

The Great Artesian Basin Water Resource Assessment: Update, January 2012

Water for a Healthy Country Flagship

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CSIRO, in collaboration with Geoscience Australia, is midway through an assessment of groundwater resources in the Great Artesian Basin.

The Great Artesian Basin (GAB) is Australia's largest groundwater basin. It stretches across one-fifth of Australia, encompassing arid and semi-arid areas in parts of Queensland, New South Wales, South Australia and the Northern Territory (Figure 1).

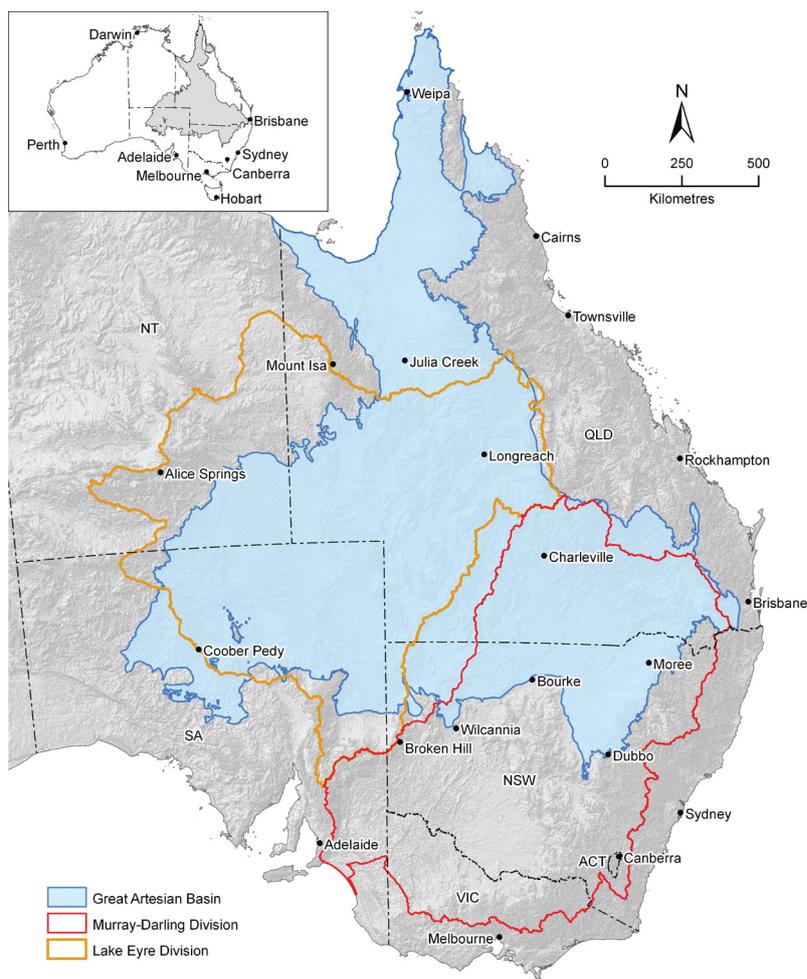
Groundwater resources in the GAB support many activities including pastoral, agricultural, mining and extractive industries and inland population centres – and demand is growing. Properly managing these groundwater resources, often for competing interests, requires a better understanding of how the whole groundwater system works. The Great Artesian Basin Water Resource Assessment (the Assessment) will help do just that by providing improved scientific knowledge to help communities make informed management decisions.

Due for completion in December 2012, the Assessment will analyse the latest groundwater data (hydrogeology, hydrochemistry) and use groundwater models to determine the current status of groundwater resources in the GAB and outline the potential impacts on them from climate change and resource development.

As well as CSIRO, Geoscience Australia is a significant contributor to the Assessment. Important aspects of the work are also being undertaken by Sinclair Knight Merz, Flinders University, the South Australian Department for Water, and MA Habermehl Pty Ltd.

Progress to date

This document reports progress as of January 2012 through brief summaries of Assessment activities and significant results to date (all final results will be available in the outputs listed on the back page).



> Figure 1. Geographic extent of the Great Artesian Basin and selected overlying surface water drainage divisions

For reporting purposes, the GAB has been divided into four regions that generally correspond with the Eromanga and Surat basins in the east and south-east, the Carpentaria Basin in the north, and the western margin flow systems that form the western extent of the Eromanga Basin (shown as shaded areas in Figure 3).

Key components of the Assessment include: data compilation and management, interpretation of the geology and

hydrogeology, development of a three-dimensional visualisation of the GAB, an update on the understanding of the dynamics of flow systems (hydrodynamics) and the water budget, groundwater flow modelling, and impacts on groundwater-dependent ecosystems.

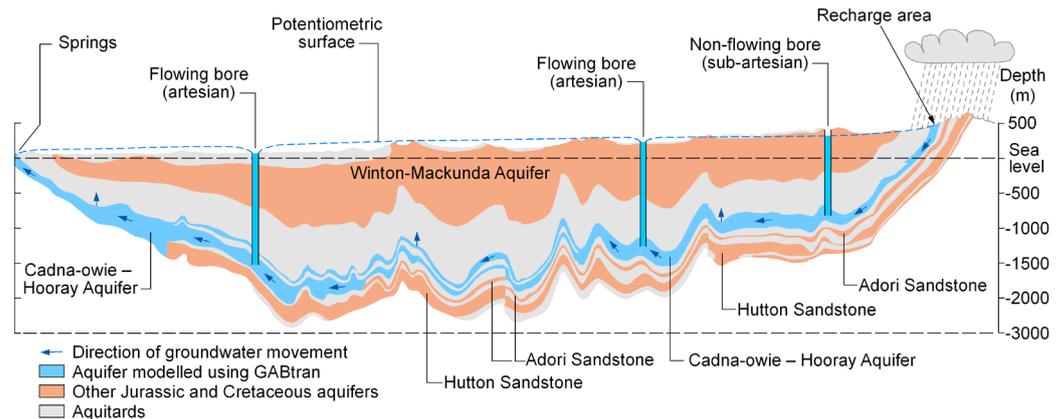
All historical data have now been collected and assessment of two of the four reporting regions (the Central Eromanga and Surat regions) is nearly complete.

Scope of the Assessment

The GAB is defined as a groundwater basin comprising layers of sandstone aquifers within rocks ranging from 65 to 250 million years old, deposited in the Triassic, Jurassic and Cretaceous periods. The Assessment is focusing on aquifers of the Jurassic and Cretaceous period, which are present across the entire GAB. Other geological formations within the GAB, such as aquifers of the Triassic period (for example, Clematis Sandstone in Queensland), may represent significant groundwater resources but are not the focus of the Assessment.

A comprehensive description of the GAB aquifers was published in 1980 and provided a basic picture of groundwater in the GAB. It described the GAB as a single, large, contiguous groundwater

> Figure 2. Basic cross-sectional portrayal of the Great Artesian Basin



flow system in which aquifers were considered to be laterally continuous across its entire extent (Figure 2).

Thus, part of the Assessment is investigating the latest geological and hydrogeological information in order to develop an updated comprehensive description of the GAB aquifers, including the geological history, structure of geological layers, and three-dimensional (3D) visualisation of aquifers and confining

layers. Another part of the Assessment is using an existing groundwater model (GABtran, extent shown in blue on Figure 2), based on the 1980 description of the GAB, to immediately assess effects of future climate and groundwater development on water levels in the Cadna-owie – Hooray aquifer, which is the main aquifer in the GAB. Undertaking these analyses for such a large groundwater basin is a considerable task.

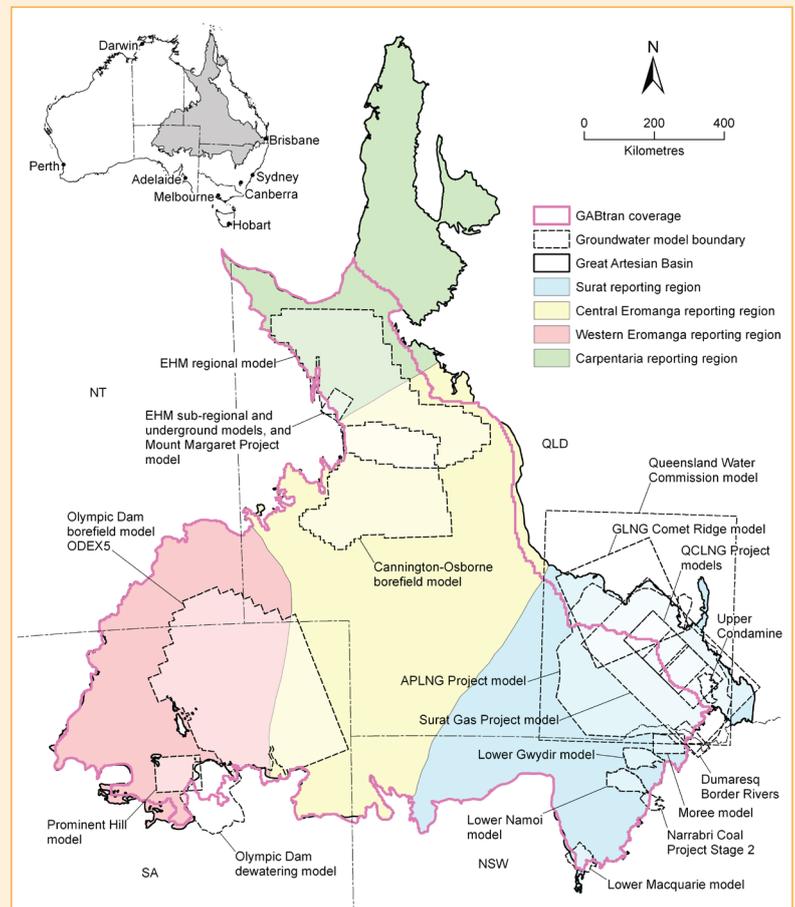
Groundwater modelling

Modelling of groundwater flow in GAB aquifers began in the 1970s for the purposes of assessing water resources and estimating environmental impacts of development. As part of the Assessment, a technical report entitled *Review of groundwater models and modelling methodologies for the Great Artesian Basin* has been prepared and will be released in the first half of 2012.

This review of groundwater models found that a total of 4 whole-of-GAB models and 18 notable part-GAB models have been developed since the 1970s (Figure 3). It also found that the existing GABtran groundwater model, originally developed for the GAB Sustainability Initiative in 2006, was the only model that could be adopted for immediate use in the Assessment.

The GABtran model only simulates groundwater flow in the Jurassic and Cretaceous aquifers as a single layer spanning the majority of the GAB (Figure 3). The model is being extended to cover the Cape York area, and will be used to simulate the effects of future climate (to the year 2070) and projected groundwater development in the GAB.

To assess the effects of groundwater development specifically related to coal seam gas development, CSIRO is collaborating with the Queensland Water Commission in the use of a recently developed multi-layer regional groundwater model for part of the Surat Basin (Queensland Water Commission model, extent shown in Figure 3).



> Figure 3. Location and coverage of groundwater models within the Assessment area

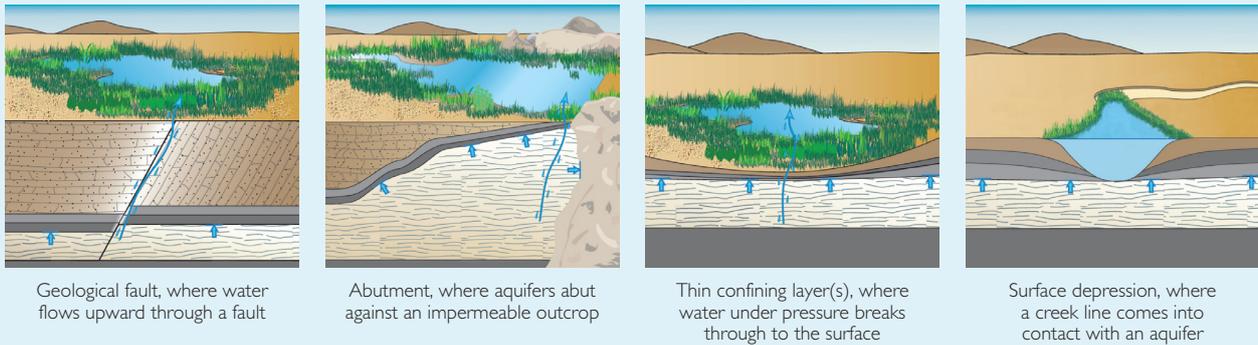
Groundwater-dependent ecosystems

Many ecosystems depend on groundwater from the GAB, particularly those associated with springs. Within the GAB, these springs are points of natural discharge at the ground surface that support biological function. They are of various shapes, sizes and biological functions and exist at a range of scales from small vents to large mounds. Natural springs and wetlands of the GAB have played

an important role in providing refuge habitat for a range of species.

The Assessment has characterised four types of artesian springs based on geological structures (Figure 4). These characterisations begin to explain the formation of artesian springs, which is needed to understand the potential impact of groundwater development.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, a total of 192 springs are listed for the Surat region and 1095 springs for the Central Eromanga region. Threatened species are associated with approximately 85 percent of the springs in the Surat region, and 46 percent of the springs in the Central Eromanga region.



> Figure 4. Depiction of the geological structures that form springs in the Great Artesian Basin, developed by Queensland Department of Environment and Resource Management

Hydrogeology

Across much of the GAB, the Jurassic and Cretaceous beds form a complex of multi-layered sandstone aquifers that are separated and partly confined by aquitards (confining layers) of both fluvial and marine mudstone and siltstone.

The Assessment is midway through its reinterpretation of existing geological and hydrogeological information. Reinterpretation of the layering of aquifers and aquitards is leading to an updated portrayal of the GAB hydrogeological framework, referred to as the hydrostratigraphy.

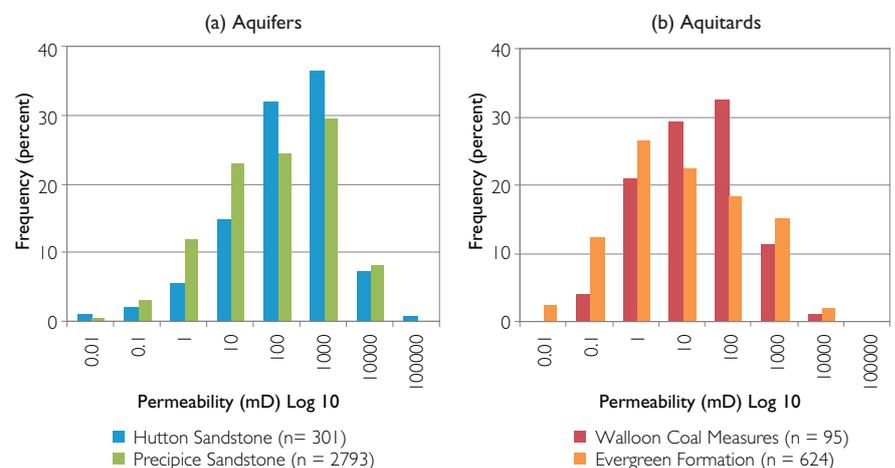
The hydrostratigraphy of the GAB is a result of four independent but overlapping geological mechanisms that have occurred since the rocks were deposited: continental tilting, subsidence, sea-level change and sediment loading from volcanic sources along the eastern margin of the continent. Understanding this geological evolution helps explain the artesian basin observed today and the physical properties of the rocks that govern groundwater movement.

Information on the physical rock properties that describe the ability to store water (porosity) and conduct water (permeability) have been collated from petroleum exploration databases in Queensland and South Australia.

Preliminary analysis for the Surat region reveals that geologic formations containing aquifers (Figure 5a) have average permeability values between 100 and 1000 milliDarcys (mD), with only a few below 10 mD. The geologic formations known to contain aquitards (Figure 5b) have average permeability values between 10 and 100 mD. Permeability was measured in a laboratory using a rapid assessment technique performed at atmospheric conditions for temperature

and pressure – different than for natural conditions present in the subsurface. As a result, measured values for the rock properties of aquitards are often less accurate than for aquifers. Accurately measuring the properties of low permeability rocks is an ongoing challenge in geosciences.

Reinterpretation of the geology and assessment of the physical properties of aquifers and aquitards are the first steps toward better defining the groundwater resources of the GAB.



> Figure 5. Permeability variation for selected aquifers and aquitards in the Surat region (n indicates the number of measurements). Units expressed in milliDarcys (mD), where 1 mD is equal to 10^{-15} m^2

Hydrodynamics

The mechanics of groundwater flow in the GAB, known as hydrodynamics, are governed by geometry and physical properties of the sequence of aquifers. To assess flow and the evolution of groundwater in the GAB, the Assessment is analysing all available groundwater monitoring data, including pressure, temperature, salinity and hydrochemistry.

Reliable groundwater pressure measurements have been made since the early 1900s. For the first time, maps of the pressure in the Cadna-owie – Hooray Aquifer have been plotted for 20-year intervals from 1900 to 2010 (example shown in Figure 6). Once analysis of the data is complete, changes in the pressure from pre-development (circa 1900) to the present day can be mapped.

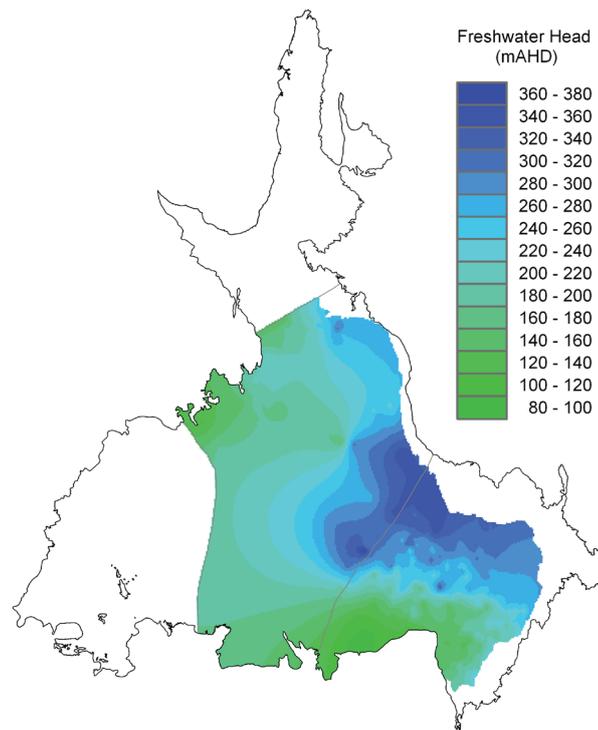
The Assessment is currently analysing vertical profiles of pressure with depth to illustrate where the potential for vertical groundwater flow (across layers) exists. The Assessment is also currently reviewing hydrochemical and isotopic data to delineate spatial trends that will help better understand groundwater flow.

Next steps

Analysis of geological and hydrogeological data will be finalised for the Surat and Central Eromanga region by mid-2012. Concurrently, the Assessment will be extended to include the Carpentaria and the Western Eromanga regions. Recent research funded by the National Water Commission – the *Allocating water and maintaining springs in the Great Artesian Basin (SA and NT)* project – will be incorporated into assessment of the Western Eromanga region.

The GABtran model will be extended into the Carpentaria region and will be used to assess future climate and groundwater development scenarios. The GABtran model will also be subjected to a rigorous analysis of uncertainty.

A collaboration and data transfer agreement has been established between CSIRO and the Queensland Water Commission to improve modelling the potential impacts of the coal seam gas industry in the Surat region.



> Figure 6. Preliminary map of artesian pressure for pre-development (circa 1900). Values are expressed in metres of freshwater head above Australian Height Datum (mAHD)

Assessment outputs

The main reporting outputs of the Assessment will be four region reports: the Surat, Central Eromanga, Western Eromanga and Carpentaria regions. In addition, a whole-of-GAB report will be compiled.

The region reports will be summarised in 4-page summary reports intended for a public audience. Similarly, the whole-of-GAB report will be summarised in a 12-page synthesis intended for a public audience.

Four technical reports will provide technical detail underpinning the region reports.

Other outputs include a computer-coded groundwater flow model, data used and produced by the Assessment (housed at Geoscience Australia), and a 3D visualisation of the GAB.



Australian Government

Department of Sustainability, Environment,
Water, Population and Communities

National Water Commission

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