WATER SMART FARMS

Introduction

The Water Smart Farms Project was an initiative of the NSW Department of Primary Industries (DPI) and has increased the water use efficiency of irrigated agriculture across the Hawkesbury–Nepean catchment, with a focus below Sydney's water supply dams. The water savings made from the project have been shared between landholders, the environment and Sydney's water supply.

The project has:

- involved turf farms, field-grown vegetable farms, nurseries, greenhouse operations and other irrigation water users
- funded infrastructure upgrades including retrofitting existing irrigation systems, converting to more efficient irrigation systems, water harvesting systems, water treatment systems, recycling systems and irrigation monitoring and scheduling equipment
- purchased unregulated river licence entitlements from willing sellers to contribute to environmental water
- delivered extensive education and training
- included the development and implementation of a mobile telephone SMS (short message service) irrigation scheduling service that delivers scheduling information to participating irrigators in real time.

Water savings made from the Water Smart Farms Project have been shared between landholders, the environment and Sydney's water supply

The project was funded by the Australian Government under the *Water for the Future* initiative and received $17.7 million of the total $77.4 million allocated to the overarching Hawkesbury–Nepean River Recovery Program. In addition, the NSW Climate Change Fund contributed $3 million and participating landholders contributed $6.6 million.

The project was commonly known as WaterSmart Farms and operated in tandem with the Nutrient Smart Management Project (known as NutrientSmart Farms). Together the two projects were known as Smart Farms.

Objectives

The primary objective of the Water Smart Farms Project was to make 5900 million litres per year of water savings at irrigated farms in the Sydney Basin. Initially, it was anticipated that these savings would comprise:

- 4400 million litres per year to be legally secured for additional environmental flows (river water savings) in the Hawkesbury–Nepean river system, and to increase Sydney's water supply security (potable water savings)
- up to 1500 million litres per year (river water savings) to remain with the participating entitlement holders.

Environmental flows can be achieved through various methods. For example, releasing water from dams or making water available for environmental benefit through water-use efficiency and licence purchases. For the purpose of this project, water savings that will contribute to additional environmental flows are generically referred to as environmental water.

In the implementation of this project, it became clear that the proposed potable water savings objective was not achievable. Therefore, while this project's overall water savings objective of 5900 million litres per year remained unchanged, the relative contributions of river water and potable water savings were revised to include purchasing unregulated river licence entitlements from willing sellers for environmental benefit. This Water Smart Farms licence purchase component supplemented the water purchased as part of the Licence Purchase Project. The revised water savings objectives are summarised in Table D1.

Table D1
Water Smart Farms revised water savings objectives

Water source	Detail	Volume (million litres per year)
River water	Proportion legally secured as environmental water through improved river water-use efficiency	3300
	Proportion to remain with irrigators	1100[1]
River water	Unregulated river licence entitlement purchased through the Licence Purchase Project	1250[2]
Potable water	Funded through the NSW Climate Change Fund, increasing Sydney's water supply security	250[2]
Totals		**5900**

[1] *The objective for water remaining with irrigators was estimated at 1100 million litres with a maximum estimated savings of 1500 million litres depending on the type of works agreed and finally implemented.*
[2] *Savings to be achieved through these two sources were flexible, as long as a minimum 250 million litres potable water saving was achieved, and a combined total of 1500 million litres was achieved.*

The NSW Government Climate Change Fund contribution of $3 million to this project has been used for training, compost and further potable water savings that will contribute to increased security for Sydney's water supply.

The project also sought to:

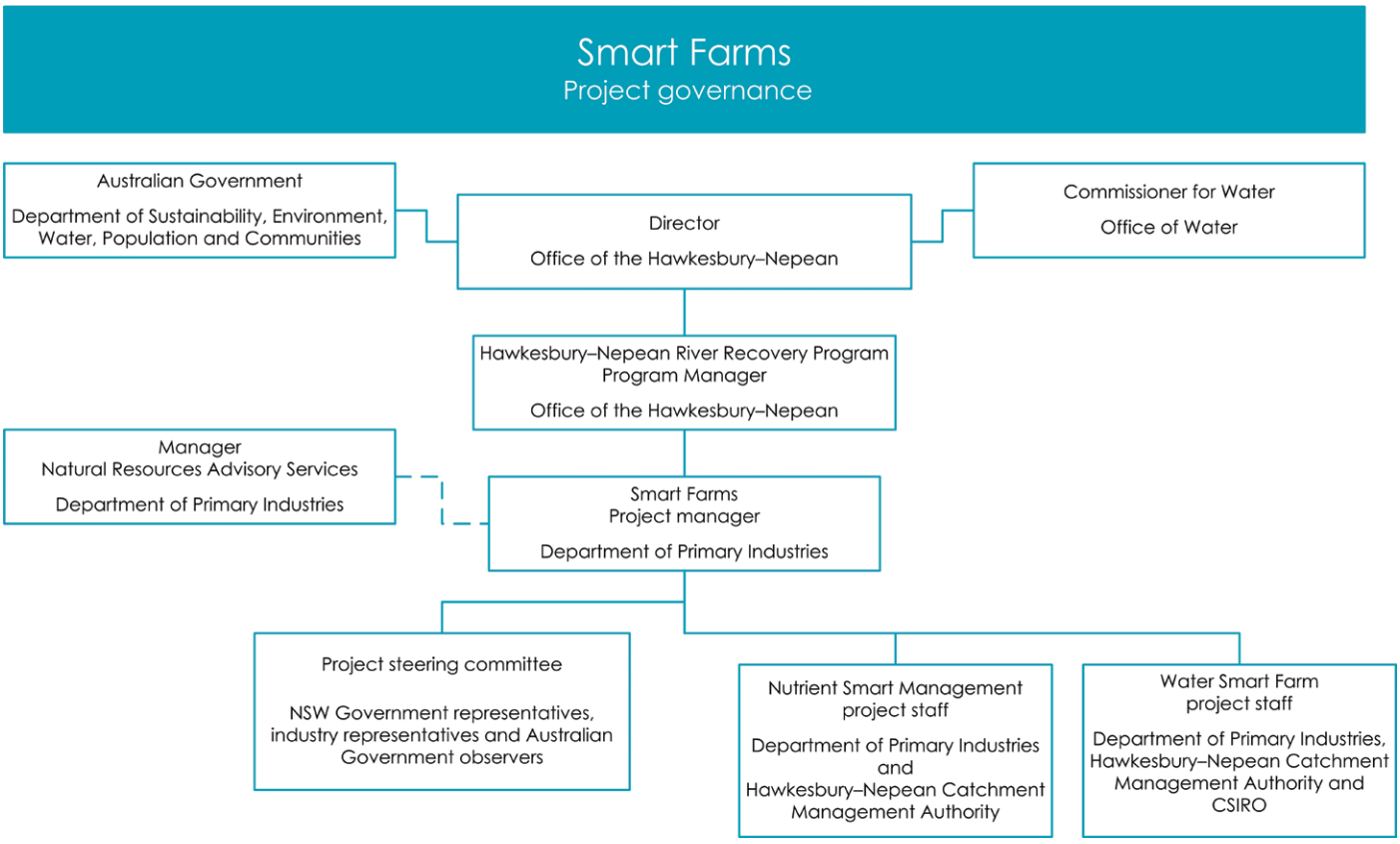
- improve irrigation efficiency of participating properties to a benchmark of greater than 85 per cent distribution efficiency
- improve the knowledge and capability of irrigators in the Sydney Basin to increase water use efficiency and to operate and maintain irrigation systems in a proper and efficient manner
- improve nutrient management to reduce nitrogen export to the Hawkesbury–Nepean river system by 11.8 tonnes per year and phosphorus by 1.2 tonnes per year.

Methods

The Water Smart Farms Project was managed by DPI while various components were sub-contracted for delivery. The Hawkesbury–Nepean Catchment Management Authority (Hawkesbury–Nepean CMA) was contracted to manage on-ground project data, incentive payments and contracts and the CSIRO was contracted to deliver the SMS irrigation scheduling service. The Hawkesbury–Nepean River Recovery Program's Licence Purchase Project (managed by the Office of Environment and Heritage) was also contracted to buy 1250 million litres of river water on behalf of the Water Smart Farms Project to meet a milestone variation relating to a change in realisable potable water savings. Figure 24 illustrates the project governance.

DPI appointed a project manager in late 2008 and built a team of 10 staff over the life of the project to deliver training and develop incentive-funded on-ground works projects. A further 14 staff had shared positions between the Water Smart Farms and Nutrient Smart Management projects. The CSIRO had up to four staff working on the SMS irrigation scheduling service at various times. Both the Hawkesbury–Nepean CMA and DPI also appointed project staff to manage data and reporting, finances, legal matters, evaluation and communication services.

Figure 24. Smart Farms Project governance



The project manager and team leaders held a weekly teleconference throughout the life of the project to ensure that issues were managed and, in the final six months, met face to face every fortnight. Weekly reports were generated and circulated to monitor progress and the financial management system was interrogated weekly to ensure budget control. Other meetings were held when needed. Water Smart Farms team meetings were held on a monthly basis and informally as required.

The Nutrient Smart Management and Water Smart Farms projects operated a joint Smart Farms Project Steering Committee. Committee members representing landholder/irrigator stakeholders were nominated by experienced local staff and invited to join the steering committee in early 2009. Members were chosen because they held representative roles for their respective industry or grower groups and were also regarded as prominent and successful industry figures. The steering committee was formed and operated under an agreed terms of reference and was chaired by the project manager. The committee met quarterly (11 times) over the life of the project and provided immensely valuable input into many aspects of the project and its delivery.

Early in the Hawkesbury–Nepean River Recovery Program, it was recognised that there were strong synergies between the Water Smart Farms, Improving Hawkesbury–Nepean Water Balance Accounting and Licence Purchase projects and that there was potential for water users to be engaged in all three initiatives. Meetings were held between the project managers and staff from each project (from Sydney Water Corporation, the Office of Water and the Office of Environment and Heritage) to establish an integrated approach and ensure consistent messages and minimal confusion. These meetings were valuable and ensured that the project teams worked cooperatively over the life of the overarching program.

A particularly critical aspect of the Water Smart Farms Project related to the transfer and security of the purchased licence entitlement. The Office of Water and members of the Licence Purchase Project team greatly assisted this process in a very confined timeframe.

Two variations were sought over the life of the project:

- The SMS irrigation scheduling service was varied to reduce training numbers and introduce a new accredited training package.
- Following improved information relating to the potable water consumption of Sydney's agricultural industries, a variation was sought and approved that reduced the amount of potable water savings required through the NSW Climate Change Fund component, and introduced a river water saving objective to off-set the reduction of potable water savings. Surplus funding, originally allocated to potable water infrastructure grants from the NSW Climate Change Fund was reallocated to project capacity building and training activities.

The project manager provided briefings and supporting evidence to assist the negotiation of these variations. In such a large and previously untested project, some milestones may require re-negotiation as improved knowledge becomes available.

Range of project activities

The Water Smart Farms Project directly addressed its objectives through the development of incentive-funded on-ground works projects and improved water management practices achieved through training-based practice change.

Funds for on-ground works were made available to irrigators who directly extract river water and for irrigators using potable water. An 80 per cent cost subsidy was available for direct extractors and a 50 per cent subsidy for potable water irrigators. Irrigators receiving the 80 per cent subsidy were required to reduce their river licence entitlements by 75 per cent of the calculated on-ground works water savings, to ensure that this water was returned to the environment.

Settling pond on a turf farm at Freemans Reach before (top) and after Water Smart Farms works

There was an extensive and diverse range of activities undertaken by the Water Smart Farms team in the delivery of the project objectives, including:

- engaging the community and providing information
- developing incentive-funded on-ground works projects with irrigators that led to water savings
- purchasing unregulated river licence entitlements from willing sellers to contribute to environmental water
- developing and delivering relevant water management training activities
- developing and promoting a mobile telephone SMS irrigation scheduling service
- establishing potable water demonstration farms
- monitoring, evaluation and reporting.

The team developed protocols, standards, templates and documents to assist the delivery of the project.

Community engagement

Engaging irrigators in the project was a critical factor in achieving success. The Water Smart Farms team initiated a stakeholder survey, the results of which were used to plan a variety of activities with the target audience.

A multi-faceted engagement process was implemented and included introductory workshops, direct advertising, mail-outs, emails, a Smart Farms webpage, newspaper articles and traditional one-on-one interaction. Pre-established community networks including both individual farmers and farmer organisations were used, as were bilingual extension officers, informal workshops and farm walks. Also valuable were demonstration sites, utilising irrigation resellers as project advocates, visits to Flemington Markets and the personal contacts and knowledge of a local ex-farmer who was recruited directly into the project. These activities built on pre-existing trust between the local farming community and Water Smart Farms staff and were a major contributing factor in achieving project objectives.

Irrigation infrastructure project site audits

Very early in the project, the project team recognised the need to engage private, independent auditors to identify achievable water savings on individual farms to ensure that savings were identified objectively on behalf of the irrigators.

The team developed protocols for the auditors and utilised an existing accreditation standard known as Certified Irrigation Agronomist established by the Irrigation Association of Australia Ltd. Potential auditors were inducted into the program through an introductory workshop followed by a technical standards workshop. In consultation with the Irrigation Association, the team also developed a reporting template for auditor use and for other non-project DPI irrigation officers. A total of 12 accredited professionals enlisted in the Water Smart Farms Project and produced over 140 audit reports. The cost of each report was fully subsidised by the project.

Developing and implementing irrigation infrastructure projects

Once the protocols and supporting frameworks were established, project activities typically focussed on the development of an incentive-funded on-ground works project with an individual landholder.

The development of each on-ground works project required coordinated activity that began with calls for expressions of interest. These were publicly made in local media (in multiple languages), electronically and through existing networks.

When a landholder expressed interest in the project, their details were entered into a local database (so they could be notified about future training opportunities) and the Hawkesbury–Nepean CMA's Catchment Information Management System (CIMS) for tracking purposes. The project received a unique identifying number from CIMS and a property map was prepared through the GIS-based Land Management Database (LMD).

Project officers would then visit the landholder to gather physical data (such as irrigation system type, equipment type and layout, soil type, drainage layout, water sources, estimates of water use and periods of watering) and assess their expectations. This information was finalised in consultation with the landholder and formed the basis of a pre-audit report, identifying potential works and water saving opportunities.

The irrigation efficiency of all planned work was determined by measuring the distribution uniformity of the proposed irrigation method. Distribution uniformity is a measure of the evenness of the water distribution delivered by individual water applicators (e.g. sprinklers) and across the whole delivery system. This variation in water application is expressed as a percentage (the higher the percentage, the greater the evenness of delivery), with a benchmark of 85 per cent. Table D2 indicates the relative industry-recognised standard distribution uniformity efficiencies for the types of works funded under the incentive program. Project staff used these figures as a guide and worked with irrigators to ensure that on-ground works were designed to provide the maximum efficiency available.

Table D2
Water Smart Farms system distribution uniformity (%)

Travelling irrigator	85
Fixed low-pressure sprinkler	90
Fixed medium-pressure sprinkler	85
Dripper	90
Mini sprinkler	60
Lateral move	85
Centre pivot	85
Lateral boom	85

When the landholder was satisfied that participation in the project matched their business or personal goals, an independent auditor was asked to prepare a full audit report, using information from the pre-audit report and any additional information from the landholder. In some cases, the landholder provided a design plan of the existing irrigation system that met the overarching project requirements and a full audit report was not required.

At this point, the Office of Environment and Heritage (early in the project) and Hawkesbury–Nepean CMA (later in the project) conducted searches of the Aboriginal Heritage Information Management System database for all projects involving on-ground works to identify any known sites of Aboriginal cultural heritage in the area. The Hawkesbury–Nepean CMA's catchment officer for Aboriginal communities inspected all project sites that were in the vicinity of known sites of Aboriginal cultural heritage to ensure the proposed works would not negatively impact on the cultural significance of the site.

Project staff negotiated the cost of the full audit report based on an established fee structure, reviewed the report and discussed the findings with the landholder. Staff then sourced quotes for the work and, together with the landholder, developed a costed project summary.

The Water Smart Farms team, guided by the project manager, the Smart Farms Project Steering Committee and the Hawkesbury–Nepean CMA, established project protocols to ensure fair and equitable determination of eligibility for participation in the project. All costed project summaries were assessed by a three-member assessment panel using a matrix designed to rank project suitability against Hawkesbury–Nepean River Recovery Program objectives.

If the project was approved, the Water Smart Farms project officer and Hawkesbury–Nepean CMA staff developed a contract (works agreement) which included:

- landowner and property details
- a description of the works to be undertaken
- details of the volume of water to be transferred/saved
- a detailed budget describing both the grant contribution and the proponent's in-kind and/or cash contributions to the project
- a description of the project outputs
- timeframes for completion
- a map showing the location and nature of the works.

The Hawkesbury–Nepean CMA sought legal advice for the works agreements and for formal responses to landowners and their legal representatives. Hawkesbury–Nepean CMA staff then reviewed the assessment panel recommendations, approved appropriate funding and created individual entries for each project in the financial management system to manage payments.

Water Smart Farms grants were given for a range of water management interventions that provided improved water management, water efficiencies and nutrient savings as well as other benefits such as reduced power requirements and labour inputs. These interventions included:

- pump upgrades (for example replacing a mismatched diesel driven unit with a variable frequency electric unit)
- mainline pipe upgrades (for example replacing asbestos cement pipes with PVC mains)
- irrigation system conversions (for example replacing a high-pressure travelling irrigator with a lateral move irrigator)

Lateral move irrigation system installation

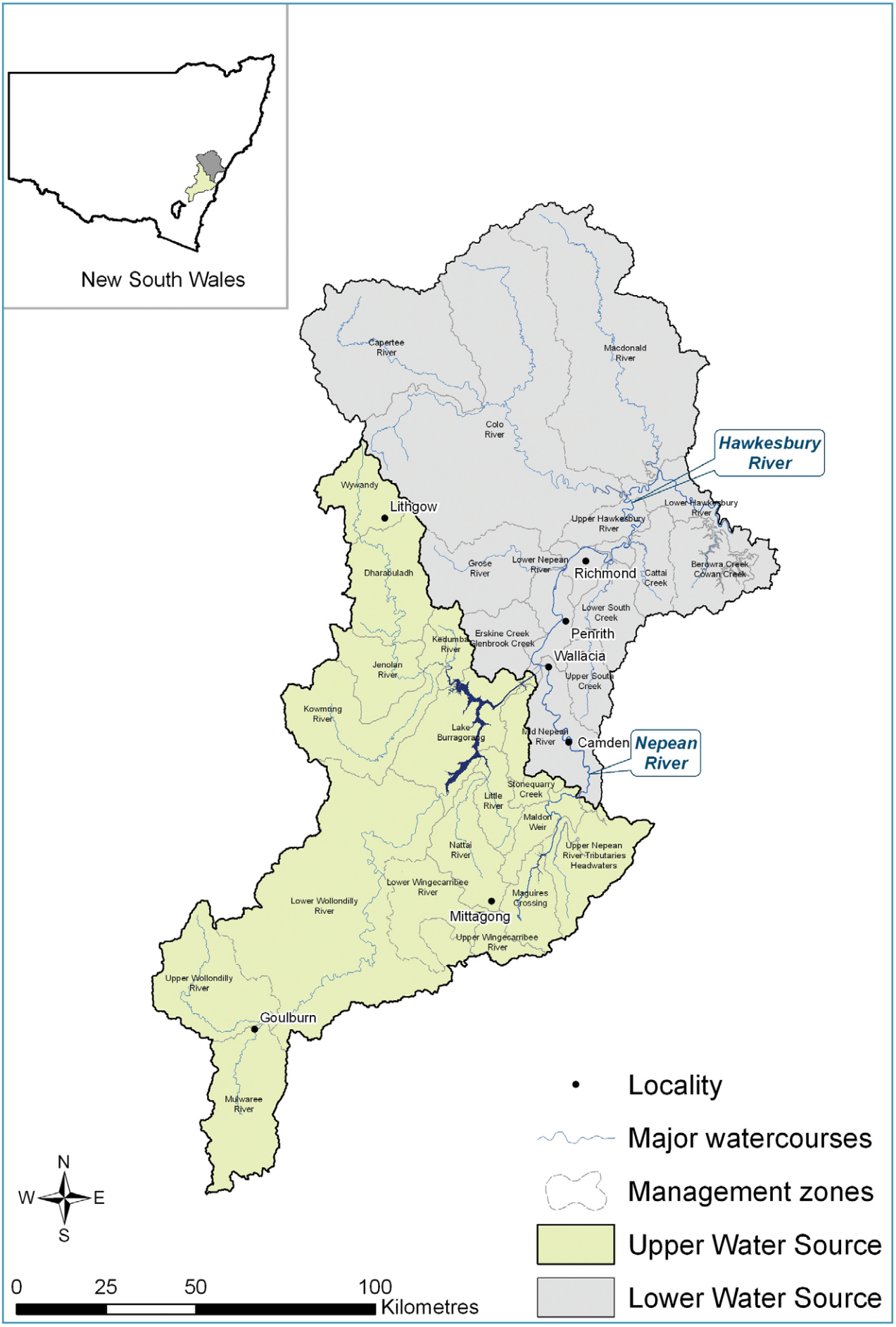
- sprinkler retrofits
- nutrient/water capture and re-use ponds
- soil aerators
- water harvesting tanks and related infrastructure
- improved water filtration units
- provision of automatic irrigation control systems
- soil moisture monitoring systems
- evaporation control on farm dams
- pathogen control systems for greenhouse water reuse.

The Hawkesbury–Nepean CMA generated weekly project tracking reports for all on-ground works projects which were used by the project officers to keep projects on schedule. Project officers monitored the progress of on-ground works and when complete documented the works with a case study and a final report which triggered the final payment from the Hawkesbury–Nepean CMA.

Purchasing water for environmental benefit

As part of the revised water savings objectives, the project was required to purchase unregulated river licence entitlements from willing sellers in the upper and lower water sources of the Hawkesbury–Nepean catchment (illustrated in Figure 25). The Office of Environment and Heritage purchased the water on behalf of DPI in conjunction with its purchasing activities for the Licence Purchase Project.

Figure 25. Hawkesbury–Nepean catchment upper and lower water sources



The amount of environmental water created is less than the total entitlement secured because the entitlements purchased are generally not fully activated, meaning licence holders do not take their full entitlement volume every year. This is because the level of activation is dependent on farm development and cropping practices, climatic and soil moisture conditions and availability of flows, including those coming from the dams, downstream tributaries and sewage treatment plants. Therefore, the real reduction estimates associated with the purchased entitlements are based on the historical level of activation of the unregulated river access licences.

Estimating this level of activation is a complex exercise. Prior to this project and before the implementation of broad-scale meters for licensed river users, historical activation levels were based on a broad-scale surveying process undertaken as part of converting the land-based entitlements to volumetric entitlements. The water sharing, plan, introduced during the project, used the information from the volumetric conversion process to establish long-term average annual extraction limits which prevent water use from exceeding current entitlement levels.

Therefore, the formula to convert the purchased entitlements to environmental water savings involved applying a ratio of the long-term average annual extraction limit divided by the sum of the unregulated river licence entitlements.

Training

Project officers were engaged in the development and delivery of training for landholders. Training needs were established through liaison with industry representatives and were individually tailored to meet those needs. For example the SMS irrigation scheduling service training package and some greenhouse training workshops were specifically developed for their respective audiences both in regards to technical material and to meet specific language requirements.

The Water Smart Farms team ran a number of workshops, including an advanced drip irrigation workshop held in Richmond, Western Sydney

Many different workshops have been offered together with supporting notes and all were delivered at no cost to participants. The field vegetable demonstration farm at the University of Western Sydney, Richmond and the potable water treatment demonstration sites located on commercial farms played crucial roles as venues for applying learning in the field.

The workshops offered to landholders included:

- Introduction to Water and Nutrient Smart Management
- Soil and Water
- Water Efficiency Technologies (for field producers)
- Waterwork (for nursery growers)
- Pump Efficiency
- Centre Pivot and Lateral Move
- Metering
- Drainage Recycling and Rainwater Harvesting (for greenhouses)
- Water Treatment and Pathogen Control in Greenhouses
- Advanced Drip Irrigation
- SMS Training
- Water and Nutrient Management in Greenhouse Production.

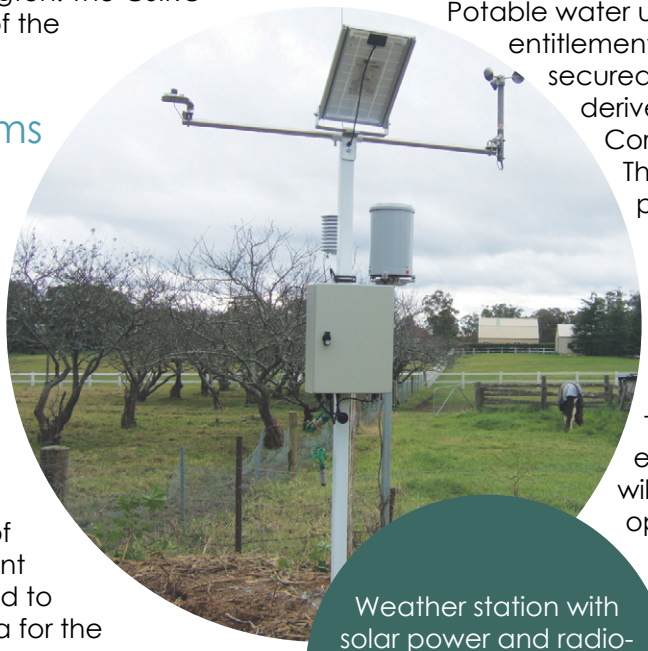
SMS irrigation scheduling service

The mobile telephone SMS (short message service) irrigation scheduling service was delivered by a project officer in partnership with the CSIRO and with support from the Water Smart Farms team. The satellite-driven service was offered to landholders to help them determine when to irrigate and how much water to apply. Satellite imagery coupled with local weather data and on-ground crop factors helped determine the crop water requirements.

Training was delivered to participants in three languages to suit grower groups and an accredited training package was produced specifically to support the program for irrigators. The SMS message contained suggested pump or irrigation run times based on the farmer's individual irrigation system performance. Project officers established weather stations at Dural, Richmond (demonstration farm), Oakdale and Leppington. The CSIRO conducted an evaluation of the program.

Demonstration farms

Through the potable water component of Water Smart Farms (funded by the NSW Climate Change Fund), six water-saving demonstration farms were established to provide a long-term legacy for potable water management extension programs. The farms showcased a range of water capture and treatment technologies, and were used to determine cost/benefit data for the water treatment options.



Weather station with solar power and radio-related function sending weather data to the irrigation satellite SMS system computer

Project officers engaged cooperators, facilitated independent audits and engaged installation contractors. The project officers assisted with commissioning the works and training the farmers in the use and monitoring of the technologies. The officers also engaged the wider farming community through workshops and farm walks highlighting the technologies established on the demonstration farms.

Monitoring, evaluation and reporting

Information management was an important aspect of the project. This included maintaining several project databases, generating reports and providing statistics for the preparation of progress reports for management and steering committees, and briefings for government. An important aspect of this activity has been the informal reports provided to colleagues within DPI in anticipation of similar projects being delivered in the future.

The Water Smart Farms Project required a complex and robust set of processes and delivery mechanisms. DPI recognised the responsibility associated with water transfers and the potential risks if savings were over estimated. To address this, the project team developed methods to ensure that water savings were genuine and that the savings realised through water transfer from licence entitlements were positive business outcomes for irrigators and the environment.

Deriving savings estimates for potable water users

Potable water users do not have individual entitlements that can be directly secured as their water supply is derived from Sydney Water Corporation's distribution system. Therefore, the estimated potable water savings are based on calculated savings associated with the on-ground works projects and water-efficiency training given to irrigators.

The realisation of the estimated potable savings will be reliant on continued optimal operation of the works and practices over time. Project participants will be motivated to maintain the potable water savings, not only by their contractual obligation to do so, but by the water bill reductions associated with water efficiency.

For the water harvesting works, a specifically designed calculator was used to determine water savings accrued from rainfall data, roof area, tank size and consumption. Where recycling equipment was installed, the savings were calculated using the capacity of the recycling unit, an estimate of the number of times water could be re-used and whatever harvested water was introduced.

Results

The Water Smart Farms Project has reserved water for environmental benefit in the Hawkesbury–Nepean river system and helped to improve Sydney's water security. This was achieved through a successful on-ground works program supported by effective communication and landholder capacity building and education.

Overall, this project made 5658 million litres of secured water savings, of which 4286 million litres will contribute to environmental water, 1110 million litres will remain with irrigators and 262 million litres will help to improve Sydney's water supply security. While this total is lower than the 5900 million-litre objective, it does not include the component of the entitlement purchased that is not expected to contribute to environmental water (288 million litres). If this component were included, the total saving would be 5946 million litres per year.

The Water Smart Farms Project made 5658 million litres of secured water savings, of which 4286 million litres will contribute to environmental water, 1110 million litres will remain with irrigators and 262 million litres will help to improve Sydney's water supply security

The project exceeded its nutrient reduction objectives of 11.8 tonnes per year of total nitrogen and 1.2 tonnes per year of total phosphorus.

Communication activities

To promote the Water Smart Farms Project, various publications were produced, including a brochure, posters and web pages. A range of more targeted communication outputs were also produced, as summarised in Table D3.

Table D3
Water Smart Farms communication output summary – direct communication

Activities		**Stakeholders engaged**	
Type	Number	Landholders/ participants	Industry members
Education/training/workshop	60	700	96
Field day – Smart Farms	10	225	41
Field day – stall at other event	14	415	444
Individual engagement	16	37	12
Newsletter	40	825	1167
Stakeholder meeting	18	253	126
Total	**158**	**2455**	**1886**

As well as direct communication with stakeholders, the Water Smart Farms project team produced eight media releases, 22 newspaper articles and six online articles, and gave one radio interview.

A variety of multicultural activities were also undertaken to cater for the cultural diversity of agricultural stakeholders in the Hawkesbury–Nepean catchment. These activities, summarised in Table D4, were facilitated by bilingual project officers within the Water Smart Farms team.

Table D4
Water Smart Farms multicultural communication activities

Language	Translation type	Number of activities	Number of landholders
Arabic	Verbal	7	69
	Written	10	~
Cambodian	Verbal	2	39
Chinese - Cantonese	Verbal	14	158
	Written	13	~
Chinese - Mandarin	Verbal	2	8
Vietnamese	Verbal	3	25
	Written	4	~
Totals		**55**	**299**

Following the completion of the project, the Water Smart Farms Project team produced YouTube videos highlighting the successes achieved by three of its on-ground works projects. The videos were created to perpetuate the educational component of Smart Farms and encourage further collaboration between farmers and government representatives.

Farms featured on the YouTube site are:

- University of Sydney – Westwood Farm. The farm produces irrigated fodder crops for a training and commercial dairy herd. New infrastructure is saving river water and protecting the environment.
- Hok Lam – Greenhouse truss tomatoes. This hydroponic farm has cut potable water use by 35 per cent. Run-off is captured, filtered and reused. As a demonstration farm for the project, it is now showing other growers how to integrate water efficiency and production values.
- Cameron's Nursery. A commercial garden nursery in Sydney's north is harvesting rain water and treating dam water to reduce potable water use. Their water-saving innovations have won awards and sparked community and industry interest.

The Water Smart Farms videos can be found by searching for 'NSW Agriculture Water Smart Farms' on the YouTube website.

Shown left is the University of Sydney's Westwood Farm video. The farm produces irrigated fodder crops for a training and commercial dairy herd. New infrastructure is saving river water and protecting the environment.

As part of the project communications, Water Smart Farms team members also prepared and delivered various refereed papers:

- Dang H (2011) Satellite and SMS Water Management System: Irrigation Scheduling Advice to Farmers in the Sydney Basin. Irrigation Australia Ltd Conference, Hobart, Tasmania.
- Doyle D (2011) Simple Soil Moisture Monitoring, poster paper – unpublished.
- Jewell L and Conasch P (2011) Appropriate Technology Transfer Methods in a Cross Cultural Peri-urban Demographic. 2011 APEN Forum - Hitting a Moving Target: Sustaining landscapes, livelihoods and lifestyles in a changing world, Armidale, New South Wales.
- Plunkett M and Waterson D (2010) Irrigation Training Investment: Understanding its Role in Improving Water Use Efficiency in the Hawkesbury Nepean Catchment. Irrigation Australia Ltd Conference, Sydney, New South Wales.
- Plunkett M (2011) Improving Water Management in a Changing Climate – the New South Wales & Australian Experience. Turf Producers International Conference, Reno, United States of America.
- Plunkett M and O'Donnell D (2011) The Pressure of Water – Assisting Hawkesbury Nepean Dairy Farmers to be WaterSmart. Dairy Research Symposium, Camden, New South Wales.
- Plunkett M, Doyle D, Jenkinson C and Machar S (2011) Engaging Irrigators in a Changing Environment – the Hawkesbury Nepean Experience. 2011 APEN Forum - Hitting a Moving Target: Sustaining landscapes, livelihoods and lifestyles in a changing world, Armidale, New South Wales.

Irrigator guidelines and related documents were produced to assist irrigators with the Water Smart Farms grant programs

Grant program funding protocols

Protocols for the Water Smart Farms grant program were developed early in the project. Irrigator guidelines and various related documents were also produced to assist irrigators throughout both the river and potable grant programs.

Key grant program documents included the:

- notice of permanent transfer form/fact sheet, which provided details on the water licence transfer process for river water projects
- Water Smart Farms complementary funding flyer, which detailed further funding avenues for potable projects where the grant available was insufficient to make the project financially viable for the irrigator
- Water Smart Farms accredited assessors list, which provided a list of the accredited assessors that irrigators could choose from to undertake an irrigation assessment (audit) on their farm
- Water Smart Farms auditor irrigator engagement proforma, which provided a binding agreement between an irrigator and an accredited assessor that a site assessment (audit) would be undertaken within a given timeframe.

Education and capability building activities

Training activities

Field days, workshops, bus trips and other training activities were held throughout the life of the Water Smart Farms Project. The events provided information about the project, and demonstrated examples of on-ground works that were eligible for funding. The events were either dedicated Water Smart Farms events or events hosted by others where the project had a significant presence.

Each formal event and training activity was evaluated to help refine subsequent activities. This included evaluation undertaken after site visits to inspect completed on-ground works and evaluation undertaken with the independent accredited auditors to help improve the site audit process.

Tables D5 and D6 summarise the demographics of participants and level of engagement for education and training activities as estimated by surveys of 486 attendees (50 per cent of total attendance) from 38 of the activities.

Gross Vale orchardist Andrew Terrey takes a discharge reading measurement at Richmond (above) and Cambodian landholders learn about different soil types (below)

Table D5
Water Smart Farms training activities – breakdown of attendees

Attendees	%
Farmers	67
Industry	10
Government	20
Other	3

Table D6
Water Smart Farms training activities – attendees' satisfaction with event content

Question	Most common response	% of respondents
Event met my expectations	'Agreed' or 'strongly agreed'	82
Instruction received was of a high standard	'Agreed' or 'strongly agreed'	85
Event was presented at a level I could understand	'Agreed' or 'strongly agreed'	90
Topics were useful	'Agreed' or 'strongly agreed'	88
Training materials were clear and helpful	'Agreed' or 'strongly agreed'	87
Pace of the event	'About right'	93
Recommend the event to others	'Yes'	96

Table D7 shows that directly targeting landholders was the most effective mechanism for promoting events.

Table D7
Water Smart Farms training activities – how attendees found out about events

Method	% of respondents
Word of mouth	28
Brochures	26
Internet or email	20
Other	26

Evaluation questionnaires completed by 109 of the 134 attendees from nine Satellite and SMS Irrigation Scheduling workshops indicated that these training events would help farmers improve their irrigation practices.

Attendees at five of the nine workshops were asked about their understanding of satellite and SMS irrigation scheduling. Of the 55 respondents, 85 per cent said they either had no understanding, a poor, or a fair understanding prior to the workshop. As a result of attending the workshop, 76 per cent believed they gained a good or excellent understanding of satellite and SMS irrigation scheduling.

Attendees at four of the nine workshops were asked to rate their understanding of soil moisture monitoring. Of the 46 respondents, 67 per cent said they either had no understanding, a poor, or a fair understanding prior to the workshop. As a result of attending the workshop, 72 per cent believed they gained a good or excellent understanding of soil moisture monitoring.

Attendees at three of the nine workshops were asked to rate their understanding of the relationship between soil type and irrigation scheduling. Of the 30 respondents, 77 per cent said they either had no understanding, a poor, or a fair understanding prior to the workshop. As a result of attending the workshop, 76 per cent rated their understanding as good or excellent.

At one of the nine workshops, 67 per cent of respondents rated their knowledge of pump and irrigation systems before the workshop as fair, while 33 per cent rated their knowledge as good. After the workshop, 67 per cent rated their knowledge as good while the remaining 33 per cent rated their knowledge as excellent.

Attendees at five of the nine workshops were asked what aspects of the training they would use on their farm, with the following results:

- At four of these workshops, 39 per cent of respondents said they would calculate readily available water and current irrigation application rates, 33 per cent said they would consider doing so and 11 per cent said they already perform this task.
- At three of these workshops, 56 per cent of respondents said they would improve irrigation efficiency by adjusting current schedules and 28 per cent said they would consider doing so.
- At all five of these workshops, 58 per cent of respondents said they would monitor soil moisture to better manage irrigation scheduling, 22 per cent said they would consider doing so, while 12 per cent said they already perform this task.
- At two of these workshops, 46 per cent said they would check the current efficiency of their irrigation system, while 25 per cent said they would consider doing so.
- At all five of these workshops, 57 per cent said they would improve irrigation efficiency through better managing operating pressures and/or appropriately selecting sprinklers, while 25 per cent said they would consider doing so.

At two pump and water meter workshops, 41 per cent of respondents rated their understanding of pumps prior to the workshop as fair, 41 per cent as good and 4 per cent as excellent. After the workshop, 7 per cent rated their understanding as good and 9 per cent as excellent. Most respondents (86 per cent) said they would consider installing a new pump which is more suitable to their watering requirements.

At two pump performance workshops, all 27 respondents agreed that the workshop improved their knowledge of irrigation pump performance and was relevant to their needs in pump management. Further results from this training are:

- 48 per cent of respondents said they would determine their water pumping requirements (39 per cent already carried out this practice).
- 63 per cent of respondents said they would determine their pump operating efficiency, and 25 per cent said they would consider doing so.
- 56 per cent of respondents said they would calculate pump operating costs and 35 per cent said they would consider doing so.
- 48 per cent of respondents said they would check pump pressure and 13 per cent said they would consider doing so (39 per cent already carried out this practice).

As a result of attending a drip irrigation workshop, more than half of the participants identified maintenance as their top priority and nearly three quarters said they would make changes to their drip irrigation management.

Demonstration farm

Of the six demonstration farms established throughout the project, one near the DPI office in Richmond on the University of Western Sydney Hawkesbury campus will continue to be managed by DPI.

During the project, 12 formal Water Smart Farms Project events were held at the farm, and various other informal activities were also undertaken, including research into the effectiveness of compost use. The farm will provide a legacy for the project, displaying best-practice nutrient and water management techniques for field vegetable and turf production.

SMS irrigation scheduling service

The SMS (short message service) irrigation scheduling service was used by 176 irrigators across the project area. The service was refined and tailored to the needs of Hawkesbury–Nepean irrigators following extensive consultation with potential users.

A flyer was developed to promote the service and a fridge magnet was later developed for participating irrigators. The magnet was designed to be displayed in the pump shed and provide basic details required for operating the service, including the SMS mobile telephone number, the required message format and project officer contact details.

An SMS training program was developed and piloted, and was formally accredited in June 2011 following refinement and consultation with the CSIRO (who developed the SMS irrigation scheduling technology).

The training module was titled 'Introduction to Satellite and SMS Scheduling' and was mapped to relevant units of competency within the nationally accredited training package AHC10 Agriculture, Horticulture and Conservation and Land Management. The units of competency that this course mapped to were Use Hand Held E-business Tools, and Schedule Irrigation.

Ten training events (including the pilot and accredited courses) were held with 126 irrigators attending the accredited courses.

Irrigated lettuce at the Richmond demonstration farm (above); water treatment system at a greenhouse vegetable farm in Rossmore (below)

Water savings audits

A formal site assessment and audit process was developed at the start of the Water Smart Farms Project, comprising both pre-audit reports undertaken by project officers and formal audit reports undertaken by independent accredited assessors.

As a result of over 200 pre-audit reports and 140 audit reports, 6190 million litres of potential water savings were identified. Not all of these potential water savings progressed into on-ground works project proposals.

On-ground works projects

The project funded 131 on-ground works projects (92 on farms using river water and 39 using potable water) as detailed in Tables D8 and D9.

Table D8
Water Smart Farms – river water-use efficiency capital works summary

Project type	Number of projects	Description of works
Centre pivot and lateral move	7	Replacing existing spray lines or travelling irrigators with larger and more efficient lateral move and centre pivot systems
Pump and/or mainline	31	Replacing low-capacity, high energy-use pumps with more efficient units and, where applicable, replacing outdated mainlines with lower-friction, higher-efficiency irrigation mains
Soil aeration	5	Using tractor-driven soil aerators to improve infiltration and reduce run-off. These were used typically on turf farms
Sprinkler irrigation systems	12	Upgrading sprinklers to higher water-use efficiency units
Travelling irrigators	29	Upgrading low-efficiency travellers to more efficient units and replacing pipe-based irrigation systems to more labour-efficient travelling systems
Water harvesting and reuse	5	Harvesting irrigation tail water (run-off captured in drains after field or plant irrigation) or rainwater from dam storage
Drip irrigation	2	Installing drip irrigation systems to replace less efficient sprinklers
Irrigation scheduling	1	Installing scheduling equipment to better utilise irrigation water through sensor-driven systems
Totals	**92**	

Table D9
Water Smart Farms – potable water-use efficiency capital works summary

Project type	Number of projects	Description of works
Equipment upgrade	1	Replacing older sprinklers with more water-efficient emitters
Water harvesting system	26	Installing tanks to capture rainfall roof run-off and replace potable water. Systems may also utilise existing dams with filters and low-level treatment works
Water recycling	11	Installing systems to reuse water particularly in hydroponic greenhouses where reuse can reduce fertiliser inputs and off-farm water losses and also reduce dependence on potable water
Water treatment	1	Installing treatment systems designed to reduce pathogens and turbidity in existing harvest or storage systems
Totals	**39**	

Maps were produced for all on-ground works projects to detail the scope and alignment of works. The overall outputs for each activity were summarised in final reporting maps.

The maps produced for the on-ground works projects were:

- distribution and value of Water Smart Farms incentives (grants)
- distribution of Water Smart Farms events for landholders using river water
- distribution of Water Smart Farms events for landholders using potable water
- distribution and magnitude of Water Smart Farms nitrogen export reductions
- distribution and magnitude of Water Smart Farms phosphorus export reductions
- distribution of Water Smart Farms water savings
- distribution of landholders engaged for the SMS irrigation scheduling service
- land use in the Smart Farms area
- distribution and results of Smart Farms soil sampling
- distribution of Smart Farms water sampling sites.

The maps can be viewed by searching for 'Hawkesbury–Nepean River Recovery' on the Office of Water website and viewing the Smart Farms section.

Monitoring and evaluation was undertaken at routine Water Smart Farms activities to ensure they were effective and could be refined if necessary. This included evaluation undertaken after site visits to inspect completed on-ground works, and evaluation undertaken with the independent accredited auditors to help improve the site audit process.

Evidence from Water Smart Farms project officers confirmed that works inspected up to the end of the project were installed to a high standard and were functioning as intended.

Feedback from landholders has been positive. Some examples include:

- 'We now have the ability to water 24/7 if required, but importantly the water is applied when and where needed resulting in a great reduction in the amount of water being removed from the river,' Kim McKean.
- 'We have already seen significant reductions in our water use and the time savings alone justify the work, which otherwise would not be possible,' Peter Cary.
- 'Accurate soil moisture information has allowed more confident irrigation scheduling decisions to be made,' Wayne Perich.
- 'I am watering more often in smaller amounts with much less run-off. Chemicals and nutrients are also absorbed into the soil quicker. I'm very happy with the results,' Steve Vella.
- 'Having my own source of clean, disease-free water is a fantastic benefit to my business and the environment,' Said Kazzi.
- 'Most excellent result. We are now fully in control of our watering schedule,' Alan Cadman.
- 'I have significantly reduced my fertiliser usage and will be far more sustainable as a business,' Joe Gauci.
- 'A very worthwhile project that has been very beneficial to my farm,' Tony Hatem.
- 'The WSF [Water Smart Farms] project has been very beneficial and the long-term sustainability of the farm has been improved,' Surrey Carter.
- 'It is much easier to irrigate the paddock, and I can grow more as I have more water available, created through savings and water harvesting,' Rod Morris.
- 'It has changed and improved farming practices as well as crop management,' Vince Hewson.
- 'We are now able to irrigate more frequently, and apply less water each time, and crop growth appears to be more even,' Mario Camilleri.

Andy and Sonja Cameron of Cameron's Nursery (left and right) and Geoff Gardiner of award sponsor City West Water (centre) at the 2012 savewater! awards®

Cameron's Nursery, who received funding through the Water Smart Farms Project, won the Business Award (small) category at the 2012 savewater! awards® and was named a finalist for the 2012 Prime Minister's Water Wise Award.

The nursery designed and implemented a state-of-the-art, computer-operated water and drainage system, incorporating drip irrigation lines that release water slowly for economical absorption by plants. It also installed water-efficient sprinklers and constructed a 2.3 million litre storage tank to help capture, store and re-use irrigation run-off and rainwater from building roofs. In the 12 months to March 2012, the nursery saved 37 per cent in overall water use and 80 per cent in potable water use.

Improved irrigation efficiency

The project sought to improve irrigation efficiency of participating properties to a benchmark of greater than 85 per cent distribution uniformity. Distribution uniformity is a measure of the evenness of the water distribution delivered by individual water applicators (e.g. sprinklers) and across the whole delivery system. This variation in water application is expressed as a percentage (the higher the percentage, the greater the evenness of delivery).

Two Water Smart Farms on-ground works projects were audited to compare irrigation distribution uniformity pre and post intervention. This included checking water pressure at the pumps, laying out catch cans to measure water output from the travelling irrigators and recording the time taken to irrigate. A short system performance report was compiled and used to discuss potential improvements with the participating farmers.

The results of the first audit showed a distribution uniformity improvement of 15 per cent, achieving 81 per cent uniformity and the second saw an improvement of 13 per cent, achieving 83 per cent uniformity.

After the audits, recommendations were made to modify the systems further. For example, pumps were upgraded to increase nozzle pressure from 55 pounds per square inch to 75 pounds per square inch and hydrants were reconfigured to ensure better overlap, further improving distribution uniformity. Although further measurements were not made, it is believed that these modifications brought the systems up to or above 85 per cent uniformity.

These practices or similar initiatives were replicated across all of the on-ground works projects. Therefore, the distribution uniformity measurements for the two audited sites are believed to be indicative of those for the overall Water Smart Farms Project, in line with the 85 per cent objective.

Soil moisture monitoring equipment at Cobbitty

Water savings

The revised river and potable water savings objectives for this project have been successfully achieved by:

- purchasing unregulated river licence entitlements for environmental benefit through
  - on-ground works for increased river water-use efficiency and resultant licence purchases
  - direct licence purchases from willing sellers
- reducing potable water use (from Sydney's water supply) to make more water available in dams and increase Sydney's water supply security through irrigation efficiency measures.

River water savings – water-use efficiency and water remaining with irrigators

The water-use efficiency activities in this project achieved 3320 million litres of river water savings for environmental benefit, exceeding the objective by 20 million litres.

Water savings were achieved through improving irrigation efficiency where a maximum of 80 per cent of the cost of works was funded by the Hawkesbury–Nepean River Recovery Program.

As part of the irrigators' contributions to the Water Smart Farms Project, 75 per cent of the total water savings associated with the water-use efficiency activities were transferred under licence to the Water Administration Ministerial Corporation (administered by the Office of Water) to contribute to environmental water and 25 per cent remained with the participating river irrigators.

Individual transfers varied from 2 million litres to 220 million litres with the average being 30 million litres.

The objective for water remaining with irrigators was estimated at 1100 million litres with a maximum estimated saving of 1500 million litres depending on the type and range of works implemented. During the planning stages to determine the agreed on-ground works projects, the 1100 million-litre objective was confirmed as the more realistic saving. However, this lower value has not affected the total water savings for the overall program as the shortfall has been easily accounted for through exceeding the secured water savings objective.

The Water Smart Farms Project achieved 1110 million litres of water savings that remained with the participating irrigators, exceeding the 1100 million-litre objective by 1 per cent.

River water savings – licence purchases

The revised water savings objectives for the Water Smart Farms Project included purchasing 1250 million litres of entitlement for the environment and reducing existing extractions from the river by 836 million litres per year. As shown in Table D10, the project exceeded these objectives, purchasing 1254 million litres of licensed river water in the Hawkesbury–Nepean catchment's Lower Water Source (shown in Figure 25) and contributing an average of 966 million litres per year to additional environmental water in the Hawkesbury–Nepean river system.

Table D10
Water Smart Farms licence purchases

Licence purchases	Objective	Outcome
Entitlement (million litres)	1250	1254
Water savings to contribute to environmental water (million litres per year)	836	966

Protection of the water savings will ensure that the savings will remain in the river system and not be available for consumptive use. They are protected at a regional level via the implementation of long-term average annual extraction limits in accordance with requirements under the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources (2011). An adaptive environmental water plan is currently under development for the management of the river water savings that will contribute to environmental water.

More information about the Licence Purchase Project and how the purchased water will be secured can be found on pages 16-19 and 56-70 of this report.

Potable water savings

The NSW Climate Change Fund contributed 50 per cent of the cost of works for improving irrigation efficiency (sprinkler retrofit and reuse/recycling) and required that all water savings from potable water irrigators be used for increasing Sydney's water supply security.

A 2009 Horticulture Australia Limited research project identified that the potable water savings estimates in the original project funding application were not a realistic reflection of current potable water use. In addition, potable irrigation system audits undertaken throughout the Water Smart Farms Project found that potable water use was a sixth of the previously identified usage of 12,000 million litres per year.

A revised proposal was approved by the NSW Climate Change Fund and the Australian Government to reduce the potable savings objective to a minimum of 250 million litres per year. The Australian government agreed that the remainder of the original 1500 million litre objective could be achieved by purchasing unregulated river licence entitlements.

The project achieved 262 million litres of potable water savings, exceeding the revised 250 million litre objective by 4.8 per cent. Of the total potable water savings, 43 per cent are expected through implementation of water harvesting systems, 54 per cent through water recycling systems, 2 per cent through water treatment equipment and approximately 1 per cent through equipment upgrades.

Water savings summary

Overall, this project made 5658 million litres of secured water savings, of which 4286 million litres will contribute to environmental water, 1110 million litres will remain with irrigators and 262 million litres will help to improve Sydney's water supply security. While this total is lower than the 5900 million-litre objective, it does not include the component of the unregulated river licence entitlement purchased that is not expected to contribute to environmental water. Although this water is an actual saving, it is not credited towards meeting the water savings objective. As shown in Table D11, if the total entitlement purchased is included, the total saving is 5946 million litres per year.

Table D11 **Water Smart Farms water savings summary**				
Activity	**Water savings** (million litres per year)			
	Upper water source	Lower water source	Average annual contribution to environmental water from purchased river entitlement plus potable water savings	Total river entitlement purchased plus potable water savings
River entitlement purchased - licence purchase	0	1254	966 to contribute to environmental water	1254
River water savings - water use efficiency	256	3064	3320	3320
Total river water savings	256	4318	4286	4574
River water remaining with irrigators			1110	1110
Potable water savings to contribute to increasing Sydney's water supply security			262	262
Total			**5658**	**5946**

Nutrient export reductions

As well as achieving water savings, the Water Smart Farms Project aimed to reduce nitrogen exports to the Hawkesbury–Nepean river system by at least 11.8 tonnes per year and phosphorus exports by at least 1.2 tonnes per year. These objectives have been exceeded by a significant margin, with DPI's project evaluation estimating that 19.84 tonnes of total nitrogen and 7.96 tonnes of total phosphorus will be prevented from entering the Hawkesbury–Nepean river system each year by upgrading infrastructure through on-ground works projects and a further 0.18 tonnes of nitrogen will be prevented from entering the river system through the purchase of unregulated river licence entitlements within the catchment.

Table D12 describes these reductions by industry type. It is apparent from these data that, on a per project basis, irrigation infrastructure projects at dairy, turf and vegetable farms achieved the greatest nutrient reductions, together with run-off and leachate recycling projects at greenhouses.

Table D13 identifies the nutrient reductions achieved by different types of intervention projects, including the small nutrient reduction expected as a result of the purchase of 1254 million litres of licence entitlement undertaken as part of the Water Smart Farms Project. Lower nutrient export rates are expected over the long term as the market responds to reduced water availability (resulting from licence purchases) through a long-term change in land use from irrigated agricultural cropping to a less intensive (non-irrigated) form of rural or peri-urban land use.

Conversion of irrigated pasture/lucerne to dryland pasture following licence purchase is conservatively expected to produce a reduction of 0.001 tonne per hectare per year of total nitrogen. The purchased water saving of 966 million litres per year which will contribute to environmental water thus equates to the conversion of approximately 161 hectares of irrigated pasture or lucerne to dryland pasture, assuming an average annual water use of 6 million litres per hectare. A conservative estimated nitrogen export reduction of 0.001 tonne per hectare per year leads to an estimated 0.16 tonnes per year of reduced nitrogen discharges from these licence purchases over the long term. It is unlikely that this land use change would result in any significant reduction in phosphorus loads to the river system.

Table D12 **Water Smart Farms nutrient reductions by industry – water-use efficiency activities only**					
Enterprise	**Number of projects**	**Total nutrient reductions** (tonnes per year)		**Nutrient reduction per project** (tonnes per year)	
		Nitrogen	Phosphorus	Nitrogen	Phosphorus
River					
Cropping	2	0.014	0.004	0.007	0.002
Dairy	4	0.871	0.26	0.218	0.065
Mixed farm	1	0	0	0	0
Mushroom	1	0	0	0	0
Orchard	4	0.183	0.049	0.046	0.012
Ornamental	3	0.102	0.042	0.034	0.014
Pasture	22	0.692	0.17	0.031	0.008
Sports turf	13	3.498	1.475	0.269	0.113
Turf	20	5.863	2.641	0.293	0.132
Vegetable	23	5.659	2.996	0.246	0.13
Subtotals	93	16.882	7.637		
Potable					
Greenhouse	8	2.955	0.323	0.369	0.04
Total	**101**	**19.84**	**7.96**		

Table D13 **Water Smart Farms nutrient reductions by intervention type**			
Intervention	**Number of projects**	**Nutrient savings calculated** (tonnes per year)	
		Nitrogen	Phosphorus
Convert system	16	7.789	3.835
Equipment upgrade	69	8.189	3.44
Retrofit system	4	0.602	0.271
Water harvesting system	12	3.257	0.414
Subtotal – water efficiency projects	101	19.837	7.96
Licence purchases	8	0.16	(negligible)
Total	**109**	**20.00**	**7.96**

The Nutrient Export Monitoring Project, managed by the Office of Environment and Heritage, undertook an external evaluation of the nutrient export reductions achieved by the Water Smart Farms Project. The external evaluation yielded nutrient reduction estimates that varied from those reported here as they were based on different assumptions and input data. However, the Nutrient Export Monitoring Project also concluded that the nutrient reduction objectives for the Water Smart Farms Project have been exceeded by a significant margin. For more information, refer to pages 121-124 of the Nutrient Export Monitoring Project section of this report.

Learnings

Learnings resulting from the Water Smart Farms Project are:

- Using bilingual officers to train and educate landholders is vital to the success of any program with a significant number of culturally and linguistically diverse participants. DPI has used bilingual officers for previous projects with noted success. The Water Smart Farms Project has reinforced the benefits of this approach.
- The framework for implementing on-ground works projects requires flexibility to derive a variety of solutions tailored to individual landholder needs.
- Operating the Nutrient Smart Management and Water Smart Farms projects under the overarching 'Smart Farms' banner allowed for streamlined communication and administration of both projects.
- Grant funding opportunities such as the Hawkesbury–Nepean River Recovery Program provide significant incentive for landholders to invest in improving their water and nutrient management systems and to carry out work that would not otherwise be undertaken.
- The most cost-effective nutrient management strategies implemented under the Nutrient Smart Management and Water Smart Farms projects were:
  - improved fertiliser management on vegetable farms
  - run-off and leachate recycling at nurseries
  - improved manure storage on field vegetable farms
  - improved effluent management at dairy farms.
- The adoption of landholder management practices and technologies is most effective when supported by appropriate information and education.
- Using independent water savings auditors increases the transparency and credibility of the auditing process.

The adoption of landholder management practices and technologies is most effective when supported by appropriate information and education