by WaterNSW in any one year and have been set to provide flexibility in extraction, the average annual extraction limit being set at a lower volume is the means by which more environmentally sustainable levels of extraction are established for the long-term. This provides a secure share of available water for the environment over the long-term, which provides a level of protection for the water sources and their dependent ecosystems. In addition, the limits encourage water demand management, recycling and the development of alternate water supplies and other strategies of the Metropolitan Water Plan. The share components and the limits were proposed with the full involvement of the former Sydney Catchment Authority (now WaterNSW).

Environmental flows for Manly Dam

As part of a requirement on Sydney Water Corporation's previous *Water Act 1912* licence, Sydney Water Corporation was required to develop a Manly Dam Environmental Flow Release Strategy (EFRS). Sydney Water's Corporation report found that infrastructure and operational constraints on the dam would only allow low flows to be released without major infrastructure spending.

As a result, the plan provides for the following steps to be taken in regards to the development of environmental releases for Manly Dam over the term of the plan:

- Stage 1: feasibility, suitability and decision on environmental flows (years 1 to 5),
- Stage 2: design and decision on an implementation date (years 6 to 7), and
- Stage 3: any necessary infrastructure modifications needed to deliver flows (year 8 onwards).

These stages of development were also adopted for local water utility and power generation dams across the Metropolitan Region including:

- Pejar Dam, Rossi Weir and Sooley Dam in the Upper Wollondilly Management Zone,
- Lake Wallace in the Wywandy Management Zone,
- dams in the Upper Wingecarribee Management Zone, and
- dams in the Lower Shoalhaven River Management Zone.

Application of daily access rules to stormwater channels

Sydney Water Corporation manages a number of streams in its area of operations that operate as stormwater channels. These include tributaries of the Parramatta River, Cooks River and Georges River, as well as some minor tributaries of Cattai Creek within the Hawkesbury - Nepean catchment. During consultation Sydney Water Corporation raised concerns as to whether the rules would apply to these water sources and noted that the plan did not clearly define circumstances when urban stormwater harvesting would require a licence and/or approval under the *Water Management Act 2000*.

Under *Water Management Act 2000*, all extractions from a water source, including urban stormwater harvesting extractions, must be taken under an appropriate water access licence, a basic landholder right or a licence exemption. DPI Water is developing a policy that will set out arrangements for managing extractions of urban stormwater under the licensing and approvals provisions of the WMA 2000 in a way that maximises the benefits of urban stormwater harvesting while minimising the potential for adverse impacts on other water users and the environment.

Goulburn Mulwaree City Council water supply and environmental flows

Goulburn Mulwaree City Council provides water to the township of Goulburn via three storages in the Upper Wollondilly Management Zone. Raw water is pumped from Rossi Weir to Goulburn's water treatment plant and water from the main storages of Sooley and Pejar Dams are released to Rossi Weir. During targeted consultation the council raised concerns that river transfers between Pejar Dam and Rossi Weir will be affected by irrigators upon commencement of the plan. The council suggested that procedures should be in place to protect the transferred flows for Goulburn's water supply.

These issues were considered during the plan development in March 2010 and the plan now states that users will have an EFPR when a transfer is occurring. Domestic and stock users may continue to pump while an EFPR is occurring.

Suspension of environmental flows from dams and weirs

The Office of the Hawkesbury-Nepean (OHN) suggested during consultation that the plan should include the capability to cease environmental flows (from dams and weirs) when the stored water is impacted by the presence of weeds or algae or affected by another incident such as a chemical spill. In these circumstances, releasing the water could have a detrimental effect on the downstream environment. It was also suggested that the volume of water not released during one of these situations be banked and utilised for environmental flows/contingent flows at a later date, as advised by the appropriate environmental water manager.

As a result of these discussions the plan provides for the suspension of environmental flows from specific dams in the plan area when the Minister is satisfied

that the releases should not be made due to an emergency situation or maintenance that would affect the flow or behaviour of water for more than 24 hours.

This rule applies to the following storages:

Avon Dam, Cataract Dam, Nepean Dam, Cordeaux Dam, Pheasants Nest Dam, Broughtons Pass Weir, Woronora Dam, Tallowa Dam, Wingecarribee Reservoir, Lake Lyell, Lake Wallace, Thompsons Creek Reservoir, Maldon Weir, Menangle Weir, Camden Weir, Sharpes Weir, Cobbity Weir, Mount Hunter Rivulet Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir, Warragamba Dam.

In other circumstances, there may be infrastructure constraints to making releases, such that the actual releases are less than those required by the plan rules.

When the releases are either chosen not to be made or cannot be made the difference between the actual release and the required release is set aside in the storage of the respective work (e.g. dam) and credited against the work's Banked Environmental Flow (BEF) account to be released at a later date. The works that allows for a BEF are Fitzroy Falls Reservoir, Warragamba Dam, Wingecarribee Reservoir, Avon Dam, Cataract Dam, Nepean Dam, Cordeaux Dam, Woronora Dam, Tallowa Dam and Lilyvale Dam.

The plan also provides for the establishment of an environmental contingency allowance account for the Upper Nepean River dams and Warragamba Dam. A volume of water may be credited to the accounts for contingent environmental purposes, fish spawning for example, as determined by the Minister.

7. Changes to water sharing rules in Kangaroo River Management Zone

During the process of replacing the Kangaroo River water sharing plan a number of minor changes were made to the daily access rules. Most of these related to changes in policy since the commencement of the 2004 plan. The major change for water users has been a small increase in the cease-to-pump which was provided for as an amendment in the 2004 plan. These changes to the water sharing rules for the Kangaroo River are discussed below.

Estimate of basic landholder rights

Since the 2004 plan the method for estimating Basic Landholder Rights (BLR) has been revised. The revised approach avoids the possibility of including domestic and stock requirements that may be sourced from groundwater. It is a standardised approach that has been applied across all catchments and is considered to provide reasonable estimates for surface water BLR usage in NSW.

The new method was applied to the Kangaroo River management zone resulting in a reduction in the estimated surface water BLR requirement from 1.047 ML/day to 0.31 ML/day.

Cease-to-pump

The amended plan includes an increase in the cease-to-pump from 5.4 ML/d to 7 ML/d. This was recommended by the Panel after careful consideration and review of two studies undertaken during the life of the 2004 plan.

A **field verification study** was undertaken by DPI Water aquatic scientists in 2008 (DWE 2008). The original study established that there were numerous benefits from increasing the cease to pump level from 1 ML/day (the voluntary cease-to-pump before the plan) to 5.4 ML/day (established by the plan) and concluded there was little scientific evidence in adopting a cease to pump below 7 ML/day to maintain fundamental ecosystem health. An addendum to the field studies report was prepared in 2014 following a request by the Panel for further information on a number of aspects of the report (NOW 2014).

A **socio-economic study** was undertaken by Department of Trade economists in 2010 (Flavel *et al.* 2012) which examined the impacts of raising the cease-to-pump level in the Kangaroo River based on outcomes of the 2008 field verification work. The study established that a cease-to-pump of 7 ML/day would not have a significant effect on irrigators. A supplementary report was prepared in 2014 following a request by the Panel for an extra model run (cease-to-pump of 10 ML/day) and concerns by water users regarding the data used for production costs (Flavel *et al.* 2014).

The field verification recommended a cease-to-pump of 7 ML/day. The socio-economic report concluded that an increase in the cease-to-pump to 7 ML/d would have insignificant impacts on water users. A cease-to-pump of 10 ML/day was also suggested as an option in the field verification report, however the socio-economic study considered that this would have a much greater impact on water users. This option was therefore rejected by the Panel.

The existing commence-to-pump (24 hours after 7 ML/day has been recorded on the gauge) has been retained in the current plan. The Panel considered that the 24 hour

period would continue to provide a period of replenishing fresh flows for the Kangaroo River system.

The Panel recommended that the findings of the field verification and socio-economic studies be included in the background document related to replacement of the Kangaroo River water sharing plan. Key findings and recommendations of these studies are therefore included in Appendix 14 (field verification) and Appendix 15 (socio-economic study) of this report.

The Panel agreed that further field verification should be undertaken during the remaining term of the Greater Metropolitan plan to assess whether a 10 ML/day cease-to-pump is required to achieve fundamental ecosystem health for the Kangaroo River. The panel considered the inclusion of an amendment provision in the plan providing for further increases to the cease to pump following these studies. However as the Greater Metropolitan plan only has a further five years before being reviewed, the panel decided that greater certainty would be provided by not including an amendment provision in the plan.

Pool management

The amended plan includes a rule whereby natural in-river and off-river pools are not to be drawn down below 100 per cent of their full containment volume. Current licence approval conditions will continue to apply to artificial pools. While this change has occurred to make pool management within the Kangaroo River consistent with state wide policy, it should be noted that there are currently no pools identified by water users or DPI field staff that would require specific protection.

Water trading

The cap on trades into the Escarpment Zone in the Kangaroo River Water Source has been revised from 1,257 ML to 1,633 ML. These changes reflect the current level of entitlement in the Escarpment Zone and corrects a previous administrative error in the 2004 Kangaroo River plan. The amended plan retains the trading rule that prohibits net increases in entitlements in the Escarpment Zone. Trades into the Escarpment Zone are possible as long as the same volume is traded out, therefore ensuring no net gain in the escarpment.

The amended plan prohibits trade:

- from rivers and in river natural pools to off river natural pools and in river and off river artificial pools; and,
- between off river natural pools; and,
- from off river artificial pools to off river natural pools.

This change is consistent with NSW policy introduced since commencement of the 2004 plan. There were no submissions received or issues raised with this proposal during public exhibition.

Amendment provisions

The amendment provision relating to field verification of the very low flow class in the 2004 Kangaroo River plan has been removed due to the work being completed.

8. Adaptive management

Adaptive management is an important part of a water sharing plan. Adaptive management refers to the process of ongoing data collection, monitoring, evaluation and review during the term of the plan that either enables plan amendments or remaking of an improved plan after 10 years. Adaptive management is a requirement of both the *Water Management Act 2000* and the National Water Initiative, and has been allowed for during the term of the plan through amending provisions and the establishment of 'limits of change' to the plan.

Where adaptive management is identified, further studies may be undertaken within agencies or by external organisations which may assist in informing the review of the plan provisions. In the case of water sharing plans, such studies could include socio-economic studies, hydrological modelling, ecological studies and information about Aboriginal cultural values.

Amendment provisions

Standard amendments that apply to all water sharing plans include:

1. amending water sources, management zones or EMUs,
2. establishing new or additional flow classes in any water source where management zones are added or amended,
3. amending water sources for which dams on third order streams or higher will not be granted,
4. amending requirements for metering or record keeping in relation to licensed access works, and
5. updating information in Schedules or deleting them if no longer required.

The plan also includes a number of specific amendments that may be made to the plan during its 10 year period of operation. These amendment provisions were part of the rule development process and are listed in Part 13 of the plan.

Monitoring, evaluation and reporting

DPI Water has developed a Monitoring, Evaluation and Reporting Framework in collaboration with key stakeholders. The framework conforms to NSW and Commonwealth government guidelines for monitoring, evaluation and reporting, and demonstrates an adaptive management approach to water planning required under the principles of the WMA 2000. The evaluation framework aims to inform the community of the outcomes of water sharing plans, and to collate the results of various legislatively required evaluations and relevant knowledge to inform the review of the water sharing plans. The framework will assess the inputs, outputs and outcomes of the water sharing plans and their operations. The assessment will consider:

1. the process of plan development (appropriateness),
2. the performance of the plan during operation (efficiency), and
3. the socio-economic, environmental and cultural outcomes of the plan (effectiveness).

The main strategies in place to assist in evaluating water sharing plans include:

1. assessment of performance indicators (using an Environmental Flows Monitoring and Modelling program),
2. an audit of plans, and
3. review of each plan at the end of its ten year term.

Performance indicators

Part 2 of the plan includes a number of standard performance indicators that will be monitored over the life of the water sharing plan. It is not practical to monitor all issues in all water sources. The performance indicators identify that monitoring will be undertaken for specific issues in key water sources. The actual procedure for monitoring each indicator may change over the period of the water sharing plan as improved methods are developed.

In order to assess performance indicators, DPI Water has established an Environmental Flows Monitoring and Modelling program which is designed to make the results of environmental flow studies more transferable between water sources and to develop more generic relationships between flow, hydraulics and ecological responses. This will enable a more efficient and effective evidence based approach to support monitoring and evaluation of water sharing plans in NSW.

Audit

The WMA 2000 requires that water sharing plans be audited regularly, at intervals of not more than five years, to determine whether the provisions of the plan are being implemented. Under section 44 of the Act the Minister for Lands and Water must appoint an Audit Panel to undertake this review.

The Audit Panel reflects the membership of the State Interagency Panel for Water Sharing and comprises representatives from DPI Water, DPI Agriculture, OEH and LLS. Representatives from the NSW Natural Resources Commission and NSW Fisheries are invited to participate in the audit process as observers.

Reflecting the requirements of the WMA 2000 the focus of the audit is on the extent to which the provisions in the plan have been implemented. The audit does not attempt to assess the outcomes or effectiveness of the plan in achieving its objectives (this is considered by DPI Water through its monitoring and evaluation process).

When conducting an audit the panel will review a range of analysis and material provided by DPI Water to:

1. identify patterns of implementation activities across water source types, across plans and types of water sharing plan provisions,
2. identify actions required to address instances of partial and non-implementation,
3. develop broad recommendations for improving the implementation of existing plans and the robustness of new plans, and
4. identify opportunities for linking the audit findings with other related processes, particularly the review of catchment action plan targets.

Plan review

At the end of the water sharing plan's 10 year term, the Minister may, on recommendation by the NRC (under Section 43A of the WMA 2000), extend a water sharing plan for another 10 years or replace the plan. An extension does not allow for

any changes to the water sharing plan. If any changes are proposed, then a replacement water sharing plan needs to be prepared.

The WMA 2000 requires that when deciding whether to extend or replace an existing plan, the Minister must consider

- the most recent audit of water sharing plans conducted under section 44, and
- a report from the NRC prepared within the previous five years, on the extent to which the water sharing plan has contributed to relevant state-wide natural resource management standards and targets of the relevant LLS catchment action plan.

Under the WMA 2000 a water sharing plan may be extended for 12 months past the expiry date of the plan to allow for a replacement plan to be prepared.

Metering and compliance

Each water sharing plan establishes the relevant mandatory conditions for extraction, including that all licences undertake measurement of extraction when directed by the Minister. Measurement of extractions will be via meters fitted to approved water supply works. Different types of devices will be required depending on the nature of the water supply work installation, the size of the work, and the affect that the operation of the work may have on the water source and other water users. Telemetry systems will be placed onto all meters, subject to availability.

The installation of meters in the Hawkesbury Nepean was completed in 2011. Users may also use a form of self-measurement to assist them to extract water in compliance with their licence conditions.

DPI Water will undertake compliance activities as necessary to enforce each individual's licence conditions, which are developed based on the provisions of the plan. Some reliance is placed on local water users to identify inappropriate or unlawful behaviour. Reports may be made by calling 1800 633 362 or emailing watercompliance@dpi.nsw.gov.au (refer to the DPI Water website at www.water.nsw.gov.au).

9. Glossary

Many of the terms in this document are defined in the *Water Management Act 2000* and are therefore not redefined here. However, there are some terms that are not and have therefore been defined here to assist with understanding the water sharing plan.

Account water: The balance in an access licence water allocation account at a particular time. An access licence water allocation account records water allocations accrued under the licence as well as water allocations taken, assigned or re-credited. The operation of the account is also governed by rules for the carrying over of credits from one accounting period to the next and rules for the maximum credit that may be allowed to accumulate in the account as established in a water sharing plan.

Alluvial, alluvium: Sediment deposited by a stream of running water, in particular along river beds or flood plains.

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt or clay) from which groundwater can be usefully extracted. The volume of water stored in an aquifer, the rate at which water can recharge, the volume of water extracted from it, and the rate at which water can move through the aquifer are all controlled by the geologic nature of the aquifer.

Banked environmental flows: planned releases of water from dams for environmental flows that are altered or cannot be made due to an emergency, capacity constraints, maintenance, refurbishment or modification and which are credited to a banked environmental flow account to be later released with the written direction of the Minister.

Connectivity: The capacity of instream biota to move longitudinally in a river system and not be impeded by barriers (e.g. weirs, dams, culverts). Connectivity is important for instream aquatic processes and biota and the conservation of natural riverine systems.

Conversion factor: The adjustment factor that is to be applied to share components when they are cancelled and reissued in a different water source, at a different access threshold or as a different licence category. It is designed to allow movement of water from one water source to another, one access threshold to another or from one licence category to another whilst minimising the impacts on third parties of such movements. These impacts may be a result of the value of a unit of share component (in terms of the average water allocations) that result from it may vary from one water source to another or from one access threshold to another or from one licence category to another.

Critical habitat: Areas of habitat (land or water) that are crucial to the survival of particular threatened species, populations or communities.

Cumulative impact: The combined impact of all surface water extraction.

Ecological values: The intrinsic or core attributes associated with naturalness, diversity, rarity and special features, but excluding representativeness used to classify water sources for apportioning water management rules.

Endangered ecological communities: Ecological communities listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.

Environmental contingency allowance (ECA): A volume of water held in storage from which releases are made for particular environmental purposes or in response to particular environmental circumstances.

Ephemeral: Temporary or intermittent; for instance, a creek or wetland which dries up periodically.

Extraction of water: The taking of water from a water source.

Extraction management unit (EMU): A group of water sources; defined for the purpose of managing long-term average annual extraction.

Flow classes: The range of daily flow rates in a river which provides the framework for sharing water on a daily basis.

Flow duration curve: A plot that shows the percentage of time that each flow rate in a stream is equalled or exceeded.

Flow gauging station: A device used to measure the height of a river, from which the flow in the river can be calculated.

Flow reference point (FRP): The site from which the flow data is calculated to determine the rates associated with a flow class and then to implement the daily access rules during the life of the plan.

Groundwater: The water beneath the earth's surface that has filtered down to the zone where the earth or rocks are fully saturated.

Groundwater dependent ecosystems (GDEs): Ecosystems that rely on groundwater for their species composition and their natural ecological processes.

Individual daily extraction limit (IDEL): The daily volume limit that may apply for a particular licence holder for each flow class. The IDEL will be specified as part of the extraction component on the access licence. It establishes a share of the TDEL for that flow class.

Instream refuge habitat: Stream habitat containing pools that retain water for longer periods of time during drought and low flow. Instream biota will migrate to these more permanent habitats to survive.

Integrated Quantity/Quality Model (IQQM): A numerical hydrologic computer model that simulates a river basin's behaviour on a daily time step, based on inflows to the system, configuration of the major infrastructure, routing and losses of flows through the system and irrigation extractions to meet crop water requirements. It also models the processes of available water determinations, uncontrolled flow and supplementary water announcements and irrigator planting decisions. This model is used to analyse and compare the outcomes of proposed water sharing options or assess potential growth-in-use over long-term climatic sequences (> 100 years).

Long-term average annual extraction limit (LTAAEL): The target for total extractions (under all water access licences plus an estimate of basic landholder rights within an EMU) which is used to assess whether growth-in-use has occurred. The actual annual extractions (metered plus estimated) are averaged over a fixed period of time defined by the water sharing plan when comparing with the LTAAEL. If the fixed period of time is greater than one water year, then in any one water year, extractions can exceed the LTAAEL without triggering a growth-in-use response.

Macro water sharing plans: Water sharing plans which apply to a number of water sources across catchments or different types of aquifers. The macro planning

process is designed to develop broader-scale water sharing plans covering most of the remaining water sources in NSW.

Management zone (MZ): An area within a water source used for defining the location of applicability of water sharing rules, but secondary to the water source. A management zone (MZ) is more likely to be designated where local dealing restrictions are in place or where cease-to-pump (EFPR) rules for works approvals apply.

Pools: Lentic water bodies (standing water), including anything falling within the definition of a “lake” found in the Dictionary of *Water Management Act 2000*, except for tidal pools and estuaries.

Regulated river: A river that is declared by the Minister, by order published in the Gazette, to be a regulated river. Typically rivers where state owned storages catch water during wetter periods and the river is used to supply stored water to meet downstream users’ orders during dry times are declared as regulated rivers.

Reliability: The frequency with which water allocated under a water access entitlement is able to be supplied in full (referred to in some jurisdictions as ‘high security’ and ‘general security’). Alternately, reliability can also sometimes be measured in terms of long-term average water availability relative to entitlement.

Riparian: Relating to or living or located on the bank of a natural watercourse, such as a river or stream.

Security: The legal status and tenure of a right to access water. This includes the level and assurance that a water access entitlement will provide that which it specifies. Security thus includes the reliability of supply. The range of water access entitlement characteristics detailed in the NWI contributes to the security of a water access entitlement.

Schedule 2: Refers to those licence holders, as identified in Schedule 2 of the plan, that may continue to access water during periods of very low flows for fruit washing, cleaning of dairy plant and equipment for the purposes of hygiene, poultry watering and misting or cleaning of enclosures used for intensive animal production for of hygiene.

Supplementary water event: A continuous period during which the taking of water from uncontrolled flows under supplementary water access licences or as no-debit access under a Regulated River (general security) access licence is permitted in all or part of a River Water source

Sustainable yield: That percentage which is allowed to be extracted from groundwater after considering the aquifer’s ability to recharge and the needs of the environment.

Total daily extraction limit (TDEL): The total limit on the daily volume of water that access licence holders in a particular category can take from a flow class. It is the sum of all the IDELs in that flow class.

Uncontrolled flow: is flow, in excess of that needed to meet the environmental provisions of the plan, basic landholder rights and water orders placed by Regulated River (general security) access licences and higher priority access licences in a water source. These flows originate from tributary inflows downstream of a dam or dam spills.

Visible flow: The continuous downstream movement of water that is perceptible to the eye.

Water sharing plan: A plan made under the *Water Management Act 2000*, which sets out the rules for sharing water between the environment and water users within whole or part of a water management area or water source.

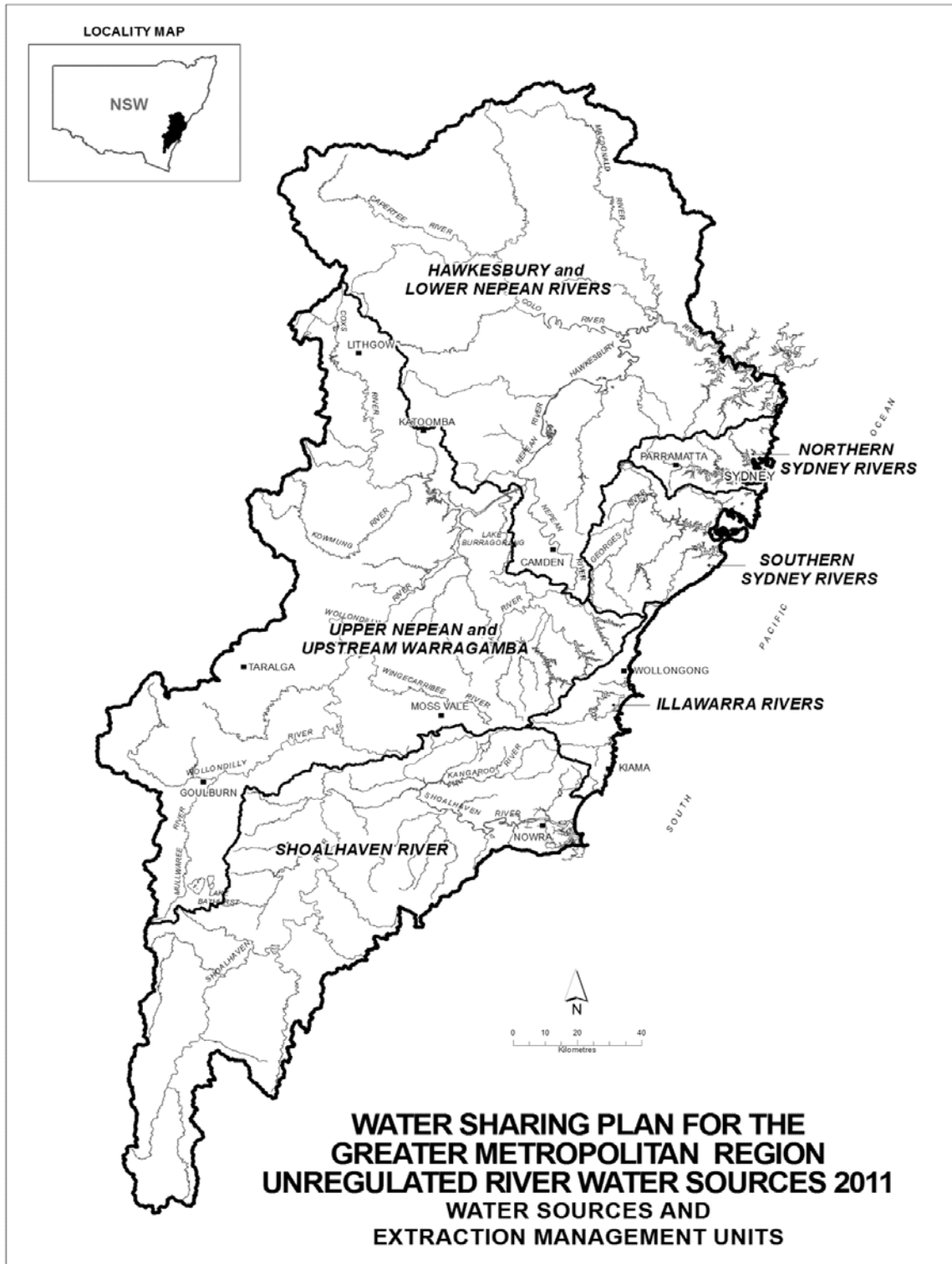
Water year: The 12 months running from 1 July to 30 June.

10. References

- DLWC 2002, *Environmental water requirements for the Kangaroo River catchment*. Science and Information Branch, Sydney/South Coast Region, NSW Department of Land and Water Conservation, Wollongong.
- DWE 2008 (Draft) Kangaroo River Field Verification. Unpublished report, Department of Water and Energy, Wollongong.
- Flavel N, Singh I and Bari M. 2012, *Kangaroo River Water Sharing Plan - Socio-economic assessment of changes to the flow rules*, NSW Department of Primary Industries, Office of Water, Sydney.
- Flavel N, Singh I and Spruyt D 2014, *Supplementary socio-economic impacts analysis of cease to pump – proposed Kangaroo River water sharing plan remake*. NSW Department of Trade and Investment, Regional Infrastructure and Services, October 2014.
- NSW Office of Water, 2010, *2010 Metropolitan Water Plan*, Department of Environment Climate Change and Water. NSW
- NSW Office of Water, 2011, *Macro water sharing plans – the approach for unregulated rivers: A report to assist community consultation*, NSW Government, Sydney.
- NSW Office of Water, 2013, *Review of 2004 Water Sharing Plans: NSW Office of Water report to the Minister for Primary Industries*. NSW Office of Water, Sydney, September 2013.
- NSW Office of Water, 2014, *Environmental water requirements of the Kangaroo River – Field Verification Addendum for 2014 WSP Remake Interagency Regional Panel*. NSW Department of Primary Industries, Office of Water, Wollongong.
- NRC 2013, *Review of 2004 water sharing plans*, Natural Resources Commission, Sydney, June 2013.
- NSW DPI. 2006, *Primefacts: Australian Grayling*. NSW Department of Primary Industries. NSW.
- Sinclair Knight Merz. 2006, *Towards a National Framework for Managing the Impacts of Groundwater and Surface Water Interaction in Australia*. Natural Heritage Trust, Sinclair Knight Merz.
- United Nations 2007, *United Nations Declaration on the Rights of Indigenous Peoples*.
- Vaze J, Teng J, Post D, Chiew F, Peraud J-M and Kirono D 2009, *Future climate and runoff projections (~2030) for New South Wales and Australia Capital Territory*, NSW Department of Water and Energy, Sydney.

11. Appendices

Appendix 1: Water sharing plan area



Amended Shoalhaven River Water Source including Kangaroo River Management Zone



Appendix 2: Identified threatened species

The macro water sharing plan process is concerned with protecting in stream water values that relate to extraction. Therefore, only threatened species that are likely to be sensitive to extraction have been considered when assessing the water source values.

Some threatened species are highly sensitive to low flow extraction, whilst other threatened species, such as plants that occur in the riparian zone, are less sensitive. Accordingly, threatened species considered to be highly sensitive to low flows are given a highly priority for protection.

The table below shows threatened species sensitive to extraction that are known or expected to occur in each water source.

This table does not include the Kangaroo River as this plan was prepared prior to the development of this assessment process. Threatened species in the Kangaroo River catchment were however considered as part of the 2004 plan development.

| | Frog Species | Macro invertebrate Species | Birds | Other Fauna | Fish Species | Wet Flora | Riparian Vegetation Species | Endangered Ecological Communities | Threatened Populations | Other Threatened Species | Other |
|---|--------------|----------------------------|-------|-------------|--------------|-----------|-----------------------------|-----------------------------------|------------------------|--------------------------|--|
| Mid Shoalhaven River | 8 | 1 | 4 | 2 | | | | | | | |
| Reedy Creek | 8 | 2 | 4 | 2 | | | | | | | |
| Boro Creek | 7 | 2 | 4 | 2 | 1 | | | | | | |
| Mongarlowe River | 8 | 2 | 4 | 2 | | | | | | | High recovery potential and high fish community integrity |
| Lower Kangaroo River | 6 | 3 | 16 | 2 | 2 | | 1 | 2 | | | Significant area of nationally important wetland, high fish community integrity |
| Lower Shoalhaven River, Lower Shoalhaven River Catchment, Bomaderry Creek | 5 | 1 | 16 | 2 | 1 | | | 2 | | | 1 nationally important wetland, high recovery potential, high value riparian vegetation, high fish community integrity |
| Broughton Creek | 5 | 1 | 16 | 2 | | | | 2 | | | Significant SEPP 65 Wetland, high fish community integrity |
| Mulwaree River | 9 | 2 | 4 | 2 | | | | | | | Significant area of nationally important wetland, |

| | Frog Species | Macro invertebrate Species | Birds | Other Fauna | Fish Species | Wet Flora | Riparian Vegetation Species | Endangered Ecological Communities | Threatened Populations | Other Threatened Species | Other |
|---|--------------|----------------------------|-------|-------------|--------------|-----------|-----------------------------|-----------------------------------|------------------------|--------------------------|---|
| | | | | | | | | | | | JAMBA/CAMBA species present |
| Lower and Upper Wollondilly River | 8 | 3 | 6 | 2 | 1 | 1 | | | | | Significant area of nationally important wetland, high fish community integrity |
| Lower and Upper Wingecarribee River | 4 | 2 | 3 | | | 1 | 2 | | | | Significant area of nationally important wetland |
| Kowmung River | 7 | 2 | 7 | 2 | 1 | | | | | | High naturalness |
| Nattai River, Lake Burragorang and Little River | 7 | 3 | 5 | 2 | | | 1 | | | | High value riparian vegetation |
| Nepean River above Douglas Park Weir | 5 | 3 | 9 | 2 | 1 | 1 | | | | | Significant area of nationally important wetland, high value riparian vegetation, high fish community integrity |
| Menangle and Mid Nepean River | 3 | 2 | 7 | 2 | | 1 | | 1 | | | Significant area of nationally important wetland |
| Lower Nepean River | 3 | 2 | 7 | 2 | | 1 | | 1 | | | Significant area of nationally important wetland, high fish community integrity |
| Erskine Creek and Glenbrook Creek | 6 | 3 | 3 | 2 | 1 | | | | | | High value riparian vegetation, high fish community integrity |
| Grose River | 6 | 3 | 3 | 2 | | | | | | | Significant area of nationally important wetland, high value riparian vegetation, high fish community integrity |
| Colo River and Capertee River | 6 | 3 | 5 | 2 | 2 | | | 1 | | | Declared wild river, high fish community integrity, high value |

| | Frog Species | Macro invertebrate Species | Birds | Other Fauna | Fish Species | Wet Flora | Riparian Vegetation Species | Endangered Ecological Communities | Threatened Populations | Other Threatened Species | Other |
|----------------------------|--------------|----------------------------|-------|-------------|--------------|-----------|-----------------------------|-----------------------------------|------------------------|--------------------------|--|
| | | | | | | | | | | | riparian vegetation |
| Upper Hawkesbury River | 7 | 2 | 8 | 2 | | | | 2 | | | Significant SEPP wetland, significant area of nationally important wetland, JAMBA/CAMBA species present, high fish community integrity |
| Lower Hawkesbury River | 7 | 2 | 8 | 2 | | | | 2 | | | Significant SEPP wetland, significant area of nationally important wetland, JAMBA/CAMBA species present, high fish community integrity |
| Cattai Creek | 6 | 1 | 8 | 2 | | | | 2 | | | JAMBA/CAMBA species present, high value riparian vegetation |
| Berowra and Cowan Creeks | 6 | 3 | 15 | 2 | | 1 | | 5 | | | High value riparian vegetation, high fish community integrity |
| Woronora River | 4 | 2 | 2 | 2 | | 1 | | 3 | | | High fish community integrity |
| Hacking River | 4 | 2 | 2 | 2 | | 1 | | | 3 | | JAMBA/CAMBA species present, high value riparian vegetation |
| Georges River Catchment | 6 | 2 | 8 | 2 | | 1 | | 3 | | | 1 significant RAMSAR wetland, 1 significant other nationally important wetland, high fish community integrity |
| Cooks River and Botany Bay | 5 | 2 | 15 | 3 | | 1 | | 4 | | | High diversity |

| | Frog Species | Macro invertebrate Species | Birds | Other Fauna | Fish Species | Wet Flora | Riparian Vegetation Species | Endangered Ecological Communities | Threatened Populations | Other Threatened Species | Other |
|-------------------------|--------------|----------------------------|-------|-------------|--------------|-----------|-----------------------------|-----------------------------------|------------------------|--------------------------|--|
| Southern Sydney Coastal | 3 | 1 | 2 | | | 1 | | | 2 | | High value riparian population |
| Middle Harbour | 5 | 1 | 15 | | | | | 4 | | 2 | High non extractive values |
| Lane Cove | 5 | 2 | 15 | 2 | | 1 | | 4 | | | High recreation value |
| Minnamurra River | 5 | 1 | 16 | 2 | | | | | 2 | | 1 SEPP wetland |
| Minnamurra Coastal | 5 | 2 | 16 | 2 | | | | 2 | 2 | | 2 SEPP wetlands |
| Macquarie Rivulet | 5 | 2 | 16 | 2 | | | | | 2 | | 1 SEPP wetland, high value riparian vegetation |
| Lake Illawarra | 5 | 1 | 16 | 2 | | | | | 2 | | 1 SEPP wetland, 1 other nationally important wetland |

Disclaimer

The Office of Environment and Heritage (OEH) has provided assessments on the presence of threatened species and their sensitivity to extraction to inform the classification of water sources through the Macro Water Sharing Planning process. The assessments were undertaken for the specific purpose of developing an initial classification of water sources. They were based on the most accurate and relevant data/ information sourced and analysed at the time.

Initial classifications were a first step to inform panel deliberations. Panels considered a range of information and used local knowledge in determining a final classification. The assessments are not absolute – for example the absence of threatened species for an assessment does not necessarily mean the threatened species are not present.

These assessments should not be used for any purpose other than classification of catchment management units as part of the Macro Water Sharing Planning process.

Appendix 3a: Interagency Working Group and support staff for Greater Metropolitan Region plan

| Name | Agency | Role | Expertise |
|--|------------------------------------|-----------------------------|--|
| Robert O'Neill | DPI Water | Agency representative/Chair | Master of Engineering Science (Water) and Bachelor of Civil Engineering (Hons 1). Over 20 years experience in water management and currently the Director, Water Policy and Planning with the NSW Office of Water. |
| Stephen Allen | DPI Water | Macro coordinator | Bachelor of Commerce, Doctor of Philosophy, Economics. 15 years water policy and planning in Sydney metropolitan and south east rivers. |
| Rebekah Gomez -Fort | Department of Primary Industries | Agency representative | 15 years experience in natural resource management, specialising in water policy for the past 4 years. |
| Susy Cenedese | Office of Environment and Heritage | Agency representative | Bachelor of Science, employed in environment and natural resources policy for 18 years with OEH and its predecessors, the last 8 years in water policy. |
| Observers | | | |
| Simone Greenaway (formerly Andrew Bryan) | SCA | Agency representative | Bachelor of Economics, Master of Economics, Executive Master of Public Administration |
| John Carse | Sydney Metro CMA | CMA observer | Civil engineer with 22 years experience in flooding and stormwater drainage. |
| Chris Presland | SRCMA | CMA observer | 15 years experience in natural resource management through management roles with catchment management authorities and NSW natural resource and environmental departments. |
| Bernie Bugden | HNCMA | CMA observer | Currently General Manager of HNCMA. Has been working for the NSW Government across a wide range of NRM areas since 1977. Has occupied regional management positions with CALM, DLWC, DNR and HNCMA since 1993. Has held regional management positions in DLWC that oversaw the development of NRM plans including water sharing plans. |
| Nefley Hetherington | SWC | Agency representative | Extensive experience in water policy and management through implementation of the 1994 COAG water reforms, development of the Water Management Act 2000, bulk water pricing and managing strategic directions of Sydney Water. |
| Doug Rhodes | OHN | Agency representative | Over 20 years experience working within NSW water agencies. Previous manager of Metro Water Sharing and Planning within the NSW Department of Infrastructure, Planning and Natural Resources. Currently a principal water planner with the Office of Hawkesbury Nepean. |
| Support Staff | | | |
| Peter Marczan | OEH | Technical support/alternate | Bachelor of Engineering, Masters of Engineering. Over 20 years experience in |

| | | | |
|-------------------|---------|---|---|
| | | representative | water quality and urban water management. |
| Peter Lloyd-Jones | OEH | Agency representative | Bachelor in Environmental Science. Worked on water reforms and water management since 1997, in the areas of water sharing planning, water policy development and implementation, water quality and riverine/wetland ecology. |
| John O'Connor | I&I NSW | Technical support/alternate representative | Agricultural research and extension and resource management, involved in water management and planning in the South Coast, Shoalhaven, Illawarra and Sydney areas, including previous Hawkesbury Nepean Water Management Forum. |
| Danny Norris | I&I NSW | Technical support/alternate representative | Water policy implementation including water use, enterprise management and basic structural adjustment strategies for water users, water licensing, groundwater/surface water interactions, flow data analysis, water sharing plan development and implementation |
| Simon Williams | NOW | Technical support | Water scientist studying the Metropolitan Rivers since 1990, assessments of urban runoff and sewage disposal in the Hawkesbury-Nepean River, member of the Scientific Advisory Panel for the Shoalhaven River environmental flows program, undertook studies into environmental water requirements for the Shoalhaven River. Managing environmental water research into the Snowy and Montane Rivers and the unregulated rivers of NSW. |
| Hemantha Perrera | NOW | Technical support (hydrology) | PhD in Civil Engineering (catchment hydrological modelling), MEng in Water Resources Engineering, BSc in Civil Engineering (Hons.), 12 year history of developing and calibrating hydrology models for NSW water sources and modelling of water sharing scenarios, particularly in the Greater Metropolitan Region. |
| Mark Harris | NOW | Policy support | Water policy and planning, utility planning arrangements, water sharing plan development and implementation |
| Lyndal Betteridge | NOW | Project Coordinator (Greater Metropolitan Region water sharing plans) | Water policy and planning, utility planning arrangements, water sharing plan development and implementation, project management |
| Kimberley Dale | NOW | Planning support | Water planning, water sharing plan development |

The work of the Interagency Working Group was based on initial work undertaken by the former Interagency Regional Panel and a number of agency support staff

Appendix 3b. South Coast Interagency Regional Panel for replacement of the Kangaroo River water sharing plan

Panel members

| | |
|------------------|---|
| Tracey Brownbill | Department of Primary Industries, Water (Chair) |
| Anne Muir | Department of Primary Industries, Agriculture |
| Daniel Wiecek | Office of Environment and Heritage |
| Chris Presland | South East Local Land Services |
| Trevor Daly | Department of Primary Industries, Fisheries |

Support staff

| | |
|----------------------------------|---|
| Stephen Allen (Plan coordinator) | Department of Primary Industries, Water |
| Kelly-Anne Lynch (Plan support) | Department of Primary Industries, Water |

Appendix 4: Contribution towards meeting the river flow objectives

Levels of assessed contribution: FULL – contributes to objective in full, HIGH - while not fully contributing to objective is considered a good level of contribution, PARTIAL - goes some way to contributing to the objective, LOW - only small degree of contribution to the objective

Note that for some systems while there may be no specific rule for each river flow objective the extent to which the rules, annual extraction limits and the risk to values contributed to the objectives was considered, and a specific rule developed only where necessary.

(*) Note that for the tidal pool water source although rules have not yet been developed the following assessment is based on the intent of the rules. Tidal pool is assessed against the RFOs based on rules intended to maintain natural variability of salinity levels, and protect from significant saltwater intrusion.

| Water source | Protect pools in dry times | Protect natural low flows | Protect important rises in water levels | Maintain wetland and floodplain inundation | Mimic natural drying in temporary waterways | Maintain natural flow variability | Maintain natural rates of change in water levels | Manage groundwater for ecosystems | Minimise effects of weirs and other structures | Minimise effects of dams on water quality | Make water available for unforeseen events | Maintain or rehabilitate estuarine processes and habitats |
|--------------------------------------|----------------------------|---------------------------|---|--|---|-----------------------------------|--|-----------------------------------|--|---|--|---|
| Shoalhaven River | FULL | FULL | PARTIAL | PARTIAL | NA | PARTIAL | PARTIAL | NA | PARTIAL | PARTIAL | LOW | HIGH |
| Illawarra Rivers | FULL | FULL | PARTIAL | PARTIAL | NA | LOW | LOW | NA | LOW | LOW | NA | PARTIAL |
| Southern Sydney Rivers | FULL | FULL | PARTIAL | PARTIAL | NA | LOW | LOW | NA | PARTIAL | PARTIAL | LOW | PARTIAL |
| Northern Sydney Rivers | FULL | FULL | PARTIAL | PARTIAL | NA | LOW | LOW | NA | LOW | LOW | LOW | PARTIAL |
| Upper Nepean and Upstream Warragamba | FULL | FULL | PARTIAL | PARTIAL | NA | PARTIAL | PARTIAL | PARTIAL | HIGH | HIGH | LOW | PARTIAL |
| Hawkesbury and Lower Nepean Rivers | FULL | FULL | PARTIAL | PARTIAL | NA | PARTIAL | PARTIAL | PARTIAL | HIGH | HIGH | LOW | PARTIAL |

Appendix 5: Reference materials

Central Data sets

- Employment in Agriculture – Australian Bureau of Statistics
- Index of Social Disadvantage – Australian Bureau of Statistics.
- Roy et al. 2001. Structure and Function of South-eastern Australian estuaries.
- Stressed rivers reports – used as the basis for identifying where there are instream barriers.
- Threatened species – fish. Data supplied by I&I NSW.
- Threatened species – other. Data supplied by OEH.

NSW DPI Water Regional Data sets

- AUSRIVAS – LNC area has a number of AUSRIVAS sampling sites (water quality). The data was used in the spreadsheet to help assess river health.
- Hydsys – Hydsys is a NSW DPI Water statewide database that holds all flow record data. Flow records are available for most water sources in the Greater Metropolitan Region (LNC) area.
- Regional Groundwater Monitoring Network – DPI Water is developing a regional groundwater monitoring network to be used to monitor alluvial groundwater levels and assess stream / surface water connectivity.
- Riparian vegetation mapping – riparian vegetation extent has been mapped across the LNC area. This was used to help determine other (non-extractive) influences on river health.
- RiverStyles Mapping – Riverstyles mapping has been completed for most of the LNC area. It is based on the nationally-adopted method developed by Macquarie University. Maps are produced of Riverstyle / Geomorphic Condition / Recovery Potential. The information was used to assess issues such as drought refuge (pools), habitat heterogeneity, etc to inform the development of flow rules.
- TRITON Water Quality database – DPI Water state wide database holding all corporate water quality data. Data was available for most basic parameters (i.e. EC, pH, temp, TP, TN) for the majority of water sources. DPI Water has an ongoing regional water quality monitoring network.

Reference materials

- NSW DPI. 2006. *Primefacts: Australian Grayling*. NSW Department of Primary Industries. NSW
- NSW Office of Water. 2010. *2010 Metropolitan Water Plan*. Department of Environment Climate Change and Water. NSW
- Sinclair Knight Merz. 2006. *Towards a National Framework for Managing the Impacts of Groundwater and Surface Water Interaction in Australia*. Natural Heritage Trust, Sinclair Knight Merz
- United Nations. 2007. *United Nations Declaration on the Rights of Indigenous Peoples*.

- Vaze J., Teng J., Post D, Chiew F., Peraud J-M., Kirono D, (2009), *Future climate and runoff projections (~2030) for New South Wales and Australia Capital Territory*, NSW Department of Water and Energy, Sydney

Appendix 6: Final classification summary

Value matrix

| | | | |
|--|--|---|--|
| <p style="text-align: center;">High instream values</p> | <p>A</p> <p>Cooks River and Botany Bay, Lane Cove River, Berowra Creek and Cowan Creek, Minnamurra Coastal, Nerimunga Creek (D)</p> | <p>B</p> <p>Lower Kangaroo River, Yarrunga Creek, Fitzroy Falls, Kowmung, Broughton Creek (E), Corang and Endrick Rivers (E), Shoalhaven River Gorge (E)</p> | <p>C</p> <p>Lower Shoalhaven River, Bomaderry Creek, Lower Shoalhaven River Catchment, Minnamurra River, Macquarie Rivulet, Lower Nepean River, Menangle, Mid Nepean River, Upper Hawkesbury River (all), Lower and Upper Wingecarribee River, Lower and Upper Wollondilly River, Mulwaree River, Lower Hawkesbury River, Grose River</p> |
| <p style="text-align: center;">Medium instream values</p> | <p>D</p> <p>Bungonia Creek, Erskine Creek and Glenbrook Creek, Wollongong Coastal, Lake Illawarra Coastal (B), Middle Harbour (A)</p> | <p>E</p> <p>Georges River, Northern Sydney Coastal, Lower Shoalhaven River, Colo River (E)</p> | <p>F</p> <p>Lower and Upper Woronora River, Lower and Upper South Creek, All management zones of the Nepean River and tributaries above Mid Nepean River, Nattai River, Lake Burragorang, Little River, Jenolan River, Kedumba, Wywandy, Dharabuladh, Hacking River (D), Macdonald River (C), Cattai Creek (C)</p> |
| <p style="text-align: center;">Low instream values</p> | <p>G</p> | <p>H</p> | <p>I</p> <p>Lower and Upper Parramatta River, Upper Shoalhaven River</p> |
| | <p>Low hydrologic stress or hydrologic risk</p> | <p>Medium hydrologic stress or hydrologic risk</p> | <p>High hydrologic stress or hydrologic risk</p> |

Risk matrix

| | | | |
|--|---|--|--|
| <p style="text-align: center;">High risk to instream values</p> | <p>A Kowmung River</p> | <p>B Grose River (D), Minnamurra River (E), Upper and Lower Shoalhaven River (D), Mulwaree River, Upper and Lower Wingecarribee River, Mid Shoalhaven River, Lower and Upper Wollondilly River, Jenolan River, Dharabuladh River</p> | <p>C Macquarie Rivulet (F)</p> |
| <p style="text-align: center;">Medium risk to instream values</p> | <p>D Hacking River, Wywandy River</p> | <p>E Colo River (H), Lower and Upper Woronora River (B), Lower Georges River and Bunburry Curran Creek, Cabramatta Creek, Prospect Creek and Georges River Catchment, Lower and Upper Parramatta River, Lower Shoalhaven River, Lower Shoalhaven River Catchment and Bomaderry Creek, Nattai River, Little River, Lake Burragorang, Macdonald River (B)</p> | <p>F Werriberri Creek (C), all Upper Hawkesbury Rivers (I), Broughton Creek, Broughton Mill Creek, Jaspers Brush Creek and Tributaries, Cattai Creek (C), Lower and Upper South Creek (C)</p> |
| <p style="text-align: center;">Low risk to instream values</p> | <p>G Nerrimunga Creek (D), Mongarlowe River (D), Bungonia Creek, Boro Creek, Reedy Creek, Shoalhaven River Gorge, Minnamurra Coastal, Wollongong Coastal, Lake Illawarra, Corang and Endrick River</p> | <p>H Lane Cove (E), Cooks River and Botany Bay, Middle Harbour, all zones of the Nepean River and tributaries above Menangle, Berowra and Cowan Creeks, Kedumba River</p> | <p>I Lower Hawkesbury River, Northern Sydney Coastal</p> |
| | <p style="text-align: center;">Low dependence on extraction</p> | <p style="text-align: center;">Medium dependence on extraction</p> | <p style="text-align: center;">High dependence on extraction</p> |

Appendix 7: Water sharing rules based on Interagency Working Group knowledge

| Management zone | Change to water sharing rules | Justification |
|--|---|---|
| Middle Harbour | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source) were not adopted. Instead an EFPR was proposed as no visible flow at the pump site or when there is no visible inflow to, or outflow from, the pumping pool. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Northern Sydney Coastal | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source) were not adopted. Instead CtP was proposed as no visible flow at the pump site or when there is no visible inflow to, or outflow from, the pumping pool. | Given the MZ consists primarily of minor tributaries, has limited users and a lack of infrastructure, it was considered that a visible flow at the pump site was the most appropriate access rule. |
| Northern Sydney Coastal | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted. Instead no net gain transfers were proposed. | The absence of river flow gauge prevents a reasonable estimation of flow stress to be determined to implement transfers in up to a specified percentage of flow stress. |
| Lane Cover River | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source) were not adopted. Instead CtP was proposed as no visible flow at the pump site or when there is no visible inflow to, or outflow from, the pumping pool. | The Lane Cove River Management Zone has limited users and a lack of infrastructure and as such a visible flow at the pump site was considered the most appropriate management rule for access in this system. |
| Upper Parramatta River | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source) were not adopted. The rule adopted was 1 ML/day which is the 96 th percentile | Since a river flow gauge is present, it was recommended that a visible flow be reference to the gauge. As the river ceases to flow below the 98 th percentile (0.67 ML/day) approximately, 1 ML/day EFPR (estimated 96 th percentile) approximates a visible flow and would ensure the connection of pools along the river. In addition a commence to pump rule (delay in commencing pumping for 24 hours) is recommended in recognition of the value of inflows to estuary systems downstream. |
| Hacking River | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level) were not adopted. A visible flow at the pump site EFPR rule was more considered more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Upper Woronora River | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level, specific flow rule for instream values) were not adopted. A visible flow at the pump site EFPR rule was more considered more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Upper Woronora River, Lower Woronora River | The indicative trading rules identified through the classification process (trades allowed into the management zone so long as total entitlements at the commencement of the plan are not exceeded) were not adopted. Instead it is proposed that there is no trading into the management zone. | The proposed transfer rules aim to protect environmental flows from and inflows to the Woronora Dam. |
| Southern Sydney | The indicative access rules identified through the classification process | The MZ has a limited number of users and a lack of infrastructure so a |

| Management zone | Change to water sharing rules | Justification |
|---|--|--|
| Coastal | (EFPR at the 95 percentile flow level) were not adopted. A visible flow at the pump site EFPR rule was more considered more appropriate. | visible flow at the pump site EFPR was considered more appropriate. |
| Southern Sydney Coastal | The indicative trading rules identified through the classification process (trades allowed up to a specified percentage of flow stress) were not adopted. Instead no transfer into or upstream of were proposed. | The MZ is located largely within a National Park and in a very good condition. By preventing transfer into the MZ it was intended to protect the values of the area. |
| Cooks River and Botany Bay | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source, specific rule for instream values) were not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Cabramatta Creek | The indicative access rules identified through the classification process (EFPR at the 90 percentile flow level, daily flow sharing to protect 70 per cent each flow class for the environment) were not adopted. Instead an EFPR level at the 85 percentile flow level was recommended (0.1 ML/day). In addition a commence to pump rule (delay in commencing pumping for 24 hours) is recommended in recognition of the value of inflows to estuary systems downstream. | The MZ has limited volumes of water available to being shared and lack of appropriate infrastructure to measure flows accurately for sharing. |
| Cabramatta Creek | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow) were not adopted. Instead no trades into Cabramatta Creek management zone are recommended. | The MZ has insufficient water available to allow trades in. |
| Georges River Catchment | The indicative access rules identified through the classification process (EFPR at the 90 percentile flow level, daily flow sharing to protect 70 per cent each flow class for the environment) were not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. Amendment provisions are included for the introduction of flow classes and daily flow sharing during the term of the plan if infrastructure is installed and sufficient data collection to enable determination and need for a EFPR at the 90 th percentile of flows, the top of A Class at the 80 th percentile of flows and the top of B Class at the 50 th percentile of flows. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Georges River Catchment | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow) were not adopted. No net gain trades have been proposed for Georges River Catchment management zone. | The absence of appropriate infrastructure does not allow management of the indicative rule. |
| Lower Georges River and Bunburry Curran Creek | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow) were adopted for the majority of the MZ. | In Harris and Williams Creeks due to the high instream value of these sub-catchments no trades into the hydrological catchments of these Creeks. |
| Minnamurra Coastal | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level) were not adopted. Instead it was | Given the low extraction levels, limited number of users and absence of a river gauge in the MZ EFPR at visible flow was considered more |

| Management zone | Change to water sharing rules | Justification |
|---------------------------|--|---|
| | considered that EFPR at visible flow at the pump site was more appropriate. | appropriate. |
| Wollongong Coastal | The indicative access rules identified through the classification process (EFPR at 95 percentile flow) were not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Wollongong Coastal | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted. Instead no trades into or upstream of the management zone were recommended. | Due to the high gradient of streams with small volumes of flow, increasingly urbanised catchments, and absence of river flow gauges to establish river stress no trades in was considered more appropriate. |
| Lake Illawarra | The indicative access rules identified through the classification process (EFPR at 95 percentile flow level) were not adopted. Instead it was considered that EFPR at visible flow at the pump site was more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Bungonia Creek | The indicative access rule identified through the classification process (EFPR at 95 percentile flow level) was not adopted. Rather the 90 th percentile flow (0.2 ML) was adopted. A commence to pump rule is also proposed to protect the instream value and allow small freshes to travel through the system. | The rule has been proposed since it has been adopted as a condition on an existing licence and the 95 th percentile is virtually a zero flow. |
| Bungonia Creek | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted. Instead no trades into or upstream of the management zone were recommended. | Due to the extent and significance of groundwater dependent karst ecosystems in the area which may be dependent on surface water inflows it was recommended that no transfers are allowed into the management zone. |
| Boro Creek | The indicative trading rules identified through the classification process (no trades into or upstream of zone) were not adopted. Instead trades in up to a specified level of flow stress were recommended. | It was considered that allowing trades into the zone would reduce hydrological stress and provide environmental benefits in other zones in the Shoalhaven Water Source. |
| Nerrimunga Creek | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source, specific rule for instream values) were not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. | The MZ has a limited number of users and inability of infrastructure to record flows so a visible flow at the pump site EFPR was considered more appropriate. |
| Corang and Endrick Rivers | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted. Instead a no trade in rule has been recommended. | The assessment of 30 per cent of the 80 th percentile indicates that insufficient water is available for additional licences. |
| Yarrunga Creek | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level, daily flow sharing to protect 40 per cent each flow class for the environment) were not adopted. Rather, the rules for Sydney Catchment Authority releases from Fitzroy Falls Reservoir are recommended as the EFPR rule for the management | The proposed access rule aim to protect the inflows to the reservoir and in turn releases. |

| Management zone | Change to water sharing rules zone. | Justification |
|--|--|--|
| Fitzroy Falls | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level, daily flow sharing to protect 40 per cent each flow class for the environment) were not adopted in full. While the EFPR at the 98 percentile (0.4 ML/day) flow level was adopted, the movement to daily flow sharing was not. | Given the limited number of licences on this small creek and on the basis that the classification was not sensitive to the individual management zone (applied to the entire Kangaroo River catchment) movement to daily flow sharing was not recommended. |
| Lower Kangaroo River | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level, daily flow sharing to protect 40 per cent each flow class for the environment) were not adopted. Rather access rules consistent with the rules of the <i>Water Sharing Plan for the Kangaroo River 2003</i> were adopted. | Given the classification was not sensitive to the individual management zone (applied to the entire Kangaroo River catchment) movement to daily flow sharing was not recommended. |
| Broughton Creek and Broughton Mill Creek | The indicative access rules identified during the classification process (EFPR at visible flow) was not adopted. Instead a 90 th percentile (0.4 ML/day) EFPR rule was adopted. A commence to pump rule is also proposed to provide protection of small freshes through the system to the estuary and high instream values. | The 95 th percentile flow level is not observed at the gauge and a higher EFPR level would ensure connection of flows across the creek. |
| Lower Shoalhaven River | The indicative access rules identified during the classification process (EFPR at the 90 percentile flow level, daily flow sharing to protect 70 per cent each flow class for the environment) were not adopted. | The 95 th percentile would ensure that irrigation demands are met. Irrigation demands between the 80 th and 95 th percentile are equivalent to 1% of environmental flows. Therefore a 95 th percentile EFPR would lead to a loss of 1% of environmental flows. |
| Lower Shoalhaven River | The indicative trading rules identified during the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted for any of the management zones below Tallowa Dam apart from Bombaderry Creek management zone. | Instead it was considered that allowing trades into the management zones would reduce hydrological stress and provide environmental benefits in other zones. In addition, the medium sensitivity of the estuary to inflows, and medium hydrological stress, allows for some trades |
| Lower Shoalhaven River Catchment | The indicative access rules identified during the classification process (EFPR at the 95 percentile flow level) was not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. | Given the management zone includes only minor tributaries and there is no river flow gauge present a visible flow EFPR was recommended. |
| Erskine Creek and Glenbrook Creek | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source, specific rule for instream values) were not adopted. | No access rules were provided as the area is within a National Park and there are no existing licences within the management zone. |
| Erskine Creek and Glenbrook Creek | The indicative trading rules identified through the classification process (trades allowed in up to a specified per cent of flow stress) were not adopted. Instead no trades into or upstream of the MZ was recommended. | No trades in was recommended as the area is within a National Park and there are no existing licences within the management zone. |
| Upper South Creek | Access rules identified through the classification process (EFPR at the 95 percentile and daily flow sharing to protect 40 per cent each flow | It was identified that the sewerage discharges to the creek were artificially raising the identified flow levels - effectively this is a regulated |

| Management zone | Change to water sharing rules | Justification |
|-----------------------------|---|---|
| | class for environment, specific flow rule for instream values) were not adopted. Rather an EFPR at the 90 percentile (0.2 ML/day) was adopted. | river. An additional delay for commence to pump is recommended in recognition of the value of inflows to estuary systems downstream. |
| Lower South Creek | Access rules identified through the classification process (EFPR at the 95 percentile and daily flow sharing to protect 40 per cent each flow class for environment, specific flow rule for instream values) were not adopted. Rather an EFPR at the 80 percentile (3 ML/day) was adopted. | Flows above the EFPR level are due to discharges from sewage treatment plants and are, therefore, available in total for licensed extraction. Introduction of daily flow rules and amendment of the flow classes is provided for if the sewage treatment plant discharges cease as this will place increased pressure on remaining flows to meet extraction needs |
| Upper and Lower South Creek | The indicative trading rules identified through the classification process (no net gains, trades are allowed into or upstream of water source) were not adopted. Instead no trades into or upstream of the MZ was recommended. | Licensing and hydrology information for South Creek indicates that the management zone is over-allocated and total entitlements, therefore, need to be reduced. |
| Cattai Creek | The indicative access rules identified through the classification process (EFPR to allow a visible flow at end of water source or in the vicinity of the pump site) were not adopted. Instead a 95 th percentile (3 ML/day) EFPR was adopted and an additional delay for commence to pump is recommended in recognition of the value of inflows to estuary systems downstream. | Regional Panel considered that the high hydrologic stress and medium risk to instream values warranted a 95 th percentile EFPR. |
| Berowra and Cowan Creeks | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source, specific rule for instream values) were not adopted. Instead, EFPR to maintain visible flow at the pump site was recommended. | Sewerage treatment plant discharges in the system provide a constant visible flow at the end of the system whilst flows above the discharge point may have ceased. |
| Berowra and Cowan Creeks | The indicative trading rules identified through the classification process (trades not allowed into management zone or upstream within management zone) were not adopted. Instead no net gain trades were recommended. | Licensing and hydrology information suggests that the management zone is not over allocated and reductions in total entitlements are therefore not required. |
| Warragamba River | The indicative access rules identified during the classification process (EFPR at the 95 percentile flow level) were not adopted. Rather, the access rules proposed serve to protect releases from Warragamba Dam for the environment and basic landholder rights. | The access rules proposed serve to protect releases from Warragamba Dam for the environment and basic landholder rights. |
| Warragamba River | The indicative trading rules identified during the classification process (trades may be allowed into but only up to a specified percentage of flow stress) were not adopted. Instead no trades into or upstream of the management zone were recommended. | The rules adopted serve to protect releases from Warragamba Dam for the environment and basic landholder rights. |
| Macdonald River | The indicative trading rules identified through the classification process (trading not permitted if the trade will increase the total licensed entitlement for the management zone)) were not adopted. Rather, no | The rule has been proposed due to the important instream value of Webbs Creek. It was considered that the instream values of the remainder of the Macdonald River Management Zone could sustain |

| Management zone | Change to water sharing rules | Justification |
|---|--|---|
| | net gain in entitlements trading has been proposed. | entitlements at the existing level, with no increase in entitlement. |
| Macdonald River | The indicative access rules identified through the classification process (EFPR for licences upstream of a strategic site once water disappears at the site or EFPR when visible flow is not observed at the pump site) were not adopted. An 80 percentile (1 ML/day) EFPR was adopted and an additional delay for commence to pump is recommended in recognition of the value of inflows to estuary systems downstream. | The 80 percentile (1 ML/day) flow is considered by the regional panel to be equivalent to a visible flow at the end of the Macdonald River. |
| Lower Hawkesbury River | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source, specific flow rule for instream values) were not adopted. | It was recommended that the EFPR varies according to the environmental flows from the upper Nepean River dams, protecting tributary inflows. |
| Colo River | Trading rules identified through the classification process (trades may be allowed into, but only up to a specified per cent of flow stress) were not adopted. Trading into the hydrological catchment of the Crown Creek within the Capertee River management zone is not permitted due to the protection of karst in the area. It was recommended that trading may be permitted in other areas of the management zone, as long as there is no increase in total entitlement. | |
| Capertee River | Access rules identified through the classification process (EFPR at the 95 percentile flow level) were not adopted. The 80 percentile (2 ML/day) flow was recommended as the EFPR level. An additional delay for commence to pump is recommended in recognition of the value of inflows to estuary systems downstream. | Flows below the 80 percentile do not register on the gauge. |
| Upper Hawkesbury River (Grose River Confluence to South Creek Confluence) Upper Hawkesbury River (South Creek Confluence to the Cattai Creek Confluence) Cattai Creek Confluence to the Colo River Confluence | The indicative access rules identified through the classification process (EFPR upstream of strategic site at groundwater level, commence to pump at observation of visible water at the site, specific flow rule for instream values) was not adopted. | It was recommended that the EFPR varies according to the environmental flows from the upper Nepean River dams environmental flow releases from St Marys Water Recycling Plant and gauged tributary inflows. |
| Menangle, Wallacia | The indicative access rules identified through the classification process (EFPR at the 95 percentile flow level, daily flow sharing to protect 40 per cent each flow class for the environment) were not adopted. | It was recommended that the EFPR varies according to the environmental flows from the upper Nepean River dams. |

| Management zone | Change to water sharing rules | Justification |
|-----------------------------------|--|--|
| Lower Nepean River | The indicative access rules identified through the classification process (EFPR when water is not observed at site, specific flow rule for instream values) were not adopted. | It was recommended that the EFPR varies according to the environmental flows from the upper Nepean River dams, tributary inflows from year six, and town water supply releases from Warragamba Dam for North Richmond. |
| Lake Burragarang | The indicative access rules identified through the classification process (EFPR at 95 percentile flow level) were not adopted. Instead it was considered that a visible flow at the pump site EFPR rule was more appropriate. | The MZ has a limited number of users and a lack of infrastructure so a visible flow at the pump site EFPR was considered more appropriate. |
| Mulwaree | The indicative access rules identified through the classification process (EFPR to maintain visible flow at end of water source) were not adopted. Instead an EFPR at the 90 percentile (1 ML/day) flow level was recommended. In addition a commence to pump rule (delay in commencing pumping for 24 hours) is recommended in recognition of the value of inflows to estuary systems downstream. | The 90 percentile flow levels aims to protect the chain of ponds given that there are large extractions by limited number of extractors in the zone. The 90 th percentile also reflects the visible flow volume. |
| Werriberri Creek | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) was not adopted. The 95 th percentile (2 ML/day) was recommended. In addition, a commence to pump rule (delay in commencing pumping for 24 hours) is recommended in recognition of the value of inflows to estuary systems downstream. | Known stress on the management zone suggests that a more stringent rule would be suitable than EFPR at a visible flow level. |
| Maldon Weir | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. | Rather, the rules for Sydney Catchment Authority releases from Pheasants Nest Weir are recommended as the EFPR rule for the management zone to protect environmental release from Pheasants Nest Weir. |
| Maldon Weir | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |
| Pheasants Nest Weir to Nepean Dam | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. | Rather, the rules for Sydney Catchment Authority releases from Nepean Dam are recommended as the EFPR rule for the management zone to protect the inflows to Pheasants Nest Weir and environmental releases from Nepean Dam. |
| Pheasants Nest Weir to Nepean Dam | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |

| Management zone | Change to water sharing rules | Justification |
|--|---|--|
| Stonequarry Creek | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. Rather a EFPR at the 90 percentile (0.4 ML/day) flow level was recommended for the first five years of the plan, increasing to an 80 percentile (0.6 ML/day) flow level from year six of the plan | . This staged approach allows time for adjustment by water users. This recommendation is in line with the Hawkesbury Nepean River Management Forum's recommendation of protecting the 20 per cent of tributary flows above Wallacia Weir. |
| Stonequarry Creek | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |
| Maguires Crossing | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. The 80 th percentile is 14 ML/day. | Rather, the rules for Sydney Catchment Authority releases from Nepean Dam are recommended as the EFPR rule for the management zone to protect the inflows to Nepean Dam and in turn releases from the dam. In addition a commence to pump rule (delay in commencing pumping for 24 hours) is recommended in recognition of the value of protecting fresh flow events through the system. |
| Maguires Crossing | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |
| Mid Cataract River, Lower Cataract River | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. | Rather, the rules for Sydney Catchment Authority releases from Broughton Pass Weir and Cataract Dam are recommended as the EFPR rule for the management zone to protect the inflows to Broughton Pass Weir and in turn releases from the weir. |
| Mid Cataract River, Lower Cataract River | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |
| Cordeaux River, Avon River | The indicative access rules identified through the classification process (EFPR to maintain visible flow at the end of the management zone) were not adopted. | Rather, the rules for Sydney Catchment Authority releases from Avon and Cordeaux Dams are recommended as the EFPR rule for the management zone to protect releases from Avon Dam and inflows to the Pheasants Nest Weir and in turn releases. |
| Cordeaux River, Avon River | The indicative trading rules identified through the classification process (trades may be allowed into but only up to a specified per cent of flow stress) were not adopted. Instead no trades in has been recommended. It was also recommended that trades from above to below the SCA dams and vice versa will not be permitted. | The rules were recommended to protect environmental releases from dams and inflows to dams. |

| Management zone | Change to water sharing rules | Justification |
|--|--------------------------------------|--|
| Wywandy Dharabuladh Kowmung Kedumba Jenolan | | The proposed access and trading rules are based on the recommendations of the former Cocks River Water Management Committee which were developed for inclusion in the draft Cocks River water sharing plan. This plan has now been included within the provisions of the Water Sharing Plan for the Greater Metropolitan Unregulated Water Sources 2010. |

Appendix 8: Adaptive management

| Management zone | Adaptive management Access rules |
|---|---|
| Upper Shoalhaven River | Additional or new TDELS may be established if the Minister is satisfied that instream values are at risk |
| Fitzroy Falls | The plan may be amended to allow for existing flow classes to be amended, new flow classes established or additionally flow classes made after year 5 provided that the top of the very low flow class and bottom of A class \leq 95th percentile and the Minister is satisfied that water users are able to store water for dry times. |
| Yarrunga Creek | Flow classes and flow reference point may be amended following a change to environmental release requirements for Fitzroy Falls |
| Lower Kangaroo River, Lower Shoalhaven River Gorge | Interchange rules between Fitzroy Falls and Lake Yarrunga may be amended |
| Bundanoon Creek, Lower Shoalhaven River, Lower Shoalhaven River Catchment, Upper and Lower Wingecarribee River, Upper and Lower Wollondilly River | Flow classes may be amended to allow for environmental flow rules from dams owned and operated by Goulburn Mulwaree Shire Council, Wingecarribee Shire Council or Shoalhaven City Council. |
| Lower Shoalhaven River | Release rules for Lake Yarrunga may be amended if the Metropolitan Water Plan 2010 is altered or as a result of a NSW Government decision on water transfers between the Shoalhaven River Water Source and the Upper Nepean and Upstream Warragamba Water Source |
| Lower Shoalhaven River Catchment | The plan may be amended to allow for system operational rules for Danjera Creek Dam and Flat Rock Creek Dam. |
| Broughton Creek, Broughton Mill Creek | Flow classes and flow reference point may be amended if gauging is undertaken that establishes more accurate percentile flow values |
| Jaspers Brush Creek | Flow classes and flow reference point may be amended to specify a new flow reference point in Jaspers Brush Creek Management Zone. |
| Minnamurra River | Additional or new TDELS may be established after year 6 if the Minister is satisfied that instream values are at risk |
| Lake Illawarra, Jenolan River, Georges River Catchment and Hacking River | The plan may be amended to allow for Aboriginal community development licences in these management zones |
| Macquarie Rivulet | Additional or new TDELS may be established after year 6 if the Minister is satisfied that instream values are at risk |
| Upper and Lower Wingecarribee River, Upper and Lower Wollondilly River | Access rules and flow classes may be amended to allow for protection of run-of-river transfers for town water supply purposes made by SCA and Goulburn Mulwaree Council via the Wingecarribee River and Wollondilly River |
| Upper Wingecarribee River | Flow classes may be amended to allow for environmental flow rules from Wingecarribee Reservoir. |

| Management zone | Adaptive management |
|--|---|
| | The plan may be amended to allow for environmental flows from Wingecarribee Reservoir |
| Lower Wingecarribee River | Additional or new TDEs may be established after year 6 if the Minister is satisfied that instream values are at risk |
| Maldon Weir, Menangle Weir, Camden Weir, Sharpes Weir, Cobbity Weir, Mount Hunter Rivulet Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir | Flow classes may be amended following a change to transmission loss factors. |
| Pheasants Nest Weir to Nepean Dam, Mid Cataract River, Maldon Weir, Camden Weir, Sharpes Weir, Cobbity Weir, Mount Hunter Rivulet Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir, Lower Nepean River | Banked environmental flow rules may be established for Pheasants Nest Weir, Broughtons Pass Weir, Maldon Weir, Menangle Weir, Camden Weir, Sharpes Weir, Cobbity Weir, Mount Hunter Rivulet Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir and Penrith Weir. |
| Upper Nepean River Tributaries Headwaters | ECA rules for Avon Dam, Cataract Dam, Nepean Dam and Cordeaux Dam may be amended following a review of the rules. |
| Wywandy | Flow classes may be amended to allow for environmental flow rules from Lake Lyell. Flow classes may be amended to allow for environmental flow rules from Thompsons Creek Dam. The plan may be amended to allow for environmental flows as a result of an independent and peer-reviewed investigation into the suitability and adequacy of licensed Thompsons Creek Flow Releases for Thompsons Creek Dam by the end of year 5 of the Plan. The plan may be amended to allow for environmental flows as a result of an independent and peer-reviewed investigation into the suitability and adequacy of transparent and translucent flow dam releases, annual channel maintenance flow releases and drought triggers for Lilyvale Dam. The plan may be amended to allow for environmental flows from Lake Wallace |
| Wywandy, Dharabuladh | Flow classes may be amended to allow for environmental flow rules from Lake Wallace. |
| Lake Illawarra, Kedumba River, Jenolan River, Kowmung River, Colo River, Hacking River | Flow classes and flow reference point may be amended to specify a new gauge. |
| Kowmung River | Flow classes and flow reference point may be amended to specify a new flow reference point in Kowmung River Management Zone. |
| Kedumba River, Kowmung River, Lower Hawkesbury River | The plan may be amended to allow for high flow conversions. |
| All management zones within the Upper Nepean and Upstream Warragamba Water Source | Environmental releases may be amended in the Upper Nepean and Upstream Warragamba Water Source following a review if the releases cannot be met. Transmission loss factors in regards to these releases may also be amended following a review during the term of the plan. Transmission loss factors must remain within the range of 0.5 to 1. |

| Management zone | Adaptive management |
|--|---|
| Lower Nepean River | <p>Access rules for licences held by Penrith Lakes Development Corporation may be amended</p> <p>A new management zone may be created above Penrith Weir with amended access rules</p> |
| Grose River | Additional or new TDELS may be established after year 6 if the Minister is satisfied that instream values are at risk |
| Grose River, Colo River | Flow classes in the Colo and Grose Rivers Management Zones may be amended if the Minister is satisfied that a review of the plan shows that in-stream values are at risk from extraction. |
| Colo River | A new management zone may be created for Little Wheeny Creek after year 5 of the plan |
| Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek), Upper Hawkesbury River (Cattai Creek to Colo River) | <p>TDELS or IDELS may be established or reassigned</p> <p>Access rules which allow limited access to very low flows may be amended following a review of the rules</p> |
| Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek), Upper Hawkesbury River (Cattai Creek to Colo River), Lower Hawkesbury River | New flow classes and access rules may be established following a review by the Minister |
| Lower South Creek | Additional or new TDELS may be established after year 6 if the Minister is satisfied that instream values are at risk |
| All management zones within the Hawkesbury and Lower Nepean Water Source | <p>Releases for environmental and town water supply purposes may be amended in the Hawkesbury and Lower Nepean Water Source following a decision by NSW Government relating to environmental releases from Warragamba Dam.</p> <p>The LTAAEL in the Hawkesbury and Lower Nepean EMU may be amended by 5% to account for growth by Sydney Water</p> <p>The LTAAEL may be amended to account for average annual evaporation and other water losses by Penrith Lakes</p> <p>Flow classes and access rules may be amended to allow for system operation rule changes in the management zones in the Hawkesbury and Lower Nepean Water Source.</p> |
| Georges River | Flow classes may be amended to specify a newly installed gauge in the Georges River Management Zone after year 5 of the plan |
| Georges River Catchment | Additional or new TDELS may be established after year 6 if the Minister is satisfied that instream values are at risk |
| All management zones within the Southern Sydney Rivers Water Source | Environmental releases may be amended in the Southern Sydney Rivers Water Source following a review for the need for and adequacy of the high flow release from Woronora Dam in meeting the needs of the environment downstream of the dam. |
| Northern Sydney Coastal | The plan may be amended to allow for environmental flows from Manly Dam. |
| All plan area | <p>The plan may be amended to allow for environmental flows from dams owned and operated by Goulburn Mulwaree Council, Wingecarribee Shire Council and Shoalhaven City Council.</p> <p>Management zone boundaries may be amended</p> |

| Management zone | Adaptive management |
|-----------------|--|
| | The release rules specified in the plan for major utility access licence holders may be amended following a review of the major utility's activities (conducted under section 282 of the WMA 2000) |
| | The LTAAEL may be amended following a review of compliance with the LTAAEL |
| | Access rules for lagoons, lakes, in-river pools and other lentic water bodies may be amended to specify a drawdown condition |
| | Rules may be implemented regarding trading from rivers to lagoons |
| | Access rules and flow classes may be amended to protect Aboriginal cultural sites and places |
| | For any new management zones established over the life of the plan flow classes may be established |
| | Flow reference sites may be amended |
| | Stock watering volumes may be amended |
| | Access rules may be amended in regards to access to very low flows |
| | IDELs may be established |
| | TDELs may be established |
| | TDELs or IDELs may be established or reassigned in a management zone where licences have been purchased and/or cancelled |
| | The plan may be amended to prohibit in-river dams in specified management zones and to grant or amend works to take water from lagoons. |
| | Schedule 2 of the plan may be amended to include additional licences exempt from taking very low flows. |
| | Schedule 3 of the plan may be amended to include additional licences permitted to extract from lagoons |
| | <p>The plan may be amended to provide for the following:</p> <ul style="list-style-type: none"> • Floodplain harvesting • Shepherding of water • New release rules for Warragamba Dam following a decision by the NSW Government • Stormwater harvesting • Aquifer interference approvals • Savings to be secured via the Hawkesbury Nepean River Recovery Project • Amend rules in relation to record keeping • Interception runoff rules |

Appendix 9: Stream gauging stations in the Greater Metropolitan Region used as flow reference points

| Station name | Station | Period of record | | Catchment (km ²) | Management Zone |
|---|---------|------------------|--------|------------------------------|---|
| | | Start | Finish | | |
| Bunburry Curran Creek at Railway Parade | 213012 | 1986 | 2007 | 736 | Georges River |
| Cabramatta Creek at Orange Grove | 213011 | 1986 | 2007 | | |
| Prospect Creek at Smithfield Road | 213009 | 1986 | 2009 | | |
| Toongabbie Creek at Briens Road | 213005 | 1979 | 2009 | 298 | Parramatta River |
| Minnamurra River at Browns Lane | 214010 | 2001 | 2007 | 118 | Minnamurra River |
| Macquarie Rivulet at Albion Park | 214003 | 1949 | 2007 | 104 | Macquarie Rivulet |
| Nattai River at The Craggs | 2122801 | 1990 | 2006 | 1343 | Nattai River and Lake Burragorang |
| Little River at the Fire Road W41 | 2122809 | 1990 | 2006 | | |
| Wollondilly River at Murrays Flat | 2122711 | 1990 | 2006 | 3369 | Wollondilly River |
| Wollondilly River at Golden Valley | 212271 | 1966 | 2006 | | |
| Nepean River at Maguire's Crossing | 212209 | 1970 | 2006 | 1188 | Upper Nepean River |
| Nepean River at Maldon Weir | 212208 | 1969 | 2006 | | Maldon Weir |
| Werriberri Creek at Werombi | 212244 | 1988 | 2006 | 160 | Werriberri Creek |
| Wingecarribee River at Greenstead | 212009 | 1989 | 2006 | 743 | Wingecarribee River |
| Wingecarribee River at Bong Bong Weir | 212031 | 1989 | 2006 | | |
| Coxs River at Wallerawang Power Station | 212054 | 1992 | 2007 | 368 | Wywandy |
| Coxs River at Island Hill | 212045 | 1981 | 2007 | 646 | Dharabuladh |
| Mulwaree River at The Towers | 2122725 | 1990 | 2006 | 759 | Mulwaree River |
| Cattai Creek at Cattai Ridge Road | 2122951 | 1991 | 2006 | 278 | Cattai Creek |
| Colo River at Upper Colo | 212290 | 1908 | 2006 | 4471 | Colo River |
| Capertee River at Glen Davis | 212018 | 1970 | 2007 | | |
| Grose River at Buralow | 212291 | 1945 | 2006 | 649 | Grose River |
| South Creek at Great Western Highway | 212048 | 1986 | 2007 | 611 | South Creek |
| South Creek at the Richmond Road | 212297 | 1981 | 2006 | | |
| Nepean River at Yarramundi | 2122001 | 1990 | 2006 | 389 (Upper Hawkesbury River) | Upper Hawkesbury River and Lower Nepean River |
| Macdonald River at St Albans | 212228 | 1990 | 2006 | | |
| Shoalhaven River at Grassy Gully No 2 | 215216 | 1987 | 2006 | 511 | Lower Shoalhaven River |
| Bomaderry Creek at Bomaderry | 215016 | 2003 | 2007 | | |
| Shoalhaven River at Warri | 215002 | 1914 | 2007 | 1068 | Mid Shoalhaven River |
| Mongarlowe River at Mongarlowe | 215210 | 1973 | 2006 | 411 | Mongarlowe River |
| Reedy Creek at Manar | 215238 | 1994 | 2006 | 367 | Reedy Creek |
| Shoalhaven River at Fossickers Flat | 215207 | 1976 | 2006 | 853 | Shoalhaven River Gorge |
| Shoalhaven River at Kadoona | 215008 | 1950 | 2007 | 573 | Upper Shoalhaven River |
| Boro Creek at Marlowe | 215239 | 1994 | 2006 | 210 | Boro Creek |
| Broughton Mill Creek at Berry | 215015 | 2002 | 2007 | 177 | Broughton Creek |
| Broughton Creek at 'The Oaks' | 215017 | 2005 | 2007 | | |
| Bungonia Creek at Bungonia | 215014 | 1981 | 2007 | 271 | Bungonia Creek |
| Corang River at Hockeys | 215004 | 1924 | 2007 | 491 | Corang and Endrick Rivers |
| Kangaroo River at Hampden Bridge | 215220 | 1965 | 2006 | 511 | Lower Kangaroo River |
| Yarrunga Creek at Wildes Meadow | 215233 | 1967 | 2006 | | |

| Station name | Station | Period of record | | Catchment (km ²) | Management Zone |
|---|---------|------------------|--------|---------------------------------|--|
| | | Start | Finish | | |
| Nepean River at Mount Hunter Weir | 212213 | 1987 | 2010 | 495 | Mid Nepean River |
| Nepean River at Camden Weir | 212216 | 1989 | 2009 | | |
| Wingecarribee River at Sheepwash Bridge | 212275 | 1955 | 2009 | 743 | Lower and Upper Wingecarribee River |
| Avon River at Summit Tank | 2122111 | 1990 | 2010 | 1188 | Upper Nepean River |
| Flying Fox No. 3 Creek at Fire Road | 2122112 | 1990 | 2010 | | |
| Loddon River at Bulli Appin Road | 2122322 | 1990 | 2010 | | |
| Cataract River at Corrimal No.1 | 2122323 | 1990 | 2010 | | |
| Goondarrin Creek at Kemira 'D' Cast | 2122201 | 1990 | 2010 | | |
| Nepean River at Nepean Dam | 2122051 | 1990 | 2010 | | |
| Burke River at Nepean Dam | 2122052 | 1990 | 2010 | | |
| Cataract River at Broughtons Pass Weir | 212233 | 1983 | 2001 | | |
| Sandy Creek at Cordeaux River | 2122205 | 2007 | 2010 | | |
| Stonequarry Creek at Picton | 212053 | 1990 | 2007 | | |
| Waratah Rivulet | 2132102 | 2007 | 2010 | 152 | Upper and Lower Woronora River |
| Woronora River (upstream of Woronora Dam) | 2132101 | 2007 | 2010 | | |

Appendix 10: New stream gauging stations proposed for the Greater Metropolitan Region

DPI Water is proposing to establish stream gauging stations on the following rivers where investigations revealed that the river is ungauged and should be gauged to inform future EFPRs, existing gauges were not suitable as a flow reference point and/or suitable sites were available for the installation of a gauge.

| River | Water Source | Status |
|---|---|-----------------------------|
| Jaspers Brush Creek | Shoalhaven River Water Source | Constructed and operational |
| Mullet Creek | Illawarra Rivers Water Source | Unsuitable for a gauge. |
| Georges River | Southern Sydney Rivers Water Source | Constructed and operational |
| Hacking River | Southern Sydney Rivers Water Source | Unsuitable and unnecessary |
| Kowmung River | Upper Nepean and Upstream Warragamba Water Source | Unsuitable for a gauge |
| Wollondilly River (above Rossi Weir) | Upper Nepean and Upstream Warragamba Water Source | Unsuitable for a gauge |
| Jenolan River | Upper Nepean and Upstream Warragamba Water Source | Unsuitable for a gauge |
| Tarlo River | Upper Nepean and Upstream Warragamba Water Source | Constructed and operational |
| Nepean River | Hawkesbury and Lower Nepean Rivers Water Source | Unsuitable |
| Hawkesbury Lagoons | Hawkesbury and Lower Nepean Rivers Water Source | Under investigation |
| Hawkesbury River (Electro-conductivity) | Hawkesbury and Lower Nepean Rivers Water Source | Constructed & operational |

Appendix 11: Changes to water sharing rules as a result of targeted consultation and updated data

| Management Zone | Change to water sharing rules | Justification |
|---|--|---|
| Lower Shoalhaven River | Investigate whether amendments to daily access rules below Tallowa Dam are appropriate, if tributary inflows below the dam do not provide for irrigation demands. | Proposed daily access rules below Tallowa Dam provide full protection of environmental flows from the dam. Where SCA extracts all remaining inflows to the dam, releases from the dam would not provide additional water for irrigation. This is likely to be offset through consumptive users being able to access the tributary inflows that occur below the dam. More work is being done by DPI Water to better understand the quantum of these inflows relative to the irrigation demands. |
| Wallacia and Menangle | Provide for limited access to very low flows for licences located on weirs and subject to a review at year Specific comment on this issue will be sought during public exhibition and detailed rules will be developed. Propose that trading of entitlements between weirs is not permitted. | Design and operation of the weirs and access rules may prohibit entitled licence access to compensatory water held in weir storage, thus making utilisation of these weir pools less effective and not consistent with their original intent. Trades between compensatory weirs would increase licensed extraction within some compensatory weirs and reduce reliability of existing licences as a result of infrastructure constraints. |
| Warragamba River | Provide a seasonally varying 'consumptive' release from Warragamba Dam of up to 25 ML/day for basic landholder rights and licensed entitlements, specifically North Richmond. An additional 5 ML/day release to dilute the Warragamba STP discharge into Warragamba River. | Construction of Warragamba Dam has reduced flows to the Nepean River below the dam thereby reducing reliability of licences located below the dam. NSW Government resolved to explore the possibility of releases from Warragamba Dam for licensed purposes. The proposed release regime will fully provide for North Richmond's demands and also improve dilution of STP discharges below the dam. |
| Lower Nepean River Management Zone | Remove the fixed 22 ML/day component of the EFPR volume at Yarramundi flow reference point for the first five years of the plan, following which the actual gauged volumes up to 22 ML/day shall be included in the EFPR rule unless a social and economic analysis suggests otherwise. Include a component of the EFPR volume at Yarramundi based on the seasonally varying component of the 'consumptive' release from Warragamba Dam to protect a portion of the release for North Richmond. | The removal of the 22 ML/day tributary inflow for the first five years shall provide water users with time to adjust to the new water sharing rules and some relief during periods of water shortage. Gauging stations will be installed on the major tributaries so that the actual tributary inflows can be better understood. Roll-out of metering will provide more accurate information regarding water users' dependence on these inflows. A seasonally varying EFPR volume shall provide licence holders below the Warragamba River other than SWC with access to 5 ML/day from the Warragamba releases on top of the other tributary inflows, the non-environmental release component from the St Marys Recycled Water Plant and any ongoing STP discharges into the river, thereby improving reliability relative to a 'no consumptive release rule'. |
| Lower Nepean River and Upper Hawkesbury River Zones | Allowance for North Richmond's annual average demands within the long-term average annual extraction limit Inclusion of a small allowance for expected growth in these demands during the period of the plan | It is important that this allowance is added to the size of the consumptive pool to minimise the risks of growth in this usage impacting on other users in this management zone. |

Appendix 11: Changes to water sharing rules as a result of targeted consultation and updated data

| Management Zone | Change to water sharing rules | Justification |
|------------------------------|---|--|
| Upper Hawkesbury River Zones | Trading of entitlement is permitted between Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek) and Upper Hawkesbury River (Cattai Creek to Colo River) | <p>This decision will broaden the trade market.</p> <p>All three management zones will still be in place and will have differing daily access rules providing protection of estuary flows which was the main concern.</p> <p>The initial classification to determine trading rules was carried out on all three zones as a whole and not on individual zones</p> <p>Gives the opportunity for licences closer to the estuary to move further away from the saltwater intrusion zone.</p> |
| Mongarlowe River | Increase the EFPR flow volume from the 95th percentile to the 90th percentile and the commence-to-pump volume from the 90th percentile to the 85th percentile. | Provide improved protection for the passage of aquatic fauna along the river. Friends of Mongarlowe River which has broad representation proposed the change. |

Appendix 12: Changes to water sharing rules as a result of public exhibition and updated data

| Management Zone | Change to water sharing rules | Justification |
|--|--|--|
| All plan area | Included an amendment provision in the plan to identify and include water dependent Aboriginal cultural assets and associated water requirements that are identified during the term of the plan | This was included as part of recognising Aboriginal connections with water. NOW is currently undertaking work across NSW to identify additional water dependent culturally significant sites. This was considered the best option as throughout consultation periods no specific sites within the GMR were brought to NOW's attention but it was recognised they may in the future. |
| All plan area | A note was included in the plan explaining how amendments to LTAAELs are announced or notified and that appropriate consultation be undertaken with key stakeholders as determined by the Minister prior to an amendment of a LTAAEL | This will be included as a note to avoid confusion and to create greater transparency. Notes on consultation will be included as a note as the requirements for consultation following amendments are prescribed in the WMA 2000. |
| Northern Sydney Coastal | The plan provides for the staged development of environmental flows from Manly Dam. Stage 1 will be feasibility and suitability from years 1 – 5 of the plan. Stage 2 will be design and decision on an implementation date from years 6 – 7 of the plan. Stage 3 is where any necessary infrastructure modifications are made to deliver the flows; this will be from year 8 onwards. | Rather than leaving the results of a study on Manly Dam open ended, this ensures that the necessary action is taken to possibly help improve the health of Manly Lagoon. |
| All plan area | A note was included in the plan relating to granting and amending water supply work approvals. The note mentions that in relation to in river dams the clause (cl. 78 of draft plan) does not apply to water supply works not requiring an approval under Schedule 1 of the Water Management (General) Regulation 2004. | No amendment needs to be made to the plan as water supply works not requiring an approval under Schedule 1 of the Regulation are already dealt with under the regulation. The note will simply direct those who are concerned to the appropriate section of the Regulation |
| (Hawkesbury and Lower Nepean Water Source) | In the Hawkesbury and Lower Nepean EMU, water access rules are to be referred to as an Environmental Flow Protection Rules (EFPRs). | The Minister's advisory group recommended that a CtP be referred to as an Environmental Flow Protection Alert to gain greater acceptance of the plan within the community. OEH and NOW noted that the term 'alert' may imply that it was not a rule to be enforced hence the term was changed to Environmental Flow Protection Rule. |
| All plan area | Included provisions providing for variation to the LTAAEL where tidal pool licences are granted for existing extraction and that all other new licences granted (e.g. Aboriginal Commercial) not initiate a variation to the LTAAEL. | Under the WA 1912 users in the tidal pool have not been required to be licensed. Under the WMA 2000 these licences will have to be licensed. As such where the licences are granted to existing extraction they will be included in the LTAAEL. |
| All plan area | Included a note under the relevant provisions stating that the volumes of the active component of the volumetric licences within the Upper Nepean Upstream Warragamba EMU and Lower Nepean and Hawkesbury Rivers EMU are estimated at commencement to be 11GL and 71GL and that the volume of the active component of the licence of Sydney Water within the Hawkesbury and Lower Nepean EMU is estimated at the commencement to be 7481ML and 5% growth of 374ML. | This would be a note as LTAAELs may require amendment due to various reasons. If specific volumes were included as provisions in the plan, the plan would require amendments each time the LTAAEL changed. |
| (Hawkesbury and Lower Nepean Water Source) | There will be a mid plan review for salinity triggers and access rules triggers in the Hawkesbury and Lower Nepean water sources. | With access rules in this water source allowing for limited access to very low flows and concerns regarding the possible depletion of the tidal pool, the IWG agreed to have a mid plan review of salinity triggers and access |

| Management Zone | Change to water sharing rules | Justification |
|---------------------------|---|--|
| | | rules to assess the effectiveness of the plan. |
| Fitzroy Falls | Daily access rules state the EFPR is at the 98 th percentile as a concession for the first five years of the plan. After year five, the EFPR will still be the 98 th percentile unless NOW can demonstrate that a concession should not apply if users can store water themselves for dry times, in which case the EFPR will return to the 95 th percentile | Using past data, the last season indicated that an EFPR would be activated for 38 days last season. Users in this region have noted that they would be less vulnerable in dry times if the EFPR was at the 98 th percentile. |
| Lower Kangaroo River | A new management zone was created consisting on Bundanoon Creek above Bundanoon Creek Dam. The EFPR is visible flow at the pump site. | The geographical conditions on Bundanoon Creek are significantly different from the Lower Kangaroo River, where the EFPR had previously proposed to be measured from Bundanoon Creek Dam is also used for town water supply. |
| Lower Shoalhaven River | Clause 79 of the plan will have a additional statement stating that releases by SCA from Tallowa Dam for Shoalhaven City Council shall be in accordance with the December 2006 Protocol or subsequent protocols | This is a protocol already in practise |
| Lower Shoalhaven River | A provision was added to the plan which allows for the plan to change, if necessary, if the release rules change in the Metropolitan Water Plan in regards to releases from Tallowa Dam. | Whilst releases from Tallowa Dam are dealt with in the Metropolitan Water Plan there was community concern that the relationship between the two plans should be clearer. |
| All Plan area | An amendment clause was included in the plan for shepherding water arrangements so that when a policy regarding this is developed provisions can be included. | NOW is currently working with the Commonwealth to develop a policy for shepherding water in rivers. There are a number of rivers in the Metropolitan Region where this policy may be applied. The Wingecarribee River is one river in which shepherding water rules may apply in the future. |
| Lower Wingecarribee River | The plan establishes a new management zone for the Medway Rivulet and other tributaries to the Wingecarribee River below Medway Rivulet. The EFPR for this management zone is visible flow at the pump site. | There are 12 licences on Medway Rivulet and its associated tributaries. Under the draft plan these licences would be subject to TDELs and run of river transfers. |
| All plan area | The plan makes clear that SCA have to make environmental releases from dams specified on its licence and cannot be transferred between dams unless it is banked environmental water. | Concern was raised at public exhibition that SCA may release environmental water scheduled for other dams from Avon Dam due to its larger valve size. SCA noted that this has not happened. If this did occur it would be a breach of licence conditions and a compliance issue. |
| Wywandy | Provisions are included in the plan that will require Delta Electricity to undertake independent investigations on improved regime of environmental flows for the Coxs River that would provide for a demonstrated improvement in river health. The provisions are similar to the provisions relating to Sydney Water's Manly Dam. | Having the same provisions as developing environmental releases for Manly Dam provides consistency across the plan area. |
| Wywandy and Dharabuladh | The plan includes a note explaining the location of Wywandy and Dharabuladh Management Zones | At public exhibition concern was raised that the names of the management zones were confusing. An explanation of their location creates clarity on this issue. |
| Mid Nepean River | Each compensation weir on the Nepean River is established as a management zone with the exception of Camden, Bergin and Thurns weirs which shall be grouped as one zone since the Bergin and Thurns have not been modified by SCA. Each new management zone also has its own access and trading rules. The access rules set a daily EFPR when flows recorded at the weirs are less than the environmental flows released from Broughtons Pass Weir | New management zones at each weir allows for environmental flows to be passed whilst users are still accessing compensation flows. It also enables transmission losses to be incorporated at each stage. The rules serve to protect the passing of environmental flows released from Avon, Nepean, Cataract and Cordeaux Dams and Pheasants Nest and Broughtons Pass water supply diversion weirs on the Upper Nepean |

| Management Zone | Change to water sharing rules | Justification |
|--|--|--|
| | and Pheasants Nest Weir less estimated transmission losses. | Rivers whilst ensuring licensed access to flows. |
| Mid Nepean River | The plan permits trades downstream of the Nepean River weirs which will be subject to standard assessment. Trades upstream will be permitted provided there is no net gain. | Many submissions raised concern at public exhibition of the limited trading opportunities between weir pools on the Nepean River. By establishing each weir pool as its own management zone and providing no net gains in trade, the plan supports the proposal to establish daily access rules for each weir pool and eliminates Menangle being disadvantaged whilst allowing trades that do not increase stress. |
| Lower Nepean River | The plan requires that the review clause relating to the inclusion of tributary inflows in the EFPR for the Lower Nepean River conduct investigations to ascertain the ecological significance of protecting tributary inflows. | With this requirement, if it is established that the additional flows are providing a positive benefit for the environment then they can be kept to provide for this function. Providing water for the environment is a key objective of water sharing plans. |
| Lower Nepean River | The plan includes a provision providing for an assessment of the suitability of splitting this management zone at Penrith Weir given a new gauge and amendments to daily access rules to start after year 5. | NOW is currently installing a gauge at Penrith weir parallel to SCA's gauge. Rules to start after year 5 to allow for new gaugings and calibrations. This split management zone allows the upper management zone's daily access rules to exclude releases from St Mary's Water Recycling Plant. |
| Lower Nepean River | The plan includes an amendment clause to the daily access rules as they apply to Penrith Lakes Development Corporation following a decision by the NSW Government on Penrith Lakes Development Corporation access to river flows. | The NSW Government and Penrith Lakes Development Corporation are looking at a range of options to fill and top up Penrith Lakes. This site is at the beginning of a process of being handed back to the State Government. |
| Colo River | By year 5 of the plan NOW is required to establish a management zone for Little Wheeny Creek, with suitable infrastructure (staff gauge or other), and a EFPR to achieve an end of system flow target | Concerns were raised at public exhibition that the assessment process for the Colo River Management Zone was inappropriate for Little Wheeny Creek. Little Wheeny Creek is home to Macquarie Perch and Platypus, which require specific flow conditions. Due to this concern, consideration of community involvement in creek rehabilitation and a lack of suitable infrastructure at plan commencement a new management zone was introduced after year 5 of the plan. |
| Upper Hawkesbury (all), Lower Hawkesbury River, Lower Nepean River, Mid Nepean River Catchment | The plan was amended to prohibit applications for new works on lagoons | Numerous named and unnamed lagoons are located adjacent to the Nepean and Hawkesbury Rivers. Many of these lagoons may provide significant aquatic habitat. The plan prohibits new works on and trades into the lagoons to protect these aquatic habitats. |
| (Hawkesbury and Lower Nepean Water Source) | Trading from a river to a lagoon is prohibited | |
| Lower and Upper Hawkesbury River, Colo River, Macdonald River, Grose River, South | The tidal reaches of the management zones which are tributaries to the Hawkesbury River were excised from the tributary management zone and included in the relevant management zone of the Hawkesbury River (tidal pool) and the corresponding daily access rules and trading rules will apply. | The access rules would reflect the tidal pool situation rather than the non-tidal reach of the tributary. |

| Management Zone | Change to water sharing rules | Justification |
|--|---|---|
| Creek | | |
| All plan area | Performance indicator 11 (1) (f) was changed to the following, "extent to which local water and major utility requirements are met" | Typographical error by NOW. |
| Lower Wingecarribee River | The second note after 16 (3) (e) (iv) was changed as this note should not apply to Sydney Water Corporation but instead, Sydney Catchment Authority | Error by NOW. The note states that flow classes may be amended under cl. 16 (7) (f) based on the finalisation of proposed future water transfer options by Sydney Catchment Authority and not Sydney Water. |
| All plan area | SCA's licence was amended so that it included a provision for the release of banked water | The licence held by SCA was amended to reflect all relevant provisions of the water sharing plan. |
| Lake Burragorang | The plan was amended to state that no releases are required when Warragamba Dam is spilling at or in excess of the environmental/riparian release requirement. | If the dam is spilling it is already providing environmental flows naturally |
| (Hawkesbury and Lower Nepean Water Source) | The LTAAEL established for SCA in the Hawkesbury and Lower Nepean Rivers EMU was amended to 6000 ML/year | Updated figures were provided by SCA. |
| Lower Nepean River | The plan was amended so that access rules (EFPR) included Sydney Water's requirements at North Richmond. | This allows for water being released from Warragamba Dam being protected for Sydney Water's requirements at North Richmond. |
| Mid Nepean River | The plan was amended by removing clause 86 (1), (2), (3) and (5) which related to modifications being made by year 3 of the plan to Douglas Park Weir, Camden Weir, Cobbity Weir, Mount Hunter Weir, Brownlow Hill Weir, Theresa Park Weir, Wallacia Weir, Menangle Weir, Sharpes Weir and Penrith Weir | The owners of these weirs (SCA) have noted that modifications to these weirs was completed by December 2010 and that modifications to Sharpes Weir and Menangle Weir will be completed by the end of 2010 and therefore it was not necessary to include a requirement to modify the weirs during the life of the plan. |
| Lower Shoalhaven River | A clause was added to the plan similar to 21 (1) (e) (ii) that states that releases of planned environmental water are not required from Tallowa Dam if the Dam is spilling at a rate that equals or exceeds the planned environmental flow requirement. | If the dam is spilling it is already providing environmental flows naturally. |
| (Shoalhaven River Water Source) | The LTAAEL for SCA in the Shoalhaven River water source was amended to 36, 000 ML/year and their share component in the same water source to 329, 000 ML/year | Updated figures were provided by SCA. |
| All plan area | The plan was amended to reflect the following: 1. Include provisions allowing the Minister to suspend environmental flows for all storages and water sources and that SCA may only suspend flows with the Minister's authority of a suspension 2. Include provisions requiring that environmental flows shall be made from a named dam except where a suspension is in place under (1) for all storages and water sources 3. Include provisions requiring that environmental water that cannot be released due to a Minister's suspension in (1) shall be banked 4. Include provisions for the release of banked environmental water from all storages and water sources. | 1 and 2. Concerns were raised at targeted consultation and public exhibition that allowances needed to be made where environmental flows could be suspended in times of emergencies. For example when an algal bloom is occurring downstream. 3 and 4. These rules allow for environmental water to be accounted for when it is not possible for the actual release to be undertaken at a specific time. |
| (Upper Nepean Upstream) | The LTAAEL established for the SCA in the Upper Nepean Upstream | Updated figures were provided by SCA. |

| Management Zone | Change to water sharing rules | Justification |
|---|---|---|
| Warragamba EMU) | Warragamba EMU was amended to be 581, 000 ML/year | |
| (Southern Sydney Rivers EMU) | The LTAAEL established for the SCA in the Southern Sydney Rivers EMU was amended to be 13, 000 ML/year | Updated figures were provided by SCA. |
| All plan area | Clause 21 (10) was amended to say that, 'the balance of water in an environmental contingency allowance account referred to in subclause (8) shall be...' | The clause previously referred to Clause 21 (1) (q) which is incorrect and an error by NOW. |
| All plan area | The word 'estimated' was removed from clause 40 (5) which now states, "The Minister may amend the LTAAEL specified in subclause (2) (b) to account for a growth in use by Sydney Water Corporation to a limit of 5% of [estimated] average annual usage". | 'Estimated' was removed to prevent, for example, if SWC over estimated their usage and therefore had a growth allowance of 5% based on the estimated usage and not their actual usage which would provide them with more water than intended. |
| Upper Hawkesbury River | NOW amended the very low flow class provisions for the Hawkesbury River MZ such that where the sum of flows at the FRPs exceeds the sum of EFPR volumes for the FRPs, then pumping may commence | Rather than the rule at public exhibition which was interpreted as flows at each and every respective FRP having to exceed the EFPR volumes for the FRP. |
| All plan area | Clause 74 (17) of the Plan was amended to give reference to sub clauses 50 (8) and (9) and not 50 (7) as originally stated. | This was a typographical error by NOW. |
| Jenolan River | Clause 76 (4) (b) was amended as it spoke of the hydrological catchment of the Jenolan River at or above the Pheasants Nest Creek confluence. | This clause was incorrect and should not have been the Pheasants Nest Creek. |
| Pheasants Nest Weir to Nepean Dam | Clause 21 (1) (k) and 21 (1) (l) were amended to state that the amount released from Pheasants Nest Weir and Broughtons Pass Weir is the 80 th percentile and not a set amount as originally stated. | Hydrology modelling of inflows conducted by the NSW Government during the term of the plan may lead to a revision of initial volume estimates of percentile inflows. |
| Wywandly | Clause 81 (1) was amended to begin with the phrase, 'when Lake Lyell is spilling at a rate that equals or exceeds the releases required by this condition.' | Environmental releases shall only be suspended where spills are equal to or greater than required environmental releases rather than from when a spill first occurs. This shall ensure that all environmental components of inflows are released from the dam. |
| Wywandly | Clause 81 (4) was amended to include a clause that the releases are not needed from the Dam when Lake Wallace is spilling and blow down is occurring | As above. |
| Wywandly | Clause 81 (8) was amended so that releases could also be suspended from Lake Wallace and Lyell due to emergencies. | This is consistent with other dams across the Greater Metropolitan Region. |
| Lower Nepean River and Upper Hawkesbury River | Access rules have been established so that when a 'water shortage' is triggered there may be limited access to the very low flows during this period. A water shortage will be signalled when a 24 hour forecast temperature above or below a predefined temperature occurs in conjunction with the amount of previous day spent on an EFPR (for specific conditions see plan or background document). Once a water shortage is signalled it will stay in place for 3 days irrespective of the pumping conditions and temperature. Although extraction of very low flows is not limited, where metered water usage shows that extraction exceeds 105 ML/day, the Minister may introduce TDELS and IDELS. | It is important to note that all of the rules allowing limited access to very low flows are only relevant for specific management zones in the Greater Metropolitan Region because of their unique and specific management issues. Flows in the Upper Hawkesbury River management zone have been augmented by artificial releases of highly treated water from St Mary's Water Recycling Plant and by transfers from Warragamba Dam to the Hawkesbury River for town water supply requirements at North Richmond for many years. Augmentation to this extent is unique to the Hawkesbury-Nepean and has led to the development of a large irrigated agriculture industry historically reliant on this supply of water. The socio-economic value of maintaining a viable local irrigated agricultural industry specifically |

| Management Zone | Change to water sharing rules | Justification |
|---|---|--|
| Lower Nepean River and Upper Hawkesbury River | <p>The plan also allows concessions for access to very low flows for the following situations:</p> <ul style="list-style-type: none"> new plantings of all crops, for a period of 30 days after planting provided that the volume of water taken does not exceed 15 kL/ha per day of those plantings herbicide application to turf provided that the herbicide application on to turf is required under a contract and provided that the volume of water taken does not exceed the minimum volume specified in the herbicide product guideline vegetable and turf washing and misting provided that the volume of water taken does not exceed 20 kL/day per access licence to water turf during the 5 day period prior to harvest provided that the harvest date is required under contract and for wetting the cutting face of turf provided that the volume of water taken does not exceed 15 kL/ha per day of that turf. | <p>able to deliver fresh produce to daily markets in a timely and efficient manner (and with minimal carbon footprint) is a significant issue for a population of over four million people.</p> <p>This agricultural industry also supplies much of Sydney's turf requirements. Some of this is provided under strict contractual arrangements relating to growth, quality and timeliness where alternate arrangements are not possible (including significant venues and events such as Olympic Park, the Sydney Cricket Ground, horse racing venues or other events of significant social/cultural value).</p> <p>The irrigated agriculture industry is also typified by having constrained small lot sizes on flat land. This further limits the possibilities for adapting to reduced access conditions by employing alternate management techniques such as harvesting overland flows or capturing and storing high flows in hillside dams.</p> |
| Lower Nepean River and Upper Hawkesbury River | <p>The rules for survival watering will be included in the plan until after year five. The access to survival water will be removed after five years where hydrologic modelling shows that the access is not necessary for the ongoing viability of the irrigation industries in the Lower Nepean and Upper Hawkesbury Rivers.</p> <p>The modelling would be undertaken is part of the mandatory five year review of the plan and would align with the review of water shortage access rules for the Upper Hawkesbury River.</p> | <p>It is anticipated that further information on irrigators' actual water usage would be available at that time and will assist with the reviews.</p> |
| Lower Nepean River and Upper Hawkesbury River | <p>When the St Mary's Water Recycling Plant is releasing 43.3 ML/day, the share of the released for the environment shall be increased to reflect the demonstrable savings from the Hawkesbury Nepean River Recovery Programme. Based on current estimate, then share of the released would be 36.2 ML/day rather than the original share of 33.3 ML/day. Where the releases from the plant are greater than 43.3 ML/day, the balance over and above the adjusted share shall be available for irrigation purposes, that is, it is not explicitly assigned to the environment. The share of releases between the environment and irrigation shall vary in accordance with inflows to the upper Nepean River dams.</p> | <p>Under the Hawkesbury Nepean River Recovery Project Sydney Water has an obligation to deliver 2.9 ML of water savings via its Recycling Water Plant at St Mary's. These access rules will achieve this obligation.</p> <p>The arrangement to vary the share of the release introduces some variability to the environmental share of originally fixed releases from the recycling plant in accordance with natural inflows to dams and allows greater access to the releases for irrigation purposes during high demand periods when inflows are expected to be low.</p> |
| Wingecarribee River, Lower Kangaroo River, Wollondilly River and Lower Shoalhaven River | <p>Environmental flows shall be developed for dams and weirs owned by Goulburn Mulwaree Council, Shoalhaven City Council and Wingecarribee Shire Council over the term of the plan as follows: Stage 1 will be feasibility and suitability from years 1 – 5 of the plan. Stage 2 will be design and decision on am implementation date from years 6 – 7 of the plan. Stage 3 is where any necessary infrastructure modifications are made to deliver the flows; this will be from year 8 onwards.</p> | <p>This process ensures that the necessary action is taken to protect the environment downstream of the works and to make the process more transparent.</p> |
| Lower Shoalhaven River | <p>Licences in this management zone will need to cease pumping when flows at the gauge Grassy Gully No 2 are at or below 69 ML/day (95th)</p> | <p>Public exhibition showed that the previous rule relied on tributary inflows being able to meet demands of licences below the dam. This is not the</p> |

| Management Zone | Change to water sharing rules | Justification |
|-------------------------|--|---|
| | percentile). | case as so a new EFPR was introduced. |
| Mid Nepean River | Trading between weirs on the Nepean River is permitted in a downstream direction and only in an upstream direction if the trade will result in no net gain for the relevant management zone. | There was concern that trading was too limited and so NOW investigated the possibilities of allowing trade to become freer within the management zones of the weirs. |
| All plan area | The plan now states that the rolling average for a growth in use response to the LTAAEL is calculated on a five year rolling average and not three. | During public exhibition, concern was raised that a three year average does not reflect climatic and seasonal variability. As a result given the climatic variability of the GMR and considering the risk of a false positive growth-in-use response relative to the risk of delayed reaction to true growth, a 5 year rolling average was deemed appropriate. |
| All plan area | BLR figures were updated | Due to revised data being available. |
| Lower Nepean River | A provision was included in the plan that provides for the Minister to determine that a 200 ML EFPR may apply where drought is declared and Penrith Lakes is being filled. | |
| All plan area | Provisions were included in mandatory conditions requiring SCA to make public notifications of environmental releases, bulk water transfers and other releases to be made over the next 24 hours for all dams. | Several submissions at public exhibition requested that SCA make publically available the data/records that are collected from flow reference points in the water sharing plan. |
| Wywandy and Dharabuladh | Delta Electricity's licence was included in Schedule 2 of the plan | This Schedule lists licences that have access to very low flows. Cl. 63 (2) of the plan states that, 'during times of very low flows, holders of major utility access licences specified in Schedule 2 may continue to access water subject to any other conditions on the access licence. Delta has a major utility access licence and therefore is included to be in Schedule 2. |
| Lake Burragorang | A provision was included for amendment of dilution releases from Warragamba Dam following government decision on final environmental flows from Warragamba Dam. | A final decision has not yet been reached and so the plan allows for these decisions to be included in the future. |
| All Plan area | The vision statement in the plan was developed in regards to Aboriginal people and their connection with water and land as follows: Part 2 (9) (2) (a) and (b) 'This Plan was developed with the recognition that the sharing of waters in these water sources contributes to: (a) Aboriginal peoples pursuing their economic, social and cultural development, and maintaining and strengthening their spiritual and customary relationship to the water; and (b) the involvement of Aboriginal peoples in the conservation, protection and management of these water sources.' | This statement was included due to feedback at consultation. |
| All Plan area | Amendment provisions were added to the plan to allow for changes to be made during the life of the Plan to account for water savings due to the Hawkesbury Nepean River Recovery Programme. | The Commonwealth of Australia in partnership with the NSW Government has funded the \$77.4 million Hawkesbury – Nepean River Recovery Project. The project seeks to improve the health of the Hawkesbury – Nepean River below the major water supply dams by in part increasing the water available for environmental flows in the river. The amendments in the plan allow for the increases in water available for the environment to be |

| Management Zone | Change to water sharing rules | Justification |
|--|---|---|
| Mid Nepean River | <p>Access rules have been established so that when a 'water shortage' is triggered there may be limited access to the very low flows during this period. A water shortage will be signalled when a 24 hour forecast temperature above or below a predefined temperature occurs in conjunction with the amount of previous day spent on an EFPR (for specific conditions see plan or background document).</p> <p>Once a water shortage is signalled it will stay in place for 3 days irrespective of the pumping conditions and temperature.</p> <p>Repayment of access to very low flows is not required at this stage. Although extraction of very low flows is not limited, where metered water usage shows that extraction exceeds 41 ML/day, the Minister may introduce TDELS and IDELS.</p> | <p>delivered through the water sharing plan.</p> <p>See justification for the same access rules in the upper Hawkesbury River.</p> |
| Upper Wollondilly River | <p>An EFPR has been put in place to protect town water supply transfers made by Goulburn Mulwaree Shire Council.</p> | <p>Town water supply has a higher priority of access than regular access licences and so this water is protected.</p> |
| Lake Burragorang, Lower Hawkesbury River | <p>The dealing rules were amended to allow trading into the Lake Burragorang and Lower Hawkesbury River Management Zones if the dealing involves as assignment of access rights into these management zones for the purpose of establishing in that management zone a new or an existing right with new or expanded adaptive environmental conditions.</p> | <p>To facilitate the transfer of purchased licences in the name of the Water Administration Ministerial Corporation, the plan ought to exempt the transfer of licences for the purpose of establishing a new or an existing licence with new or expanded adaptive environmental conditions.</p> |
| Lower Nepean River and Upper Hawkesbury River Management Zones | <p>Trades are permitted from the upper Hawkesbury River management zones into the Lower Nepean River Management Zone so long as the total licensed share in the latter zone does not exceed 3.65 GL. Trades from the Lower Nepean River Management Zone into the upper Hawkesbury River management zones are permitted so long as the total licensed share in the latter zones does not exceed the total licensed share at the date of the commencement of the plan.</p> | <p>A careful analysis of the reach of the river between Warragamba Dam and Yarramundi indicates that under the new plan rules and all climatic conditions there is an excess of flows above the EFPR by more than 20ML/d. A small amount of trade into this reach could therefore be justified of up to 10ML/d (3.65GL/yr), thus still providing some conservatism in the estimate of flows above the EFPR.</p> |

Appendix 13. Summary of the field verification studies

The 2008 field verification report

DWE 2008 (Draft) *Kangaroo River Field Verification*. Unpublished report, Department of Water and Energy, Wollongong.

Abstract

The water resource allocation in the Kangaroo River has the potential to impact on the low flow requirements of aquatic ecosystems in this catchment. The estimated peak daily demand greatly exceeds the 95th flow percentile and almost equals the 80th flow percentile, and as such, providing minimum environmental flow rules is necessary to maintain fundamental ecosystem health. In 2003 the Southern Water Management Committee developed a Water Sharing Plan for the Kangaroo River, which attempted to provide water for the environment, by setting water access rules.

The Plan rules can be varied by the Minister following a field verification. In the Kangaroo River, the plan states that the variation of the Cease-to-pump (CTP) level should not result in the very low flow level being less than 4 Mld⁻¹ or being greater than 7 Mld⁻¹. The purpose of this report is to provide comment as to whether the Plan rules satisfy the statutory objectives of the Kangaroo River Water Sharing Plan as stated in s75.

In determining suitable minimum environmental flows of the Kangaroo River, an assessment was carried out consisting of field observations, photographs and spot gauging of very low flows throughout the catchment, over two periods in 2002 and 2003. Hydraulic modelling of velocity microhabitats was also undertaken and involved research in defining the relationships between macroinvertebrates and riffle microhabitats. Additionally, the available water quality data was investigated to assess relationships with river discharge.

Hydrological assessment of very low flows

The very low flow gauging undertaken in October 2002 indicated that at a flow of 7.5 Mld⁻¹ at Hampden Bridge, flows of approximately 5 Mld⁻¹ occurred in each of the main tributaries (Brogers Creek, Upper Kangaroo River, Barrengarry Creek). This suggests that approximately 7 Mld⁻¹ of abstraction was occurring between the gauging sites and the Hampden Bridge gauge.

The low flow gauging study indicated a high degree of consistency in baseflow yields of 0.05±0.01 Mld⁻¹/km² (mean±SD) for six catchments that ranged in size from 3 - 116 km² and were probably relatively unaffected by abstraction. Baseflow yields in catchments ranging in size from 7 – 336 km² that are probably affected by abstraction were considerably lower, ranging from 0.014 – 0.022 Mld⁻¹/km².

Low flow field observations undertaken in February 2003 indicate that at a flow of 2 Mld⁻¹ at Hampden Bridge, higher flow rates of approximately 4 Mld⁻¹ were observed in the Upper Kangaroo River. At a flow of 2 Mld⁻¹ at the Hampden

Bridge Gauge, field observations indicated that Riffle 2 had ceased to flow and could no longer be considered as providing riffle surface water habitat. Riffle 1, which has some outcropping bedrock in its floor, did maintain surface water flow at this very low flow rate. However, the reduction in velocity between flow rates of 8 Mld^{-1} and 2 Mld^{-1} was evident in field observations through changes in the pattern of surface flow characteristics (ie. a reduction in hydraulic microhabitats).

Hydraulic assessment of velocity microhabitats

Recent work by Brooks *et al.* (2005) indicates that macroinvertebrate assemblages are related to the distribution of different velocity classes or microhabitats (zones) within riffles. That is, different types of “bugs” were found in each velocity class. In Riffle 1, the fastest velocity class (ie. class 3) was not present below 25 Mld^{-1} . At flows of 1 Mld^{-1} there was only one velocity microhabitat present, the slowest velocity class 1. At a flow of 5.4 Mld^{-1} , classes 1 and 2 were present in Riffle 1. However, velocity class 2 formed only 0.2% of the total riffle area. Increasing flow to 8 Mld^{-1} increased the area of velocity class 2 microhabitat by 2.75 times. An increase to 10 Mld^{-1} expands the area of this microhabitat by 5 times.

Based on the work by Brooks *et al.* (2005), increasing the area of velocity class 2 microhabitat via a higher cease-to-pump (CTP) level would increase the level of habitat protection for a more diverse range of invertebrates.

Water quality

A significant negative relationship between river discharge and electrical conductivity, alkalinity and sodium were recorded for the period 1977 to 2007. That is during low flow periods these variables typically recorded their highest levels. These results indicate a greater contribution of groundwater to the system than surface water during low flow periods.

No clear threshold step change below 10 Mld^{-1} were recorded with the manual samples, as very few samples were collected during these dry periods, but for the continuous electrical conductivity data there appears to be a small increase in conductivity below 10 Mld^{-1} . At this stage these electrical conductivity results by themselves are not conclusive for setting low flow environmental water rules, but they possibly indicate a greater contribution of groundwater and provide some additional supporting evidence for assessing the drying of these riffles habitats.

Fish passage

The HEC-GeoRAS hydraulic modelling indicates that the CTP limit does not provide sufficient depth for Macquarie Perch passage through Riffle 1. Flow rates of 25 Mld^{-1} and 170 Mld^{-1} are required to provide a continuous path with minimum threshold depths of 0.12 m and 0.25 m, respectively, through the riffle. Given the regular frequency of discharge events, the use of the CTP to set fish passage rules for Macquarie Perch rules is not appropriate, and other mechanisms in the plan should be applied to achieve the fish passage objective.

Recommendation

Raising the CTP from 1 Mld⁻¹ to the new CTP level (5.4 Mld-1) has provided a number of benefits and provides an increased level of low flow protection. However, raising the CTP from 5.4 Mld⁻¹ provides additional benefits, including a greater protection of running water habitats and the dependent biota. A higher CTP should be considered by Government but further assessment of socio-economic impacts of any alterations to CTP limits is required for an informed recommendation on environmental water requirements and water user needs.

Addendum to the field verification report 2014

NOW 2014 *Field verification addendum*. Unpublished report to South Coast Interagency Regional Panel, July 2014, Department of Primary Industries, NSW Office of Water, Wollongong.

With the remake of the Water Sharing Plan for the Kangaroo River water source scheduled for 2014, the Draft version of the Kangaroo River Field Verification Report (DWE 2008) was handed to the Interagency Regional Panel (IRP) for consideration. It was emphasised that the report was a draft and had not undergone the rigour of review as prescribed in the soon to be replaced WSP, but was the most recent assessment of environmental flow requirements for the Kangaroo River available.

Following consideration by the IRP, several comments were forwarded to the Plan Ecological Performance unit.

The primary comments were:

- The recommendations as worded were ambiguous.
- The benefits of creating more area of velocity class 2 in riffles were not sufficiently clear. A request was made to quantify the area of extra velocity class 2 in terms of actual area rather than percentage area⁷.
- The ecological benefits of having more velocity class 2 were insufficiently clear.
- An addendum document is to be prepared to address the issues raised by the IRP.

Recommendations

After consideration of the evidence provided by the original environmental water discussion paper, the draft field verification study and the additional analysis provided by this addendum report, it is evident that a minimum of 10 ML/d is likely required to improve fundamental ecosystem health. However, as there is a small level of uncertainty surrounding the difference between modelled and observed velocities at this time, it is considered prudent to keep to the original recommendation of 7 ML/d. There is no evidence to suggest a CtP of less than 7 ML/d would maintain or improve fundamental ecosystem health in the long term.

Given that further investigations are currently in progress, it would be appropriate for the WSP to contain an amendment provision allowing for an increase in the CtP to 10 ML/d should the results confirm the validity of the velocity modelling technique in the determination of environmental flow requirements.

The Plan Ecological Performance unit therefore recommends that a CtP of at least 7 ML/d be included in the new WSP for the Kangaroo River Water Source, with an amending provision for an increase to 10 ML/d subject to completion of further studies.

7. Please refer to page vii of the draft field verification report for an account of the ecological significance of velocity classes.

This recommendation has been made on the basis of ecological considerations only and factors other than these have not been taken into account.

Appendix 14. Summary of the socio-economic studies

The 2012 socio-economic study

Flavel N., Singh I. and Bari M. 2012, *Kangaroo River Water Sharing Plan - Socio-economic assessment of changes to the flow rules*, NSW Department of Primary Industries, Office of Water, Sydney

This study was undertaken to provide estimates of socio-economic impacts of recommended changes to the flow rules for the Kangaroo River Water Sharing Plan (WSP). It identifies and assesses the socio-economic impacts of the recommendations of the field verification report (DWE, 2008).

The ecological field verification of the Kangaroo River WSP has recommended that in order to maintain 'fundamental ecosystem health' the very low flow cease to pump (CTP) condition should be raised from a flow of 5.4 ML/d to 7 ML/d at Hampden Bridge.

The analysis suggests that increasing the CTP level to 7 ML/d would not have significant economic impacts for the irrigators, a potential production loss of 0.61% per year. If the total irrigated area in Kangaroo River was to return to 909 ha, the annual average gross value of irrigated production lost is estimated to be \$30,060 per year. This could be expressed as \$33 per hectare of irrigated crops or \$350 per irrigation licence holder per year.

The average annual impacts presented above are based on the assumption that CTP events are evenly distributed over the years. However, in reality some years would be unaffected whereas others may register longer duration CTP events and or multiple additional CTP events. The economic impacts during the less affected years will be minimal while the impacts in the affected years would be higher than the averages presented here.

Supplementary socio-economic analysis 2014

Flavel N, Singh I and Spruyt D 2014, *Supplementary socio-economic impacts analysis of cease to pump – proposed Kangaroo River water sharing plan remake*. NSW Department of Trade and Investment, Regional Infrastructure and Services, October 2014.

This supplementary study estimates socio-economic impacts of changes to the flow rules for the replacement of the Kangaroo River Water Sharing Plan (WSP). To maintain 'fundamental ecosystem health', the draft Kangaroo River Field Verification of the WSP (DWE, 2008) recommended that the very low flow Cease To Pump (CTP) condition should be raised from a flow of 5.4 ML/d to 7 ML/d at Hampden Bridge. The ensuing socio-economic assessment report (Flavel *et al.* 2010) found that this change in CTP conditions would not have a significant economic impact on water users. The recommendation to change the CTP condition was not implemented during the life of the 2004 WSP.

This supplementary report documents likely socio-economic impacts in response to requests from :

- irrigators to estimate quantity of production from the high production irrigated pastures and crops and the current cost of alternative feed, and
- water planners to extend the sensitivity of the socio economic impacts of the cease to pump and the commence to pump beyond that recommended by the ecological field verification.

Two options were examined:

- Option 1: Impacts assessment of the CTP change from 5.4 to 7 ML/d, and
- Option 2: Impacts assessment of the CTP changes from 5.4 to 10 ML/d.

In addition, under each option, the economic impacts analysis considered two scenarios:

- Scenario 1: The Full Activation of Licensed Entitlement Scenario based on the full activation of the total issued entitlements in the WSP, and
- Scenario 2: The Current Activation of Licensed Entitlement Scenario based on a 25 per cent level of activation of the Full Activation of Licensed Entitlement Scenario. This more closely represents the present level of licence activation.

This supplementary report uses the instantaneous gauge reading at 8 am each day, whereas the previous report (Flavel *et al* 2010) used the mean daily reading.

The analysis of Option 1, assessment of increasing the CTP level to 7 ML/d, estimates a potential gross value of irrigated production loss of 1.9 per cent per year. This is less than the 5 per cent change in average annual gross value of irrigation production threshold and would not have significant economic impacts for the irrigators.

Under Option 1 Scenario 1, full use of licensed entitlement, 909 ha, the annual average gross value of regional irrigated production lost is estimated to be \$128,230 per year (1.9 per cent). Under Option 1 Scenario 2, current activation of licensed entitlement, 227 ha, the annual average gross value of regional irrigated production lost is estimated to be \$32,050 (1.9 per cent).

The analysis of Option 2, assessment of increasing the CTP level to 10 ML/d, estimates a potential gross value of irrigated production loss of 5.0 per cent per year. This equals the 5 per cent change in average annual gross value of irrigation production threshold and may have significant economic impacts for the irrigators.

Under Option 2 Scenario 1, full use of licensed entitlement, the annual average gross value of regional irrigated production lost is estimated to be \$342,260 per year (5.0 per cent). Under Option 2 Scenario 2, current activation of licensed entitlement, 227 ha, the annual average gross value of regional irrigated production lost is estimated to be \$85,560 (5.0 per cent).

It is expected that full activation of licences, (Scenario 1), would increase the frequency and/or length of CTP events as the volume of water extracted would increase and the CTP trigger Supplementary socio-economic impacts analysis of cease to pump – proposed Kangaroo River water sharing plan replacement would be activated earlier. The consequent economic impacts would therefore be greater. To understand the extent of such changes would require significant hydrological modelling that was beyond the scope and resources of this assessment. The Scenario 1 results (assuming extraction 4 times current levels) are acknowledged as an underestimate of the likely actual impacts. The analysis of Scenario 2, where extraction is consistent with the river gauge readings used in the analysis and thus the timing and duration of CTP events, provides an accurate estimate of likely impacts.

In addition, the report provides sensitivity analysis for the key assumptions in the analysis. A comparison between the base case and sensitivity analyses indicates that the results do not differ substantially.

The average annual impacts to irrigators assume that CTP events are evenly distributed over the time. In reality, however, some years would be unaffected, whereas others may register longer duration CTP events and / or multiple additional CTP events. The economic impacts during the less affected years will be zero or minimal, while the impacts in the affected years could be higher than the averages presented here.