18. GROUNDWATER QUALITY AND AVAILABILITY

18.1 PROCESSES

18.1.1 Cause

Groundwater begins with rain that infiltrates into the ground. The amount of water that infiltrates varies widely, depending on the land surface, permeability and moisture content of the soils and geological features such as the exposure of rock fractures at the surface. Groundwater is part of the drainage system that maintains supply to the rivers and creeks and wetlands. Water that does not infiltrate becomes surface water and reaches the drainage system more quickly by overland flow.

Groundwater can be stored in the saturated soil (unconfined water table) immediately below the root zone, or deeper down in the confined aquifers in rock formations. A description of the types of aquifers can be found in Section 10 - Hydrogeology. It is from the deep aquifers that water is extracted through bores for stock and domestic use or irrigation supplies. The latter are mostly located in alluvial aquifers associated with current or old river paths, which have high yields due to their very significant porosity.

Groundwater moves from points of recharge to points of discharge. This may be into swamps, rivers, springs or at the ground surface if rises in the water table have occurred and a new equilibrium is being established. Flow rates are generally quite slow i.e. < 1 metre / day, but can be as slow as only a few mm / day if the permeability is low, or may be much faster in areas with large openings in the rocks. Flow paths are usually parallel and consequently there is little mixing between the different sources of water. However, the construction of bores through a number of aquifers allows the water to mix.

Groundwater commonly feeds into streams and rivers; however, the converse also happens and the stream may provide water to the aquifer, particularly when streamflow is high and the watertable is low.

Faulting is an extremely important process in ground water movement. Movement of water occurs through the cracks left from faulting. Some explanation of the nature of faults and their role in groundwater movement is provided in Section 10. Faulting and other geological formations can also result in barriers that can cause groundwater to rise, resulting in discharge at the surface. Faulting and fractures can also impact on unconsolidated alluvial aquifers, causing a build up of gravel and other unconsolidated materials to great depths and an accumulation of water behind these faults.

18.1.2 Upstream/Downstream Inter-Relationships

The removal of trees and other perennial vegetation has resulted in increased recharge across much of the landscape, which has led to rises in water tables and Standing Water Levels in confined aquifers.

Recharge for deep regional groundwater systems such as the limestones in the Lachlan Fold Belt, can occur many miles away from the source, and take very long periods of time to move through the system. In this case, the individual farmer has little opportunity to impact on the process. In small local systems, recharge and discharge sites may be within the same property or the same hillslope. In this instance, it is possible for the landholder to impact on the process.

On the other hand, extraction of ground water also has an influence on the surrounding area. Pumping lowers the watertable in the surrounding area - known as the "cone of depression". This causes groundwater flow to be diverted toward the bore. Where large quantities of water are being extracted, this can be to the disadvantage of nearby smaller bores that are not so deep, and can infact cause these shallower bores to run dry periodically. In some situations where bores are located near to a river or creek, the cone of influence may extend to the river, which then contributes water to the bore being pumped through "induced recharge". DLWC often puts license conditions on new bores to maintain a certain distance (often 400 metres) away from any other bores in order to minimize the impact of the cone of influence.

18.2 PRESENT CONDITIONS

18.2.1 Distribution and Severity

Whole zones of faulting occur, and may include regional linear faults, which can transfer water over very large distances in the landscape, e.g. the limestone formations in the Lachlan Fold Belt. The limestone aquifer, which includes cavernous rocks, is a large regional system, and has a hydraulic gradient from the south i.e. ground water flows northward through the catchment. This aquifer yields adequate water for irrigation, mostly to the south of the catchment, but not much in Little River. The aquifer will be subject to a Groundwater Management Plan (yet to be completed) and irrigators can expect to experience reductions in water allocations.

Unconsolidated alluvial aquifers occur along the Macquarie, including around the confluence with Little River. It is possible that a major lineament runs north east through Toongi and Wongarbon, and has resulted in a massive build up of alluvial deposits on the Macquarie River to beyond Ponto and also into Barneys Gully and the Arthurville area in the Little River catchment. (This same lineament may also be the reason that the Talbragar dramatically alters in course from downstream of Ballimore to just upstream of Elong Elong.) (Pers. comm. Ann Smithson, DLWC, Dubbo March, 2000)

The Upper Macquarie Alluvial Aquifer was classified as a medium risk aquifer in the NSW Water Reforms - Aquifer Risk Assessment Report.

There are numerous fractured rock bores located in the hard rock formations throughout the catchment, especially in the volcanics, which yield enough water to provide stock and domestic supplies. Landholders in the Baldry and Cumnock areas are concerned about the quality of groundwater, particularly iron content around Baldry and the increasing salt concentrations.

18.2.2 Environmental and Socio-Economic Impacts

Where water tables have risen to within 2 metres of the surface, seepage is occurring. In many areas, this is causing dryland salinity due to the salts dissolved in the ground water or mobilized in the soil. Where salts are not present, then waterlogging occurs at these sites. In Yeoval, groundwater levels are very close to the surface and during winter, there are problems with septic systems seeping through the soil surface. There is also the potential for groundwater contamination. Cabonne Shire and its rate payers are having to pay increased rates to convert septic systems to sewerage. Any reduction in water entitlements will certainly have negative economic benefits to irrigators. However, there are likely to be very few landholders affected in Little River.

18.3 THE FUTURE
18.3.1 Trends

Preliminary analysis of the SWL in bores on the Wellington sheet indicates that watertables have risen on average 1.6 metres in the ten years since the 1989 bore census, and the average depth to the water table is 6 metres. However, this depth varies with location. DLWC is developing maps of salinity risk areas for groundwater contours for the Mid Macquarie region. The maps for Wellington and Dubbo are almost completed (Pers. comm. Ann Smithson, DLWC, Dubbo March, 2000)

18.4 CURRENT ACTIVITIES

18.4.1 Consultation
As part of the water reform process, the Macquarie Groundwater Management Committee has been established to make recommendations on the future entitlements and allocations for groundwater irrigation licenses. These committees have a responsibility to consult with the general community. However, any decisions are expected to only have limited impact on the people in Little River catchment as there are thought to be only a few irrigation licenses along the Macquarie floodplain and maybe a few in the Limestone aquifers.

18.4.2 Planning

As yet no Groundwater Management Plan has been developed for the Upper Macquarie Alluvium or for the limestone aquifer system that extends the length of the catchment and originates to the south. Once implemented, these plans will be reviewed on a five yearly basis and will apply the goals and principles of the Groundwater Policy at a local level.

18.4.3 Research and Development

A few PhD research projects have been carried out in the Little River Catchment. These projects include investigation of the hydrogeology in the Arthurville area (Nahla Matti pers.comm. Orange Ag College), and hydrogeology and dryland salinity in the Suntop (Callan (2)) and Burgoon (Kazemi (50)) areas. The latter studies are focused on the Canowindra Porphry Volcanics. These projects have been supported by Hydrogeological Assessment for Salinity Landscapes Management - HASLAM Project.

The Salinity Group within DLWC, Central West believe they now have a reasonable understanding of the salinity processes in some parts of the catchment, particularly in the Hervey Ranges and around Yeoval. However, the processes are less well understood in the central section of the catchment.

The "Mid Macquarie Project" covers the upper reaches of the Macquarie valley and is being undertaken by DLWC with NHT funds. It includes the Regional Census of Bores in fractured rocks to assess changes in the depth (SWL) and the electrical conductivity of the groundwater. Twelve -15 sites / 100 000 sheet are being analyzed, and compared with data from the 1989 bore census and also from the time of construction. Selected bores are preferably deep i.e. > 30 metres and access only one aquifer. SWL's are closely correlated with climatic conditions and so where possible bores are selected that were constructed in similar conditions - in this case, dry times have been selected

As well, a review of all the original bore logs is being carried out in an attempt to produce a contour map of the depth to water table (at the time of construction). This has been completed for the Wellington and Cumnock sheets, but has not been digitized and consequently is not available. This is being undertaken through the Salinity Hazard Mapping program.

Aeromagnetic data for the Narromine sheet has been purchased by DLWC Salinity team, and will assist in revealing information about the underlying geological structures, which will help understand groundwater movement.

Projects funded by the Bureau of Resource Science (BRS) (formerly part of the Australian Geological Survey Organisation (AGSO))- are looking at magnetics, radiometrics, bore data and deep seizmology, and water use in hydrogeological provinces in the Mid Macquarie Valley.

Remapping of the known salinity sites in the catchment has been completed and will be available for the whole catchment once digitizing into the GIS is complete.

18.4.4 Monitoring and Evaluation

Electro-Magnetic Induction EMI surveys have been undertaken for the Landcare Groups of Arthurville, Myrangle, Hervey Ranges, Suntop, Burgoon, Saddleback and Yahoo Peaks and soon at Yeoval. The EMI reports are in various states of completion and some require further analysis prior to being delivered to the Landcare Groups.

Numerous shallow piezometers have also been installed on properties within the same Landcare groups. However, very little data has been collected or collated, except in Arthurville where they are read bimonthly and one site at Myrangle.

Nested deep piezometers, which tap into the individual aquifers, are needed in various parts of the subcatchments, (not only in discharge areas) to obtain information on groundwater flows and pressures, and the extent of the supply. While existing production bores can provide some useful information, they may be yielding water from more than one aquifer, so their chemistry, yield and pressure are a reflection of all the aquifers and may give meaningless or misleading information. Continued monitoring is essential to understand what is happening with recharge and whether water tables are rising. This data is necessary to characterize the catchments and prioritize the areas where preventative management practices need to be implemented.

Shallow piezometers only give trend data and an indication of what is happening near the surface - which is very short notice relative to geological timeframes.

Where ground water is extracted for irrigation, only the pumps in the alluvial areas are monitored.

18.4.5 Best Management Options (BMOs)

Ann Smithson (Hydrogeologist, DLWC, Dubbo) has made the following recommendations about requirements for monitoring bores, in order to provide useful information on groundwater flows and changes in SWL and water quality.

- Remeasure bores on a regular basis - at least every ten years and preferably 5 years
- Data at the time of construction is not a very good reference point
- Need to determine the correlation between climate and the original SWL
- Specify priority areas for more detailed monitoring and assessment
- Increase the number of departmental monitoring bores in fractured rock and, where they meet selection criteria ,add to original bore monitoring network,

Monitoring bores need to be installed to understand the groundflow characteristics in the subcatcments. Data from peizometer network and stock and domestic bores are inadequate to provide useful information.

18.4.6 Institutional

The NSW Government introduced a Groundwater Policy as part of the Water Reform Process. The Policy document covers Groundwater Quality Protection, Quantity Management and Dependent Ecosystems. Management tools associated with this policy include Groundwater Management Plans, guidelines for Local Government and industry, aquifer availability and vulnerability maps for NSW, education strategy, legislative mechanisms for groundwater management, licensing tools and conditions for groundwater users and economic instruments applicable to groundwater management (42).

Other associated pieces of legislation include the Water Administration Act 1986, Environmental Planning and Assessment Act 1979 and the Protection of the Environment Operations Act 1997 (incorporating the Clean Waters Act 1970 and the Environmental Offences and Penalties Act 1989).

18.4.7 Investment

The Water Reform Process is backed by $117 Million budget over the whole state. Benefits include improved monitoring investigations and Waterwise subsidies for improvements to on-farm layouts and water distribution. Significant amounts of money from Salt Action and NHT have been invested in the catchment for the installation of piezometers, Electro-Magnetic Induction surveys and the Mid Macquarie project. The HASLAM provide funding for PhD research projects.

18.5 ANALYSIS

18.5.1 Identified or Perceived Gaps

The lack of information about the hydrogeology on a whole catchment basis is a real limitation to analysis and interpretation of the processes driving dryland salinity in Little River. There has been no funding provided for the installation of nested deep piezometers, so there is no capacity to characterize catchments and consequently no ability to prioritize which catchments should be the target of preventative management treatments. These monitoring bores cost around $100/m for installation, but shallow piezometers and EMI surveys cannot substitute for the understanding they can provide about the hydrogeological processes.

Although efforts are being made in the Regional Bore Census to correlate rainfall and bore levels there are some difficulties in interpreting changes over time in the bores selected. In some cases the same bores could not be located, so it is not sure whether even the same aquifers are being read. Much credence is being given to the MDBC Salinity Audit; however, only two points in time were used to reach the conclusions, with no correlation for climate.

There are a number of inadequacies in the Electro-Magnetic Induction surveys. As electro-magnetic induction is strongly influenced by a range of attributes including soil moisture, clay content, electrical conductivity due to salts and other less readily explainable factors, it is necessary to ground-truth the results and undertake laboratory analysis to be able to interpret the EMI readings. Surveys should be undertaken over a short time frame to reduce the impacts of different climatic conditions on the results. The raw data from EMI surveys can be quite misleading if not validated by laboratory testing. Delays in writing up and releasing the reports following the surveys means that in some situations the data may be out of date and hence some of the benefits are lost in utilizing the maps as potential land management tools.

Although there are numerous shallow piezometers installed across the catchment, very poor use has been made of this investment, as readings have not been made regularly, nor collated and analyzed. Many of the piezometers in the area need to be pumped out and cleaned to ensure an accurate data set is obtained. At present, many are only useful for monitoring change, not providing information on the actual SWL or electrical conductivity. Unless electrical conductivity readings are taken from piezometers which have been pumped out, they are not a true reflection of the salinity levels of the ground water, as concentration by evaporation or dilution by rainfall may significantly affect the readings.

18.5.2 Key Stakeholders and Contacts

Department of Land and Water Conservation
Ann Smithson - Hydrogeologist, Dubbo
Greg Brereton - Manager Groundwater Services, Dubbo
Gabriel Salas - Hydrogeologist, Dubbo
Madhwen Keshwan - Hydrogeologist, Dubbo

Bureau of Resource Sciences
Mark Glover
Peter Baker
Jim Kellett - GAB Consultative Committee

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