NSW GOVERNMENT

State of the catchments 2010

Groundwater

Central West region

State Plan target

By 2015, there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses.

The intent of the target as defined by the Natural Resources Commission (NRC) is to 'ensure that groundwater continues to support ecosystem function, human health and economic activity'.

Background

The target is broad-ranging in terms of the values that it is attempting to improve. The three key areas addressed by the target are outlined below:

Ecosystem function

Ecosystems that are fully or partially reliant on groundwater to maintain ecosystem function are known as groundwater dependent ecosystems (GDEs). These occur across both surface and subsurface landscapes and are highly variable. GDEs have their species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC 1996).

A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the NOW website: www.water.nsw.gov.au.

Note: All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.

GDEs are classified into six broad types:

- karst and caves
- groundwater dependent wetlands
- aquifers
- base flow rivers and streams
- terrestrial vegetation
- estuarine and near-shore marine ecosystems.

Human health

This element of the target refers to the maintenance of beneficial uses of groundwater by preventing deterioration in groundwater quality or contamination by the pollutants. Groundwater pollution can take many forms, ranging from saltwater intrusion and the release of such matrix elements as iron and arsenic from over-extraction, to contamination from pollution events (eg chemical spills, leakages, or contaminated runoff into poorly constructed bores).

Economic activity

Maintenance of a range of beneficial uses (as defined by the NRC) is achieved by keeping groundwater extraction at sustainable levels. This provides a level of security of supply and decreases the risk of contamination and ecological harm occurring from over-extraction.

Within the Central West region there are alluvial, fractured rock and porous rock province groundwater management areas (GWMAs). Table 1 identifies the GWMAs in the region. The locations of the GWMAs are shown in Figure 1.

Table 1 GWMAs in the Central West region

Alluvial GWMAs	Fractured rock GWMAs	Porous rock GWMAs
Bell Valley Alluvium	Lachlan Fold Belt	Great Artesian Basin
Castlereagh Alluvium	Orange Basalt	Gunnedah Basin
Cudgegong Valley Alluvium	Warrumbungle Basalt	Oxley Basin
GAB Alluvial	Liverpool Ranges Basalt	Sydney Basin
Coolaburragundry-Talbragar Valley Alluvium		
Lower Macquarie Alluvium		
Upper Macquarie Alluvium		

The highest yielding bores are located within the alluvial aquifers of the Lower Macquarie GWMA. The depth and permeability of these alluvial sediments provide large irrigation supplies in the Narromine area. Irrigation supplies are also pumped from the high yielding alluvium of the Upper Macquarie GWMA. Yields in the other alluvial GWMAs also support irrigation, although as the depth

of the alluvium decreases, the yield diminishes.

The Great Artesian Basin is a significant resource that supports irrigation in the south of the region and grazing, farming and other industries across its full extent. The sandstone aquifers in the north-western corner of the region are over 500 m deep and yield artesian flows.

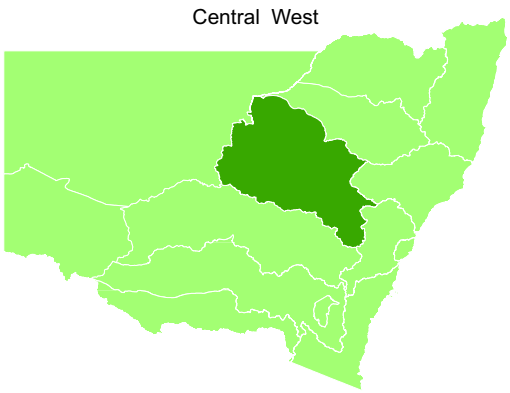
Water management plans for the Lower Macquarie GWMA and Great Artesian Basin GWMA commenced in October 2006 and July 2008, respectively. In the Lower Macquarie Groundwater Management Plan area, the level of entitlement prior to the commencement of the plan exceeded the long-term annual average extraction limit (LTAAEL). This is the proportion of the long-term average annual recharge of water to the groundwater system available for extraction. The plan reduces the level of water entitlement over ten years to the LTAAEL. Licence holders have also received structural adjustment through the Achieving Sustainable Groundwater Entitlements (ASGE) scheme to alter their enterprises to the reduced level of entitlement.

Bores into the fractured Orange Basalt can yield irrigation supplies and consequently there is a high level of entitlement within this GWMA. There is also a high concentration of stock and domestic bores in and around the city of Orange, as the aquifer is used extensively as a water supply for rural residential lots in the city's vicinity.

The Lachlan Fold Belt GWMA is present throughout the whole of the region and effectively forms the catchment basement. It outcrops throughout the tablelands and slopes. In the northern portion of the region, the Lachlan Fold Belt GWMA is overlain by the porous Gunnedah Basin, Oxley Basin and Great Artesian Basin. The Lachlan Fold Belt GWMA's lateral extent results in it having diverse characteristics, although typically bore yields are small and sufficient for stock and domestic supplies only, due to the limited permeability of the rock sequences.

In the upper catchments of all GWMAs, groundwater discharge contributes to stream base flows and springs. These systems support a diverse range of aquatic and terrestrial ecosystems, either directly or indirectly. Dryland salinity and in-stream salinity are significant issues in some areas in the mid and lower part of the region. The Central West Catchment Management Authority (CMA) is involved in the management and mitigation of dryland and in-stream salinity issues.

Map of the catchment



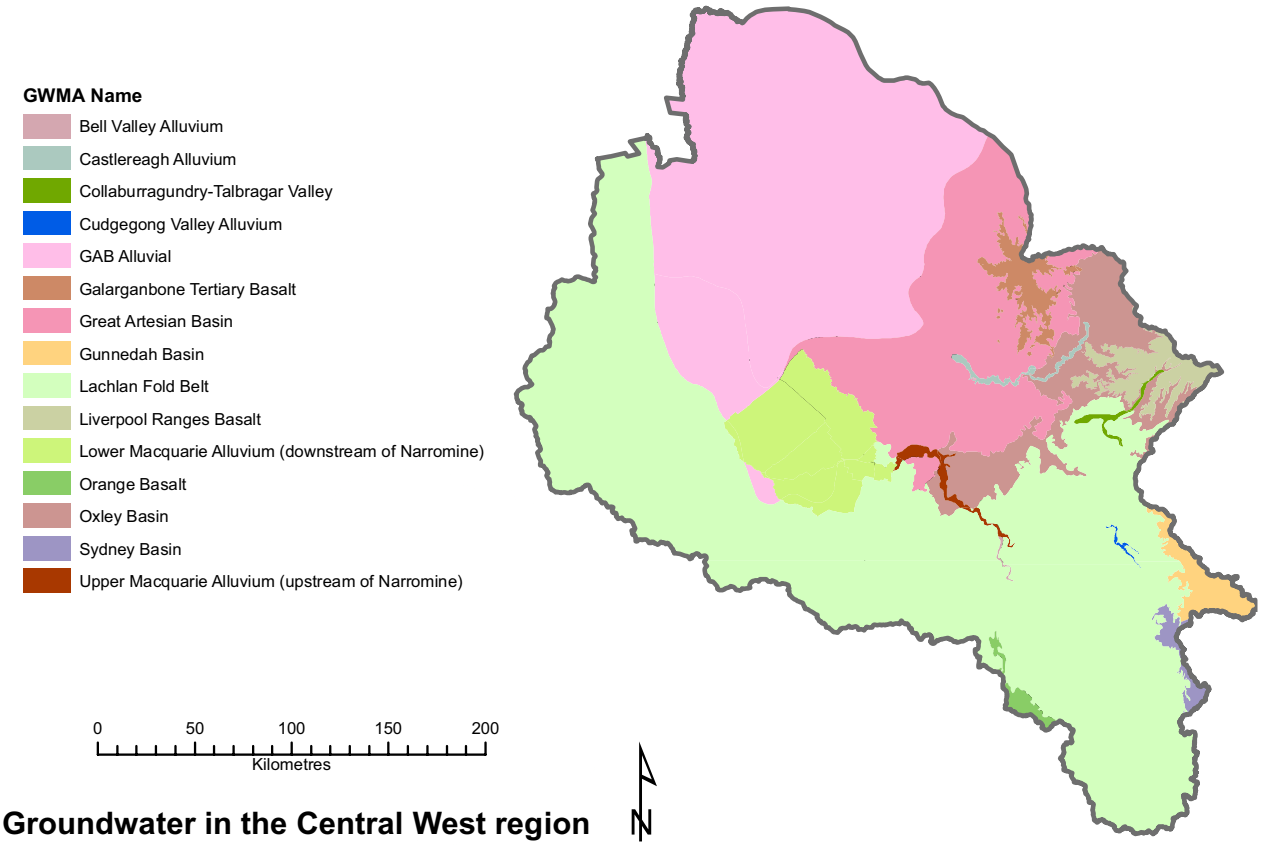


Figure 1 Central West region groundwater management areas

Assessment

The assessment of condition and pressure for the groundwater aquifers in the region has been based on the GWMAs. The assessment focuses on the whole of each GWMA, including the areas extending beyond the Central West region.

Current monitoring focuses on the influence of groundwater use on groundwater levels. Monitoring is concentrated in the areas of groundwater use for irrigation and commercial and town water supply. It consists of the monitoring of groundwater levels and metering of use.

The assessment of condition and pressure relative to the target has been based on both available information and expert opinion within the NSW Government. Seven indicators were used to assess both condition and pressure. Of those seven indicators, one was quantifiable for both condition and pressure using available information. The condition indicator quantified is the ratio of the amount of groundwater actually extracted and used in a given year compared with the LTAAEL. The pressure indicator quantified is the ratio of the total annual entitlements for extraction held by licence holders compared with the LTAAEL. Low ratios for these indicators would result in a ranking of 'very good' for condition and 'very low' for pressure.

The other six indicators used for assessing condition and pressure were determined using expert opinion, as current monitoring of aquifer systems in NSW does not provide sufficient data for more comprehensive analysis.

Condition

In addition to the quantifiable indicator of extraction vs LTAAEL, the six other indicators of

condition used to asses each groundwater source within the Central West region are described in Table 2.

Table 2 Description of condition indicators

Indicator	Description
Extraction vs LTAAEL	The total annual usage compared with the LTAAEL available for extraction
GDE condition	The condition of GDEs in the region, in terms of their access to the amount and quality of groundwater they require
Landscape condition	The condition of the wider landscape in terms of potential changes caused by land-use to groundwater quality and the volume of water available for recharging the aquifer: Increased recharge causes groundwater levels to rise, which can have an impact on the productivity of agriculture and the condition of urban infrastructure. Taken together, these measures can be used to make an assessment of landscape condition
Regional groundwater levels	Change in regional groundwater levels from the influence of extraction: Where groundwater levels are not monitored, changes in the duration of pumping time that groundwater is available for basic landholder access and other licensed users can be used as a surrogate
Local groundwater levels	Change in local groundwater levels from the influence of extraction
Groundwater quality	Groundwater quality, as measured by the following: • groundwater acidity • groundwater salinity • nutrient concentrations • contamination from heavy metals and hydrocarbons • changes in beneficial use category (resulting from groundwater quality changes) • freshwater/saltwater interface (indicated by electrical conductivity)
Aquifer integrity	The integrity of the aquifer matrix, which can be affected by dewatering and compaction with consequent ground subsidence or upsidence, or by various land-use activities

The Lower Macquarie GWMA is divided into six management zones to enable a representative analysis of the GWMA. The assessment of condition and pressure has been based on these zones.

The GWMAs in the Central West region are generally in good to very good condition (see Table 3). It is the alluvial aquifers that have the lowest condition rankings. The localised clustering of groundwater use in some of these GWMAs (such as the Lower Macquarie zones 4 and 6, Cudgegong Alluvium and Bell Valley Alluvium) is causing impacts on areas of these systems. However, at a GWMA scale the impact of groundwater use is not causing a decline in condition.

The condition assessment of the Gunnedah Basin GWMA is based on the area outside of the region

and may not reflect the actual condition of the GWMA in the region. Groundwater resources in the Central West region are generally not overused. The highest use is occurring from the Lower Macquarie groundwater sources. The level of groundwater use in the region is shown in Figure 2.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has completed an assessment of the sustainability of the surface and groundwater systems at a catchment scale as part of the Murray–Darling Basin Sustainable Yields Project. The assessment was based on 18 regions representing the major tributaries of the Murray–Darling Basin including the Macquarie–Castlereagh region. The reports can be viewed at www.csiro.au/partnerships/MDBSY.html.

Table 3 Groundwater source condition summary

GWMA no. and name	GDE Condition	Data Confidence	Trend	Landscape Condition	Data Confidence	Trend	Regional Groundwater Levels	Data Confidence	Trend	Local Groundwater Levels	Data Confidence	Trend	Groundwater Quality	Data Confidence	Trend	Aquifer Integrity	Data Confidence	Trend	Percentage Use to the LTAAEL	Data Confidence	Trend	GWMA Condition Index
008 Lower Macquarie Alluvium Zone 1		L	?		H	↔		H	↑		M	↔		L	↔		H	↔		H	↑	
008 Lower Macquarie Alluvium Zone 2					H	↔		H	↑		M	↔		M	↔		H	↔		H	↑	
008 Lower Macquarie Alluvium Zone 3		L	?		H	↔		H	↑		M	↔		M	↔		H	↔		H	↑	
008 Lower Macquarie Alluvium Zone 4					H	↔		H	↑		M	↔		M	↔		L	?		H	↑	
008 Lower Macquarie Alluvium Zone 5					H	↔		M	↔		M	↔		M	↔		H	↔		H	↑	
008 Lower Macquarie Alluvium Zone 6		L	?		H	↔		H	↑		M	↓		M	↔		L	?		H	↑	
009 Upper Macquarie Alluvium					H	↔		M	↓		M	↓		M	↔		H	↔				
010 Cudgegong Valley Alluvium					H	↔		H	↔		M	↔		M	↔		H	↔				
019 Coolaburragundry–Talbragar Alluvium					H	↔		H	↔		M	↓		M	↔		H	↔				
020 Bell Valley Alluvium					H	↔		H	↔		M	↓		M	↔		H	↔				
063 GAB Alluvial					M	↑		H	↔		M	↔		M	?		H	?				
066 Castlereagh Alluvium					H	↔		H	↔		M	↓		H	↔		H	↔				
601 Great Artesian Basin		M	?					L	↔		M	↔		L	?		H	?				
604 Gunnedah Basin		L	?		L	?		L	?		L	?		L	?		L	?				
608 Oxley Basin–Inland					M	↔		M	↔		M	↔		L	↔		H	↔				
801 Orange Basalt					M	↑		H	↔		M	↔		L	?		H	↔		M	↔	
811 Lachlan Fold Belt - Macquarie Catchment		L	?		M	?		M	↔		M	↔		L	?		H	?				
813 Warrumbungle Basalt					L	↔		L	↔		L	↓		L	↔		L	↔				

Condition

- Very good
- Good
- Fair
- Poor
- Very poor
- No data

Trend

- ↑ Improving
- ↔ No change
- ↓ Declining
- ? Unknown

Data confidence

- H High
- M Medium
- L Low

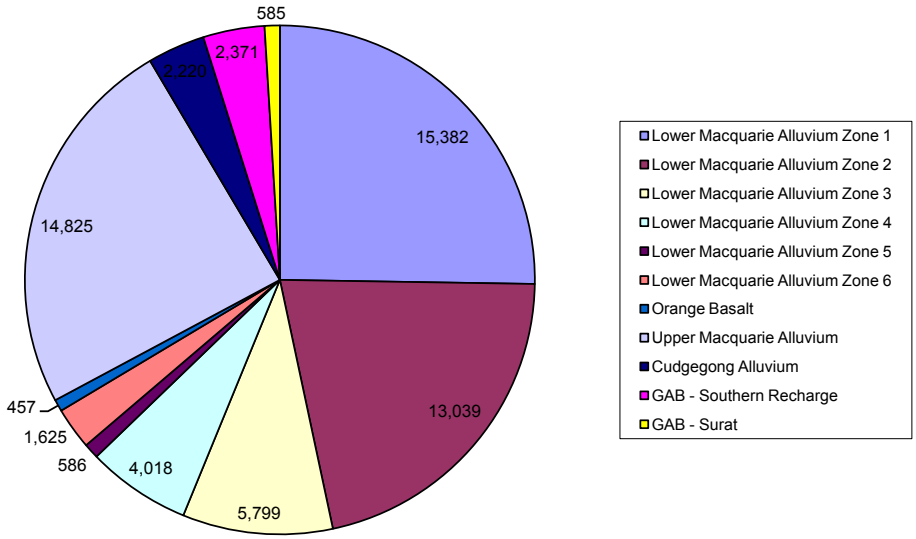


Figure 2 2007–08 metered groundwater use in the Central West region (megalitres)

At a GWMA regional scale, the level of groundwater use in the Central West region is unlikely to affect the condition of GDEs. However, there may be localised areas where groundwater use is causing impacts on terrestrial or other GDEs that have not been identified.

There are significant knowledge gaps in relation to groundwater quality and the location and condition of GDEs, especially terrestrial, wetland and base flow GDEs.

In the Great Artesian Basin (GAB) Surat groundwater source, depressurisation of the aquifer system has reduced the area of the GAB that is artesian. This is affecting some terrestrial GDEs that have a reliance on the water. The NSW Cap and Pipe the Bores Program should assist in increasing groundwater pressures and maintaining the GDEs in the region.

Dryland agriculture has caused shallow watertables and saline outbreaks on the slopes. The current drought conditions have assisted in reducing these shallow watertables and the influence of salinity is therefore declining.

There is limited information on the condition of GDEs in the region. A desktop assessment by the former Department of Water and Energy (DWE 2008) identified high priority GDEs in the region, as shown in Figure 3. The desktop assessment methodology does not currently include terrestrial ecosystems.

A trial project has been conducted on the use of remote sensing to identify groundwater dependent ecosystems (Yang et al. 2008). DECCW is investigating the surface water and groundwater relationship in the Macquarie Marshes.

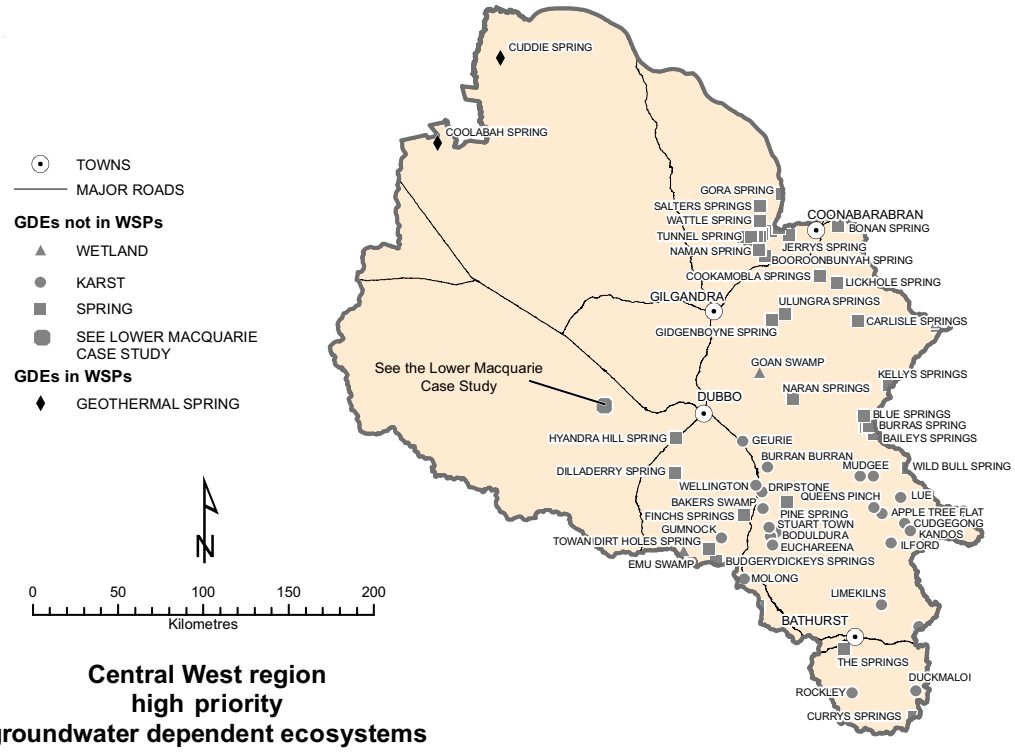


Figure 3 High priority and water sharing plan (WSP) identified GDEs

Pressures

'Pressures' in this report refers to the potential impacts of human activity on the groundwater system. (NB: This is different from the 'pressure' term as used in the discipline of hydrogeology.)

In addition to the quantifiable indicator of entitlements vs LTAAEL, the six other indicators of pressure used to assess each groundwater source within the Central West region are described in Table 4.

Table 4 Description of pressure indicators

Indicator	Description
Entitlements vs LTAAEL	The total annual entitlements compared with LTAAEL available for extraction
GDE groundwater availability	The pressure on GDEs from long-term and seasonal changes in groundwater levels, including the influence of changes in groundwater levels in highly connected systems
Land-use pressures	The pressure of land-use on aquifer systems: The indicator also identifies the pressure that shallow groundwater levels place on productive land or urban areas (eg the creation of salinity issues), and combines both these measures into a single indicator

Regional impacts	The extent to which current groundwater extraction could potentially affect regional groundwater levels
Localised impacts	The extent to which current groundwater extraction could potentially affect localised groundwater levels
Groundwater quality impacts	Potential contamination of groundwater from: • various discrete or dispersed sources • migration of water of a lower quality • acidification from exposure of acid sulfate soils through the lowering of groundwater levels • changes to seawater and groundwater interfaces from extraction in coastal sand aquifers
Aquifer structure pressures	The effect on groundwater flow systems from compaction, or changes to aquifer material through groundwater extraction and from the removal of aquifers in mining or quarrying activities

The main pressures in the region are land-use change, groundwater use in some GWMAs, groundwater quality, and the level of entitlement compared with the LTAAEL (see Table 5). The main land-use change pressures are river regulation and agriculture. River regulation has altered the natural river behaviour and its relationship with the associated groundwater aquifers. This has altered the surface water groundwater interaction with the river system. Agriculture has altered the amount of water that leaks through the root zone from rainfall and through irrigation.

The areas of the region where groundwater use is placing pressure on GWMAs are the Lower Macquarie Alluvium and Upper Maquarie Alluvium. In these GWMAs, there are localised concentrations of groundwater use, which are causing either large annual variations or long-term declines in groundwater levels.

The level of groundwater entitlement compared with the LTAAEL in the Lower Macquarie, Upper Macquarie, Cudgegong Alluvium and Orange Basalt groundwater sources indicates that full use in these areas may affect the condition of the GWMAs. The implementation of a water management plan in the Lower Macquarie GWMA will ensure that use does not exceed the LTAAEL by 2016.

There is limited information on groundwater quality in the Lower Macquarie GWMA. However, groundwater use in this area may cause an increase in groundwater salinity within the fresher aquifers. The increase in groundwater salinity may occur as a result of leakage from higher salinity aquifers, caused by the use of groundwater from the lower salinity aquifers.

The pressure assessment of the Gunnedah Basin GWMA is based on the area outside of the region and may not reflect the actual condition of the GWMA in the region.

There is limited knowledge on the location of GDEs within the region, especially terrestrial ecosystems. Their identification is required prior to any assessment of the pressure on these systems being conducted.

Table 5 Groundwater source pressure summary

GWMA no. and name	GDE Groundwater Availability	Data Confidence	Trend	Land-use Pressures	Data Confidence	Trend	Regional Impacts	Data Confidence	Trend	Localised Impacts	Data Confidence	Trend	Groundwater Quality Impacts	Data Confidence	Trend	Aquifer Structure Pressures	Data Confidence	Trend	Entitlement/Share Component to the LTAAEL	Data Confidence	Trend	GWMA Pressure Index
008 Lower Macquarie Alluvium Zone 1		L	?		M	↑		H	↑		M	↔		L	?		H	?		H	↑	
008 Lower Macquarie Alluvium Zone 2					M	↑		H	↑		M	↔		L	?		M	?		H	↑	
008 Lower Macquarie Alluvium Zone 3		L	?		M	↑		H	↑		M	↔		L	?		M	?		H	↑	
008 Lower Macquarie Alluvium Zone 4					M	↑		H	↑		M	↔		L	?		M	?		H	↑	
008 Lower Macquarie Alluvium Zone 5					M	↑		M	↑		M	↔		L	?		M	?		H	↑	
008 Lower Macquarie Alluvium Zone 6		L	?		M	↑		H	↑		M	↓		L	?		M	?		H	↑	
009 Upper Macquarie Alluvium					M	↔		M	?		M	↔		L	?		M	?		H	↔	
010 Cudgegong Valley Alluvium					M	↑		H	↔		M	↓		L	?		H	?		H	↔	
019 Coolaburragundry–Talbragar Alluvium					M	↑		H	↔		M	↓		L	?		H	?		H	↔	
020 Bell Valley Alluvium					M	↑		H	↔		M	↓		L	?		H	?		H	↔	
063 GAB Alluvial					M	↓		H	↔		M	↔		L	?		H	?		H	↔	
066 Castlereagh Alluvium					M	↑		H	↔		M	↓		M	?		H	?		H	↔	
601 Great Artesian Basin		L	↑		M	↔		L	↔		M	↔		M	?		H	?		H	↔	
604 Gunnedah Basin					M	↓		L	↔		L	↓		H	↔		H	↓		H	↔	
608 Oxley Basin–Inland					M	↓		M	↔		M	↔		L	?		H	?		H	↔	
801 Orange Basalt					M	↓		H	↔		M	↔		L	?		H	?		H	↔	
811 Lachlan Fold Belt - Macquarie Catchment					M	↓		M	↔		M	↔		L	?		H	?		H	↔	
813 Warrumbungle Basalt					M	↔		L	↔		L	↔		L	?		H	?		H	↔	

Pressure

- Very low
- Low
- Moderate
- High
- Very high
- No data

Trend

- ↑ Increasing
- ↔ No change
- ↓ Decreasing
- ? Unknown

Data confidence

- H High
- M Medium
- L Low

Management activity

Regional initiatives

The State Plan natural resource management targets are being addressed through state, regional and local partnerships. The catchment action plans (CAPs) and the investment programs that support the CAPs are the key documents that coordinate targeted projects for the improvement of natural resources across NSW. The CAPs describe the whole-of-Government approach, and specify regional targets and activities that contribute to the achievement of the state-wide targets. The Central West CAP can be found at www.cw.cma.nsw.gov.au/AboutUs/cap.html.

Land-use planning in the region is primarily achieved through local environmental plans (LEPs). All LEPs in the state are currently being reviewed by local governments in consultation with NSW Government agencies and the local community. The plans aim to ensure that appropriate

development occurs in the landscape with consideration of future population demands, economic issues and the protection of natural resources and environmental assets in the area. LEPs are statutory controls against which development proposals are assessed. With respect to groundwater, LEPs ensure that development is prevented or restricted in locations where there is a high likelihood of groundwater contamination or the potential for development to increase salinity within the landscape.

Land-use pressures

Groundwater systems in the Central West region are influenced by land-use activities such as the regulation of the Macquarie River and land clearing. Saline outbreaks occur in the mid and lower slopes of the region. The driver for these outbreaks is recharge to the aquifer system, which is increasing groundwater levels, causing shallower watertables and raising salinity generally in the lower areas of the landscape.

Management activities in the region include:

- investment in revegetation and the management of remnant vegetation and perennial pastures in dryland areas by the Central West Catchment Management Authority (CMA)
- other activities by the Central West CMA, such as:
  - community consultation on important natural resource management (NRM) issues
  - providing support to other groups and individuals for NRM activities
  - incentive programs that promote better management of salinity recharge and discharge across the landscape
  - partnering with other organisations (eg local government) to better manage saline landscapes
  - promoting efficiency of water use and reduced groundwater extraction
  - benchmarking groundwater systems (such as the airborne electromagnetic survey of the Macquarie Marshes)
- activities by a number of groups in the region, which are contributing to better outcomes for groundwater systems, such as:
  - landholders/primary producers
  - community groups
  - Stipa Native Grasses Association
  - Landcare groups
  - local councils
  - NSW Government agencies
  - Australian Government agencies.

Groundwater use and entitlement

The groundwater target is being addressed at the state level through water sharing plans (WSP) for groundwater sources where there is over-allocation of entitlements or a need to protect high value ecosystems. The implementation of WSPs, which are plans to ensure the equitable and sustainable sharing of water, will ensure long-term water level management for GDEs and other beneficial uses. However, some groundwater systems in NSW will remain under stress until current processes to reduce use to sustainable levels are complete. Key initiatives to meet this challenge include:

- continuing the implementation of current WSPs
- completing the remaining WSPs in the Murray–Darling Basin by 2011 and elsewhere before 2013
- expanding the existing groundwater level monitoring network through capital funding by the NSW Government
- adjusting future WSPs where necessary to account for climate change impacts
- effectively implementing the monitoring, evaluation and reporting strategy.

There are a number of activities being implemented to better understand groundwater systems. These include:

- expansion of the existing groundwater level monitoring network
- implementation of telemetered time series groundwater level monitoring sites in the inland alluvial WSP areas.

Groundwater dependent ecosystems

There are a number of activities being implemented around NSW to better understand GDEs, including:

- a trial remote sensing project to identify terrestrial GDEs in the Lower Macquarie GWMA
- staged spatial mapping of potential GDEs across NSW
- the investigation by Central West CMA of base flow GDEs within the region.

Further reading

ARMCANZ & ANZECC 1996, *National Principles for the Provision of Water for Ecosystems*, Occasional Paper SWR No 3, Sustainable Land and Water Resource Management Committee, Subcommittee on Water Resources, Canberra.

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Yang X, Smith P, Yu T & Gao H 2008, Monitoring evapotranspiration for terrestrial groundwater dependent ecosystems using satellite-based energy balance model, The International Archives of the Photogrammetry, *Remote Sensing and Spatial Information Sciences*, Vol XXXVII, Part B8, Beijing.

Published by: Department of Environment, Climate Change and Water NSW, 59–61 Goulburn Street. PO Box A290, Sydney South 1232.
Ph: (02) 9995 5000 (switchboard). Ph: 131 555 (environment information and publications requests).
Ph: 1300 361 967 (national parks, climate change and energy efficiency information and publications requests).
Fax: (02) 9995 5999. TTY: (02) 9211 4723.
Email: info@environment.nsw.gov.au Website: www.environment.nsw.gov.au
DECCW 2010/375 ISBN 978 1 74232 688 7 November 2010
Cover photo: J Turbill/DECCW – 'windmill in vivid red sunset'