Chapter 3
Managing Water Resources

Key Points

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Status of Indicator</th>
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<tr>
<td>3.1 Surface water extraction</td>
<td>Very little information is available on surface water extraction and its effect on the health of the Catchment.</td>
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<tr>
<td>3.2 Groundwater extraction</td>
<td>Very little information is available on groundwater extraction and its effect on the health of the Catchment.</td>
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<tr>
<td>3.3 Environmental flow objectives</td>
<td>SCA complied with environmental release requirements 99.7% of the time.</td>
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<td></td>
<td>Environmental flow requirements within the Catchment need to be further developed.</td>
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<td></td>
<td>The transfer of bulk water may be affecting the health of waterways within the Catchment.</td>
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Pressures in the Catchment

Managing water resources in a sustainable way is essential for our long-term utilisation and for the health of ecosystems. Extraction of surface water and groundwater for human uses such as agriculture, drinking water and industry can place significant stress on the environment, and increasing demands for extraction increase the importance of sustainable management practices.

The major outcome from surface water extraction, and the associated weirs and dams, is the reduction and modification of a river’s natural flows. Impacts of flow modification include:

- reduced volumes of water for the downstream environment
- reduced ability of the environment to cope with natural drought periods
- reduced variability of flow regimes, e.g. the flooding of riparian zones
- changes in the duration and timing of flow events
- creation of large, standing water bodies which are ideal for algal blooms
- degraded water quality (Chapters 2 and 5)
- loss of habitat connectivity, including physically blocking fish passage (Chapter 5)
- change in water temperatures (Chapter 5).
Groundwater extraction further modifies the catchment’s hydrology, which impacts on groundwater dependent ecosystems, such as wetlands, and adds stress to many creeks and streams, which can be reliant on groundwater during dry periods. Groundwater is extracted for irrigation, industry and commercial purposes, but the majority of extraction is for stock and domestic purposes. The Southern Highlands is an area of increasing groundwater use due to generally good water quality in aquifers and current restrictions on surface water extraction.

Climatic variability, including rainfall and drought periods, should be reflected in the management of flow regimes and water extraction to provide sufficient environmental flows. Groundwater use can increase in drought periods in response to availability of surface waters, which may impact on groundwater dependent ecosystems.

Raw water is also often transferred in large amounts between areas and storages in the Catchment as part of SCA’s management of raw water. These bulk water transfers can place significant stress on streams and creeks. The physical process of erosion and the rapid and extreme change in flow volume can adversely affect the riparian ecosystem.

### 3.1 Surface water extraction

**Background**

The allocation of water is very important in Australia as rainfall is highly variable. The harvesting of surface water through farm dams or from direct extraction from waterways must be sustainable so that enough water is available to supply residences and to maintain healthy ecosystems. So that the water resource can be used in a sustainable manner, it is important to know both the amount of surface water that is extracted and the ecological impacts of different levels of extraction within the Catchment.

While the quantities of water extracted within the Catchment are modest compared to the 630 gigalitres extracted from the storages per annum for urban water supply, their importance lies in their location and timing. Water retained and extracted from the storages primarily impacts on the natural flows of the river systems below the dams. This is a major focus of the Hawkesbury–Nepean River Management Forum (HNRMF). Similarly, retention and extraction of water within the Catchment can impact on the flows required for local ecosystem health and therefore need to be appropriately assessed and monitored.

To extract water from rivers and streams beyond ‘basic’ land holder rights, an access licence must be obtained from DIPNR. These licences detail what the water is extracted for and the maximum volume that is to be extracted per annum. This information is summarised in Figure 3.1 below. However, the allocation of water in the licence may differ greatly from actual use as the volume of water extracted, in most cases, is not measured. Accurate measurements of volumes of water extracted will be available in the near future. DIPNR has issued notices to all water users requiring monitoring of all extractions. This will include time event monitoring of annual volumes exceeding 200 ML per annum, use of electricity consumption and pump calibration to estimate annual volumes between 20 ML and 199 ML per annum and the use of pump diaries for annual volumes 20 ML per annum.

From 1998 landholders right to harvest the runoff from their property without needing a licence, registration, fees or metering was limited to 10%. This is referred to as the ‘harvestable right’. The harvestable right means that the water must be captured from the land and not extracted from rivers, streams or groundwater. There are also licence exemptions which include dams constructed for the control or prevention of soil erosion, dams constructed for runoff detention or flood mitigation, dams that capture contaminated waters and dams on very small properties. Figure 3.2 maps the location of all farm dams greater than 50 m in diameter using data from Landsat imagery. The green dots mark dams that were in place in 1990 and the red dots mark the dams that were built between 1990 and 2000.
Findings

The greatest volume of water that is licensed for extraction within the Catchment is from the Shoalhaven, Wollondilly, Kangaroo and Coxs Rivers, with the majority of the water extracted used for irrigation (Figure 3.1). Less than 10% of water licensed for extraction from each river was for purposes other than irrigation, except at Mongarlowe River where 20% was for other purposes. These uses were town water, stock, railway, pisciculture, domestic, industry, mining, farming, high and low security recreation. Additional information see Appendix E Table 2.

The other major user of water within the Catchment is Delta Electricity which on average extracts almost 15,000ML per annum from the Upper Coxs River for the operation of Mt Piper and Wallerawang power stations.

Figure 3.1 – Maximum volume (megalitres) of water licensed to be extracted per annum and the use of the water extracted

<table>
<thead>
<tr>
<th>River</th>
<th>Megalitres per annum</th>
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<tr>
<td>Boro Creek</td>
<td>200</td>
</tr>
<tr>
<td>Bungonia Creek</td>
<td>400</td>
</tr>
<tr>
<td>Coxs River</td>
<td>1200</td>
</tr>
<tr>
<td>Endrick River</td>
<td>800</td>
</tr>
<tr>
<td>Jerabatguilla Creek</td>
<td>800</td>
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<tr>
<td>Kangaroo River</td>
<td>800</td>
</tr>
<tr>
<td>Little River</td>
<td>800</td>
</tr>
<tr>
<td>Mongarlowe River</td>
<td>200</td>
</tr>
<tr>
<td>Mulwaree River</td>
<td>800</td>
</tr>
<tr>
<td>Nerrimunga Creek</td>
<td>800</td>
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<tr>
<td>OHares Creek</td>
<td>800</td>
</tr>
<tr>
<td>Reedy Creek</td>
<td>800</td>
</tr>
<tr>
<td>Shoalhaven River</td>
<td>800</td>
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<tr>
<td>Wallerawang River</td>
<td>800</td>
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Source: DIPNR data, as at 2003

Farm dams may indicate pressure on water quantity for ecosystem health within the Catchment as they intercept a significant proportion of surface flow from low and medium intensity rainfall events. In high rainfall events, which are the most important for filling the main reservoir, Lake Burragorang, it is assumed that farm dams will overflow and do not retain the greater proportion of that flow.

There is a very large number of farm dams in the Upper Wollondilly River, Mulwaree River, Wingecarribee River and Werribberri Creek sub-catchments (Figure 3.2). The Nerrimunga Creek, Reedy Creek and Braidwood Creek sub-catchments also have a large number of farm dams. The sub-catchments that feed into Warragamba Dam have the higher concentration of farm dams than the other sub-catchments feeding storages. There was a 17% increase in the number of farm dams from 1990 to 2000 (Figure 3.2).
Implication

There is growing demand for water within the Catchment primarily for agricultural purposes. The extent of this demand, its sustainability and impacts on local ecosystems is not well quantified.

There is a clear, well-established link between the volumes of water in the river and the health of aquatic ecosystems. Current data do not allow a solid assessment to be made whether water extraction from the river system, or water harvesting in farm dams have a detrimental effect on river health. However research undertaken by DLWC on the impact of farm dams on streamflow concluded that an increase in the volume of farm dams has the potential to significantly impact on streamflow particularly under low flow conditions (Sinclair Knight Merz, 1999).

Widespread sub-division of agricultural land for rural residential subdivision could potentially lead to the take-up of currently unused ‘harvestable rights’ continuing the rapid increase in the numbers of farm dams seen in the 1990s. It is consequently imperative that data on extractions and farm dams be collected to inform the discussion about magnitudes and timing of environmental flows required to maintain healthy rivers in the Catchment. In that context it is also important to collect data on magnitudes and patterns of background flow that allow assessments of the relative impacts of water extractions.

Availability of such data will allow informed management decisions to be made about sustainable levels of extraction and water harvesting in the Catchment.

Future directions

Quantification and reporting of actual extractions as proposed by DIPNR is essential for monitoring the issue and establishing trends. This needs to be supported by research into the impacts of increasing farm dams and water extraction on flows, and their impact on ecosystems at different levels.

Recommendation 7: That DIPNR expands research into the impact of different levels of extraction of water from rivers and the harvesting of water in farm dams on ecosystems and flow regimes within the Catchment in order to establish sustainable extraction levels and to guide resource allocation and management.

Target

That the harvesting of surface water and the extraction from waterways minimise impacts on ecosystem health. In the longer-term surface water harvesting should be within levels specified in relevant water management/sharing plans.

3.2 Groundwater extraction

Background

In periods of low flow and drought, groundwater can assume greater importance to maintaining base flows in streams and wetlands and for the water supply. Groundwater can be the main source of flows in many rivers and streams in summer months. The extraction of groundwater must also be managed, as extraction of groundwater can introduce more saline water into an aquifer and reduce base flows to waterways. Groundwater is derived from rain which percolates down through the soil or fractures in rock, filling up the pores between sand grains or the fissures in rocks. Up to half of the rainfall in a given area may reach the water table and thus recharge the groundwater. Geological formations such as those composed of sand, sandstone and limestone which contain usable quantities of groundwater are called aquifers. The aquifer closest to the ground surface is called the shallow, or unconfined, aquifer (its upper surface is the water table) but there are also deeper confined (sometimes called artesian) aquifers where the water is confined under pressure between relatively impervious layers (Water and Rivers Commission 2003).
Figure 3.2 – Map of farm dam locations in the Sydney Drinking Water Catchment

Note: The green dots mark dams that were in place in 1990 and the red dots mark dams that were built between 1990 and 2000.
The extraction of groundwater requires a licence under the *Water Act 1912* which is administered by DIPNR. Extraction for irrigation, industry, recreation (e.g. golf courses) and commercial purposes is managed through renewable licences. Extraction for stock and domestic supply as a ‘basic landholder right’ is administered through a non-renewable (perpetual) licence. Applications for extractions of significant quantities of groundwater are required to be supported by an impact assessment. There are however, no requirements to meter or report actual groundwater usage.

Management of groundwater resources in the Catchment is mainly limited to monitoring of groundwater levels in the Southern Highlands. There has also been a number of studies on the sustainability of groundwater extraction in the Wollondilly–Nepean aquifers and in portions of the Coxs River sub-catchment (DIPNR).

**Findings**

As noted above there is currently no information available on the quantity of groundwater extracted within the Catchment. The results of groundwater monitoring in the Southern Highlands indicates that levels have declined since 1999, however, there was a partial recovery during 2003 (DIPNR). It is anticipated that groundwater pumping will increase in response to reduced volumes of stored water in farm dams.

There are 2229 groundwater works (mostly bores) within the Catchment, these are concentrated in the Kangaroo River, Werriberri Creek and Wingecarribee River sub-catchments and around the town of Goulburn (Figure 3.3).

**Implication**

As was found for surface water extraction, the extent of demand for groundwater and its sustainability is not well quantified. High demand areas such as the Southern Highlands, Kangaroo River, Werriberri Creek and Wingecarribee River sub-catchments need to be a priority for management. Measures should be put into place to determine and protect the quality and quantity of groundwater.

**Future directions**

Quantification of groundwater usage is important for monitoring this issue and establishing trends. The development of a catchment-wide groundwater monitoring ‘key sites’ network would also assist assessment and management of resource capacity and help identify any deterioration trends. The information should be supported by research into the extent and capacity of systems experiencing high levels of demand to enable the assessment of sustainable yields for these resources.

**Recommendation 8:** That DIPNR develops and implements a monitoring plan and reporting requirements that provide reliable information on groundwater extraction within the Catchment.

**Recommendation 9:** That DIPNR expands research to establish and refine estimates of sustainable yields from groundwater systems within the Catchment.

**Target**

Management of groundwater resources to ensure sustainable use by:

- maintaining water level and pressure
- maintenance of water quality.
Surface and groundwater interaction

Surface and groundwater systems are interconnected with water moving between the two systems at different locations. The specific dynamics of this interaction within the Catchment is not well documented although DIPNR has undertaken some assessments of groundwater in the Southern Highlands and the Coxs River sub-catchment. The Water Sharing and Water Management Plans managed by DIPNR also consider groundwater issues.

The importance of this issue for the overall sustainable management of the water resources is reflected in the work being undertaken by the Drought Expert Panel. This panel is examining the potential of groundwater to be used to supplement water supplies from storages. The report from this work is expected to be available in 2004.

**Recommendation 10:** That DIPNR and SCA expand research to better understand the interaction between surface and groundwater systems within the Catchment.

State of the Catchment

3.3 Environmental flow objectives

Background

Flow regime is a key driver of river condition. Changes in the flow regime can cause changes to river geomorphology, habitat, water quality and greatly influence the riverine biota. ‘Environmental flows’ is the term used to describe the mimicking of elements of natural variability between high and low flows, which are intended to supply the needs of the environment to maintain ecosystem function (Nature Conservation Council of NSW 2003).

The magnitude and timing of flows in many NSW rivers has been modified as a result of the demand for both urban and agricultural development. The harvesting of water through farm dams and river extractions (see 3.1 Surface Water Extraction) and the construction of dams and weirs in NSW rivers has reduced and changed the frequency of natural flow. This has resulted in an increase in periods of no flow or extremely low flow, degraded water quality, reduced riverine habitat, reduced flooding of riparian zones, floodplains and wetlands, increased algal blooms and erosion of river channels.

To ensure sufficient volumes of flow for the riverine environment, the amount of water extracted and the amount of water captured by dams must be managed. The SCA is obligated to ensure they release certain volumes, specified in their licence, from its storages for the downstream environment. However, the pressure that extractions and other barriers within the Catchment place on the volumes left for the environment is less well documented.

The current environmental flow requirements are recommendations of the HRC Inquiry into the Hawkesbury–Nepean River system. The HRC also recommended the HNRMF develop detailed recommendations for environmental flows which if approved by Government will be included into the SCA’s water management licence to improve the current requirements.

The most appropriate process for addressing the issue of environmental flows is the development of water management plans for sub-catchments subject to significant demand for water extraction. This issue is being examined in detail by the HNRMF and is a critical link in maintaining healthy ecosystems throughout the Catchment.
Figure 3.3 – Map of groundwater bore locations in the Sydney Drinking Water Catchment
The bulk transfer of water through natural water courses can also significantly affect ecosystems through prolonged flooding impacting bank stability and riparian vegetation.

**Findings**

Dams, weirs and barriers permanently alter the flow of rivers and streams, create a barrier to fish passage and effect water quality, particularly temperature and the occurrence of algal blooms. Within the Catchment the majority of weirs and barriers are in the Upper Wollondilly River, Kangaroo River, Wingecarribee River, Werriberri Creek, Upper Coxs River sub-catchments and the upper section of the Bungonia Creek sub-catchment around Barbers Creek (Figure 3.4).

There are 36 SCA gauging stations present in the Catchment, most of these are located around water storages (Figure 3.4). There are also 11 SCA gauging stations located outside the Catchment, in the lower Hawkesbury–Nepean Catchment area. Most of this gauging is for the purpose of managing the main water storages and the bulk water transfers between storages and to water filtration plants. There is very little gauging within most sub-catchments.

**Environmental flows**

The *Stressed Rivers Assessment Report NSW* (1998) rated Lake Burragorang, Upper Coxs River, Wingecarribee River and Upper Wollondilly River with a high combined stress rating for proportion of water extracted and environmental stress. However, no action has been taken to date to prepare water management or water sharing plans for any of these sub-catchments.

A water sharing plan has been prepared for the Kangaroo River and a water management plan is currently being prepared for the Coxs River. The commencement of these plans has been delayed to July 2004 while the Council of Australian Governments national water initiative is developed. It is anticipated that the National Plan for Water will be announced in April 2004. It is then intended that the NSW *Water Management Act 2000* will be amended to reflect the new agreed principles and outcomes outlined in the National Plan. As noted above the preparation and implementation of water management plans to address environmental flows within the Catchment is anticipated to be addressed by the HNRMF.

**Releases from SCA storages**

The SCA is required to release specified volumes for environmental flow purposes from Avon Dam, Broughtons Pass Weir, Cataract Dam, Cordeaux Dam, Nepean Dam, Pheasants Nest Weir, Warragamba Dam and Wingecarribee Dam according to its Water Management Licence (DLWC 2001). The SCA met its environmental release requirements 99.7–99.8% of the time since the introduction of the Water Management Licence in April 2001, except for Avon Dam. The outlet works at Avon Dam do not allow the required flow to be released at present (DLWC 2001). In 2002–03 the SCA released a total of 279,597 ML of bulk water from its major storages to rivers, 80,956 ML of which was released specifically for environmental flow. Corresponding volumes for 2002–02 were total flows of 232,960 ML including environmental flow releases of 91,585 ML.

The volume of water released from water storages and weirs for a combination of environmental flow and bulk transfer targets over the past four year is summarised in Figure 3.5. The release of water from water storages decreased at Cataract Dam, Cordeaux Dam Fitzroy Falls reservoir, Tallowa Dam and Broughtons Pass weir from the previous year and an increase in water released from Warragamba and Wingecarribee Dams (Figure 3.5). There was also large increases in the volume of water released from Cataract Dam, Cordeaux Dam and Fitzroy Falls reservoir from 2000–01 to 2001–02. The release of water from Tallowa Dam has gradually decreased over the past three years.
Bulk water transfer

The volume of water transferred from the Shoalhaven system to the Wingecarribee reservoir and from the Fish River to Cascades Dam remained unchanged from the previous audit period. The volume of water transferred from the Wingecarribee Reservoir to Warragamba Dam increased by 24% and to the Nepean Dam via the Glen Quarry Cut increased by 85% from the previous audit period (SCA 2003).

In accordance with the SCA’s Water Management Licence an independent assessment was completed in May 2003 of the environmental impacts of bulk water releases from its Upper Nepean storages. This assessment covered the river stretches between the Cataract, Cordeaux, Nepean and Avon Dams, and the downstream off-take weirs at Pheasants Nest and Broughtons Pass.

The conclusions from the assessment on the impact of bulk water transfers were that:

- the loss of variation in stream flow and loss of habitat due to long periods of reliance on environmental flows may impact on stream biota
- it is likely that the geomorphological and chemical similarities between streams above and below the storages outweighed the combined impacts of the storage and the release regimes.

As a result, the report recommended that releases from dams should reflect increasing flow variation (where possible, without compromising security of water quality and quantity) to mimic actual inflows. That the releases should incorporate a mix of flows rather than from a single dam for long periods.

Implication

Environmental flows

The lack of specific provision of environmental flows to ecosystems throughout the Catchment is a significant source of stress for many sub-catchments and almost certainly contributes to poor outcomes noted across other indicators. It is important that a program for implementing water management plans be quickly established once the recommendations of the HNRMF have been adopted.

Volumes of water released from storages is measured by SCA. However, the volumes flowing in upstream sites and inflows to storages are not measured adequately to provide sufficient information for provision of
Figure 3.4 – Map of weirs, gauging stations and barriers in the Sydney Drinking Water Catchment
environmental flows. The HNRMF recommendations will address this issue. Due to the large number of weirs and other barriers reducing flows and flow variability (Figure 3.4), plus many water extractions throughout the Catchment, representative gauging sites or other effective mechanism for the monitoring of flows would be valuable. At present, there appears to be a limited spread of gauging stations across the Catchment (Figure 3.4). An accurate knowledge of extractions and flow volumes would assist the management of environmental flows across the entire Catchment. Again a quick response to the recommendations of the HNRMF on this issue is important to ensure that appropriate mechanisms are in place to manage water allocations and environmental flows.

Management of impacts of bulk water transfers

The increase in the volume of water transferred from the Wingecarribee Reservoir will put increased pressure on the receiving waterways with large flows causing localised flooding (e.g. Wingecarribee River Figure 3.6) and bank erosion. The release of water from the Glen Quarry Cut (Figure 3.7) increases the flow into Glen Quarry Creek, which increases bank erosion (Figure 3.8). There needs to be an investigation into whether the large flows during transfers can be managed in a way that does not affect the health of the ecosystem. Ramping of transfer water (i.e. the gradual increasing or decreasing of the volume of water) is designed to assist the stability of banks and also enable fauna to adjust to changing flows. The ramping volumes are based on findings of a 1994 study, however, a recent study during the releases in August 2003 has identified erosion and bank retreat due to releases.

Recommendation 11: That DIPNR develops and implements appropriate mechanisms to enable the reliable reporting of environmental flows for relevant sub-catchments.

Recommendation 12: That DIPNR initiates an investigation of the management of large flows during transfers under the SCA Water Management Licence to minimise impacts on the health of the ecosystem.

Target

Initially, the development and implementation of water management plans for all relevant sub-catchments. In the longer term, environmental flows consistent with requirements of the water management plans.

Figure 3.6 – Localised flooding in the Wingecarribee River from water transfer to Warragamba Dam, August 2003
Figure 3.7 – Water released from Glen Quarry Cut into the Glen Quarry Creek, August 2003

Figure 3.8 – Increased flow in Glen Quarry Creek 100m downstream of Glen Quarry Cut – bank erosion on the right bank of the creek, August 2003.
Actions and Response

Response to issue

*It is widely recognised that water is a finite resource and we are extracting too much. Both the scale of human population and economic activity are placing excessive water demands on the environment through landuse change, discharges and overflows from sewerage reticulation and urban runoff. All of these factors which contribute to reducing the sustainability of water resources are dealt with in other sections. This section covers the major actions aimed at managing water resources within the Catchment. The management of external demands for water from the Catchment (e.g. water supply to Sydney) is being addressed through other processes such as the Hawkesbury–Nepean River Management Forum. The three major responses to the unsustainable use of water have been to:*

- quantify available water resources and develop mechanisms to allocate water for the environment and other uses
- undertake bulk water transfers between storages within the Catchment to balance the supply and demand of water customers
- increase the efficiency of water use to achieve more with the available water.

Water management

A key element of the water reform process was a legislative basis for water management plans to provide a clear direction on how water is to be shared between users and the environment. One of the primary objectives of this process is to improve the health of the State’s waters by requiring that protection of water sources and their dependent ecosystems has first priority in water sharing plans.

The Hawkesbury–Nepean River Management Forum (HNRMF) and the Independent Expert Panel on Environmental Flows were established to determine appropriate environmental flow regimes for the Hawkesbury–Nepean River System.

The water sharing plans are statutory plans that will be in effect for 10 years and reviewed after five. They will provide a period of security to meet environmental needs as well as for water users. Within the Sydney Drinking Water Catchment, the Kangaroo River water sharing plan was gazetted on the 26 February 2003. The water sharing plan covers an unregulated water source. The interim environmental flow objectives established in 1998 were used to guide river management committees and form the basis for the environmental water provisions in the water sharing plan.

The Water Administration Ministerial Corporation (WAMC), administered by DIPNR regulates surface and groundwater extractions. The WAMC licences the SCA to access water resources in its area of operations and requires environmental flows to be released from storages to help maintain the ecological health of downstream rivers.

Water use efficiency

The SCA initiated an independent study of water loss from its assets as part of a maintenance strategy. A program of works is being developed in response to the study’s recommendations. Many assistance schemes are in place to promote efficient water use by irrigators across the state of NSW. Of those that apply to lands within the Catchment, the Water Reform Structural Adjustment Program provides extension, education services and financial assistance to the NSW irrigated agricultural sector. There are two specific initiatives under the program relating to water use efficiency:
• the WaterWise on the Farm initiative which aims to improve the capacity of irrigated farm managers to adjust to water reforms primarily through the adoption of best irrigation management practices and technologies

• the NSW Agriculture Water Use Efficiency Unit has also been established to provide information and advice to irrigators and government on water use efficiency, water access and licensing.

As well as water use efficiency, another key role in the effective re-use of water resources is:

• the NSW Water Conservation Strategy which promotes integrated water-cycle management in NSW, including improving water efficiency in the industrial, commercial and agricultural sectors.

**Effectiveness of response**

Previous audits have identified the need to collect data on stream flow for both managing water extraction and monitoring environmental flows. This audit confirms the importance of this issue (see Recommendation 11).

Previous audits also recommend that data should be collected to enable assessment of groundwater extraction against sustainable yield. While there has been some work on this issue, this audit considers that there would be benefit in undertaking further work on this issue (see Recommendation 8 and 9).