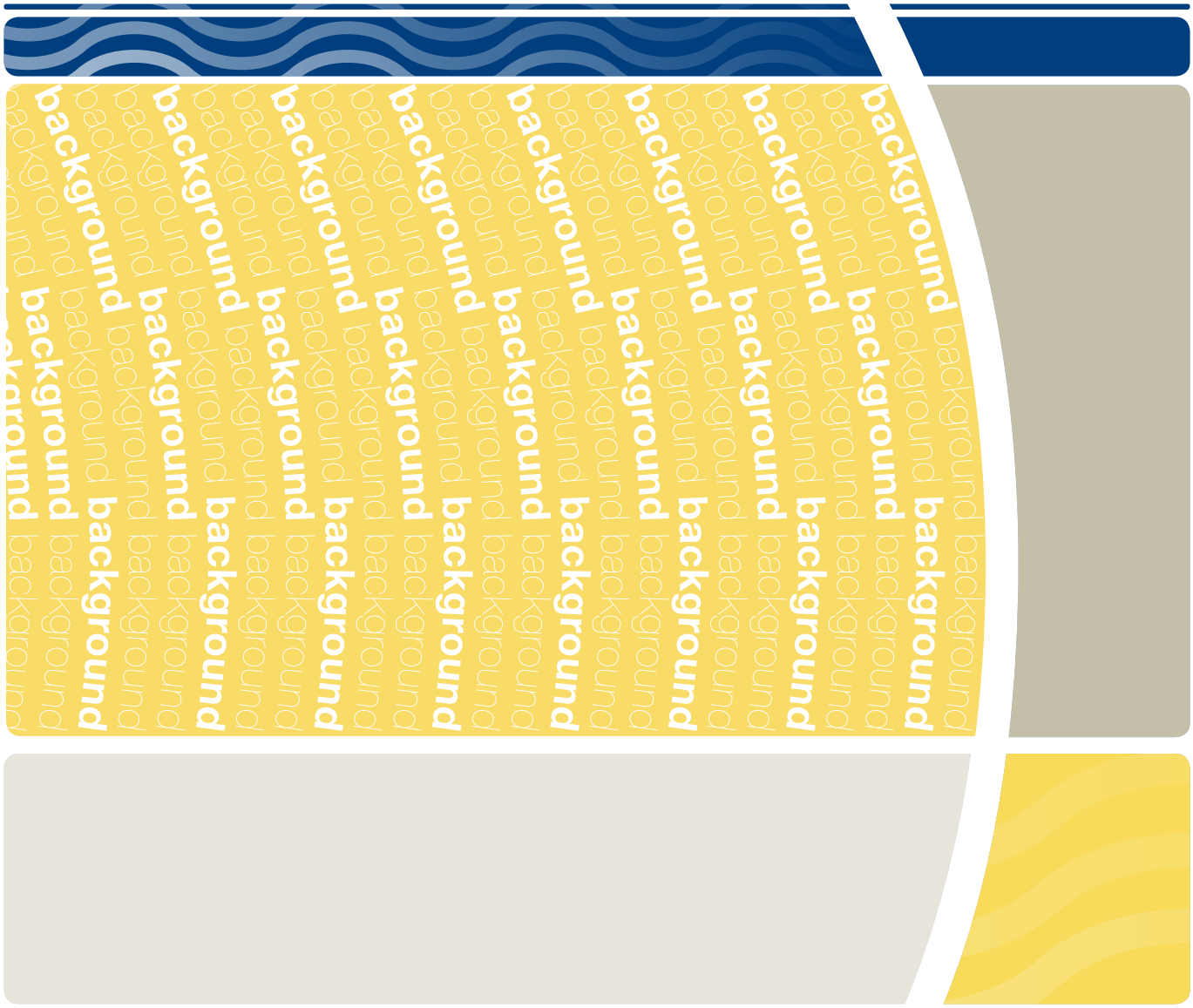
NSW GOVERNMENT | Office of Water

Water Sharing Plan
Greater Metropolitan Region Groundwater Sources
Background document



Leading policy and reform in sustainable water management

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The NSW Office of Water manages the policy and regulatory frameworks for the State's surface water and groundwater resources to provide a secure and sustainable water supply for all users. The Office of Water also supports water utilities in the provision of water and sewerage services throughout New South Wales.

Water Sharing Plan for the Greater Metropolitan Region
Groundwater Sources – Background document

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Introduction

Water sharing plans are being progressively developed for rivers and groundwater systems across NSW 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. In July 2004, 31 water sharing plans commenced in NSW, bringing these water sources and some 80 per cent of water extracted in the state under the management and licensing provisions of the WMA 2000.

In recent years, water sharing plans for unregulated[1] rivers and groundwater systems have been completed using a 'macro' or broader-scale river catchment or aquifer system approach. Approximately 95 per cent of the water extracted in NSW is now covered by the WMA 2000. The macro planning process is designed to develop water sharing plans covering most of the remaining water sources across NSW. Each macro plan covers a large river basin rather than a single sub-catchment, or in the case of groundwater systems, covers a particular type of aquifer (e.g. fractured rock) within that river basin. These macro plans will generally apply to catchments or aquifers where there is less intensive water use compared with the areas that were covered by plans in 2004.

The *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (the plan) covers 13 groundwater sources.

Water sharing provisions that the plan focuses on are:

- environmental water provisions – the share of the water reserved for the environment
- the long-term average extraction limit for each water source
- access, dealing (trade) and work[2] approvals rules.

In developing the plan other water management tools are applied, including:

- growth-in-use assessment and management tools
- available water determinations – for allocating water to access licence water accounts
- water allocation account management rules
- management of surface and groundwater connectivity rules
- rules for granting access licences – the types of licences that may be granted
- rules for granting new and amending existing works, such as the types of set back conditions that are required
- mandatory conditions on access licences and water supply works approvals
- system operation rules.

This document provides background to the development of the rules in the plan and includes:

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

[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.
[2] For groundwater, these work approvals are usually for bores.

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

- the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* – a legal instrument written in its required statutory format
- a guide to the plan – a plain English version of the plan explaining the key sections and rules
- rule summary sheets for each groundwater source detailing the management rules.

In addition, general information is also available on the macro planning process including:

- *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 NSW
- The *Macro Approach for Groundwater Water Sharing Plans* – explains the method used to develop water sharing rules for groundwater systems across NSW
- *Guidelines for groundwater sharing plan report cards* – explains the information presented in report cards
- *Setting the water sharing rules* – a one page brochure which outlines the key steps for developing the rules.

Purpose of the plan

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.

Water sharing plans provide a legislative basis for sharing water between the environment and consumptive purposes. Under the WMA 2000, a plan for the sharing of water must protect each water source and its dependent ecosystems and must protect basic landholder rights. For groundwater, basic landholder rights referred to in the plan are domestic and stock rights as defined in section 52 of the WMA[3]. Sharing or extraction of water under any other right must not prejudice these rights. Therefore, licensed water users are effectively the next priority for water sharing. Among 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 also recognise the economic benefits that commercial users such as irrigation and industry can bring to a region. On commencement, 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.

In conjunction with other provisions of the WMA 2000, water sharing plans set rules so that commercial users can continue to operate productively. In general, commercial licences under the WMA 2000 are granted in perpetuity, providing greater commercial security of water access entitlements. Water sharing plans also define the access rules for commercial users for 10 years providing all users with greater certainty regarding sharing arrangements[4].

Benefits for water users

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

- greater certainty – the plan sets out the water sharing arrangements for a 10 year period
- clear trading (dealing) and access rules that will help foster trading
- automatic conversion of licences in the plan area to perpetual water access licences providing greater security – 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.

[3] Section 55 of the WMA 2000 also allows for native title holders to take and use water in the exercise of native title rights. At the time the draft plan was completed there were no native title rights to water held in the plan area.

[4] Security versus reliability. These terms are used differently across different jurisdictions, often interchangeably. The National Water Commission encourages the adoption of nationally consistent terminology based on the National Water Initiative. The definitions in the glossary relate to NWI-consistent use of these terms. In summary, security provides better tenure for an entitlement and does not necessarily provide greater reliability as this is determined by seasonal and climatic conditions.

Environmental considerations

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

Most of the groundwater within the area covered by the plan is protected from extraction. The total volume of water licensed for extraction in each water source is generally much less in comparison to their average annual recharge.

The plan also imposes new restrictions on access that may be applied to specific areas that need protection or to manage groundwater surface water connectivity. Distance criteria are also used for any new water supply works (e.g. bores / spear points) that results in exclusion zones around any groundwater dependent ecosystems (GDEs) that require protection from extraction.

Description of the plan area

The Greater Metropolitan Region groundwater sources are located on the east coast of NSW, covering an area of approximately 32,500 square kilometres, from Broken Bay in the north, to Shoalhaven Heads in the south, and Lithgow and Goulburn to the west. The region is bounded by the Hawkesbury River catchment to the north and west and the Shoalhaven River catchment to the south and south-west. The region also includes the groundwater of the Illawarra and metropolitan Sydney. Appendix 1 includes a map of the area covered by the plan, showing each of the 13 groundwater sources. Each of these is described below.

Fractured rock groundwater sources

The **Goulburn Fractured Rock Groundwater Source** is bounded to the north by the Murruin Range, the Pacific Ocean and rocks of the Sydney Basin to the east, and Great Dividing Range in the south and west. The groundwater source covers an area of 8,175.31 square kilometres, and rock types are a mixture of Palaeozoic rocks which are mainly volcanic in origin. Most of the groundwater found within these rocks is suitable for some domestic, agricultural and limited industrial uses. High salinity groundwater does underlie some areas near Goulburn. Although groundwater may be in supply, the water quality may limit potential uses. Bore distribution is well spread out, but there is some concentration around major townships like Goulburn.

The **Coxs River Fractured Rock Groundwater Source** covers an area of 1,700.46 square kilometres and is bounded by the Murruin Range to the south, sedimentary rocks associated with the Sydney Basin to the east, the Great Dividing Range to the west and extends north to the township of Wallerawang. Rock types associated with this groundwater source are similar to that of the Goulburn Fractured Rock Groundwater Source and water quality between the two is also similar.

Porous rock groundwater sources

The Sydney Basin is an asymmetrical structural basin which has its centre around Fairfield and extends from Port Stephens in the north to Bateman's Bay in the south. It has been split into six separate groundwater sources in the plan. Within this basin bore depths are variable, ranging from 20 to 200 metres with most bores less than 60 metres deep. Groundwater quality, in particular salinity in several areas, may limit its potential uses.

The **Sydney Basin South Groundwater Source** is bounded by the Illawarra Range to the north, the Turpentine Range to the south and east, and the geological boundary of the Goulburn Fractured Rock to the west. This groundwater source has a total area of 3,034.83 square kilometres, and bore distribution is mainly limited to the northern half of this area with national parks covering much of the southern part.

The **Sydney Basin Richmond Groundwater Source** is bounded by the main arm of the Grose River to the south, Blue Mountains Range to the south-west, Wolgan River to the north-west, Colo River to the north and Hawkesbury River to the east. Much of this groundwater source is covered by national parks with bore distribution constrained to the eastern area of Kurrajong and Grose Vale. It covers an area of 1,978.39 square kilometres.

The **Sydney Basin North Groundwater Source** is bounded by the main arm of the Colo and Hawkesbury River to the south, Kulnura – Mangrove Mountain Groundwater Sources to the east, the Hunter Range to the north and Great Dividing Range to the west. As much of this groundwater source is covered by national park, the bore distribution is more concentrated in the western and northern areas. This groundwater source covers an area of 5,226.18 square kilometres.

The **Sydney Basin Nepean Groundwater Source** is bounded by Lake Burragorang to the north, Nepean River and Cataract River to the east, and the Illawarra Range to the south. It covers an area of 3,857.47 square kilometres. National parks cover much of the north-western portion of this groundwater source and the bore distribution is concentrated to the north-east around Camden and south-western areas of Moss Vale. The geology consists of sedimentary sandstone amid siltstone formations with intervening coal seams. In May 2004, December 2005 and June 2007 parts of this groundwater source were embargoed under the WA 1912 to prevent new commercial licences. The groundwater source is divided into two management zones, one zone covering the current embargoed areas and the other covering the non-embargoed areas, to facilitate management of extraction. The management zones are the Nepean Management Zone 1 (current embargoed areas) and Nepean Management Zone 2 (non-embargoed areas).

The **Sydney Basin Coxs River Groundwater Source** has a geological boundary to the west where it comes into contact with the Coxs River Fractured Rock. The eastern boundary is marked by the Blue Mountains Range. Bores are fairly evenly distributed across the groundwater source which covers an area of 528.95 square kilometres. The geology consists of sedimentary sandstone and siltstone formations with intervening coal seams.

The **Sydney Central Basin Groundwater Source** is bounded by the main arm of the Hawkesbury River to the north and by the Nepean River to the west and south. Much of Sydney's population is within this groundwater source (with a total area of 3, 757.59 square kilometres), and bores are evenly distributed across the area. The geology consists of sedimentary sandstone and siltstone formations with intervening coal seams.

The **Sydney Basin Blue Mountains Groundwater Source** is bounded by the main arm of the Grose River to the north, Blue Mountains ridge line to the west, Lake Burragorang to the south and the Nepean River to the east. With such a large proportion of this groundwater source covered by national parks, bore distribution is concentrated through the central area associated with the towns of Leura, Katoomba and Wentworth. The geology is sedimentary sandstone and siltstone formations with intervening coal seams. The total area of this groundwater source is 1,139.16 square kilometres.

In February 2007 the Blue Mountains Sandstone Groundwater Management Area was embargoed under section 113A of the WA 1912 to prevent new commercial licences. Existing domestic bores on properties on reticulated water supply in the Blue Mountains City Council Local Government Area within this groundwater source were also restricted by orders under section 324 (2)[5] of the WMA 2000. These orders applied from June 2007 until December 2009 and were equivalent to Sydney Water's level 1 mandatory reticulated water supply restrictions. This was done to limit the impact of bore pumping on groundwater dependent ecosystems, such as hanging swamps.

Coastal sands, tertiary sands and alluvial groundwater sources

The **Metropolitan Coastal Sands Groundwater Source** consists of aeolian and alluvial quaternary sand deposits along the coast, extending from the Hawkesbury River in the north to Crookhaven River in the south, excluding the area covered by the Botany Sands Groundwater Source (described below). The area of the Metropolitan Coastal Sands Groundwater Source is 165.69 square kilometres, and the sand deposits are typically small, isolated beach deposits. The largest of these coastal sand deposits is situated along the Shoalhaven River where it meets the Tasman Sea and extends north along Seven Mile Beach. With relatively high rainfall infiltration rates and relatively insoluble nature of sands, the groundwater is typically of good quality. Groundwater extraction is largely associated with shallow (<6 metre depth) domestic spear points, along with a few larger high-yielding works that draw water for recreational purposes.

[5] Earlier orders were made under section 323 of the WMA. The WMA was amended in 2008 and the section number changed for temporary water restrictions orders.

The **Maroota Tertiary Sands Groundwater Source** covers an area of 4.38 square kilometres. Water bearing zones occur within tertiary sands deposits across the Maroota plateau and within the underlying Hawkesbury Sandstone. The sand deposits at Maroota range to a maximum thickness of about 40 metres, and occupy an area of 5 square kilometres on high terrain some 5 to 6 kilometres from Wiseman's Ferry. Yields are typically low (0.1 to 2.5 litres per second) and water quality is generally good (total dissolved solids < 1000 milligrams per litre).

Groundwater at Maroota is widely used for domestic, industrial and agricultural purposes. The tertiary sand deposits store a valued source of shallow groundwater supply. Sand mining is an active industry in the area, with numerous quarries having been established. It has been recognised that sand mining at Maroota may have an adverse impact on the groundwater, particularly in situations where quarrying extends below the water table. The main concerns are the potential for a decline in supplies to existing groundwater users and a reduction in discharge from natural springs.

Issues such as a potential decline to existing groundwater supplies have prompted councils and catchment management authorities to seek advice from the NSW Office of Water regarding the potential impacts of quarrying on groundwater resources, and the steps which could be taken to minimise these impacts. The Office of Water has taken an approach which is aimed at protecting the interests of groundwater users and ensures the long-term sustainability of groundwater. Recommendations include limiting the depth to which mining can extend and requiring that monitoring piezometers be a condition of consent on all mining development applications.

The **Botany Sands Groundwater Source** consists of the aeolian sand deposits that envelope Botany Bay and covers an area of 91.12 square kilometres. The groundwater is mostly low in salinity and high-yielding, and has been an important source of water supply for Sydney's industry and community for over 100 years. The NSW Government has been actively managing the extraction of groundwater in the Botany area. In August 2003, an embargo under section 113A of the WA 1912 was made in the northern part of the aquifer because available water was depleted by plumes of contamination. This embargo prevented any new applications to extract groundwater being made. In August 2006 an order prohibiting the use of existing domestic bores was made for four zones within the northern Botany Sands Aquifer under Section 323 of the WMA 2000 (now section 324). The ban on domestic use was made in the interest of public health and the zones were based on current and historical land use activity and therefore the potential for contamination. For more information visit the Office of Water website www.water.nsw.gov.au under Water management > Water quality > Groundwater.

In June 2007 the remaining parts of the Botany Sands Groundwater Source were embargoed under the WA 1912 to prevent any additional commercial extraction. The aquifer is still used mainly for industrial purposes, along with domestic use in residential areas outside the restricted areas. With the current drought conditions, there is also some interest in exploring whether the groundwater is capable of supplementing Sydney's urban water supply. This groundwater source is split into two management zones. Botany Management Zone 1 (covers the embargo of August 2003 area) and Botany Management Zone 2[6] (covers the embargo of June 2007 area).

The **Hawkesbury Alluvium Groundwater Source** comprises the alluvial deposits of the Hawkesbury River, extending downstream of the Warragamba Dam to the township of Spencer, and covers an area of 122.68 square kilometres. The alluvial deposits are broadest in the Windsor to Wilberforce area. However, a large proportion of the licensed bores have been constructed further downstream along the thinner alluvial deposits associated with meanders of the Hawkesbury River. Groundwater quality, in particular salinity in several areas, may limit its potential uses.

[6] Sections of this management zone are also covered by an order under section 324 of the WMA 2000 that prohibits the extraction of groundwater in specified zones other than for the purposes of irrigation of land for recreational or commercial purposes, and water that is taken for monitoring purposes. This is to protect public health and more information can be obtained from the NSW Government Gazette of 1 September 2007.

Land use history

The region includes the country of five indigenous nations. Yuin and Tharawal country includes Shoalhaven River, with Tharawal occupying the lower reaches of the River. Tharawal country also includes lands of the Illawarra and north to Botany Bay. Eora country spans the coast north of Tharawal country to around the Parramatta River and west to the eastern boundary of the Hawkesbury River catchment. The Hawkesbury River catchment is largely Dharug country, with the exception of the Wollondilly River, which is Gundungurra country and may also include the Shoalhaven River around Kingpin Mountain.

The region's rivers are a source of sustenance for Aboriginal peoples, often serving as clan boundaries, and have an important place in the Dreaming. While relations to country may vary across and between nations, nations share 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 understory across drier sandstone country emerged with these fire regimes.

With European settlement across the region in the late 18th and 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 following European arrival. 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 crops. Stone fruits were even tried as early as 1804. Hogs and goats, the only stock farmed, were soon replaced by cattle. Lands were cleared and cattle driven deeper into the catchments. 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 Shoalhaven River are two notable estate orchards. These orchards grew fruits, nuts and vegetables. Hawkesbury River was first used for irrigation during 1828. Considerable drainage of wetlands for agricultural land commenced on the lower floodplains of the 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 fishing harvesting commenced in the estuaries of the Hawkesbury and Shoalhaven Rivers.

In 1879 the Royal National Park (then 'The National Park') south of Sydney, the first national park in Australia and possibly the world, 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 Shoalhaven River from the turn of the century. Coal mining resumed in a number of districts and extensive limestone quarrying commenced at 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 1959, Sydney's drinking water catchments, including the catchment of Nepean River, covered an area of over 9000 square kilometres, 140 kilometres of river was inundated by Warragamba Dam alone. Wingecarribee Dam was completed during the 1970s and inundated much of the upper reaches of the Wingecarribee River. Tallowa Dam on Shoalhaven River was completed in 1976 impounding waters in the Shoalhaven River Gorge, Kangaroo River, Bundanoon and Yarrunga Creeks in Morton National Park. Welcome Reef Dam has been proposed for upper Shoalhaven River at various times, covering a catchment of 15,300 hectares, and inundating some 50 kilometres of Shoalhaven River, 30 kilometres of Mongarlowe River and 20 kilometres of Boro Creek.

From the 1930s through to the 1950s fresh perishable produce, particularly fruit, vegetables and milk, dominated agricultural land use, although 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 II. 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. With the exception of a small number of state forests on the northern escarpment of 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 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 Nepean and Hawkesbury River catchments were declared in 1959, 1969 and 1979 respectively. In 1993 an area of 350,000 hectares of the Blue Mountains National Park was declared wilderness. Three years later 125,000 hectares of Kanangra Boyd National Park was declared wilderness, and in 1999 an area of 361,000 hectares of Wollemi National Park was 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 an area of 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 have been gazetted as national park, nature reserve, or state conservation area.

Following World War II, pressures of the major urban centres called for the NSW Government to devote considerable tracts of rural lands for residential purposes. From the 1960s councils were already encouraging rural residential subdivisions across the region. In the 1970s land was acquired to establish the Macarthur Growth Centre close to Campbelltown. 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. Land will be released to provide up to 220,000 new homes over the next 25 years. 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. In addition 38,000 new homes are proposed over the next 25 years in the Illawarra, many of which will be located on agricultural land.

Additionally, 26,300 additional houses are planned for the Shoalhaven City Local Government Area over the next 25 years, the majority of which will be located in existing vacant urban lands around Nowra and Bomaderry.

The Botany Sands Groundwater Source has been affected by poor site management in the past from industry and residential development. From Redfern to Waterloo and to the shores of Botany Bay this groundwater source has had a long history of industrialised development which required large volumes of water for processing purposes.

To the south of Botany Bay the area surrounded by Woolooware, Weeney, Quibray and Bate Bays has played host to various industrial activities currently and in the past including petrochemical operations, paper manufacturing, tanneries, automotive industries, pharmaceutical, gelatine production, sand extraction operations and a sewage treatment plant. Industry coupled with urban development has led to extensive modification of the groundwater source.

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 millimetres while in the north east the average annual rainfall is 2400 millimetres 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 rainfall of 2,300 millimetres. The lowest rainfall occurs at Albion Park with an average annual rainfall of 1,200 millimetres.

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

In metropolitan Sydney, the highest average annual rainfall is 1,500 millimetres in the south-east of the catchment around Darkes Forest. The lowest average annual rainfall of 900 millimetres 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.

Entitlement and use

There are approximately 786 water licences in the area covered by the plan, totalling 62,348 megalitres of entitlement. The majority of these licences are for irrigation purposes, with a significant proportion also used for industrial purposes. There are embargoes on applications being made for new commercial licenses in the Botany Sands and Sydney Basin Blue Mountains groundwater sources, as well as orders applying under section 324 of the WMA 2000 that restrict water extraction in these groundwater sources.

Table 1 shows the current volumes of licensed entitlement and the number of licences for each groundwater source. Groundwater is also extracted within the Greater Metropolitan Region to meet basic landholder rights. Extraction for this purpose does not require a licence.

Table 1: Total entitlement and approximate number of licences for each groundwater source

Groundwater Source	Entitlement (unit shares)	Approximate number of existing licences
Botany Sands	11,156	80
Maroota Tertiary Sands	189	8
Metropolitan Coastal Sands	1,409	33
Sydney Basin North	557	19
Sydney Basin Richmond	15,923	50
Sydney Basin Central	2,592	120
Sydney Basin Blue Mountains	138	13
Sydney Basin Nepean	16,294	285
Sydney Basin South	2,880	67
Hawkesbury Alluvium	1,019	22
Sydney Basin Coxs River	6,926	12
Goulburn Fractured Rock	3,151	71
Coxs River Fractured Rock	114	6
Total	**62,348**	**786**

Local water utility requirements

The NSW Government's plan to secure Sydney's water supply has been outlined in the 2006 Metropolitan Water Plan. One aim of this plan is to develop extra supply and diversification of water sources through developing groundwater resources. The Sydney Catchment Authority does not currently hold any groundwater entitlement for borefield development and extraction. However, it may in the future, depending on the outcomes of any pilot testing programs, analysis of sustainability and planning approvals. If these access licences are obtained during the term of the water sharing plan they may be located in the following water sources:

- the Sydney Basin Nepean Groundwater Source for the Kangaloon borefield
- the Sydney Basin Central Groundwater Source for the Wallacia-Mulgoa borefields
- the Sydney Basin Blue Mountains Groundwater Source for the Leonay-Emu Plains borefield.

The water access licence volumes in each of the groundwater sources will be based on their water supply drought security requirements, within long-term extraction limits and with allowances to provide for the flexibility required to enable access during drought periods and natural aquifer recharge during wetter periods.

Current extractions for town water supplies are small in proportion of the total entitlement within these water sources, as seen in Table 2.

Table 2: Licensed town water supplies from groundwater for each groundwater source

Groundwater Source	Entitlement (ML)
Sydney Basin Richmond	29
Sydney Basin Nepean	11
Goulburn Fractured Rock	100
Total	**140**

Developing the plan

Scope of the plan

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

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

The aquifer types and groundwater sources that occur within the boundaries of the plan and their connectivity characteristics are given in Table 3. It is based on principles and recommendations in *Towards a National Framework for Managing the Impacts of Groundwater and Surface Water Interaction in Australia* by Sinclair Knight Merz (2006). When developing the plan, the level of connectivity, the relative level of impact and the timing of connection between the surface water and aquifers has been considered. Those aquifer types that have a significant level of connection and a high possibility of impact on the instream values of the related surface water system generally have rules developed that specifically consider this connection.

Table 3: Connectivity between aquifer types and surface water

Aquifer type	Groundwater sources	Level of connection between surface and groundwater	Level of impact on instream values	Estimated travel time between groundwater and unregulated river
Coastal sands	Botany Sands Metropolitan Coastal Sands	Significant (tidal section only)	Low due to connection with saline water	Days to months
Tertiary Sands	Maroota Tertiary Sands	Low – moderate	Low since not major contributor and low level of connection	Years to decades
Alluvial	Hawkesbury Alluvium	Significant	High due to impact on base flows	Day to months
Fractured rock	Goulburn Fractured Rock Coxs River Fractured Rock	Low – moderate	Low since not major contributor	Years to decades
Porous rock	Sydney Basin Blue Mountains Sydney Basin Coxs River Sydney Basin Richmond Sydney Basin Central Sydney Basin Nepean Sydney Basin South Sydney Basin North	Low – moderate	Low since not major contributor	Years to decades

Water management units

The plan falls across a number of water management areas including; the Southern Water Management Area, the Hawkesbury-Nepean Water Management Area, the Southern Sydney Water Management Area, and the Sydney Harbour Water Management Area. Water management areas are constituted areas of land by an order under section 11 of the WMA 2000. These are generally declared at the catchment level.

Water sharing plans generally have a hierarchy of planning units to which the plan provisions may apply. Some surface water sharing plans include extraction management units. These are the highest management units in which rules apply. They may be as large as a water management area but with different boundaries, and they cover one or several water sources. Extraction management units are usually defined for the purpose of establishing a geographic area over which the long-term average annual extraction limit (LTAAEL) for surface water applies. The plan does not establish extraction management units.

The highest level of management units described in this plan is the water source. There are 13 water sources established in the plan. Water sources in this context are one or more places where water occurs naturally below the surface of the ground. These have been established for the purpose of creating a geographic area over which the LTAAEL applies. An available water determination (AWD) can be made for each licence category within the water source, and any growth in extraction above the LTAAEL is managed across the water source. Access and trading rules are also generally applied at the water source level. The spatial extent of the water sources in this plan is shown in Appendix 1.

A water management zone is the next level down in the planning unit hierarchy. It is part of a water source and is the level at which more refined implementation of access or trading rules are applied. In the plan two water sources have been split into management zones for more refined management. These are:

5. Sydney Basin Nepean Groundwater Source – Nepean Management Zone 1, Nepean Management Zone 2
6. Botany Sands Groundwater Source – Botany Management Zone 1, Botany Management Zone 2.

Project groups

State Interagency Panel

The State Interagency Panel (SIP) has overall responsibility for the state-wide 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 state-wide significance.

The SIP is chaired by the NSW Office of Water. The group has representatives from the Office of Water, Office of Environment and Heritage (OEH) and the Department of Primary Industries (DPI). There are also three Catchment Management Authority (CMA) representatives. The Office of Water is responsible for the overall delivery of water sharing plans.

State Groundwater Panel

The plan rules have been recommended by the State Groundwater Panel (SGP). This is an interagency group comprising representatives from the Office of Water, OEH, DPI and CMAs. Appendix 2 lists the names of the SGP representatives and their areas of expertise. The panel had access to staff from the agencies to provide technical and scientific information. The key roles of the panel were to review, and where appropriate modify the outcomes of the regional assessment and the proposed groundwater sharing rules produced by the regional working groups to ensure integration and overall consistency across groundwater sources.

Regional Assessment Working Groups

The regional assessment working groups used local knowledge and expertise to do a risk assessment for each groundwater source in their region and propose plan provisions. Long-term average annual extraction limits and water reserved for the environment were defined based on these risk assessments. These assessments and the plan provisions were reviewed by the SGP.

Greater Metropolitan Interagency Working Group

The Greater Metropolitan Interagency Working Group (IWG) is specific to the Greater Metropolitan Region plan area and has replaced the role of Interagency Regional Panel in this region. The IWG includes representation from the Office of Water, OEH, DPI, Sydney Metropolitan CMA, Southern Rivers CMA, Hawkesbury-Nepean CMA, Sydney Water Corporation and the Sydney Catchment Authority. This group primarily focuses on surface water issues but also covers groundwater issues where required for the Greater Metropolitan Region.

Coxs River Water Management Committee

This former water management committee was formed in 2001 and was made up of representatives of the community and government agencies. The committee developed a draft water management plan for surface and groundwater specific to the Coxs River catchment. This draft plan was superseded by the plan covering the Greater Metropolitan Region. Subsequently, the recommendations of the former committee were considered by the SGP in developing the rules for the groundwater within the former draft plan area.

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 an intergovernmental agreement, the National Water Initiative (NWI), which 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, the need to service rural and urban communities, and 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 (visit the the Water reform section of the National Water Commission website www.nwc.gov.au for details).

The intergovernmental agreement contains provisions on water planning including:

- settling 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 NWI sets outcomes, guidelines and timelines for water plans and planning processes. The National Water Commission (NWC) is an independent statutory body responsible for providing advice to CoAG on the implementation of the NWI and national water issues, and undertakes a biennial assessment of each states' progress on implementing the NWI.

Natural Resources Commission

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

Table 4: Contribution of the plan to the relevant NRC state-wide targets

Relevant state-wide target	Contribution by water sharing plan
By 2015 there is an increase in the recovery of threatened species populations and ecological communities (Target 3).	Rules developed to help protect specific groundwater dependent ecosystems (GDEs). Common access rules for both groundwater and surface water will be implemented close to rivers in recognition of their connected nature, and to prevent over-extraction of groundwater and resultant impacts on rivers.
By 2015 there is an improvement in the ability of groundwater systems to support their groundwater dependent ecosystems and designated beneficial uses (Target 6).	Rules will be applied which protect significant GDEs.
By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained (Target 8).	Rules developed to help protect specific GDEs, including wetlands.
Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being (Target 12).	Plans provide a defined share of water and defined security of access. Water markets encourage movement of water licences to high-value uses. Rules developed based on risk assessment which considered community dependence on water extraction.

Catchment Action Plan

The plan is consistent with and contributes to the following Catchment Action Plans:

- Southern Rivers Catchment Management Authority Catchment Action Plan (SRCMACAP). The SRCMACAP can be found on the Southern Rivers Catchment Management Authority (SRCMA) website www.southern.cma.nsw.gov.au in the Plans and strategies section.
- Hawkesbury-Nepean Catchment Action Plan (HNCAP). The HNCAP can be found on the Hawkesbury-Nepean Catchment Management Authority (HNCMA) website www.hn.cma.nsw.gov.au in the CMA Strategies and plans section.
- Sydney Metropolitan Catchment Action Plan (SMCAP). The SMCAP can be found on the Sydney Metropolitan Catchment Management Authority (SMCMA) website www.sydney.cma.nsw.gov.au in the About us section.

One of the CMA's responsibilities, as observer, is to provide the SGP with advice on the alignment of the proposed classification and extraction limits and rules with the priorities in their CAP.

Other considerations

Protecting Aboriginal values

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

Aboriginal communities have indicated that water sharing rules should protect natural instream values and GDEs. While 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 and GDEs. This is consistent with the proposed provisions of the plan.

Further 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.

For more information visit the Office of Water website at www.water.nsw.gov.au under Water management > Water sharing plans > How water sharing plans work, or contact the licensing enquiries hotline on 1800 353 104.

There are many declared Aboriginal places in NSW, which are protected under the *National Parks and Wildlife Act 1974*. For a full list of these sites please refer to the OEH website at www.environment.nsw.gov.au. The Office of Water is currently developing a list of high priority culturally significant sites that are groundwater dependent. This list will be used to identify culturally significant sites as part of the assessment undertaken by the Office of Water during the processing of an application for granting or amending a water supply work approval.

Key environmental assets

The Greater Metropolitan Region contains a significant number of GDEs, some of which are sensitive to water extraction. A list of the high priority GDEs such as karsts, springs, wetlands and vegetation communities is included in the plan. The plan sets out specific provisions for protecting listed GDEs. These GDEs and other environmental assets were also considered when assessing the environmental value of the groundwater source and its risk from extraction when determining the long-term average annual extraction limit for each water source.

It is recognised that there are varying levels of risk to aquifers from groundwater extraction across the plan area. In particular, three groundwater sources were identified as having high risk to their aquifer assets – ecological, water quality and aquifer integrity assets (see Table 5). In these groundwater sources a larger portion of the recharge was reserved for the environment and, where there was also a risk to the accessibility, mitigating rules included in the plan provisions to protect the aquifer asset, while maintaining access.

Table 5: Groundwater sources with a high risk to aquifer assets

Groundwater Source	Factors considered that rate the risk as high
Coxs River Fractured Rock	The risk of a change in groundwater levels and a change in the timing of groundwater level fluctuations on GDEs is considered high. It may be expected that a reduction in groundwater level(s) or piezometric pressure beyond seasonal variations could result in the permanent loss of defined habitat types. This water source includes significant GDEs such as Jenolan Caves.
Goulburn Fractured Rock	The risk of a change in groundwater levels on GDEs is considered high. It may be expected that a reduction in groundwater level(s) or piezometric pressure beyond seasonal variation could result in the permanent loss of defined habitat types. There are locally significant GDEs, icon reserve sites and high community values on karst systems in the area, although generally most of the area is a highly modified landscape.
Botany Sands	There is a high risk of changing the water quality in this aquifer in particular the chemical conditions of the groundwater source due to the large number of contaminated sites in the aquifer, which could lead to permanent change in chemical conditions.

Key economic and social assets

The plan recognises the economic benefits to the region that are generated by commercial users such as irrigators and industry. There are varying levels of community dependence on access to groundwater across the plan area. The plan therefore sets rules so that commercial users can continue to operate productively. In particular three of the 13 groundwater sources are considered to have a high community dependence on commercial extraction from groundwater. This meant there was a high risk to some financial or social assets

should there be a change to access rules or availability of the groundwater resource in these areas (see Table 6). In these groundwater sources larger portions of the recharge are available for extraction and where there is also a risk to the aquifer assets or the environment then specific mitigating rules may be included in the plan provisions to protect the aquifer asset, while maintaining access.

Table 6: Water sources with a high risk to financial and/or social assets

Groundwater source	Factors considered that rate the risk as high
Sydney Basin Nepean	The risk to the dependence on groundwater related activities is considered high in this groundwater source as there is a large volume of groundwater extracted in proportion to the total licensed volumes. This water is generally used to support significant investments in vineyards, horticulture and mineral water bottling. The risk to investment in agriculture or industry is considered high due to these significant investments that require groundwater.
Sydney Basin Richmond	The risk to the dependence on groundwater related activities is considered high in this groundwater source as there is a large volume of groundwater extracted in proportion to the total licensed volumes. This water is generally used to support the orchard industry for permanent plantings.
Maroota Tertiary Sands	The risk to ongoing groundwater usage and to the dependence on groundwater related activities is considered high as a large volume of groundwater is extracted in proportion to the total licences entitlement. Full entitlements are used and there is high reliance on these due to the dry conditions, and the limited extent of the groundwater source in area and depth. The risk to investment in agriculture or industry is considered high due to the significant investment in activities requiring groundwater with extractive and irrigation industry relying heavily on this groundwater source. Similarly there is a high risk to employment in agriculture or industry as majority of the local population within the area of this groundwater source are employed in groundwater associated activities, e.g. market gardens and extractive industries.

Protecting basic landholder rights

For groundwater, basic landholder rights (BLR) includes water for domestic and stock purposes which is extracted from any aquifer underlying the landholder's property. It also includes water extracted for native title purposes. Under section 52 of the WMA 2000, groundwater may be extracted to meet defined domestic and stock purposes without a licence, although the work (usually a bore) must still be approved by the Office of Water.

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 domestic and stock users. There are currently no extractions to provide for native title rights. However, these rights may be activated during the term of the water sharing plan. Further, there are usually less stringent rules applying to works in the plan for BLR users compared with the rules for other extraction.

Domestic and stock rights can be restricted by the Minister under section 324 of the WMA 2000, for instance, to protect the environment or public health, or to preserve existing basic landholder rights. These restrictions are outside the framework of the plan. The Office of Water is also developing a 'reasonable use guideline' which will limit extractions under domestic and stock rights to a reasonable volume and more clearly define what is considered to be a reasonable purpose, which is important where these extractions are not metered.

Other water sharing considerations

There are a number of policies and water related issues that required consideration with the development of the plan and the associated water sharing rules. A large range of reference material was also used in addition to the knowledge of panel members and technical support staff. Reference material is listed in Appendix 3.

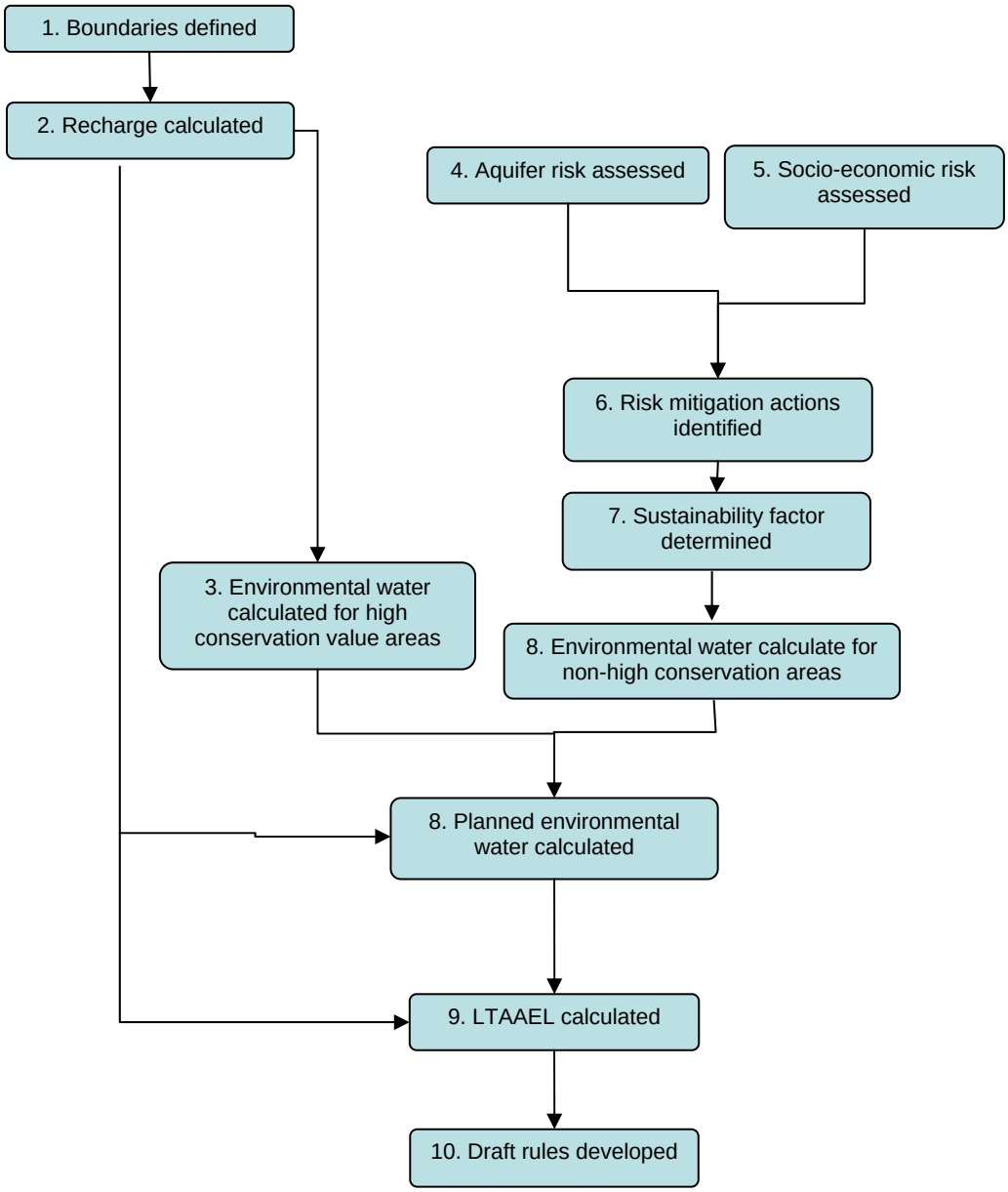
Rules for groundwater sources

Risk assessment approach to determining sustainable limits

The plan was developed based on the groundwater 'macro planning' risk assessment process. This is the current approach of the NSW Office of Water to developing water sharing plans for non-highly connected groundwater sources and is described in Bish *et al*. 2006. The macro approach is a risk-based approach based on best available information that gave a relative assessment for groundwater sources and provided the basis for rules for water access and for managing water supply works that relate to groundwater extraction. The process used assessments ('high', 'medium' and 'low') to indicate different levels of risk. The adopted approach helped to clarify a range of values and risks, indicating where an optimal balance might be between extraction and retention of groundwater recharge in an aquifer to meet environmental needs. In some areas, natural assets need strong protection; in others there is more socio-economic reliance on groundwater for extraction. The broad scale relative assessments allowed the most appropriate provisions to be developed for inclusion in water sharing plans.

The environmental values of the 13 Greater Metropolitan Region groundwater sources were weighed up against the socio-economic dependence and consideration was given to the possibility of any actions that could be taken to reduce (mitigate) the risk to the environmental values. As a result, a 'sustainability factor' was determined for each of these groundwater sources. This factor then went towards determining the volume of average annual recharge to each aquifer which is reserved as environmental water and the volume which may be available for extraction. Rules were also then developed for the water source and endorsed by the SGP. An outline of the risk assessment process for groundwater is detailed in Figure 1.

Figure 1: Macro planning groundwater risk assessment process



Recharge calculations

Recharge is the volume of water that infiltrates into an aquifer. It is expressed as a volume in megalitres per year (ML/yr). Recharge usually comes from rainfall and from surface water, such as river flows. The recharge calculations for all of the Greater Metropolitan Region groundwater sources are based on rainfall recharge only. That is, the calculation does not include other forms of recharge such as river recharge, side slope or upward recharge. It is calculated based on a percentage of infiltration of average annual rainfall between 1921 and 1995 over the groundwater source area. This approach is precautionary and goes towards the determination of the volume of groundwater reserved as planned environmental water and the volume that is potentially available for extraction in each groundwater source.

The average annual rainfall recharge volumes for the Greater Metropolitan Region groundwater sources are displayed in Table 7. The recharge figure for high conservation value areas within each of the groundwater sources is treated separately from the rest of the recharge in that 95 or 100 per cent of this recharge is reserved as planned environmental water, while the percentage of the recharge for

the remainder of the water source that is reserved as environmental water is determined by the sustainability factor.

Note that for the purposes of defining recharge and dedicating 95 or 100 per cent of recharge from areas of high environmental value areas to planned environmental water, high environmental value areas include national parks, nature reserves, historic sites, Aboriginal sites, state conservation areas and karst conservation areas. It does not include any special areas gazetted under the *Sydney Water Catchment Management Act 1998*.

Table 7: Average annual recharge for the Greater Metropolitan Region

Water Source	Area (km^2)	Average annual rainfall (ML)	Infiltration (%)	High environmental value areas Estimated average annual rainfall recharge (ML/yr)	Non-high environmental value areas Estimated average annual rainfall recharge (ML/yr)	Total Estimated average annual rainfall recharge (ML/yr) #
Sydney Basin North	5226.18	4,486,443	6	190,457	78,730	269,187
Sydney Basin South	3034.83	3,755,436	6	85,542	139,784	225,326
Sydney Basin Nepean	3857.47	3,741,377	6	58,537	165,946	224,483
Sydney Basin Richmond	1978.39	2,131,294	6	92,706	35,172	127,878
Sydney Basin Blue Mountains	1139.16	1,307,904	6	62,898	15,577	78,474
Sydney Basin Central	3757.59	3,820,386	6	45,563	183,661	229,223
Sydney Basin Coxs River	528.95	521,870	6	2,798	28,514	31,312
Coxs River Fractured Rock	1700.46	1,657,418	4	39,073	27,224	66,297
Goulburn Fractured Rock	8175.31	6,494,594	4	47,486	212,298	259,784
Maroota Tertiary Sands	4.38	3,583	3	0	1,075	1,075
Metropolitan Coastal Sands	165.69	202,672	3	7,100	53,702	60,802
Botany Sands	91.12	101,413	3	1,174	29,250	30,424
Hawkesbury Alluvium	122.68	100,854	5	129	4,913	5,043
Total	**29782.21**	**28,325,244**		**633,463**	**975,846**	**1,609,309**

Average annual rainfall recharge (ML/yr) = [{water source area (ha) x mean rainfall (mm)}/100] x % infiltration rate.

Note: The average annual recharge was calculated using rainfall data between 1921 and 1995

Risk assessment

The aquifer risk assessment considered the risk that groundwater extraction placed on the groundwater source and its high priority groundwater dependent ecosystems, and identified risks to ecological, water quality and aquifer integrity assets. The socio-economic risk assessment looked at the dependence of local communities on groundwater extraction in terms of the risk to financial and sociological assets. An overall risk valuation was attained for the groundwater source, which is equal to the highest value attained on any criterion.

Mitigation measures, applied through rules in the water sharing plan, can reduce the impact of extraction on a groundwater source. For example, a groundwater source may have its environmental risk reduced from high to medium if the effect of extraction can be successfully mitigated. Mitigation measures were applied to the following groundwater sources:

- Sydney Basin Central
- Maroota Tertiary Sands
- Botany Sands.

For more detailed descriptions of the risk assessments and any mitigation actions taken in these groundwater sources refer to the groundwater source report cards, available on the Office of Water website www.water.nsw.gov.au. More general information on the risk assessment process is presented in the report *Macro water sharing plans – the approach for Groundwater. A report to assist community consultation*.

Sustainability factor

The recharge volume calculated for the area outside the high environmental value areas of each groundwater source is split between the environment and water potentially available for extraction. The sustainability factor was based on a matrix and determined the percentage of recharge in these parts of each groundwater source that was reserved as planned environmental water. The remaining percentage in the non-high conservation area was included in the long-term average annual extraction limit (LTAAEL) which is the volume potentially available for extraction. The sustainability factors for the groundwater sources covered by the plan are in Figure 2.

Figure 2: Sustainability factors for the Greater Metropolitan Region Groundwater Sources

High environmental risk	**5%**	**25%** Goulburn Fractured Rock Coxs River Fractured Rock	**50%**
Moderate environmental risk	**25%** Sydney Basin North Sydney Basin Blue Mountains Sydney Basin Central*	**50%** Sydney Basin South Metropolitan Coastal Sands Botany Sands* Hawkesbury Alluvium	**60%** Sydney Basin Richmond Sydney Basin Nepean Maroota Tertiary Sands*
Low environmental risk	**50%**	**60%** Sydney Basin Coxs River	**70%**
	Low socio-economic risk	**Moderate socio-economic risk**	**High socio-economic risk**

* **Note** that the Sustainability Index Value is calculated after mitigation has occurred.

Defining planned environmental water

Planned environmental water is derived from the average annual rainfall recharge volumes. A percentage of this rainfall recharge from the high environmental value areas (either 95 or 100 per cent) has been added to a percentage of rainfall recharge from the non-high environmental value areas (dependent on the sustainability factor) for each groundwater source. Details of the planned environmental water reserved for each groundwater source in the plan are in Table 8.

Annual rainfall recharge reserved in high environmental value areas

Groundwater extraction is generally not permitted in areas such as national parks and reserves to ensure protection of groundwater dependent ecosystems. The approach to restrict extraction and reserve the annual rainfall recharge volumes as planned environmental water in these high environmental value areas is consistent with the precautionary principle. This means that volumes made available for licensed use are limited until the groundwater system is further assessed (such as, assessment of through flow) and the effect of groundwater extraction is better known.

However, it is appropriate in some instances to consider making some of this rainfall recharge over the high environmental areas potentially available for extraction. This is particularly the case where a level of through flow would naturally be occurring in a hydrologically connected system (in particular coastal sands, tertiary sands and alluvial deposits) and in some instances where there is existing extraction occurring within the high environmental value areas (e.g. town water supply extraction in some coastal sands areas).

Therefore, in all coastal sands groundwater sources and in other groundwater sources where there is a current demand to meet existing entitlements or a future demand, (i.e. during the term of the plan) for town or urban water supply it is proposed that an assumed estimated through flow of 5 per cent of the recharge generated from the high environmental value areas, where hydrologically appropriate, be made available for possible extractable use. Importantly, if the high conservation value area is below the gradient of the groundwater flow from the extraction, it may not be valid to give a further 5 per cent to this area as through flow (i.e. not hydrologically appropriate). The remaining 95 per cent of recharge generated from the high environmental value areas would be accounted for as planned environmental water. All other groundwater sources would have 100 per cent of the recharge generated from the high environmental value areas reserved as planned environmental water.

Annual rainfall recharge reserved in non-high environmental value areas

Following the results of the risk assessment, each groundwater source was placed in the sustainability matrix to provide the percentage of recharge in the non-high environmental value areas to be reserved as planned environmental water. This percentage is 100 minus the sustainability factor percentage.

A minimum 30 per cent to a maximum 95 per cent of the long-term average annual rainfall recharge volume in the non-high environmental value area of each groundwater source may be reserved as planned environmental water for a groundwater source depending on the outcomes of the risk assessment. This builds on the original *NSW Groundwater Dependent Ecosystem Policy (2002)* which recommended a minimum of 30 per cent.

In the plan a minimum of 40 per cent and a maximum of 75 per cent of the rainfall recharge has been reserved as planned environmental water in the non-high environmental value areas.

Table 8: Planned environmental water for the Greater Metropolitan Region groundwater sources

Water source	High environmental value areas Average annual rainfall recharge (ML/yr)	% of average annual rainfall recharge from high environmental value areas reserved for the environment	Non-high environmental value areas Average annual rainfall recharge (ML/yr)	% of average annual rainfall recharge from non-high environmental value areas reserved for the environment	Planned Environmental Water (ML/yr)
Sydney Basin North	190,457	100	78,730	75	249,504
Sydney Basin South	85,542	100	139,784	50	155,434
Sydney Basin Nepean	58,537	100	165,946	40	124,915
Sydney Basin Richmond	92,706	100	35,172	40	106,775
Sydney Basin Blue Mountains	62,898	95	15,577	75	71,435
Sydney Basin Central	45,563	100	183,661	75	183,308
Sydney Basin Coxs River	2,798	100	28,514	40	14,204
Coxs River Fractured Rock	39,073	100	27,224	75	59,491
Goulburn Fractured Rock	47,486	100	212,298	75	206,709
Maroota Tertiary Sands	0	95	1,075	40	430
Metropolitan Coastal Sands	7,100	95	53,702	50	33,596
Botany Sands	1,174	95	29,250	50	15,740
Hawkesbury Alluvium	129	100	4,913	50	2,586
Total	**633,463**		**975,846**		**1,227,272**

Defining the long-term average annual extraction limit

The percentage of water potentially available for extraction is termed the long-term average annual extraction limit (LTAAEL) and is expressed in megalitres per year (ML/year); this is the estimated sustainable limit for each of the groundwater sources. The LTAAEL for the groundwater sources in the Greater Metropolitan Region is as expressed in Table 9. The LTAAEL was calculated by applying the sustainability factor derived from the risk assessment process, which determined the percentage of the average annual rainfall recharge over the non-high environmental areas that can be potentially made available for extraction. Also added to this figure is 5 per cent of the recharge from the high environmental value areas where applicable.

Table 9: LTAAEL for the Greater Metropolitan Region groundwater sources

Water source	High environmental value areas Average annual rainfall recharge (ML/yr)	% of average annual rainfall recharge from high environmental value areas made available for possible extraction	Non-high environmental value areas Average annual rainfall recharge (ML/yr)	Sustainability factor (% of average annual rainfall recharge non-high environmental value areas made available for possible extraction)	LTAAEL (ML/year)
Sydney Basin North	190,457	0	78,730	25	19,682
Sydney Basin South	85,542	0	139,784	50	69,892
Sydney Basin Nepean	58,537	0	165,946	60	99,568
Sydney Basin Richmond	92,706	0	35,172	60	21,103
Sydney Basin Blue Mountains	62,898	5	15,577	25	7,039
Sydney Basin Central	45,563	0	183,661	25	45,915
Sydney Basin Coxs River	2,798	0	28,514	60	17,108
Coxs River Fractured Rock	39,073	0	27,224	25	6,806
Goulburn Fractured Rock	47,486	0	212,298	25	53,074
Maroota Tertiary Sands	0	0	1,075	60	645
Metropolitan Coastal Sands	7,100	5	53,702	50	27,206
Botany Sands	1,174	5	29,250	50	14,684
Hawkesbury Alluvium	129	0	4,913	50	2,456
Total	**633,463**		**975,846**		**385,178**

Water sharing rules

Managing extraction to the long-term average annual extraction limit

Total extraction in the groundwater source is managed to the LTAAEL. A growth in use response will be triggered if average annual usage over a three year period in a groundwater source exceeds the LTAAEL by more than 5 per cent. Growth in use is managed through a reduction (from 100 per cent) in the available water determination for aquifer access licences in the groundwater source. The AWD will be reduced by an amount necessary to return total water extractions to the LTAAEL.

Unassigned water

The plan includes a provision for review of recharge and LTAAELs during the fifth year of the plan. Unassigned water is the water potentially available for extraction under the LTAAEL that is not yet allocated to an access licence, and not estimated to be required to meet current and potential future priority requirements for extraction such as basic landholder rights extraction, extractions by specific purpose access licences, for example major and local utilities (town and urban water supply) and Aboriginal cultural or from exemptions under the WMA 2000.

With no other constraints, the unassigned water component in some groundwater sources could theoretically become fully assigned to new entitlements by the fifth year of the plan. To avoid this

occurring, a staged process for any release of new entitlements has been developed for those systems that have a defined volume of unassigned water.

There will be no unassigned water made available through the controlled allocation process where entitlements plus basic landholders' rights equal 90 per cent or more of the LTAAEL. In groundwater sources where total entitlement plus basic landholder rights is less than 90 per cent there may be trading in existing water entitlement. However, in these groundwater sources there is also the potential for the Minister to issue new entitlement through a controlled allocations order under the WMA 2000.

The current and potential future priority requirements for extraction must be accounted for (including an estimate for growth) before defining the amount that could be released as a controlled allocation. Any increase in these priority requirements over and above the LTAAEL must be met through a reduction in available water determinations to aquifer access licences. Estimating and reserving water to meet future priority requirements before releasing water through any controlled allocation will prevent over-allocation or sending misleading signals to the water market.

In groundwater sources that, after consideration of current and future priority requirements, have unassigned water, only a percentage of this volume may be released through the controlled allocation process before a review is initiated. The trigger for the review is based on the sustainability factor determined through the risk assessment for each groundwater source. The review required will be a review of recharge, environmental needs and priority extraction requirements. That is, the percentage of unassigned water that can be allocated under a controlled allocation before a review is equal to the sustainability factor for that groundwater source. Unassigned water allocated below the trigger is considered a low risk of controlled allocation creating unsustainable levels of licensed entitlement. Controlled allocation above the trigger is a more uncertain risk of over-allocation and a review will therefore be undertaken before additional controlled allocations are made.

Aquifer interference

Activities which intersect ('interfere with') an aquifer may involve:

- Extraction of groundwater that flows into a void to allow the activity to operate safely. This is often called de-watering, and the water extracted is often referred to as 'incidental groundwater'.
- Other impacts resulting from the intersection of the aquifer, such as changes to groundwater flow paths and gradients, subsidence and cracking of river beds, river bank collapse, destruction/removal of the aquifer structure, and artificial aquifer recharge.

Volumes of water incidentally taken in the course of aquifer interference activities, such as the water intercepted during mining operations, have in the past required a licence under the WA 1912.

Operators of these activities will continue to be required to hold an access licence and sufficient account volume to account for incidental water taken. This includes activities where extraction associated with aquifer interference activity was occurring when the plan commenced.

An application for a new licence can be applied for in all groundwater sources under the plan except in zones or water sources where the plan does not allow applications to be made for new aquifer access licences, such as for Botany Management Zone 1 of the Botany Sands Groundwater Source, Sydney Basin Nepean Management Zone 1 of the Sydney Basin Nepean Water Source and the Hawkesbury Alluvium Groundwater Source. Water may be traded to acquire the volume needed to account for water taken in these areas.

Protecting environmental values and groundwater dependent ecosystems

The groundwater reserved for the environment, or 'planned environmental water' has been detailed above in the section titled *'Defining planned environmental water'*. This is part of the defined environmental water in the plan. All aquifer storage volumes in each groundwater source are also reserved for the environment.

The plan includes a number of additional provisions that protect environmental assets. These include the identification of high priority (high conservation value) Groundwater dependent ecosystems (GDEs). These GDEs are listed in a schedule to the plan. The GDE lists were developed through an interagency expert panel which included karst, wetlands, vegetation, and groundwater experts.

There are many types of caves and karsts throughout NSW. The list of high priority karst environment GDEs provided in a schedule to the plan includes limestone karst environments only. High priority cave and karst environments are currently under investigation and may be identified during the term of the plan. If verified as high priority GDEs, the schedule will be amended to include further high priority cave and/or karst environments. This schedule also includes all temperate highland peat swamps on sandstone. These GDEs are located in the Blue Mountains and Newnes Plateau regions.

Additional protection for these identified GDEs and for protecting base flow in connected rivers is afforded through specific rules for granting or amending water supply works approvals – see section titled *'Water supply works approvals'* for detail. The distance rules cover new or replacement works such as bores, and stipulate a minimum distance these works are required to be located from high priority GDEs or the associated river.

There are also powers in section 324 of the WMA 2000 for managing the environmental impacts of existing works within these groundwater sources, for example. on high priority GDEs.

Water supply works approvals

The plan contains rules for granting or amending water supply work approvals and the management of existing works for groundwater sources. These rules determine where water supply works can be located and how existing works may be managed where they are already within the distance restriction. For new and replacement works there are rules to:

- minimise interference between neighbouring works
- locate works away from contaminated sites
- protect base flows in rivers and GDEs
- protect groundwater dependent culturally significant sites
- manage surface and groundwater connectivity.

Note also that powers in section 324 of the WMA 2000 can be used to manage temporary local impacts on new and existing works.

The plan also contains rules to manage existing works where the work is located close to the river. These rules are described below in the section '*Managing connectivity and access rules*'. This is to limit any additional potential impacts on the adjacent river.

The development of rules for the granting or amending of water supply works and management of existing works has followed a two-stage process:

- Stage 1: regional staff identified draft recommendations for rules
- Stage 2: the State Groundwater Panel reviewed the regional recommendations and recommended rules which were consistent across groundwater aquifers throughout the state. Note that while there is a need for consistency across aquifer types, a change to the rules may have been warranted to cater for local conditions.

This work was reviewed and reconsidered in light of the significant progress made on rules development by the State Groundwater Panel, as a result of the development of water sharing plans in other areas of the state.

For details about the proposed rules for water supply works approvals for each groundwater source covered by the plan, visit the Office of Water website at www.water.nsw.gov.au and refer to individual report cards or the water sharing plan.

Managing connectivity and access rules

Ground and surface waters are inextricably linked. The actual connections between surface and groundwater systems vary significantly between systems. For example, surface water recharging alluvial aquifers may emerge again at a discharge point in the river within hours. In contrast, water recharging aquifers in the Goulbourn Fractured Rock Groundwater Source, for example, may not discharge to streams for many years or decades. The connection characteristics need to be considered in linking surface water and groundwater planning, because in some cases, the same water is being accessed.

The level of connectivity, the relative level of impact and the timing of connection have been considered in developing both the groundwater and associated unregulated river water sharing plans for the Greater Metropolitan Region.

The aquifer types and groundwater sources that occur within the Greater Metropolitan Region water sharing plan and their connectivity characteristics are given in Table 3.

Managing connectivity in the Hawkesbury Alluvium Groundwater Source

Based on an assessment of levels of connectivity within the plan area, the Hawkesbury Alluvium has been treated as a specifically identifiable and separate groundwater source in the water sharing plan for the Greater Metropolitan Region groundwater sources. This is due to the high connection between the surface water and its alluvial groundwater source and because it is a significant alluvial aquifer that requires specific management.

Licences nominating water supply works in the Hawkesbury Alluvium Groundwater Source are proposed to be subject to the relevant access rules applying to unregulated river access licences of the Upper Hawkesbury (Grose River to South Creek) Management Zone in the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources*. These access rules will apply after year six of the plan and apply differently depending on the distance of the work from the top of the high bank of the river:

- at or less than 40 metres, licences will be subject to the relevant unregulated river access rules
- greater than 40 metres licences will be subject to the relevant unregulated river access rules, with a 30 day delay in the commencement.

These access rules will not apply to licences nominating existing works solely for the extraction of basic landholder rights, replacement bores or to a water supply work used for monitoring,

environmental management or remedial works purposes. These rules would also not apply to existing local or major water utility access licences until any major augmentation of their water supply works is undertaken.

Management of connectivity in all other Greater Metropolitan Region groundwater sources

All remaining alluvium in the plan area has lower levels of management and will be managed as miscellaneous unmapped alluvium. This will mean that they will not have a LTAAEL (separate extraction limit) calculated and will take their share of water from the underlying groundwater source (i.e. the porous or fractured rock water source that underlies these smaller alluvial deposits).

To manage the connection close to the river in all other groundwater sources in the plan it is proposed that, after year six of the plan, all licences in these water sources that nominate works within 40 metres from the top of the high bank of a river be subject to the relevant access rules applying to unregulated river access licences of the corresponding management zone in the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources*. Licences greater than 40 metres from the river will not be subject to unregulated river access rules.

Available water determinations

The maximum available water determination (AWD) for a water source is used to manage growth in extractions, above the LTAAEL. That is, if growth is assessed to have occurred then the maximum AWD will be reduced to respond to less than 1 ML/unit share.

AWDs are primarily used to credit water into a licencee's water allocation account. The AWD for groundwater access licences in all the groundwater sources in the plan is 1 ML/unit share. That is 100 per cent of entitlement, unless a growth in use response is required.

Carryover and water accounts

The maximum volume of water that can be carried over from one water year to the next, in water allocation accounts for aquifer access licences, is 10 per cent of the access licence share component expressed as ML/year or 0.1 megalitres multiplied by the number of unit shares for the licence and expressed as unit shares, in all groundwater sources excluding the Botany Sands, Maroota Tertiary Sands and Hawkesbury Alluvium. No carryover is permitted in water allocation accounts for aquifer access licences in the Botany Sands, Maroota Tertiary Sands or Hawkesbury Alluvium groundwater sources.

Carryover is also prohibited in allocation accounts that are for domestic and stock, local water utility and major water utility access licences in all groundwater sources covered by this plan.

Trading of access entitlement

The water market is an effective and equitable way to reallocate water between users. Trading can occur either on a permanent or temporary basis. The National Water Initiative (NWI) sets out guidelines for water trading. Trading of water entitlement needs to be addressed in the plan within a framework that maximises the flexibility for users to be able to use water to its highest value but does not adversely impact on water sources or existing users.

In most groundwater sources trading is allowed within a groundwater source, but no trading is allowed into or out of the groundwater source. This is to ensure that any groundwater source cannot be further degraded as a result of trading into that source. There are trading restrictions within those groundwater sources that have defined management zones, specifically the Sydney Basin Nepean and Botany Sands groundwater sources. This is to protect the groundwater source and existing users in these management zones from the potential impacts of additional extraction. Trade can occur within a management zone but not between management zones in these groundwater sources.

Consultation

The risk assessments and the State Groundwater Panel's recommended rules underwent targeted consultation with specific interest groups [7] before the draft plan was written. Formal public exhibition[8] of the plan ensured wider public consultation.

While developing the plan, the participating agencies (the Office of Water, OEH, DPI and the CMAs) identified areas where better data is needed for making future water planning decisions. Similarly, the community suggested areas where further analysis or data gathering is required. This local input was essential in the finalisation of the plan.

CMAs assisted with 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, CMAs looked for stakeholders to provide:

- local knowledge and expertise – for example, other natural or socio-economic values that had not been considered by the State Groundwater Panel
- feedback on the practical elements of the proposed water sharing rules – to make certain they are easily implemented by the licence holders
- confirmation that there are no unintended outcomes from the plan – it was essential that this be given due consideration before the draft plan was finalised
- specific comments on any Minister's notes included in the draft plan.

Targeted consultation on the draft rules

Targeted consultation on the draft plan began in late 2009 (Table 10). The objectives of this consultation were:

- 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
- to provide a 'first opportunity' to informally consult with key stakeholders to test the suitability of the proposed water sources, management zones, access and trading rules.

Table 10: Key groups consulted in the plan area as part of the targeted consultation

Date	Group	Location
19 October 2009	Water Users Associations	Penrith
20 October 2009	Major utilities	Penrith
21 October 2009	Peak stakeholder representative groups	Sydney
22 October 2009	Local government	Penrith
26 October 2009	Targeted Hawkesbury-Nepean stakeholders	Windsor and Camden
27 October 2009	Targeted Sydney and Illawarra stakeholders	Chester Hills
28 October 2009	Targeted Shoalhaven stakeholders	Nowra and Braidwood

[7] 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 rules' potential impacts.

[8] 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.

Stakeholders were encouraged to submit their comments in writing. A total of 24 groundwater submissions were received as a result of the targeted consultation in the Greater Metropolitan Region. These were reviewed by the State Groundwater Panel and changes were made to the draft water sharing rules where appropriate.

Refining water sharing rules as a result of targeted consultation and updated data

The State Groundwater Panel reviewed all submissions and matters raised at the meetings and, consequently made some changes to the initial draft water sharing rules. During this review process, submissions were incorporated into the assessment process. Table 11 outlines the changes to the proposed rules as a result of this consultative process, or the inclusion of new data.

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

Water source	Change to water sharing rules	Justification
All	The plan will more clearly stipulate that rules for an escarpment apply above the escarpment and not below it.	The panel agreed that the draft rules were not clear regarding where rules applied in relation to an escarpment and this should be more clearly defined.
All	Concerns were raised that distance restrictions do not provide sufficient protection against impacts on the environment and individual impact assessments should be done when installing a bore.	The panel discussed the current situation in regards to assessment of bore applications. It came to the agreement that further work would be done to investigate what has been done in other water sharing plans to see if it would be applicable for the Greater Metropolitan Region to provide for further individual assessment or limits on rates of extraction from works.
All	Submissions raised concerns regarding the protection of sacred Aboriginal cultural sites	The panel recommended that the NSW Office of Water investigate the protection of Aboriginal cultural values to determine whether further provisions need to be made in the plan if there are additional groundwater dependent culturally significant sites that are not already identified that need protection within the plan.
All	It should also be noted that concerns were raised that classifications of water sources were considered inconsistent across some groundwater sources. The panel believed that the limited information available during targeted consultation did not fully explain the classification process. A range of information was available during public exhibition detailing the Panel's recommendations and which addressed concerns raised.	

Public exhibition of the draft water sharing plan

Public exhibition of the water sharing plan was held in mid 2010 in the plan area (Table 12). The objectives of this consultation were:

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

Table 12: Public Exhibition meetings held as part of public exhibition of the plan

Date	Group	Location
27 May 2010	Local Government Association groups	Penrith
15 June 2010	Illawarra stakeholders	Jamberoo
16 June 2010	Shoalhaven stakeholders	Nowra
17 June 2010	Shoalhaven stakeholders	Braidwood
21 June 2010	Hawkesbury-Nepean stakeholders	Windsor
22 June 2010	Sydney and Hawkesbury-Nepean stakeholders	Liverpool and Camden
28 June 2010	Blue Mountains stakeholders	Katoomba
29 June 2010	Blue Mountains stakeholders	Moss Vale
30 June 2010	Southern tablelands stakeholders	Goulburn
1 July 2010	Aboriginal community stakeholder groups	Goulburn
1 July 2010	Hawkesbury-Nepean stakeholders	Penrith
6 July 2010	Capertee Valley stakeholders	Capertee
29 July 2010	Groundwater users within the Kangaroo Valley unregulated water sharing plan area	Kangaroo Valley

Refining water sharing rules as a result of public exhibition and updated data

Stakeholders were encouraged to submit their comments in writing. A total of 121 groundwater submissions were received as a result of the public exhibition in the Greater Metropolitan Region. These were reviewed by the State Groundwater Panel and changes were made to the draft water sharing rules as appropriate.

Table 13: Changes to water sharing rules as a result of public exhibition and updated data

Water source	Change to water sharing rules	Justification
All	The Office of Water to continue to review rainfall data to determine whether extended rainfall record period can/should be included as basis for recharge calculations	Recharge was calculated on average rainfall between 1921 and 1995. The Office of Water is investigating the options/benefits for inclusion of more recent data. New data is held for 1865 to 2006 with data to mid-2010 for a model update.
All	The Office of Water has included in the background document the period of rainfall that the recharge calculations are based on.	Many submissions asked for this information and the Office of Water has since included it in the background document.
All	The Office of Water to amend the provision 29 (4) of the plan to change 'hydrological' study to 'hydrogeological' study.	This provision was amended to be more specific to groundwater sources.
All	Amend distance criteria clause in the plan so that distances from all high priority GDEs can be increased, 'a greater distance if the Minister is satisfied that…'	This was amended to provide greater protection if needed, both at a greater and lesser distance, outside of the distance criteria if it can be demonstrated that there will be no impact.
Sydney Basin Richmond and Sydney Basin Coxs River	The criteria for local employment in this water source was changed from Low to Medium	The criteria were changed as the panel considered local knowledge from submissions. The change did not alter the results of the macro classification process.

Water source	Change to water sharing rules	Justification
All	The Office of Water to investigate developing a simple fact sheet for provision on the internet to provide information for existing licence holders and BLR access on the implications of the plan.	Submissions were received from licence holders commenting that they did not understand the information sent to them and that they were unsure of impacts on their existing entitlements. The Office of Water to investigate further information to make available for water planning activities.
All	The Office of Water has placed a note in Part 5 and clause 23 of the plan to detail the water sources where SCA entitlement is being sought during drought.	A number of submissions noted that although the Metropolitan Water Plan and the background document detailed that SCA were seeking further entitlement in particular areas, however no mention was made of this in the plan.
Goulburn Fractured Rock	The Office of Water double checked LTAAEL figures and LTAAEL to be 53, 074 ML.	Submissions alerted The Office of Water to discrepancies between LTAAEL figures in the plan and the background document.
Sydney Basin Blue Mountains	Spelling was amended throughout the plan and other documents to reflect plural 'Blue Mountains'.	It has been referred to as the singular and should in fact be plural.
All	As an ongoing process The Office of Water will further consider how sources of Aboriginal cultural information is documented and considered as part of the planning and assessment process. A note was added to the plan that clarifies that some culturally significant sites have already been identified as high priority GDEs and where distance rules for high priority GDEs and culturally significant sites both apply, the more stringent rules will be applied for protection.	It is recognised that the plan may be able to be improved over time in relation to the recognition of water dependent cultural requirements and associated provisions to provide for these. The plan does currently limit the source of information however a process is under development to look at the various sources of site information.
All	Linked access rules apply to all water below the ground area. Maps were reviewed to ensure that they demonstrate this.	Although linked access rules apply to all water below the ground area, if bores are drilled into the parent material they may be exempt from linked access rules if they follow specific casing requirements.
All	The amendment clause relating to rainfall calculations was broadened to allow for changes in recharge calculations based on the use of extended rainfall record periods.	The amendment allows for adaptive management.
All	The Office of Water reviewed the high priority GDE list in consultation with OEH. It was agreed that information for hanging swamps in Schedule 6 of the plan are too narrow. The listing was broadened to include all Temperate Highland Peat Swamps on Sandstone in the Plan area, this includes many individual swamps.	The listing was considered too narrow. No latitude or longitude specifications were included as this was considered not appropriate for a group listing.
All	The LTAAEL in Table 9 in the background document was amended to the correct figure.	Submissions alerted The Office of Water to the error that the total LTAAEL for the plan area was less than the individual LTAAELs added together.
Hawkesbury Alluvium	The share component figure for the Hawkesbury Alluvium in Table 1 of the background document was amended to 1019 unit shares.	Submissions indicated that share component information for the Hawkesbury Alluvium was inconsistent in the plan and the background document.

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 life of the plan that either enables plan amendment or remaking a better plan after 10 years. Adaptive management is a requirement of both the WMA 2000 and the NWI, and has been allowed for during the life of the plan through amending provisions and 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 plan provisions.

Monitoring of plan performance

The Office of Water is also developing a Monitoring, Evaluation and Reporting (MER) Framework. This framework will be developed in collaboration with key stakeholders and will be consistent with the MER needs of the Natural Resources Commission and the National Water Commission. The intention is that the framework can be applied to existing water sharing plans and macro water sharing plans to enable the development of a specific MER plan.

Performance indicators

The plan includes a number of performance indicators that will be monitored over the 10 year life of the plan.

It is not practical to monitor all issues in all groundwater sources. The performance indicators identify that monitoring will be undertaken for specific issues in key groundwater sources. The actual procedure for monitoring each indicator may change over the period of the plan as improved methods are developed.

Plan review

Under the WMA 2000, the Natural Resources Commission is required to undertake a review of this plan prior to any decision to extend its term or to make a new plan.

The MER framework developed will consider the statutory requirements for the different types of evaluation:

- An audit of the plan, at intervals of no more than five years, for the purpose of ascertaining whether its provisions have been effected. This audit is to be carried out by the State Interagency Panel, which has now been appointed by the Minister for Water
- An audit of the plan by the Natural Resources Commission to assess to what extent the water sharing provisions have contributed to the relevant state-wide targets, and natural resource standards and targets in the relevant catchment management area. The Natural Resources Commission will call for public submissions when undertaking its review
- An annual review of implementation programs.
- The application of information from the relevant monitoring and evaluation programs to inform progress against the relevant state-wide targets and requirements of the National Water Commission under the National Water Initiative.

Implementation

Implementation programs

An implementation program may be established that sets out the means by which the objectives of this plan are to be achieved. The process for monitoring of the performance indicators will be outlined in the implementation program.

An annual review of the implementation program will be conducted to determine whether the implementation program is being effective in implementing the water sharing provisions. The results of this review will be included in the Office of Water's Annual Report.

Monitoring water extractions

Each water sharing plan establishes the relevant mandatory conditions for extraction, including that all licences undertake measurement of extraction. The Office of Water will develop a measurement of extractions strategy to meet the objectives of the NSW Water Extraction Monitoring Policy.

Measurement of extractions may be via meters or other forms of monitoring devices fitted to approved works, or via alternate monitoring systems, to provide water extraction estimates. Different types of devices may be required depending on the nature of the water supply work installation, the size of the work, and the effect that the operation of the work may have on the groundwater source and other water users.

Under the Water Use Monitoring Program assessment of water sources is being undertaken across the state to identify priority areas of measurement of extractions and to determine the most suitable measurement options. It is likely that this will be implemented in high priority areas initially, with roll out to all water sources over time, as appropriate.

Note: Decisions regarding the timetable for introduction of measurement of extractions are still under consideration. In the interim, water users are encouraged to use other forms of self-measurement to assist them to extract water in compliance with their licence conditions, which will be developed from the relevant plan provisions. Water users may install flow meters of their own volition. Meters need to meet new national water meter standards and be installed in accordance with the manufacturer's specifications.

Compliance

The Office of Water will undertake compliance activities as necessary to enforce compliance with legal entitlements including each individual's licence conditions, which are developed based on the provisions of the plan once it is implemented. Some reliance is placed on local water users to identify inappropriate or unlawful behaviour and report this to the Office of Water. Reports may be made by calling 1800 633 362 or by emailing watercompliance@water.nsw.gov.au. For more information refer to the NSW Office of Water website at www.water.nsw.gov.au.

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 below 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.

Connectivity: A connected system is defined as any system with significant connectivity occurring between an aquifer and a surface water system. Connected systems are those where there is a zone of continuous saturation between the river and the aquifer.

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

Extraction of water: Taking of water from a water source.

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

Flow classes – describe the range of daily flow rates in a river and provide the framework for sharing water on a daily basis.

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 relying on groundwater for their species composition and their natural ecological processes.

Long-term average annual extraction limit (LTAAEL): The limit set for total extractions within a groundwater source.

Macro water sharing plans: Water sharing plans that 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: 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 rules for works approvals apply.

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.

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

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

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

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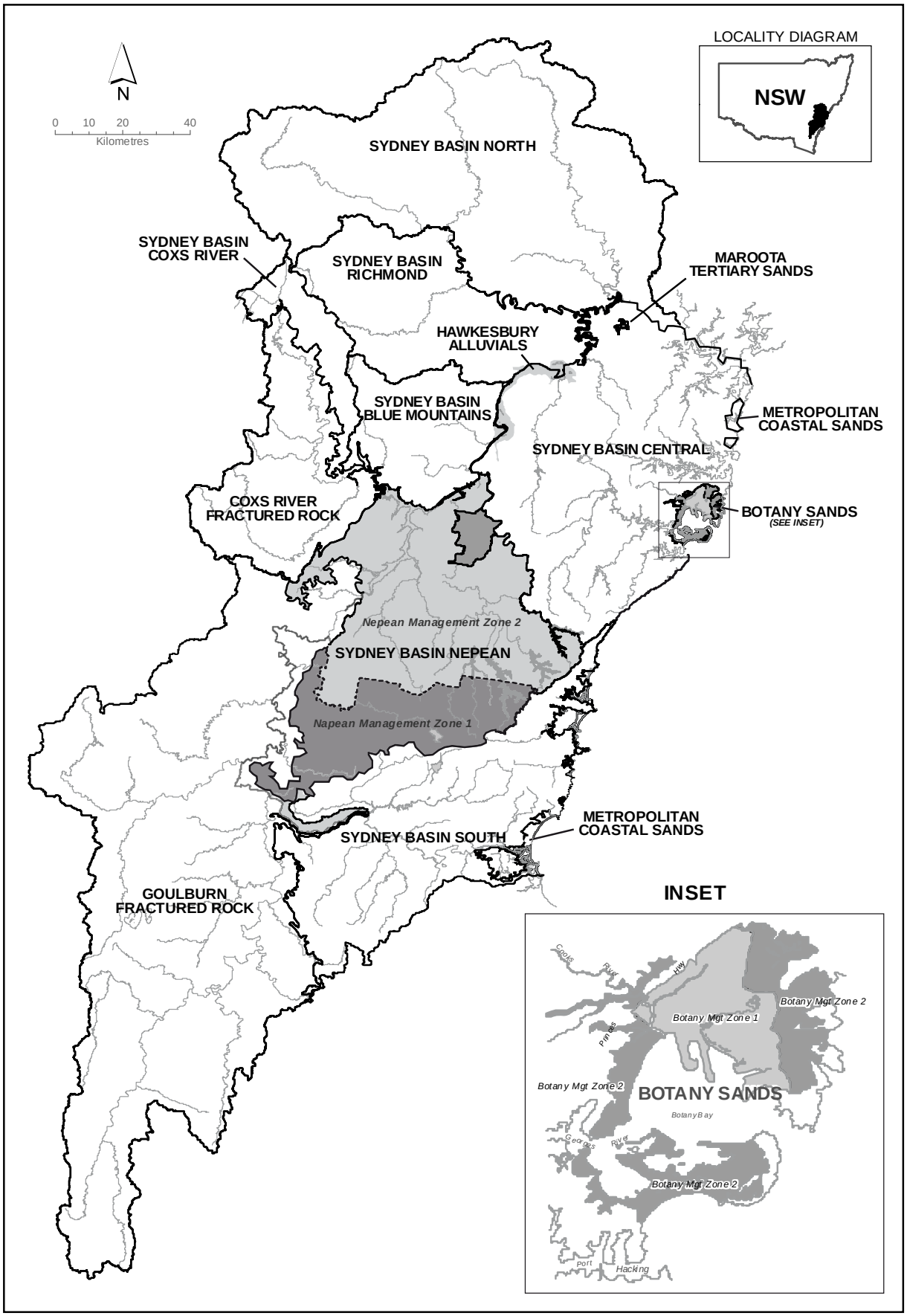
Appendix 1: Water sharing plan area

Groundwater sources and management zones



Appendix 2: State groundwater panel and support staff – membership and expertise

Name	Agency	Role	Expertise
Interagency Regional Panel			
George Gates	Office of Water	Agency representative	Extensive background, experience and expertise in hydrogeology and related groundwater management. Worked on developing groundwater policies and water sharing plans for NSW Office of Water and its predecessors. Current position is State Groundwater Manager.
Danny Norris	I&I NSW	Agency 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, local knowledge of flow behaviour of catchments.
Peter Lloyd Jones (formerly David Winfield)	OEH	Agency representative	Measuring ecological response of environmental flows, regional input and delivery of water reforms / water sharing plan development, input into state water policy development.
Fiona Marshall	Hunter-Central Rivers CMA	Observer	Currently General Manager of Hunter Central Rivers CMA. Previous experience with CMA as Business Manager Investment. Experience with DIPNR and DLWC delivering programs such as Landcare, property planning etc to the community. Over 25 years experience in the natural resource field.
Alexandra Anthony	Murray CMA	Observer	Currently chair of Murray CMA, convenor of the Water Working Group for NSW CMAs, chair of the Murray-Lower Darling Environmental Water Advisory Group, chair of the Barmah-Millewa Consultation Reference Group, member of the Murray-Lower Darling State Water Customer Service Committee.
Support staff			
Jan Gill/ Elizabeth Cala	Office of Water	Policy support	Water policy and legislation, particularly for groundwater.
Anna Bailey	Office of Water	Technical support/ Alternate SGP representative	Surface water and groundwater management, planning/ policy development and implementation.
Lyndal Betterridge	Office of Water	Project Coordinator (Greater Metropolitan Region water sharing plans)	Water policy and planning, utility planning arrangements, water sharing plan development and implementation, project management
Kimberley Williamson	Office of Water	Planning support	Water planning, water sharing plan development
Michael Williams	Office of Water	Technical support	Aquifer framework, hydraulic parameters and groundwater flow path data. Modelled impacts of other users, GDEs and streams.
John Williams	Office of Water	Technical support (groundwater)	Groundwater analysis and hydrology.

Appendix 3: Reference materials

General

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Appendix 4: Identified high priority groundwater dependent ecosystems

Identified high priority groundwater dependent ecosystems in the Greater Metropolitan Region

Name	GDE type	Groundwater source	Corresponding surface water Source
Blue Mountains Sedge Swamps	Wetlands	Sydney Basin Blue Mountains	Hawkesbury and Lower Nepean
Botany Wetlands	Wetlands	Botany Sands	Southern Sydney Rivers
Boyd Plateau Bogs	Wetlands	Coxs River Fractured Rock	
Budderoo National Park and Barren Grounds Nature Reserve Health Swamps	Wetlands	Sydney Basin South	
Coomonderry Swamp	Wetlands	Metropolitan Coastal Sands	Shoalhaven Rivers
Currys Springs	Wetlands	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Ferny Spring	Wetlands	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Kiaramba Spring	Wetlands	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Lachlan Swamps	Wetlands	Botany Sands	Southern Sydney Rivers
Lake Bathurst	Wetlands	Goulburn Fractured Rock	Upper Nepean Upstream Warragamba
Lanes Yards Springs	Wetlands	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Long Swamp	Wetlands	Sydney Basin Central	
Longneck Lagoon	Wetlands	Sydney Basin Central	Hawkesbury and Lower Nepean
Macquarie Rivulet	Wetlands	Sydney Basin South	Illawarra Rivers
Minnamurra River Estuary	Wetlands	Sydney Basin South	Illawarra Rivers
O'Hares Creek	Wetlands	Sydney Basin Central	Southern Sydney Rivers
Pitt Town Lagoon	Wetlands	Hawkesbury Alluvium	Hawkesbury and Lower Nepean
Salt Pan Creek	Wetlands	Sydney Basin Central	Southern Sydney Rivers
The Morass	Wetlands	Goulburn Fractured Rock	Upper Nepean Upstream Warragamba
Thirlmere Lakes	Wetlands	Sydney Basin Nepean	Upper Nepean Upstream Warragamba
Towra Point Estuarine Wetlands	Wetlands	Botany Sands	Southern Sydney Rivers
Wingecarribgee Swamp	Wetlands	Sydney Basin Nepean	Upper Nepean Upstream Warragamba
Coastal Saltmarsh in the Sydney Basin Bioregion	Vegetation Community	*	
Cumberland Plain Woodland	Vegetation Community	*	
Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion	Vegetation Community	*	

Name	GDE type	Groundwater source	Corresponding surface water Source
Kurnell Dune Forest in the Sutherland Shire and City of Rockdale	Vegetation Community	*	
Pittwater Spotted Gum Forest	Vegetation Community	*	
Bendethera	Karst	*	
Billys Creek Caves	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Bungonia	Karst	Goulburn Fractured Rock	Shoalhaven Rivers
Canyonleigh	Karst	Goulburn Fractured Rock	Upper Nepean Upstream Warragamba
Capertee Valley	Karst	Sydney Basin North	Hawkesbury and Lower Nepean
Church Creek Caves	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Cleatmore (Cheitmore)	Karst	*	
Colong Caves	Karst	Sydney Basin Nepean	Upper Nepean Upstream Warragamba
Ettrema and Jones Creek	Karst	Sydney Basin South	Shoalhaven Rivers
Hollanders River	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Jaunter Caves	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Jenolan Caves	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Jerrara	Karst	Goulburn Fractured Rock	Shoalhaven Rivers
Limeburners Flat	Karst		
Little Wombeyan Creek	Karst	Goulburn Fractured Rock	Upper Nepean Upstream Warragamba
Mt Fairy	Karst	Goulburn Fractured Rock	Shoalhaven Rivers
Murruin Creek	Karst	Goulburn Fractured Rock	Upper Nepean Upstream Warragamba
Portland	Karst	Sydney Basin Coxs River	Upper Nepean Upstream Warragamba
Tuglow Caves	Karst	Coxs River Fractured Rock	Upper Nepean Upstream Warragamba
Wombeyan Caves	Karst	*	
Wyanbene	Karst	Goulburn Fractured Rock	Shoalhaven Rivers

* **Note**: A number of the high priority GDEs listed do not have a given location. This is due to there being insufficient information on the location or a GDE is located on private land where landowners have requested that the information not be made public. When applications for new works are made to the NSW Office of Water, staff will ensure that they are assessed against information held by the Office regarding the location of these ecosystems.