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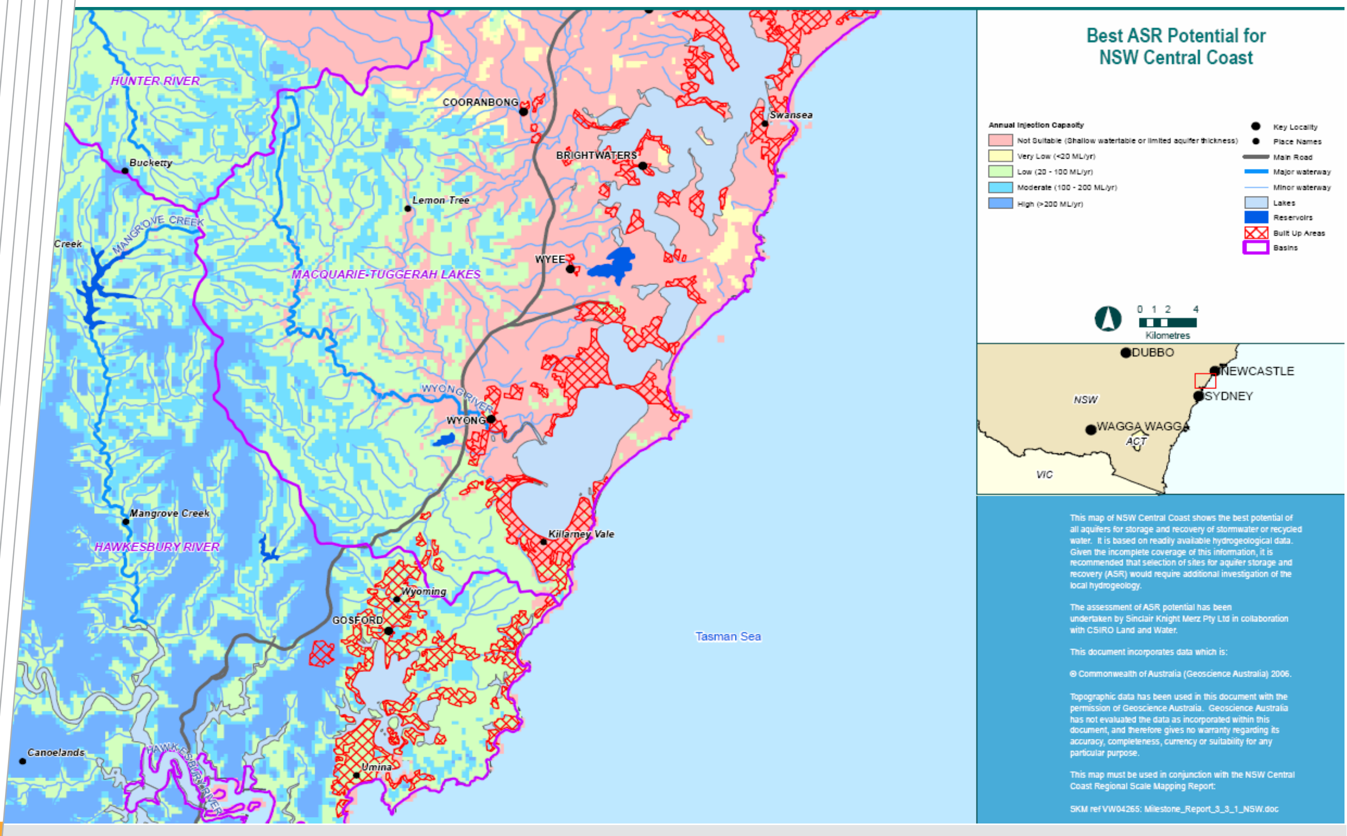

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Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia

Milestone Report 4.3.1 – Follow Up Report for Opportunity Assessment (Mapping) Component

Robert Molloy, Lauren Helm and Peter Dillon

December 2009

National Water Commission – Raising National Water Standards Project

Australian Government
National Water Commission

Water for a Healthy Country Flagship Report series ISSN: 1835-095X

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Citation: Molloy R[1], Helm L[1] and Dillon P[2]. Facilitating recycling of stormwater and reclaimed water via aquifers in Australia. CSIRO: Water for a Healthy Country National Research Flagship. 20 pp

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Cover Photograph

Description: Map of ASR opportunity for Central Coast NSW (derived from Molloy, R., Lennon, L., Helm, L. and Dillon, P. (2009). NSW Central Coast Opportunity Assessment for Aquifer Storage and Recovery. Water for a Healthy Country Flagship Report to National Water Commission for Raising National Water Standards Project: Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia - Milestone Report 3.3.1, Apr 2009.)

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EXECUTIVE SUMMARY

As part of the ‘Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia’ project, Sinclair Knight Merz (SKM), in collaboration with CSIRO, was commissioned to undertake an assessment of subsurface storage opportunities for three regions in Australia. The assessments were undertaken for the Adelaide metropolitan region, Central Coast of NSW, and South East Queensland. The assessments identified prospective regions for Aquifer Storage and Recovery (ASR) based on hydrogeological conditions, and where data allowed provided an estimate of the annual volume of stormwater that could be harvested and treated, based on the availability of open space for wetland treatment.

This report provides a follow up for the three regional opportunity assessments. It includes reporting on actions that have occurred as an outcome of the mapping and assessment of ASR potential.

The results from the project were presented at stakeholder forums, seminars and conferences. CSIRO and SKM have also presented and used the findings in other projects and forums aimed at improving the knowledge and uptake of ASR schemes.

The geographic analysis of source water and open space provided an indicative estimate of a regions’ potential for stormwater harvesting and ASR. The maps, which classify ASR potential as high, moderate and low were found to be informative to stakeholders involved in the planning of alternative water supply systems. Outputs from the study have subsequently been used in Adelaide and Brisbane to instigate further investigation and design stormwater harvesting schemes.

In regions other than Adelaide, the consideration of ASR as part of water planning strategies has been limited. However, the regional assessments are leading to greater consideration being given to ASR in conjunction with both stormwater harvesting and recycled water use. In addition to the significant number of projects proposed for Adelaide, several projects have been proposed for Brisbane, and ASR schemes on the Gold Coast are likely to be expanded.

The level of interest is higher in areas where schemes have already been implemented. This finding indicates that higher rates of uptake will be achieved through the implementation of more ASR schemes. Larger scale schemes will also lead to greater recognition of the potential for ASR. Review of the ASR potential should be undertaken as more hydrogeological data is obtained through drilling programs and investigations for individual ASR schemes. Regional ASR assessments should also be considered for other urban centres where there are water shortages and there is potential to undertake stormwater harvesting.

1. INTRODUCTION

Managed Aquifer Recharge (MAR), including Aquifer Storage and Recovery (ASR), has great potential across Australia in both urban and rural environments. However, the relatively high cost of investigating schemes, relative to other options, is often a significant impediment to their establishment. Regional opportunity assessments provide a means for giving a strategic appraisal for aquifer storage, and to reduce some of the initial uncertainty associated with investigations.

As part of the 'Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia' project, Sinclair Knight Merz (SKM), in collaboration with CSIRO, was commissioned to undertake an assessment of subsurface storage opportunities for selected regions in Australia. The opportunity assessments aimed to complete a regional examination of aquifers to assess the potential for storage and recovery of surplus water; identify potential for detention storage (e.g. wetland treatment) to harvest stormwater; and estimate the demand for recovered water. Three regions were chosen for assessments:

1) Central Coast of New South Wales, covering the region between the Hawkesbury and Hunter Rivers;
2) South East Queensland, covering the region between the New South Wales border, Noosa Heads and Toowoomba; and
3) Adelaide metropolitan region of South Australia.

The key objectives of the assessments were to prepare regional maps of the aquifer storage potential for each region, which could be used for preliminary planning of individual schemes and to also provide an indication of the cumulative storage potential for strategic water resource planning. For the Adelaide region, the assessment built upon previous mapping of the aquifers to provide an estimate of the cumulative volume of stormwater that could be harvested and treated using wetlands prior to storage. The regional maps produced were intended to be a guide for assessing regional potential (i.e. not a substitute for site specific assessments).

Separate technical reports were prepared for each regional assessment, and presentations made to regional stakeholders.

This report provides a follow up for the three regional opportunity assessments. It includes reporting on actions that have occurred as a consequence of the preparation of the maps and reports.

2. BACKGROUND

The general technique referred to as Managed Aquifer Recharge (MAR) is the process of intentionally injecting or infiltrating water into an aquifer and then extracting the water for use at a later date. Aquifer Storage and Recovery (ASR) is a specific type of MAR that involves injecting harvested source water (stormwater or recycled water) via one or more wells, into an aquifer with subsequent extraction for reuse via the same wells. ASR is predominantly a means of storing water, but may also provide further water treatment as a result of the biogeochemical processes within the aquifer (Dillon *et al*, 2008).

ASR presents an opportunity to provide wet season storage for stormwater or recycled water, for recovery to meet demand when needed. Subsurface storage of stormwater or recycled water can create new water resources, especially for non-potable uses, and is likely to be more cost effective than surface storages in urban areas.

In general, selection of an ASR site has four requirements:

1) A demand for water of the quality that can be recovered;

2) Access to a source of water, such as from a stormwater drain or recycled water pipeline;

3) Sufficient land available to build a detention storage and/or treatment system; and

4) An aquifer with suitable storage capacity and water quality, and allowing adequate rate of injection and capacity to recover stored waters.

2.1. Mapping methodology

Figure 1 shows the methodology used for the regional ASR opportunity assessments. The methodology is based around the concept that the mean annual recharge volume achievable is determined by the interrelationship of three key factors:

- *ASR potential* – areas considered preferable to ASR development based on hydrogeological criteria (e.g. aquifer lithology, aquifer transmissivity and available storage)

- *Source water* - stormwater runoff from open drains and creeks (rural) and closed or lined drains (urban)

- *Open space* - to harvest, treat and temporarily store stormwater from creeks and drains

The method for determining the ASR potential was adopted having considered previous efforts in Melbourne (Dudding et al, 2006), Adelaide (Pavelic et al, 1992; Hodgkin 2004) and Perth (Scatena and Williamson 1999). The method involved analysis of various aquifer parameters and operational constraints (e.g. maximum allowable impressed head, well efficiency, period of operation, and velocity across the well screen) to determine the annual injection rate per bore, for a given area. The analysis is conducted for each of the significant aquifers, with an ASR potential map for each distinct aquifer system produced.

Geographic analysis is undertaken to highlight areas of open space, within close proximity to creeks and drains, to identify potential for detention storage to harvest and treat stormwater. The identified areas of open space are then integrated with the ASR potential (using a geographic overlay approach) to highlight areas where stormwater harvesting potential coincides with suitable aquifers.

Stormwater run-off modelling is used to determine the relationship between size of detention storage and mean annual recharge volume achievable. This analysis is then scaled up to a preliminary regional assessment of the volume of water that can potentially be captured and recharged.

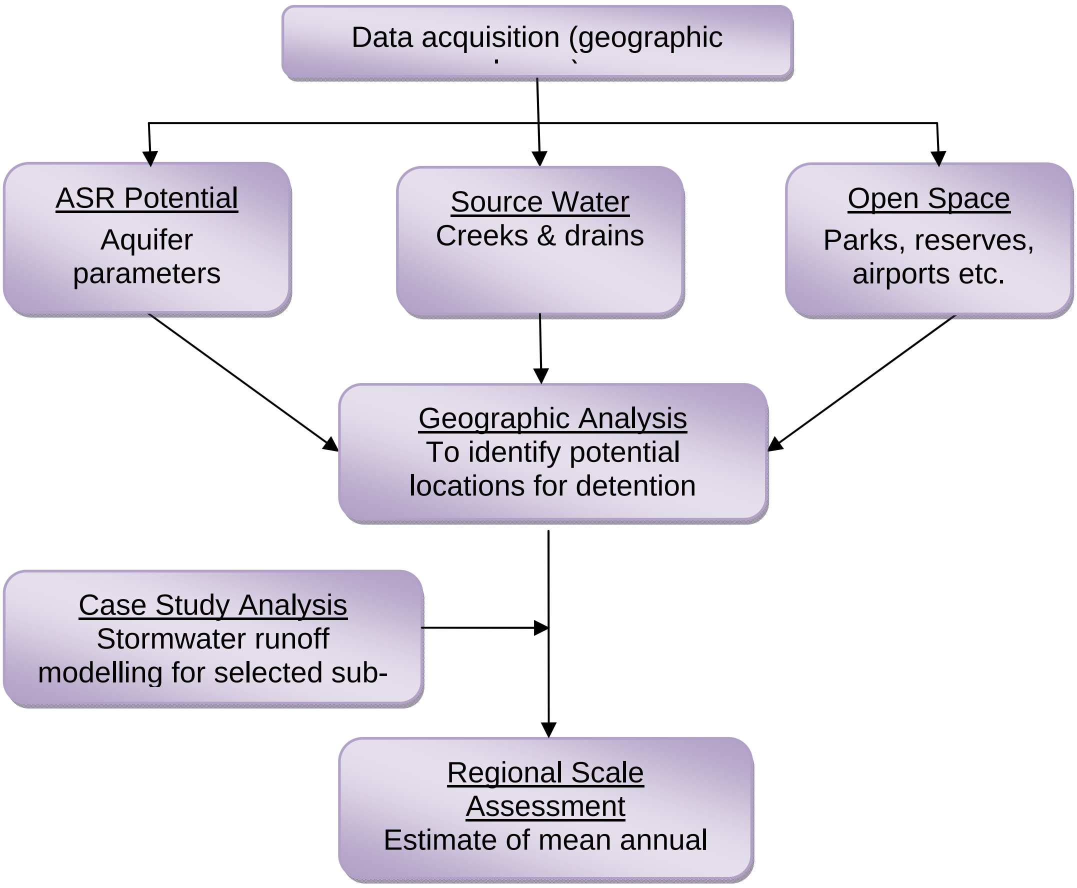

Figure 1. Methodology for evaluating stormwater harvesting potential for ASR

2.2. Classification of ASR potential

The ASR potential represents the volume of water that could be injected through a single bore that fully penetrates the aquifer and is operated continuously for 180 days. The volume that could be injected into a bore was calculated using the Theis solution to transient groundwater flow, in four categories ranging from very low to high (Table 1).

Table 1. Estimated ASR capacity for a single well

Category	Average Injection Rate	Annual Injection Volume (ML/yr)	Potential Water Supply
High	>1 ML/day (>11.6 L/sec)	>200	Moderate size stormwater catchments, detention pond and treatment plant or sewer trunk main and treatment plant
Moderate	0.5 - 1 ML/day (5.8 - 11.6 L/sec)	100 – 200	Small size stormwater catchments, detention pond and treatment plant or sewer main and treatment plant
Low	0.1 - 0.5 ML/day (1.2 - 5.8 L/sec)	20 – 100	Rain water or stormwater from small housing, commercial or industrial developments with detention storage and treatment
Very Low	<0.1 ML/day (<1.2 L/sec)	<20	Rain water from individual houses or cluster developments

In broad terms, the categories in this table reflect the potential magnitude of an ASR project. High ASR capacity represents areas potentially capable of realising single well ASR projects greater than 200 ML/yr. Moderate to low ASR capacity represents areas potentially capable of realising 100 to 200 ML/yr and 20 to 100 ML/yr projects respectively. Very low ASR capacity represents areas limited to about < 20 ML/year projects. Sites with very low ASR capacity may still be adequate for small scale operations. Larger scale operations are however much more likely to be economically attractive, providing incentive for maintenance and environmental safeguards for ASR operations (Dillon and Pavelic, 1996; Dillon and Molloy, 2006; Dillon *et al.,* 2009).

In developing a classification based on aquifer characteristics, there is a risk that ASR schemes may not be considered in some areas where they may still be a viable option in comparison to the alternatives (e.g. large tanks). An example might be that in an area of ‘Low ASR potential’, use of multiple wells could overcome the slow injection rates, thus increasing the storage potential.

The use of ASR potential maps for planning purposes should therefore take into consideration the limitation of the classification process. In general most aquifers are suitable for ASR; however some provide better storage and recovery efficiency.

3. RESULTS FROM REGIONAL ASSESSMENTS

3.1. Adelaide metropolitan – ASR potential

The Adelaide ASR mapping was undertaken to quantify the potential for harvesting stormwater. Unlike previous studies, it took account of three potential constraints; the volume of stormwater runoff, open space available to provide detention storage to permit recharge, and capacity of the aquifers to store additional water. The study considered only those catchments that overlie areas where recharge potential was mapped by Hodgkin (2004) and excluded fractured rock aquifers and Quaternary aquifers. This subsequently excluded the Field River, Christies Creek, and Onkaparinga River and Estuary that overlie fractured rock or Quaternary aquifers with as yet unknown potential for ASR. Previous studies have determined an approximate mean annual volume of stormwater runoff for the catchments included in the study area (73 GL the Adelaide Coastal Waters Study; Wilkinson *et al*, 2005) and the capacity of Tertiary aquifers to store additional water (78 GL for the most realistic set of assumptions and excluding fractured rock and Quaternary aquifers; [Hodgkin, 2004]).

Geographic analysis of open space and source water availability identified 62 potential sites for the detention and treatment of stormwater for ASR. The total potential wetland area of all identified sites was approximately 272 Ha.

Stormwater runoff modelling of selected sub-catchments within the larger Patawalonga catchment was undertaken to estimate the mean annual volume of stormwater that could be captured. Four simple methods were then used to extrapolate from the model-predicted water capture for the Patawalonga catchment, to estimate the mean annual volume that could be captured from the study area. The estimates varied between 30 GL and 47 GL, indicating the degree of uncertainty of such simple estimates based on extrapolation from one catchment. The lower estimates are known to be less than those calculated based on firm data for only a fraction of the study area. Hence a figure of approximately 30 - 50 GL/yr is a reasonable estimate of the mean annual volume that could potentially be captured across the study area (excluding fractured rock and quaternary aquifers), based on the available information and the scope of the study.

To improve the assessment of harvesting volumes it was recommended that harvesting plans be developed for each major catchment within the Adelaide metropolitan region. Such plans could be based on calibrated flow models accounting for land use and ensure that land adjacent to existing and future urban drains, that is co-located on suitable aquifers, be identified and 'water harvesting' be a declared land use for urban planning and development approval processes.

3.2. South East Queensland – ASR potential

For South East Queensland, the ASR potential was determined through analysis of groundwater yield information (derived from pumping test data), to provide an estimate of the annual injection capacity for a given area. There is a high degree of certainty in the estimated ASR potential where data is available (i.e. groundwater yield estimates). However, where the data are sparse the reliability of estimates of ASR potential is considered to be low, especially in geologically complex terrain.

Data from private wells that was held by the state water resource management agency was not released for this study, so over much of the region data were sparse. Hence no estimate could be made of the potential volume of aquifer storage in suitable areas. Private wells tend to be more abundant where well yields and groundwater quality are favourable, so the areas with highest potential for storage were obscured. However, storage in such areas, would no doubt need to be allocated to sustaining production, rather than delivering to new city water supplies that would require governance arrangements to address competing demands on groundwater storage.

The mapping exercise revealed that the ASR potential for the Quaternary Alluvium, predominately valley fill, was moderate to high (> 0.5 ML/day/bore). Within the Tertiary age formations the ASR potential was generally low to moderate (0.1 to 1 ML/day/bore); however some areas of greater ASR potential (> 1 ML/day/bore) were identified to the south of Brisbane and around Toowoomba.

Geographic analysis of open space and source water availability identified 546 potential locations for the detention and treatment of stormwater for ASR within the Greater Brisbane metropolitan area. Approximately 2,400 Ha were assumed to be available for the detention and treatment of stormwater for ASR, of which approximately 120 Ha of total wetland area (which may provide approximately 1,200 ML active wetland storage) was located in the vicinity of aquifers with estimated high to moderate ASR potential (> 0.5 ML/day/bore).

3.3. Central Coast, NSW – ASR potential

The Central Coast region of New South Wales lies midway between Sydney and Newcastle, between the Hawkesbury and Hunter Rivers. The region, which is serviced by two urban water authorities – the Gosford-Wyong Councils Water Authority and Hunter Water Corporation –, has been subjected to severe drought in recent years, placing strains on the traditional water supplies. Regional water strategies indicate that the combined urban demand in the study area is about 100 GL/year, and that greater use of alternative water sources should be considered for offsetting future demand.

The mapping exercise revealed that approximately one third of the study area is suitable for high or moderate capacity ASR projects (> 100 ML/yr/bore) and up to 72% of the study area has some potential for ASR. The total additional storage volume of the mapped aquifers was estimated to be 1,250 GL, of which approximately 320 GL is accessible at high to moderate recharge rates (> 5.8 L/sec). Of this storage, 296 GL is in the unconfined Terrigal Formation and 6 GL in the unconfined Clifton Sub-group. The best prospects for high injection rates were found to be in the confined Terrigal Formation (11 GL). A further 3 GL of storage at moderate rates is estimated for each of the confined Terrigal and Clifton Sub-group aquifers.

Within the urban environment, approximately 45% of the built up area was found to have aquifer storage capacity available. The total additional storage volume accessible at high to moderate injection rates (> 5.8 L/sec) was estimated to be 4 GL, with up to 17 GL potentially accessible at lower rates. Almost all of the storage within the built up area was found to be within the unconfined aquifer.

Geographic analysis of source water and open space highlighted locations where appropriate areas of open space available for stormwater detention, coincided with potential source water and suitable aquifers for subsurface storage. Stormwater runoff analysis undertaken for two case study locations showed that abundant stormwater is available for injection into ASR schemes. The tightest constraint on the volume of water that could be harvested was found to be the recharge rate dictated by the aquifer, with the next tightest constraint being the available volume for stormwater detention.

4. OUTCOMES OF REGIONAL ASSESSMENTS

4.1. Planning benefits

The regional assessments allow water resource planners to include consideration of stormwater harvesting and ASR within a holistic approach to the urban water supply. In Adelaide, where ASR is readily accepted as a method for storing both stormwater and recycled water, plans are now being considered to significantly increase the volume of stormwater being harvested. In other regions, the consideration of ASR as part of water planning strategies has been limited. However, the regional assessments are leading to greater consideration being given to ASR in conjunction with both stormwater harvesting and recycled water use.

4.1.1. Water strategies for Adelaide

Modelling by Wallbridge and Gilbert (2009) indicated that Adelaide has the potential to harvest, treat and store a further 42 GL/year of stormwater. This is in addition to the 18 GL/year from existing and currently planned schemes. These volumes are significant when compared with current water supplies that provide about 170 GL/year to Adelaide.

Adelaide's Tertiary aquifers are considered suitable for storing the majority of the stormwater harvested from the proposed schemes. However, for areas where the aquifers are not considered suitable for these large scale schemes, consideration is being given to building transfer pipelines to move the harvested water to areas where ASR is of higher potential.

The enhancement of aquifer potential mapping and stormwater harvesting undertaken for this project and by Wallbridge and Gilbert (2009) has given confidence to the development of these schemes. The SA Government (2009) Water for Good Plan provides for development of 60 GL stormwater harvesting via ASR in the Adelaide Metropolitan Area and a further 15 GL in regional South Australia by 2050. Intermediate targets in the metropolitan area are 20 GL/yr by 2014 and 35 GL/yr by 2025.

4.1.2. Water strategies for Brisbane

Recognition of ASR as a suitable storage method for stormwater harvesting in Adelaide is in significant contrast to other Australian cities where the potential is not appreciated. In the Queensland Water Commission's Draft Water Strategy for South East Queensland (2008) there is minimal appreciation for stormwater harvesting. Rainwater tanks and stormwater harvesting are forecast to provide only 7% of the urban water supply by 2056. The strategy acknowledges the investigations and proposals by Gold Coast Water to utilise ASR for storage of recycled water. However, there is a misconception that aquifers are of limited potential in other areas.

The mapping in South East Queensland undertaken for this project suggests that the potential is far greater than allowed for in the water strategy. The contrasting views on the potential of ASR are likely to be associated with previous investigations aimed at identifying new groundwater resources. Many of these investigations did not identify groundwater systems that could yield significant volumes of potable water to meet immediate demands. Subsequently, large scale stormwater harvesting and ASR were not considered as significant alternatives in strategic planning. The mistake is that many of the aquifers that were identified as being of limited value for groundwater supplies due to brackish groundwater; do have potential to provide storage and treatment for stormwater harvesting schemes.

It is anticipated that investigations being carried out by the Queensland Urban Water Research Alliance will highlight the increased potential of stormwater harvesting, and together with the outputs from the ASR mapping and incorporating information from private wells will improve recognition of alternative water supplies in future strategic plans.

Brisbane City Council is soon to commence investigations to identify locations where stormwater harvesting can be used to enhance recharge of unconfined aquifers in order to increase baseflows to urban streams, wetlands and coastal estuaries. The ASR mapping will be used as an input to this study.

4.1.3. Water strategies for NSW Central Coast

For strategic planning of water supplies for the NSW Central Coast, stormwater harvesting is not considered as an alternative to traditional supply options. Hunter Water has released plans for the construction of a large (450 GL capacity) dam on the Williams River at Tillegra that will provide both additional streamflow harvesting as well as provide the required buffer storage to ensure ongoing supply during droughts. These large scale solutions are considered to be of greater benefit than multiple small scale schemes.

Hunter Water does support the development of stormwater harvesting where conditions are suitable. One example is Figtree Place in Hamilton, which is a medium density town house development, built in the 1990s. Stormwater harvested from the site supplies up to 50% of indoor water needs for hot water use and toilet flushing, up to 100% of residential outdoor needs and up to 100% of demand for the adjoining bus washing facility. Rainwater from roofs is collected in underground tanks. Tank overflows are directed to trenches that recharge groundwater and diversion from impervious areas is directed to a central detention basin for recharging groundwater.

Access to the ASR potential maps will enable greater consideration to be given to the development of similar stormwater harvesting and recharge schemes.

4.2. Raising awareness

An additional benefit of the regional ASR mapping is to raise the awareness of using aquifers as alternative to reservoirs, especially in urban environments. The ASR mapping was presented at planning forums in Adelaide and Brisbane, and at the OzWater’09 conference. Copies of the Regional Assessments were also distributed to representatives of the water authorities with responsibilities for water supply in each of these regions.

4.2.1. Stormwater reuse planning workshop, Adelaide

In September 2008, the South Australian Office for Water Security hosted a “Stormwater Reuse in Adelaide Planning Workshop”, which was attended by 48 of Adelaide’s key stakeholders in the stormwater field. The aim of the workshop was to seek consensus on the way forward in relation to stormwater management in Adelaide – particularly from a water security perspective. Robert Molloy and Peter Dillon spoke on this opportunity assessment and the potential for indirect potable use of stormwater via aquifer storage respectively

The participants recognised that ASR needs to be a major part of any large scale stormwater harvesting schemes. However, the roles and responsibilities of key stormwater management stakeholders need to be clarified, along with a regulatory framework for management of the resource.

4.2.2. Urban Water Security Research Alliance ASR forum in Brisbane

The Urban Water Security Research Alliance hosted a forum on 20 May 2009 in Brisbane, where Peter Dillon and Robert Molloy presented the study findings. The following issues were raised in the discussion that followed the presentations:

- Economics of end use verses capture cost will influence the investment in ASR schemes.
- Fractured rock aquifers offer potential for ASR; however performance in these aquifer systems is unpredictable, which makes it difficult to estimate potential without access to drilling results.
- There are significant perceived health risk barriers that need to be overcome to allow water recovered from ASR schemes to be used for potable purposes. However, once overcome there may be significant cost benefit where the recovered water can be distributed using existing (potable) water supply distribution systems.
- Aesthetic values of lakes and wetlands need to be considered when designing stormwater treatment systems. For some schemes the need to maintain water levels will limit the active storage volumes. In other schemes aesthetic values may be enhanced by recovery of stored water for maintaining lake water levels during dry periods.
- For ASR schemes to become mainstream components of water supply systems ownership and maintenance aspects need to be clarified.
- Harvesting of stormwater needs to take into consideration the environmental requirements of streams when diversions systems are designed – flows following rainfall events provide essential ecological functions. However, there is still potential to harvest the proportion of flow associated with the increased rates of run-off from impervious surfaces in urban environments.

In summary, the forum concluded that ASR should be considered in combination with large scale stormwater harvesting schemes in South East Queensland and that demonstration schemes should be established.

4.2.3. Conference Proceedings and Articles

The results of the regional assessments have been presented at several industry conferences and internally promoted by SKM and CSIRO.

A paper on the findings from the NSW Central Coast Regional Assessment was presented at OzWater'09, which is the biannual conference of the Australian Water Association (Molloy *et al*., 2009). Dillon gave a brief summary of the overall NWC project 'Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia' at the NWC Groundwater Forum in Canberra 24-25 Nov 2009.

4.2.4. Stormwater harvesting plans

A key recommendation from the regional assessments was that to improve the assessment of harvesting volumes, stormwater harvesting plans be developed for major sub-catchments. Such plans should be based on calibrated flow models, accounting for land use and ensuring that land adjacent to existing and future urban drains that is co-located on suitable aquifers, be identified. The reliability of recharge with respect to variable rainfall and drought scenarios also needs to be determined.

Further work has been undertaken in Adelaide for the development of stormwater harvesting at sites identified in the Regional Assessments. This work has subsequently contributed to the successful funding applications under the National Urban Water and Desalination Plan: Special call for stormwater harvesting and reuse projects (See projects listed in Table 2).

In South East Queensland, Brisbane City Council are undertaking desk top studies to assess where stormwater harvesting and managed aquifer recharge, can be implemented to improve groundwater contributions to urban streams and wetlands. The spatial data compiled for the ASR mapping will be used as input data for the Brisbane project.

Table 2 South Australian Projects that received funding under Round 1 of the National Urban Water and Desalination Plan: Special call for stormwater harvesting and reuse projects

$2.6 million to City of Unley – involves the capture and storage of stormwater for reuse at local sports grounds, reserves and the Wayville showground to reduce the demand on potable water supplies, restore and improve natural creek systems and reduce the impact of urban flooding.	To offset approx. 98 ML/year. (total yield 114 ML/year).
$63.8 million to SA Department of Water, Land and Biodiversity Conservation to coordinate delivery of seven projects - includes: ▪ $7 million to City of Salisbury for Unity Park Biofiltration and Reuse - harvest stormwater from the Dry Creek catchment for treatment through six biofiltration cells and storage in the aquifer for later recovery. ▪ $15 million to City of Onkaparinga for Water Proofing the South Stage 2 - harvest stormwater by diverting water at five sites into off-stream wetlands, treat and then inject into the aquifer for storage. ▪ $9.6 million to City of Playford to harvest stormwater from within the Smith Creek drainage system for irrigating sporting fields, reserves and other uses. ▪ $4.9 million to SA Water for the Adelaide Airport Stormwater Scheme –source water from the Brownhill/Keswick Creek system. A storage basin will capture flows which will then be treated using biofiltration and media filtration. ▪ $2.9 million to Adelaide Botanic Gardens and SA Dept. Environment & Heritage for the Botanic Gardens First Creek Wetland ASR project – create an offline wetland for the treatment of harvested stormwater and develop ASR scheme. ▪ $20 million to City of Charles Sturt for the Water Proofing the West Stage 1 project – involves developing infrastructure capable of capturing, treating and supplying stormwater to replace potable water for irrigation and industrial use. ▪ $3.9 million to SA Water for Barker Inlet Stormwater Reuse Scheme project – supply fit-for-purpose treated stormwater as an alternative to the potable water currently sourced from the River Murray and used for industrial, commercial and public open spaces in the Regency Park area.	These projects will offset approx 3.57 GL/year. (total yield 8 GL/year).

4.2.5. Integrated management of ASR schemes

It is likely that with increased awareness and incentives for the development of multiple ASR schemes in urban environments the need for integrated management will also increase. In Adelaide, where the characteristics of the Tertiary aquifers are more widely understood, groundwater modelling is being undertaken to assess implications of increased recharge and cumulative impacts on groundwater resources. Recent modelling projects have been instigated by the Cities of Salisbury and Tee Tree Gully to inform the integrated management of ASR schemes by the Councils.

To date this level of modelling has not been implemented in other regions. However, the mapping has shown that in many areas multiple schemes can be implemented and that such modelling is likely to be a requirement in the development of integrated management of the groundwater resource. As such standard approaches for integrated management should be investigated. These also allow the accumulation of sufficient volumes of harvested water to potentially enable economic treatment and control systems that would be required for indirect potable reuse to be a competitive safe option.

5. CONCLUSIONS

Preparation and reporting of the regional assessments of ASR potential have enabled the following conclusions to be made:

- The accuracy of storage capacity estimates is influenced by the availability of hydrogeological data, which for many areas is limited. In areas where greater investment has been made in drilling investigations greater confidence can be placed in the regional assessments. Greater coverage of data is usually found in areas where groundwater is a major source for water supplies, as opposed to areas that have traditionally depended on surface water. Information and data from private wells is required for use in water resources management and should be on the public record.
- The complexity of the geology in a region impacts on the completeness of the maps. Where aquifers have a larger regional extent, interpretation of the available information is more suited to mapping aquifer characteristics. However, in areas such as Brisbane, ASR potential was assessed using available bore data rather than characterising performance of the complex array of aquifers.
- The geographic analysis of source water and open space was considered to be a suitable method for providing an indicative estimate of a regions potential for stormwater harvesting and ASR. The maps, which classify ASR potential as high, moderate and low were found to be informative to stakeholders involved in the planning of alternative water supply systems. Outputs from the study have subsequently been used in Adelaide and Brisbane to instigate further investigation and the design of stormwater harvesting schemes that incorporate ASR.
- Stormwater runoff analysis undertaken for case study locations indicates that abundant stormwater is available for injection into ASR schemes. The potential harvest is proportional to rainfall rates and frequencies of events. The tightest constraint on the volume of water that could be harvested was found to be the recharge rate dictated by the aquifer, with the next tightest constraint being the available volume for stormwater detention.
- To improve the assessment of harvesting volumes it is recommended that harvesting plans be developed for major sub-catchments. Such plans should be based on calibrated flow models, accounting for land use. Land adjacent to existing and future urban drains that is co-located on suitable aquifers should be identified on urban planning maps and titles annotated as land suitable for stormwater harvesting. The reliability of recharge with respect to variable rainfall and drought scenarios also needs to be determined. This type of modelling has been undertaken and used to assist in successful funding applications for ASR projects in Adelaide.
- In regions other than Adelaide, the consideration of ASR as part of water planning strategies has been limited. However, the regional assessments are leading to greater consideration being given to ASR in conjunction with both stormwater harvesting and recycled water use. ASR projects have been proposed for Brisbane, and ASR schemes on the Gold Coast are likely to be expanded. In Perth, recharge via the superficial aquifer is used to reduce runoff and to help sustain groundwater irrigation supplies, without planned volumetric management of groundwater resources.

The awareness of ASR has been increased across Australia as a result of this project. The level of interest is higher in areas where schemes have already been implemented, which suggests that higher rates of uptake will be achieved through the implementation of more ASR schemes. Larger scale schemes will also lead to greater recognition of the potential for ASR as a common alternative to traditional water supplies.

Review of the ASR potential mapping should be undertaken as more hydrogeological data is obtained through drilling programs and investigations for individual ASR schemes. Regional ASR assessments should also be considered for other urban centres where there is potential to undertake stormwater harvesting.

In summary the investment by the NWC in regional assessments will result in increased consideration and development of ASR schemes in the future.

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