Groundwater Management in NSW

Challenges and Opportunities for Groundwater Management in NSW

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DPE

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1. Purpose

Dr Andrew McCallum from DPE-W approached Jacobs on 3/6/2021 to write a brief 10 page Problem Statement on Challenges and Opportunities for Groundwater Management in NSW. The intended target audience is NSW Treasury and similar non-technical stakeholders. The intention of the Problem Statement is to identify issues and provide a justification for groundwater reforms in NSW.

2. Groundwater: an opportunity for our water future

2.1 Why we need a major shift in the focus on groundwater management: the problem.

Groundwater is the water resource of the future. Groundwater offers considerable scope to underpin economic and societal growth through appropriate use of groundwater. Groundwater sources offer substantial benefits over other water supply options, in terms of security of supply (compared with surface water), no evaporative loss (compared with dams), smaller capital and distribution costs (compared with seawater desalination), smaller environmental impact and greater investment certainty. Furthermore, there are existent and emerging water management challenges which groundwater can play a key role in addressing.

Groundwater management and use has proven that actions now are essential to provide the foundation for the sustainable use of this vital resource. Judicious management adopted from the outset avoids the need to remediate in the future. This is because a fundamental characteristic of groundwater is that problems are slow to develop, and also slow to remedy. This means that long term planning is the key to groundwater management. Economic prosperity of many regional areas in NSW depends on sustainable long term groundwater use and management.

The community is calling for greater participation in groundwater management decisions and much better transparency of decision making. Closely linked to this is that the community also want better defined certainty for investment decisions. The availability of groundwater is a key factor in supporting communities and enabling economic growth. This is in the context of greater stress on all water resources due to population growth, new industries, land use change conflicts and climate change. Technology change also offers new opportunities for some aspects of groundwater management to be more efficient. These and many other reforms are outlined in this report. To achieve greater resource use efficiencies and less conflict a range of key challenges and opportunities are discussed below. The challenges listed can also become opportunities if the required activities are undertaken.

A 30 year planning time fame is proposed, i.e. up to 2050, however these challenges need to be addressed now if there is any serious intention of achieving them by 2050.

2.2 Value and Status of the resource: why it matters

In NSW, groundwater comprises 20% of all water use. Groundwater is the sole water source for over 150 towns in NSW. Across NSW there are more than 10,000 groundwater license holders and many thousands more landholders have a right to take groundwater for domestic and stock purposes. Groundwater supports economic development with over $1 billion generated for the state economy through different activities requiring groundwater (DPE, 2022). There is potential for more use in some areas to support human activities.

Projections of climate change in NSW and the effect it will have on rivers and wetlands suggests that the large and climate-resilient supply offered by groundwater is going to become increasingly important to sustain the level of water use we have at present, or to grow. The ability of groundwater to store large volumes of water and to supply water even through severe droughts is groundwater’s fundamental to society.

Groundwater flows into almost all rivers in NSW and is the major process keeping rivers flowing each dry season. As such groundwater maintains river flow and, in this sense, its economic significance is much greater than direct consumptive use only. Groundwater also plays an integral role in maintaining the health of ecosystems – so called Groundwater Dependent Ecosystems (GDE). GDEs include almost all streams in NSW, wetlands, lakes, vegetation, and many other subtle environmental processes (for example coastal fish breeding).

NSW aquifers are under various levels of stress from development. Some of the major alluvial aquifers in the Murray Darling Basin are over-developed. The many coastal aquifers are generally fully developed. In contrast most the porous rock aquifers have potential for greater sustainable groundwater usage. This broad range of development status calls for an equally broad range of management responses.

2.3 How to ensure sustainable extraction: sustainable to whom?

The key purpose of defining the amount of groundwater that can safely be extracted (the sustainable yield) is to ensure long term access to the resource and to avoid significantly adversely impact on the environment (which includes rivers and streams). This has a major impact on agricultural productivity. In NSW many of the major aquifers are over developed, resulting from insufficient understanding of the sustainable yield when the aquifers were being developed. This has resulted in a significant loss of wasted capital (in terms of dry bores, unused pumps, empty pipelines, unused irrigation infrastructure, poor security of supply to urban water supplies), social disruption and degradation of the environment.

Defining the sustainable yield is initially a technical task involving monitoring, data assessment and impact assessment. Following this the water resource managers (DPE) and the community need to make difficult decisions about trade offs between competing uses (e.g. S&D uses, irrigation users, urban users, new mines, the environment, impacts on stream flows etc.) This second step is often where it is difficult to reach broad consensus. There is a pressing need for a higher standard of technical input, based on evidence, and community participation to achieve efficient and equitable use of this vital resource. Increased competition in regional areas for groundwater can create contentious conflicts and antagonise rural communities against economic development. During droughts the robustness of the sustainable yield decisions become especially critical, as there is increasing pressure to make available what may appear to be a bountiful source of water.

2.4 Climate change: planning for the future

With climate change leading to further water insecurity, groundwater will become an even more strategic resource for rural communities and economic activities. Longer drought periods will also increase groundwater demand as river flows decrease. These same climatic change processes also affect how groundwater is replenished, how often, and by how much.

A recent study for DPE-Water (CSIRO, 2011) suggests average decreases of 15% in diffuse groundwater recharge across the state by 2050. These adverse impacts are important but are generally less severe than for surface water supplies. Furthermore the huge groundwater storage and minimal evaporation means that groundwater is more resilient to climate variability, so long as it is managed effectively. The World Bank (Clifton et al., 2010) advocates groundwater as one of the key climate change adaptation options. But this option is only realistic when groundwater is an integral part of a long term strategic plan.

2.5 Groundwater management planning: getting community buy-in

The primary tool used by government to achieve the significant benefits of efficient groundwater use is the Groundwater Management Plan (GMP), as described by Foster et al., 2015. NSW has a well developed groundwater planning process, primarily through the Water Resource Plans. However many of the policies and procedures have not kept pace with modern technologies, practices and priorities.

Groundwater planning and management challenges often tend to be poorly understood or overlooked despite groundwater's strategic importance for many communities and economic activities (e.g. mining, irrigation). Groundwater management is also challenged by a lack of information and incomplete regulatory frameworks. Meanwhile, aquifer depletion and poor quality threaten community livelihoods, supply security, as well as ecosystems. Good GMPs that are "owned" by the local community are designed to address these, and other, issues.

Expensive efforts were made through the Structural Adjustment process in the early 2000's to begin to address the over development in major aquifers in the Murray Darling Basin in NSW, as shown in Table 2.1. This cost Federal and State government taxpayers $135 million and resulted in significant community conflict. The challenge now is to ensure that our groundwater management evidence base and the subsequent planning is sufficiently robust so that communities and government do not need to go through this process again in the future. Clear rules are required about water sharing and conflict resolution in GMP's. The ultimate aim is to have communities engaged and educated.

GMP's need to address a range of relatively new issues such as how to make water level response management more widespread, how and if to use brackish groundwater, and if strategic groundwater reserves should be set aside for future strategic reasons, e.g. new industries, drought and emergency reserves, urban demand.

Table 2.1: Entitlement reductions for the major aquifers in the NSW MDB.

Valley	Pre Plan Entitlement (ML)	New Entitlement (ML)	Reduction (ML)	% Reduction
Gwydir	65,885	28,719	37,166	56
Lower Lachlan	206,455	105,654	100,801	49
Murray	267,440	83,580	183,860	69
Murrumbidgee	512,409	267,500	244,909	48
Lower Macquarie	133,730	65,524	68,206	51
Upper and Lower Namoi	438,475	167,102	271373	62
Total	1,624,394	718,079	906,315	

A key component of GMPs is to encourage more efficient groundwater use. This essentially is focussed on efficient irrigation water use. A combination of government policy, market mechanisms and education are required to significantly improve water use efficiency. Large improvements have occurred in many countries over the last 20 years and Australia can learn a lot from these practices.

2.6 Addressing the gap between entitlement and use: a locked up opportunity.

There is often a large difference between groundwater entitlement and actual use, with many aquifers having entitlements being at least double the use. This has often been brought about by the wet period in the 1970's where it was, incorrectly, assumed that the typical recharge rate was far greater than what has subsequently been observed. This has resulted in many irrigation license holders "sitting" on large entitlements, and in recent decades this has been seen like their superannuation. This has acted to "lock up" groundwater resources and hence retard new investments.

NSW has partially addressed the issue by introducing the concept of the LTAAEL (Long Term Average Annual Extraction Limit) whereby annual determinations are announced. This approach has short term merit, but does not address the long term problem. A rational and efficient method to address long term unused entitlements (without paying compensation) is required as part of the groundwater management planning process, at both a State policy and a local scale.

2.7 Management and monitoring cost recovery: who pays?

NSW Government funded groundwater management and monitoring activities and those activities funded through groundwater license fees represent an inadequate funding base to achieve the reforms required for upgraded groundwater management in NSW. This has resulted in inadequate investment in management, investigations and research, and inadequate and worsening monitoring infrastructure. Even though some minor increase in cost recovery is possible through user fees and charges this will not be nearly adequate to support the significantly upgraded effort required. An increase in government funding is required over the next decade at least.

2.8 Metering, monitoring assets and information management: the need for data

Fundamental to groundwater management is good quality and timely data, specifically usage data, real time groundwater level data across the 4,700 state observation bores, groundwater quality data at intervals of at least 6 monthly, land use change data, temporal and spatial evapotranspiration data and many other data types. However the majority of this data is provided via the state observation bore network. This predominantly mild steel network was gradually constructed mainly during the 1970's to 1980's and is now in urgent need of maintenance, refurbishment or abandonment and replacement. This asset represents a very significant capital investment of over $256.8 million (Synergies Economic Consulting, 2016). Current funding only allows for a fraction of the network to be maintained.

Actual usage data from bores is generally measured by flow meters. Most of these meters are relatively old propellor type meters which are frequently not accurate, not calibrated and not maintained. This encourages illegal use and under reporting of use. A 20 year program to gradually upgrade these meters is required. In some countries with high groundwater use (e.g. China, Spain, Western USA) groundwater metering is being phased out as being too expensive and unreliable. These nations have turned to satellite based remote sensing to indirectly measure groundwater use over large areas. This new technology should be considered for areas of intensive groundwater development in NSW.

All these data types are distilled, using groundwater models and other methods, into information that is the fundamental basis for management. However modelling resources are limited, monitoring networks are outdated and educational material needs upgrading.

2.9 Surface water groundwater interaction: the taboo topic

Many technical studies undertaken over the last 20 years have clearly shown that surface water groundwater interaction is a major issue in much of eastern Australia. Nathan and Evans (2011) and Walker at al. (2020) discuss the basic concepts whereby almost all groundwater pumping within a catchment ultimately reduces stream flow in that catchment. How much of a reduction that occurs is a function of many technical factors. However the challenge is that this impact on stream flow can occur rapidly (in days) or gradually over many decades. When this occurs outside of the irrigation season (i.e. more than say 6 months) then few state governments have developed water management plans to deal with this gradual reduction in stream flow. Furthermore because of a lack of understanding of this basic process the same parcel of water (groundwater and surface water) is counted twice, leading to an overestimate of the total available water resource in a catchment.

The NSW water sharing guidelines deal with the situation where the bore is highly connected to the surface water system, is close to the banks of a river, and where the impact is felt within the irrigation season. However dealing with the long term impacts and bores far away from the river is a more difficult challenge and hence most governments, including NSW, have found it difficult to allow for this. The water planning rules that have been developed are not based on a great deal of science. Devising a management approach, supported by real science, is a clear priority for reform.

2.10 Provisions for GDE usage: finding the balance

The protection of Groundwater Dependent Ecosystems (GDE) is enshrined in legislation in all states in Australia. However when it comes to making environmental water provisions in GMPs there is frequently scepticism in the community and at times clear opposition. This is often because the basic science has not been undertaken in the local GMP area and because the GDE provision takes water away from the users. In some cases an overly precautionary approach has been taken which is not supported by the science. Finding the balance for protection of GDE's and making groundwater available is a difficult decision. NSW does not operate a no impact policy. A clearly articulated state policy combined with sufficient science to support a local GMP will aid this process.

2.11 Efficient groundwater trading: great opportunities, but not as simple as first thought

Temporary and permanent groundwater trading has been a very positive process in NSW water management. There were 742 temporary trades and 65 permanent trades in 2020/21. Trading has achieved its intended purpose of freeing up new water for economic development. However the approval process has been heavily criticised as being too slow and costly, and from a DPE point of view it has become very burdensome. Effectively the approval of a permanent trade is equivalent to the granting of a new license. Methods to streamline the process need to be considered, especially the development of new data bases and making the traded price public. Secrecy of this important data is contrary to good market mechanisms.

2.12 Managed Aquifer Recharge: making it happen

Managed aquifer recharge (MAR) has been hailed as one of the major technical solutions to address groundwater over development issues, tackle climate change and to make more "new" water available. National guidelines have been published of how to facilitate a MAR project, both from a technical and policy perspective. Significant MAR schemes have been constructed in Adelaide and Perth, and other smaller schemes exist around Australia. Hundreds of major MAR schemes exist throughout North America, China, India and Europe. In parts of Europe to obtain a new groundwater license it is necessary to have an accompanying planned MAR scheme. MAR is not new technology.

However there is very little actually happening in NSW. There are several major reasons for this: lack of technical training, lack of planning of where MAR might be feasible, high cost and time delay of initial field investigations, however it is believed that the major factor is the continuing major financial subsidy to surface water schemes. There have been many studies showing that the true cost of MAR schemes is less than surface water schemes, however this is not appreciated by many water planners. To seriously encourage MAR schemes in NSW, DPE should embark on a major program addressing the four key impediments identified above.

2.13 Conjunctive Water Management: a step too far?

Conjunctive Water Management (CWM) is the process of using groundwater and surface water in an irrigation or urban setting from the two different sources for consumptive purposes (Evans and Dillon, 2017). It is essentially a water planning approach that uses the fundamentally different characteristics of groundwater and surface water, as shown in Table 2.2, to maximise the total available water resource.

Table 2.2: Typical characteristics of groundwater and surface water

Characteristic	Groundwater	Surface Water
Response time	Slow	Quick
Time lag	Long	Short
Size of storage	Large	Small
Security of supply	High	Low
Spatial management scale	Diffuse	Generally linear
Flexibility of supply	Very flexible	Not flexible

The distinction between planned CWM (where it is practiced as a direct result of management intention – generally with a top down approach) as compared with spontaneous CWM (where it occurs at a grass roots level – generally with a bottom up approach) is important. In the NSW situation, planned CWM would be the role of DPE. Another important distinction is between green field (where planning of a new scheme is undertaken) and brown field (where planning is retrofitting an existing scheme). Introducing CWM into a brown field scheme (e.g. an existing irrigation area) is much more challenging. The planned conjunctive management of groundwater and surface water has the potential to offer significant benefits in terms of economic and social outcomes through significantly increased water use efficiency. Even though allowing for surface water groundwater interaction may be part of CWM, it is not necessarily the case. CWM requires a much greater level of planning than that which has typically occurred in irrigation districts in Australia, although there are examples in urban water supply planning.

Many of the challenges identified earlier in this paper (e.g. metering and monitoring) are required for CWM. As water resources become more stressed in NSW due to the pressures identified earlier in this paper the adoption of CWM will become more important.

2.14 Groundwater Quality and Contamination: the dirty stuff

Gradual deterioration of groundwater quality, generally due to large variety of causes in both urban and agricultural settings is occurring. This represents a serious long term and essentially irreversible problem. A stronger focus on land use planning for both point and diffuse source is needed in NSW. DPE does not have control over these policies, but can provide critical input to this policy development. The legislation generally already exists, however the ability to ensure compliance with the appropriate regulations and procedures represents a human resourcing issue. Quality management plans need to focus at the groundwater source level. The need is especially critical to declare groundwater protection zones around urban supply bores. Community education is also a key requirement for effective groundwater protection.

2.15 New energy resource access: resolving conflict

New energy resources (principally geothermal, coal seam gas and shale gas) are frequently opposed at the local community level on the grounds that the adjacent groundwater resource will be adversely impacted. The claimed groundwater impacts are frequently used to block developments. Although greater hydrogeological understanding is often required, this will generally not solve the problem. The development of State and National standards to provide guidance for both proponents, and government approvals will help to guide the process. Community education is also needed to aid a rational discussion of the real issues.

A clear priority for which use of groundwater is preferred is required. This would provide clear signals to the market as the long term use of groundwater.

3. Summary

Major challenges face groundwater management in NSW over the next few decades. A continuation of the status quo will not adequately address these issues. In many cases these challenges can be turned into opportunities for better water management and a significant increase in groundwater use efficiency. Table 3.1 aims to point out the implications of the two paths followed.

Table 3.1: Comparison of the impacts on groundwater challenges between continuation of current efforts and required reforms in 2050.

Challenge	2050 without reforms	2050 with reforms
Sustainable groundwater use	Gradual and increasing reduction in security of supply, dry bores, reduced surface water flows, land subsidence, death of GDE's.	Stable rural communities, confidence in investment, stable long term groundwater levels, intended use of infrastructure, GDE's protected.
Climate change	Reduced availability of groundwater due to reduced recharge, unacceptable impacts on surface water flows, redundant and wasted infrastructure	MAR extensively adopted. Security of supply maintained, confidence in investment, some reduction in available groundwater (without MAR), but far less than for surface water.
Groundwater management planning	Community distrust of plan objectives, increased illegal use, poor adoption of plan components, increased compliance costs	Far less community conflict, less illegal use, less expensive compliance, better use of the resource. Engaged and educated communities.
Addressing the gap between entitlement and use	In under-developed aquifers: resource locked up and unused, stifling investment.	Addressing the gap between entitlement and use
Management and monitoring cost recovery	Poor cost recovery of DPE costs. Inadequate investment in management, investigations and research. Inadequate and worsening monitoring infrastructure.	True value of groundwater recognised. Adequate cost recovery for appropriate level of management. Plan development and monitoring self funding.
Metering, monitoring assets and information management	Ongoing deterioration of groundwater monitoring network. Improper bore abandonment. Limited and inadequate metering of usage. Poor data management	Reliable usage and groundwater level data. Data storage systems that efficiently meet licensing needs. Confidence in modelling increased.
Surface water-groundwater interaction	Continued undermining of surface water entitlements. Double accounting causing over estimation of available total water resource.	True picture of available total water resource. Protection of surface water flows and ecosystems. Ability to plan surface water releases to increase groundwater recharge.
Provisions for Groundwater Dependent Ecosystems	Technically unknown water provisions for GDE's. Polarisation of communities into two extreme positions.	Community acceptance of GDE water provisions. Working towards finding a balance between consumptive and environmental water needs.
Efficient groundwater trading	High groundwater trading costs to both government and users. Slow approval process. Both factors limiting trading opportunities.	Rapid approval of trades, especially temporary trades. Trading rules defined in groundwater management plans

Challenge	2050 without reforms	2050 with reforms
Managed aquifer recharge	Very little adoption of MAR. Significant regulatory approval hurdles. Technical requirements very burdensome on proponents. Major time delays for approval.	Major increase of the available groundwater resources. Groundwater quality improvement. Strong community acceptance and ownership. Cost attractive relative to other water resource options.
Conjunctive water management	Almost non existent at off farm scale. Limited at on farm scale. Common ignorance of CWM by both water agencies and users. Is used in salinity mitigation schemes.	Implementation at catchment scale. Optimal use of the total available water resource, creating “new” water. Relatively easy for green filed developments and challenging for brown field developments.
Groundwater Quality and Contamination	Point and diffuse sources identification, including from improper bore construction, land use change and waste disposal practices, are insufficient.	Increased education of risks, especially for urban and intensive agriculture, aimed at minimising irreversible contamination. Protection zones defined for all urban supply bores.
New energy resource access	Major community opposition to geothermal and gas developments. Claimed groundwater impacts frequently used to block developments.	Development of State and preferably National standards to provide guidance for both proponents and government approval. Provide greater confidence for investment.

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